Architectural Education and the Reality of the Ideal: Environmental design for innovation in the post-crisis world
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This project has been carried out with the support of the European Community and in the framework of the Lifelong Learning Programme.

The content of this project does not necessarily reflect the position of the European Community, nor does it involve any responsibility on the part of the European Community.
Architectural Education and the Reality of the Ideal: Environmental design for innovation in the post-crisis world

EDITOR :: MARIA VOYATZAKI
Architectural Education and the Reality of the Ideal: Environmental design for innovation in the post-crisis world

Transactions on Architectural Education No 61

Editor
Maria Voyatzaki

Cover Image and Logo Design: Emmanouil Zaroukas
Layout design: Dimitris Apostolidis
Printed by: Charis Ltd, Thessaloniki, Greece

ISBN 978 2 930301 60 0
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I would like to take the opportunity to express my sincere thanks to Mike Fedeski, from Cardiff University, for his vast academic contribution and inspired ideas, which he generously offered to our group throughout this project. I would also like to thank my colleagues from the host institutions and in particular Professors Roberta Amirante and Antonella Violano, from Federico II and from the Seconda Università degli Studi di Napoli respectively, for their help and support on organizational matters.

Special thanks for their hard work, as members of the organizing committee, are owed to Maria Isabella Amirante, Emeritus Professor, Seconda Università degli Studi di Napoli, Roberta Amirante, Professor, School of Architecture, Federico II, Napoli, Monica Cannaviello, Architect, PhD. in Technology of Architecture and Environment, Second University of Naples, Antonio Bosco, Researcher, Aggregate Professor, Department of Architecture and Industrial Design, SUN, Italy, Rossella Franchino, Associate Professor, Dep. of Architecture and Industrial Design, Second University of Naples, Caterina Frettoloso, Researcher Aggregate Professor, Dep. of Architecture and Industrial Design, Second, University of Naples, Francesca Muzzillo, Associate Professor, Dep. of Architecture and Industrial Design, Second University of Naples, Sergio Rinaldi, Associate Professor, Department of Architecture and Industrial Design, SUN, Italy, Paola Scala, Assistant Professor, Federico II, Antonella Violano, Researcher Aggregate Professor, Dep. of Architecture and Industrial Design, Second University of Naples.

The quality of the content of this book is mostly a result of the reviewing work undertaken by Maria Isabella Amirante, Professor, Seconda Università degli Studi di Napoli, Italy, Roberta Amirante, Professor, School of Architecture, Federico II, Napoli, Italy, Dimitris Bikas, Professor, School of Engineering, Aristotle University of Thessaloniki, Greece, Ilaria Garofollo, Professor, School of Architecture, Trieste, Italy, Mike Fedeski, Honorary Senior Lecturer, Cardiff University, Welsh School of Architecture, United Kingdom, Nikos Kalogirou, Professor, Head of School, School of Architecture, Aristotle University of Thessaloniki, Greece, Eleni Maistrou, Professor, Head of School of Architecture, National Technical University of Athens, Greece, Juri Soolep, Professor, Umea School of Architecture, Sweden, Constantin Spiridonidis, Associate Professor, School of Architecture, Aristotle University of Thessaloniki, Greece and Antonella Violano, Researcher Aggregate Professor, Dep. of Architecture and Industrial Design, Second University of Naples.

Special thanks also go to the architect Manos Zaroukas for his work on the graphic design of the cover of this volume and to the graphic designer Dimitris Apostolidis for its page layout.

The accomplishment of this endeavor would have been impossible without the hard work, dedication and perseverance in all fronts organizational, secretarial as well as editorial of Asimina Chatzimanoli Architect, AUTH, MSc Environmental Design and
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Last but not least, I wish to thank all the contributors for their hard work without which the materialization of this effort would have been impossible.

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Introduction

The present book emerged from an international conference held in Napoli from 3-5 October 2013 co-organised by the European Network of Heads of Schools of Architecture and the European Association for Architectural education. Two universities in Naples, the Second University and Federico II University, hosted the event. Over a year prior to the event, six teachers of architecture with close relation to the conference theme met and set up the conference title and agenda. Namely, Mike Fedeski from Cardiff University, Peter Kjaer from Umea University, Eleni Maistrou from the National Technical University of Athens, Alberto Sdegno from Trieste University, Constantin Spiridonidis from Aristotle University of Thessaloniki and Maria Voyatzaki from Aristotle University of Thessaloniki. Mike Fedeski further elaborated, refined and rewrote this agenda, which arrived at schools of architecture across the Globe. Eighty-five academics from 19 different countries responded and made their contribution.

The Conference was entitled: Architectural Education and the Reality of the Ideal: Environmental design for innovation in the post-crisis world.

This was the second conference in its series on teaching environmental design to architects. The first, held two years ago in Cyprus, was entitled “Teaching a new Environmental Culture: The Environment as a question of Architectural Education”. It focused on the way schools of architecture in Europe embrace the contemporary concern that architecture should be environmentally conscious and sensitive. It investigated the manner in which environmental issues have become part of school curricula, and explored the pedagogical approaches that schools implement to ensure that knowledge and skills adequate for these issues are passed on to students. Methods for integrating the environment into the design studio were investigated that could support the profile needed of a graduate capable of creating environmentally sensitive architecture.

In short, the first event focused on the structure of environmental education. The second was primarily oriented towards the content of this education. To this end, our network wished to prime this debate by making two central and complementary propositions. The first was that the environment could and should be approached as a force for innovation in architectural design; as a context from which new ideas, forms and materialities could emerge able to advance architectural thinking and creation. The second proposition was that this innovative ideal had to be aligned with the reality of the human situation being shaped by the post-crisis world. In other words, it had become imperative to redefine the environmental design ideals, which serve nowadays as objectives for our educational practices, in the light of the significant economic and cultural changes that have been overtaking us over the last twenty years.

The conference elaborated on these propositions through four themes.

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A great part of the text has been written in the form of the conference call by Mike Fedeski.
Theme 1  
*Education: top ten environmental objectives for studio design*

The range of knowledge and skills that can be brought to environmental design is too wide to be covered comprehensively even in a specialist course, and can only be sampled in a normal undergraduate course in architecture. The design studio is the normal platform from which students can appreciate the intimate connection between the environment and all other issues involved in design, and in which they gain lasting experience from trying out what they learn. Yet studio teachers can do no more than draw the attention of students to a limited number of environmental objectives, which they must reconcile with the many other demands of project briefs. What should these environmental objectives be?

Fashion has seen the emphasis shift from performance standards to energy saving, from the building’s environment to its impact, from internal spaces to urban ones, from the fabric to services, and so on. It is time to step back and ask what objectives are essential if students are to be prepared for their role in designing buildings fit for the future.

What their courses leave out, students may perhaps learn later on in practice, or may never learn. However, from the outset good studio teachers can hone their students’ environmental awareness to tune in spontaneously to what really matters, so that they understand how to integrate that into their other design ambitions.

This theme aims at reaching consensus on the top ten environmental objectives that do matter and which students should be encouraged to meet as a matter of course in their designs.

Theme 2  
*Reality: education for a credible social and political future*

In the years since environmental design became a research-based feature of architectural education, its horizon has expanded from the science of interior environments to the ecology of the entire planet. It has shifted far, but has it shifted far enough?

Sustainable ideals are not, of course, just about conserving the natural environment, but also involve serving the social and political lives of communities. If we seek values to guide architectural education, it is there that we should look. And it is there that we find the profound changes in attitude towards environmental issues which have had a strong impact in past years on the principles that underpin environmental teaching.

The changes have taught us that present practice must anticipate future consequences, and made us realize how interconnected our own actions are with events far away. In architectural education, we are preparing students now for their future practice, practice in which they in turn will have to anticipate interaction with a world very different from today’s. To prepare them well, we need to be as aware as possible of the direction in which this future lies. That is the issue addressed by this theme.
It asks how the expectations society has of environmental design might be shaped by the present economic crisis and by the structural changes underway in the world politically and economically. We must wake up to the fact that the challenges motivating environmental designers are likely to shift and diversify significantly, and that many of our current preoccupations may already have become irrelevant to many people in many places.

Theme 3

*Computation: environment and architectural innovation*

Recent post-graduate programmes at schools of architecture have followed two main streams: computational design and environmental design. Whilst the former has brought students the abilities to perform highly accurate simulation and to manipulate a large number of design parameters very quickly, the technology is too often sequestered for morphogenic experiments, an indulgence that diverts students from its broader ability to engage with the complexity of the real world. Paradoxically, environmental design courses often do attend to wide-ranging political, social or scientific issues, but then neglect the spatial and aesthetic qualities of architecture. The result is that few of them have managed to exploit the potential of computational design for making environmental parameters drivers of building form. In this theme, a resolution to that paradox is sought.

Advances in digital computation that can influence our future approach to environmental design, bringing innovation to architecture, are not limited to optimizing design but extend to the production phase, to specifying components for complex assemblies, building rapid prototypes, fabricating components for volume production, remotely automating construction on-site, and controlling the operation of the completed building.

The theme asks how these advances can motivate students aesthetically in their design of environmentally conscious buildings: whether a synthesis is possible between software for controlling building fabric and form, and software for simulating building environments; how building form can be generated by responding to environmental stimuli; what changes will result from bridging the time gaps between design, construction and habitation; whether notions of adaptivity, responsiveness, interactivity and intelligence in buildings will be enhanced by the new logic; and what influence new materials and manufacturing techniques will have on environmental form.

Theme 4

*Interface: objective design and the human experience*

In designing buildings and townscapes for occupation by people, environmental designers necessarily focus their attention on the physical attributes they can readily predict through drawing and simulation. They design physical environments that meet simple and limited targets. How their occupants will inhabit and interpret them
in reality seems beyond the predictive ability of available tools and is too often neglected. The built and human worlds have become separated in designers’ imaginations by an interface beyond which they are either unable or unwilling to tread. The artificial objectivity that this separation gives to environmental design may well discourage architectural students who gain their motivation from designing places to give people positive enjoyment, whether social, aesthetic or intellectual.

This theme considers ways of dissolving that interface. It looks at whether students could design for the full complexity of the environment, and its variation across spaces and over time; whether students could take into account more of the thermal, visual and sonic attributes that its inhabitants experience, consciously or unconsciously; whether students could recognize the multifarious preferences of inhabitants, and their desire for individual satisfaction; whether students could have regard for the influence of inhabitants on the environmental performance of buildings; and whether students could project the changing behaviour and identity of inhabitants and how that might impinge on the robustness of their designs. It asks what means are available for doing any of this, and whether they would offer students access to a richer reality which would be a better source of inspiration and motivation.

This was a conference with a purpose. Hopefully, it redefined what we should teach students about environmental design in our contemporary culture. It was proposed that if environmental design is to make a difference, it would have to be relevant. It has to be relevant to architectural design and practice, making it attractive enough to drive innovation. And it has to be relevant to the demands and needs of future society, which may be changing faster than we can follow.

These, our propositions, were pursued through the four conference themes. One defined and elaborated the essential environmental objectives that design studios should follow in order to prepare their students fittingly for the future. Another reflected on the challenges that this future could bring, focussing on the shifts in environmental thinking most likely to emerge in the post-crisis world. And the other two examined what might motivate designers to bring innovation to these challenges. One as finding a renewed synthesis between environmental design and form-making through advances in digital technology. The other was opening up ways of anticipating the experiences, expectations, preferences and habits of living inhabitants who enjoy and interact with building environments.

The responses to the above themes constitute the content of this book.
Initiations
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The Solid and the Liquid in Environmental Design Education
Solid and Liquid

Between Parmenides' conviction that nothing in our world is changeable, and that of Heraclitos that everything is in a permanent state of change, there is Aristotle’s in-between doctrine that even though the natural world is permanently changeable, there is always something solid and constant, which nevertheless differs after changes occur. Ever since, our appreciation of the natural world has sometimes been based upon the priority given to the solid components of reality and other times driven by those in the process of changing. At least in recent history, the first approach led us towards the adoption and adherence to models, standards, archetypes, modulors, ergonomics, but also, more broadly speaking, to rationalisation, internationalisation, mass production, control and prediction. The latter approach opened us up to typologies, selected historic references, memories and cultural spatial identities, as well as differentiated social meanings and symbolisms. In the last fifteen years, we have been experiencing a new reconciliation of these two different logics. Both solid and changeable components of our world are no longer ranked on the basis of their degree of stability or transformability, but they can be occasionally prioritized as always depending upon the overall dynamics emerging by the broader and unstable conditions in which the overall system exists. Aristotle’s aspirations are now glorified.

Environment

In this new mindset and contemplation the debate on environmental issues appears to be radically transformed. It started with the adamant conviction that environmental issues are questions of physics based upon the solid and classic laws of nature and as such they should be treated as technical. After the 70s this debate progressively shifted its basic hypothesis conceiving, this time, the environmental issues not as primarily technical, dependent upon natural laws, but mostly as social and political and for this reason changeable, transformable and liquid. The terms sustainability and ambience, which has dominated this debate in the last 30 years, perfectly expresses this shift from the priority of the solid and unchangeable, in the understanding of environmental problems, to the predominance of the changeable and transformable. Nowadays, we are experiencing a shift according to which, both solid and liquid factors of the environmental problems are described by the term ‘parameter’, which is rather neutral. All parameters affect the complexity of the system and their temporary hierarchies emerge from the specific dynamics of the broader system. Physics and humanities are now invited to be in a condition and in a relation of ‘sympathy’. Parmenides and Heraclitos are no longer rivals; they are now allies.

Architecture

Architecture as a manifestation of our cultural values and perceptions is profoundly affected by these changes. Changes in the ways we appreciate the world transform the way our thinking is framed. Strong, new concepts emerge from the new constraints this framework imposes. This is something that both thinkers and architects support. A few years back Jean Baudrillard and Jean Nouvel had agreed that strong concepts emerge as the outcome of a creative way of encountering constraints; the
higher the perplexity of the constraints the stronger the concept. New constraints lead to new concepts and new concepts to new statements, practices and creations. This explains why architects are not only familiar with dealing with constraints, but they find this task challenging and intriguing.

In the second part of the last century we experienced significant changes in the fundamental concepts driving architectural creation. The persistence in the common and solid characteristics of architecture and of the humans inhabiting it led to concepts such as the ‘man of the modulor’, an expression of the common and timeless constitutive of the ‘user’, who in the name of democracy had to inhabit identical spaces accommodated in the same form, be it in France, Morocco or India. Later on, the persistence in the different and changeable, that is to say, the liquid characteristics of architecture and the human led to the concept of the human as a social being, who in the name of democracy, had to inhabit spaces reflecting his particular social, cultural and individual differences. Nowadays, due to the changes in our global understanding mentioned above, architecture is no longer considered as the act of creating an artefact that stands alone, tangible, perceived or presented to the senses. From the constraints imposed by this new mental framework, strong, new concepts emerge. Architectural creations are now defined, not as complete entities exposed objectively and factually to our experience in order to function, to serve, to represent, to note or connote, and to stimulate memories and feelings. However, they are increasingly conceived as parts of a broader assemblage of other entities and conditions, an alterity. We are moving from a concept of architectural creation as a finished hierarchised total, to its conception as a part establishing multiple, not solid, unpredictable and emergent relations with the other entities of this complex and dynamic assemblage of solid and changeable elements. As part of this assemblage, the building is conceived as an interface in a dynamic system of relationships dependent upon and defined by a flux of information and data; a point in a point cloud. Between its proper substance and its alterity there is a continuum. The solid and the liquid are amalgamated in the form of information and data.

Architecture and Environment

Environmental issues have taken up a major part of contemporary architectural thinking and creating. Architecture for centuries conceived dwelling and the city either as shelters for the human beings to be protected from the natural elements, or as powerful weapons and efficient representations of their dominance over the natural forces, laws and phenomena. Even though nature, as generator of the alive, has always been the architects’ source of inspiration, it has also always been the competitive ‘other’ to be conquered, mastered and dominated. This architectural production of our civilization is usually defined as the built environment, which distinctly and implicitly is opposed to the natural environment, where the former undergoes a process of naturalization and the latter a process of domestication.

The answer architecture has given to the question ‘which environment for the human being?’ has been structured either through the dominance of the technical perception of the environmental issues or through the above-mentioned dominance of their socio-political understanding. However, buildings continue to be major causes of harming nature. Pollution from heating and cooling buildings still exceeds that of cars.
The building industry, which is the second largest industry in the world, still manufactures building materials that consume enormous energy and exhaustible resources. Buildings and their construction still account for more than half of the entire greenhouse gas emissions. Environmental sensitivity, sustainability, ecology, pollution, global warming, climatic change and the greenhouse effect, are simply terms emerging from the uncontrolled and aggressive invasion of the built into the natural environment or of human intervention in nature. Moreover, our homes, which are the highest lifetime purchase and investment, are built, to a greater or lesser extent, in the same way they were built, at least, fifty years ago. The home that will virtually define our lives for twenty, thirty or forty years in the future is designed only for today, based upon an implicit (and obsolete) conception that the future is just a repetition of the present.

The articulation of the new approaches to environmental issues with the new conceptions about architectural creation remains an open issue not only for the architectural community but also for the academic community that educates architects. What we need to redefine now is how from the new conceptions about architecture and the environment, new concepts can creatively emerge that will, in turn, drive architectural design towards interesting, efficient and innovative proposals. How the amalgamation of the solid and the liquid can open up new creative avenues to architectural design. This is an extremely important challenge to be explored and capitalised.

**Information Technology**

Information technology can play a very significant role in the creative amalgamation of the contemporary considerations of architecture with new views on the environment. The conception of the dwelling as an active part of a broader assemblage on the one hand, and the environment as a decisive dimension of this assemblage that permanently affects its parts and is constantly affected by their nature and action on the other, bring architecture and the environment into the same relational and associative system of information flow and data through which computer simulations investigate and manage complexity. Information technology has already provided architecture with high-end powerful computer software and hardware able to generate and fabricate intriguing architectural forms –although this achievement should not be seen as an end in itself. In parallel, Computer Numerically Controlled (CNC) machines allow for testing, simulation and mass customization at all scales and of any volumetric or construction complexity. The contribution of digital fabrication to the environment has been underplayed, but it would be interesting to note that it can merit in less material wastage due to the ability of cutting patterns in an optimised way. Material can also be economised as with rapid prototyping the structural efficiency and performance can be tested and verified towards the marginally small sizing of components. File-to-factory techniques of communication between the designers’ desktop and the construction site can save shipping material to the site as it can be locally processed as well as save human power of expertise transport by operating remotely from the site while at times it can also involve robots for non-standard operations while or after the building is constructed. At the same time the same technology advances software to offer accuracy in modelling and simulation of the
environmental performance of buildings and their components; advances always accompanied by the thorny subject of scaling up results and of transforming data from models to real life situations.

A body of knowledge on interactivity, adaptivity and responsiveness (actuators, transformation in real time with arduinos and intelligent environments) as well as on computation that generates new materials (encoded materiality) with specific properties that augment the environmental impact are progressively developed. Technology appears to be an affective catalyst of this expected articulation. It is promising that there are significant improvements on the interoperability between the two approaches; form generation and environmental simulations.

Environmental Design Education

How can the new conceptions about architecture and the environment be accommodated in our educational environments? Given that Building industry is responsible for more than 40% of resource consumption and environmental impact, it is in this sector that some of the largest contributions to ecological and economic sustainability may be made through better design and management. The question arising is how a school of architecture prepares its students to be part of the solution and not part of the problem?

The usual clashes on the scientific versus the humanistic bias mentioned, is not only central and fierce in many contemporary architectural curricula, but is also even tougher given the rich body of knowledge that sciences have generated in the domain of the environment. The scientific feature of this particular knowledge is what has often been the source and cause of the indifference of architects who believe that design, as a creative act, can dismiss science. By focusing on the social, political and cultural dimension of architecture (mainly in the 80s and 90s) architectural curricula kept environmental issues out of the design studio treating them in autonomous modules with a purely technical agenda.

Taking into account the experience of the previous ENHSA publication on “Teaching a New Environmental Culture; The environment as a question of Architectural Education”7 in 2011, there is an extended urge to blend environmental education into the design studio. The pedagogy, teaching methods and techniques have been central in this discussion among educators on how to teach environmental design to architecture students. This request appears to be absolutely justified with the contemporary views and conceptions of the environment and of architecture as discussed. How about seeing this new mental framework as yet another constraint towards a stronger concept? What if a design perseveres the environmental obligation as a social responsibility, as a way towards a stronger and more ethical concept? These two subject areas of the spectrum have to be revisited and be complementary to the pedagogic aspects of formal education. In the same amalgamation strategy, we need to reconsider the two poles of the environmental debate. The one is the role of technology in environmental thinking as a way towards global and sustainable architecture, and the other pole is the ethical dimension of the appreciation of the broader ecosystem and the systemic role of the architect, the occupant and architecture in it.

The environment can and must be appreciated as an innovation catalyst of architectural design; as a framework from which new ideas, forms and materialities can
emerge offering innovative advancements in architectural contemplation and creation. This requested innovative ideal has to enhance and preserve its links with the contemporary conceptions of reality and the human as they are shaped in our contemporary world. In other words, it is high time we redefined the environmental design ideals as objectives of our educational practices, after all the significant changes and shifts that have occurred in the last twenty years.

Epilogue

Aristotle taught us that movement and change, genesis and decay—which are particular forms of change—occur in the natural world all the time. Things actually change, and this change is registered, but at the same time, things do not always change entirely. In every change there can be something solid, something maintained or preserved, while at the same time it is different from what it was. ‘We do not design from scratch’ Bruno Latour 8 reminds us. There is always something known, used, experienced and tested. Something solid used as a framework of constraints, to safely build on. But at the same time through the act of creation we are introducing invention, change, transformation, alteration towards the liquid, the unknown, the risky, the mistaken, the ‘intentionally uncontrolled’, as Jean Nouvel states. After that the new building is never entirely new, as it is part or should be a sympathetic part of what already exists in its conceptual and physical context. It has to be in a sympathetic relationship with its broader system, if it is to be amalgamated with it, to blend into it.

There is an ethical basis in this particular relationship between the solid and the liquid: it is not hierarchical. It can occasionally acquire different hues by different priorities, associations, gravities and magnitudes. As a consequence, this attitude can either lead to an extremity of the absolute dominance of the liquid in the form of inventive experimentation towards radical innovation. Contemporary technologies can become enabling technologies by introducing virtuality immaterially, as opposed to artefacts with physical presence and impact that most likely harm than enable. The same attitude can lead to the other extremity of the absolute dominance of the solid leading to non-design when building is not necessary. It is an expectation of contemporary discourses on a new environmental culture to encompass ethics as one of their cornerstones.

This sympathetic relationship between the liquid and the solid also affects the way we look back or the way we look forward; the ways in which we invent, predict, imagine and manage the future and the ways in which we think, analyse, memorise and investigate the past. Nowadays the ethical attitude emerging from the framework we have elaborated in this essay is to avoid looking only ahead (like in modernism) or looking only back (like post-modernism). The invitation is now to contemplate the future together while critically considering the past. To creatively imagine the myth of the future, but also to critically analyse the myths we created in the past: to invite and accommodate in this contemplation both Prom(y)theus and Epim(y)theus 10.
Notes

1. On Nature, which has survived only in fragmentary form. In this poem, Parmenides describes two views of reality. In “the way of truth” (a part of the poem), he explains how reality (coined as “what-is”) is one, change is impossible, and existence is timeless, uniform, necessary, and unchanging. http://en.wikipedia.org/wiki/Parmenides

2. Heraclitus is famous for his insistence on ever-present change in the universe, as stated in the famous saying, “No man ever steps in the same river twice” (known as ‘ta panta rhei’). http://en.wikipedia.org/wiki/Heraclitus


Inspirations
The Role of Scientific Analysis in Creative Design

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The seduction of the scientific method

From my earliest childhood I was fascinated with how things worked. This quickly led to a love of science at school, and then onto study physics at university. Having been totally seduced by the purity and simplicity of universal laws, I was surprised and interested to hear in a lecture on the Philosophy of Science that, in the speaker’s view, scientific method was “the method that worked”. This introduced a notion of pragmatism that appealed to me, and steered me away from the nebulous sphere of theoretical physics into the application of physics to problems of the everyday world. And after a brief period in medical physics, I moved into building science.

My initial response was that the physics needed was fairly simple, but soon began to realise that the object of application was not. For example, heat flow through the building envelope seems like simple school-book physics – a linear equation – until complications set in like three dimensional flow (cold bridges), effects of airflow through porous materials (breathing wall) and heat flow into infinite mass (earth contact buildings) This is all further complicated by non-steady flow.

One of the basic difficulties that I identified was knowing when an approximation was acceptable, and when it was not; the danger being that the approximation may eliminate the very effect being investigated. A good example of this is the earth-sheltered building. This was a hot topic in the early 1980s, with extravagant claims being made by devotees, with almost religious fervour. These claims were not just restricted to hot arid climates, where the earth-sheltering principle is well established in vernacular architecture, but for temperate and cool climates as well.

The root of the problem was in the assumptions of the earth temperature; it was sometimes claimed that it was at or close to the deep earth temperature. The problem with this is that unless the occupant was happy to live at this temperature, typically around the annual above-ground mean, there would be a steady heat flow into the ground. An alternative claim, is that eventually this heat flow, would warm up the surrounding soil. The problem with this assumption is that it does not allow for the heat flow from the warm soil to the surrounding cooler soil. Why and when should this flow suddenly stop? One is reminded of the expression “there is no such thing as a free lunch” or the more scientific version – the law of conservation of energy – the first law of thermodynamics. Further to this, there were some very optimistic interpretations of the term “earth-sheltered”, with some designers claiming that the magical properties of the earth were realisable with little more than a few square meters of roof-garden!

I assisted a PhD student who was studying underground and earth-sheltered housing world-wide, (Mulligan 1988) and we developed a thermal network model in order to throw some light on these issues. By considering progressively deeper masses of soil around the cave and longer simulation times, we were able to understand the significance of these false assumptions. Our final conclusion then, which I think would stand today, was that except in hot climates, there is little or no advantage in (un-insulated) earth contact, as shown by this illustration (Fig. 1) from her thesis.

I began then to realise that even the physical world, was host to a multitude of uncertainties which could not be eliminated by the cunning design of the “experiment”, as in the physics laboratory, and that these had to be dealt with by reasoned judgement.
Analytical tools in architectural design

The pre-computer era

The 1980s was, at least in building science, the beginning of the digital revolution, and this was largely brought about by the micro-computer. Before this, most quantitative tools were based upon pre-calculated data in the form of tables and graphs. These were often ingenious and effective. A particularly good example is the Daylight Protractor, invented in the 1950s at the Building Research Station, England (Fig. 2). This enabled the designer to calculate the daylight factor (DF) from the design geometry of the room. The protractor, as the name suggests, was in fact measuring a solid angle of the sky visible through the opening, but gave an output which also took into account the variation of sky brightness with altitude, and the variation of transmission of the glass with angle of incidence.

Graphical tools enabled large quantities of solution data to be presented simultaneously to the user, and then by means of the additional information – axes, legends etc, select the appropriate solution. In their early form, the data was calculated “by hand”, and toward the end of their era, by computer, but since computing power was so limited the time taken to produce the data was too long to be carried out whilst the tool was in use.

We worked on an energy design tool of this kind, originally as a method to be applied to entries in a series of Architectural Design competitions, the LT Method (Baker & Hoch, 1989), organised for the European Union ARCHISOL solar programme. Pre-calculated graphs presented the annual primary energy consumption per square metre as a function of glazing ratio for various orientations, building types and climates. Es-
essentially, it took account of the energy balance between fabric loss, ventilation loss, solar gain, useful daylighting and internal gains from artificial lighting and equipment.

One of its objectives was to illustrate to the user the sensitivity of the result to the design parameters he/she was handling. For example, in the LT curve shown above, the heating can be seen to rise slowly, whilst the lighting curve drops rapidly and then levels off around 35% glazing ratio. The cooling load increases more dramatically and nicely illustrates that large glazing ratios cannot be defended on energy performance grounds. The curves were generated using a spreadsheet-based model which evaluated the usefulness of solar and other gains, by an empirical correlation method based on the monthly load/gains ratio.

We felt that a tool of this kind can have a value beyond the simple proving of a specific design, in that it exposes some of the mechanisms and interactions that lead to the end result. In using the LT Method in workshops, we found that participants were forming generalised rules and conclusions which they could apply to future design without using the method.
The exponential rise of computing power is now part of recent history, and this has made powerful simulation programmes available in both practice and education. There has also been great strides in the accuracy and comprehensiveness of the algorithms used, and the integration of energy uses such as in heating, cooling and lighting, is now commonplace.

I often sit on student review panels, and apart from highly sophisticated graphics, the most noticeable thing is that students routinely carry out simulations and parametric studies that two decades ago would only be available to cutting edge research teams. In all but the smallest practices, much the same applies. But I wonder if this huge increase in analytical power has actually led to better design?

In my view there is an important difference between the accuracy (and comprehensiveness) of analysis on the one hand, and the usefulness on the other.

In the 1990s there were extensive exercises to compare simulated data with data from real buildings. The results were discouraging, and this initially generated a certain cynicism amongst some designers. However it was seen as a question of accuracy.

In response to this a very expensive programme of test cells was set up. These were little more than insulated boxes where all of the energy dependent variables were closely controlled and the one component that caused the most trouble, the occupant, was banned! The positive result from this programme was the refinement of algorithms, from which modern softwares are now benefitting. However, not sur-

**Fig. 3**

LT Curves for south-facing single glazing in mid-European coastal climate, showing annual primary energy consumption for heating, lighting and cooling. Energy consumption per square metre relates to floor area of passive zone, defined as within six metres of façade.

**Computers and simulation**

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prisingly, it did little to help explain the routinely observed massive discrepancies between predicted design performance and what actually happened when the building was built and occupied.

It seems that errors in the physics based algorithms have now almost been eliminated and in that sense the tools are highly accurate. But is it useful to know (with a high level of accuracy) that building A will consume so many kWh if ... and then a huge range of assumed parameters ..., when the certainty of those assumed parameters being correct, is low?

Take the case of internal gains. In highly insulated buildings, the assumed value and temporal and spatial profile of internal gains can have a huge effect on the net energy required for heating. I have witnessed students making a completely wrong decision, based on a particular assumption about the nature of internal gains. My point is that this has nothing to do with the accuracy of the simulation, but rather the accuracy of the assumptions. We might then ask if there is something missing from current design tools, that could alert the user to this? However, even alerting someone is still not providing an answer; the problem of the assumed values remains. What we need is a whole new component in the software which challenges the user to consider the vagaries of occupant behaviour, and to determine the impact this will have on their design.

An educational experiment

I propose an educational experiment. A design brief is given to three groups of students. All groups have received generic design teaching applicable to the subject of the brief. Group 1 is given no further support. Group 2 is given a scripted simulation exercise using generic building designs, and Group 3 is required to carry out simulations of their proposed design. The design are then subjected to the normal review process, except that none of the numerical results are shown, and the reviewers do not know which group the presenter is from.

A further suggestion is that when and if simulation results are used explicitly in the presentation of design proposals, the author is required to explain the significance of the results and how the results have influenced the design.

Safe territory design

The perceived accuracy and “truthfulness” of simulated results have another negative consequence. They lead to the notion of optimised design. Whilst the shape of a gas turbine blade can probably be truly optimised, the design of a dwelling, a school or a hospital cannot. This really follows from the discussion above – that a building may perform extremely well for a set of given conditions, but may perform badly when some of those conditions don’t apply. To give an obvious example, a building optimised for daytime occupancy, when useful daylight and solar gains are available, may perform far less well if occupancy shifts to the evening and night-time.

Figure 4 illustrates this and introduces the concept of “safe territory” design, sometimes referred to as “robust design”.

Nature is often referred to, erroneously, in support of optimised design, where the process of natural selection is seen as a kind of parametric study. But this is not so.
The “design” on a butterfly’s wing is not optimised, it is simply good enough to scare most of the birds away, and perhaps to be interesting to a mate. It is not optimised to a particular function, since there are thousands of other “design parameters” equally critical to survival, and the number of permutations simply do not allow them all to be explored.

So robust, safe territory, or good enough design is what we should be seeking, and ideally, analytical design tools should steer us in that direction, not to lead us to the false goal of optimisation.

The human factor

Thermal comfort

In the early days of building monitoring, human beings were the curse of the building scientist. They just kept messing things up – interfering; sometimes with good intentions and sometimes with sabotage at heart. In desperation, buildings were sometimes monitored with simulated occupants – little devices that convected, radiated, evaporated, and opened the windows at exactly 24.5 °C every time, just like really well-behaved people. No attempt was made to take account of any human behaviour.

Fig. 4

The concept of safe territory design as distinct from optimised design. The diagram shows the energy performance (the inverse of consumption) as a function of two variables as a 3-dimensional surface. Though difficult to imagine, in the case of a building, this surface has many more than 3 dimensions, and many more opportunities for non-optimum performance.
in simulations, and under performance of buildings occupied by real people was always excused by blaming the occupants.

At about this time I became interested in thermal comfort, and my first response to Fanger’s heat balance comfort theory was one of great enthusiasm. Here was a mechanism, based on simple physics, to explain something as nebulous as human comfort. This seemed a brave step across a divide.

However, I soon became aware of another side of the story. The classic work of Humphries (Humphries, 1978) in which data from field studies convincingly showed that people reported comfort over far wider ranges of conditions than could be accounted for with Fanger’s theory, equally attracted me. The crucial difference in the data was that Fanger’s was obtained from test chamber experiments, where the human subjects were totally constrained in their activity, dress and even posture, whereas Humphrey’s data was gathered from people going about their everyday lives. The explanation was adaptation. That is, if permitted, people would behave in such a way to minimise their discomfort. This is a result of nature’s drive for the maintenance of a stable body core temperature. It was no more mysterious than people feeling hungry when they needed food!

This went a long way to explain why people messed up the monitored building exercise. They were simply trying to make themselves comfortable. Sometimes it could save energy, like being quite content to put on more clothing rather than turn up the heating. But more often, it led to increased energy consumption, as, for example, when the occupant opens the window in a room controlled by a thermostat.

**Adaptive opportunity**

Several field studies (Baker & Standeven, 1996) were carried out to identify the relevant adaptive behaviour and quantify it, in terms of the departure from a heat balance or neutral temperature. These include subjective adaptations, such as adjusting dress, adjusting activity level, adjusting posture, and objective adaptations where people make small adjustments to the local environment with controls such as openable windows and blinds. It was soon realised that certain environments offered more opportunity than others, and that some of these adaptive opportunities were, to some extent, in control of the designer. In one of our studies, (Guedes M, 1999) we even found that people’s reported comfort was improved in the presence of adaptive opportunity, even if they did not carry out the adaptive action – i.e. there was a strong psychological factor.

Further evidence of psychological factors was observed in another Cambridge study by Nicolopoulou (Nicolopoulou et al, 2001). She compared subjects reported comfort with Fanger predicted comfort of people sitting outside. The results showed an even wider divergence than indoor studies, as illustrated in figure 5. A further subtlety discovered was that subjects that were waiting to meet someone were less tolerant of non-neutral conditions than those who were free to move at any time, suggesting that perceived adaptive opportunity is a key factor.

It became clear to me then, that the human factor is as important as the physical, and if scientific analysis has a place in the building design process, then it has to embrace human behaviour. Quite how this is to be done, is an on-going challenge.
The role of research - data, knowledge, wisdom

The field of architecture in particular is a wonderful mix of disciplines, interests and motivations, ranging for the purely technical, to psychological, sociological and simply aesthetic. This I have always found very stimulating. However, I have observed how a designer without a scientific background, may, on occasions, over-value the results of building physics analysis. The scientific consultant is often to blame, since he/she has their own profession to promote.

I remember one occasion when in a design meeting the energy consultant tabled a huge stack of graphs, the result of several days of expensive simulation. The question to be solved was how much energy a small glazed courtyard would save when added to a large shopping centre. Common sense should have shouted “not much” since it was virtually open to the air, and its area of contact was small. The problem could have been solved with sufficient accuracy by a simple “back of envelope” calculation. But here we had the design team, giving this question far more attention (not to mention resources) than it deserved.

I like to consider there to be a transition from data, to knowledge and then to wisdom. Data is just data – stops there – like the pile of graphs. If we know how to analyse it we might be able to convert it to knowledge, something that will address the problem in hand. But if from experience of several problems, we can convert that knowledge to wisdom, we move from the specific to the general, and we do not have to go through the specific analytical phase every time. I think that there is a danger that because computing has made analysis so accessible and available, and data so easy to generate, the role of design wisdom is being undervalued.

Teaching should re-address this; not turning its back on the value of analysis, but synthesising the wealth of knowledge that we now have from real and simulated data, into a generalised design skill.

Conclusions

It is generally accepted that we are facing a global crisis due to the emissions of fossil carbon. A large proportion of this is from the built environment. Clearly there is a need for new buildings to make minimal demand on fossil energy, and a more press-
ing need is to design improvements to our existing buildings. Neither of these is solely a technical issue but must take account of the human factor.

Our evolutionary instincts, relate to a very different world, where consumption, acquisition and control were aids to local survival and had little effect at a global level. Now science, technology and communications render these same instincts much more dangerous.

Scientific support to design must move away from the purely technical and embrace the interaction between human emotions and behaviour, and the physical world. As in other disciplines such as sociology and psychology, this will need a much more experiential approach, but will be no less scientific for that. After all, the "scientific method" is the method that works. The combining of conventional analytical techniques and knowledge-based solution engines (expert systems) is already taking place in other disciplines. This may well be the way forward in the design of the built environment.

References
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Tradition and Innovation in the Architectural Environment
At first sight Hardwick Hall (1590-1597 - 53º 10'N) by Robert Smythson and the Kolumba Museum (2003-2007) - 50º 56'N by Peter Zumthor could hardly be more different (Figures 1 & 2). Hardwick was built as the home of the aristocratic Elizabeth, Countess of Shrewsbury; it stands on a hilltop in Derbyshire in the middle of England. The Kolumba Museum in the centre of Cologne (2003-2007) was designed to house a remarkable collection of sacred art, both ancient and modern. My proposition is that, by studying buildings of the substance and quality of these, and others, we may develop a proper and relevant understanding of the architectural environment. I strongly believe that innovation in architecture should be rooted in an understanding of its history and of the lessons that history teaches.

I have researched, taught and practised environmental architecture since the 1960s. At the outset my research was rooted in the methods of building science, of physical modelling and, then, in the early days of computer modelling. I also worked in monitoring building performance. I regard quantitative understanding as the foundation stone of the field. In my research over the past two decades, however, I have tried to explore the historical and cultural dimensions of environmental design in architecture. In this I acknowledge a considerable debt to Reyner Banham, who's Architecture of the Well-tempered Environment broke new ground when, in 1969, it first brought historical credibility to environmental studies. But Banham’s project, significant as it was, was essentially a history of the technologies of environmental architecture. It was about means rather than ends. In The Environmental Imagination, which is a study of two centuries of environmental architecture, 1800-2000, from Soane to Siza and, alphabetically from Aalto to Zumthor, I made a distinction between the technics and the poetics of environment. My aim was to suggest that environmental design in architecture is, or should be, as much a matter of quality – poetics as it is of quantity – technics.

Fig. 1
Robert Smithson, Hardwick Hall, Derbyshire.

Fig. 2
Peter Zumthor, Kolumba Museum, Cologne.
My research method was to travel to selected buildings in Europe and North America and to make careful observations of the environments within them using my human senses as the principal instrument of record. In the studies the relationship between building and climate is a fundamental factor, albeit implicit, whether at high Nordic latitudes, in works of Aalto, Asplund, Fehn or Lewerentz, central Europe with Mies, Le Corbusier and Zumthor, the more southerly contexts in which Scarpa, Moneo and Siza’s buildings were placed and the climatic diversity of the United States with Kahn and Holl. In my later book, *Architecture and Climate*, this relationship is brought to the forefront on my studies of four centuries of British environmental history - from Smythson to the Smithsons.

In the context of this conference my argument is that the teaching – and hence the practice - of environmental design should be founded on an historical sense and be considered as much a question of poetics as of technics, if it is to be relevant in the ‘post-crisis world’.

**Case Studies: Smythson and Wren**

To try and illustrate my argument I will begin by comparing two remarkable, historic English buildings, Robert Smythson’s Hardwick Hall and Christopher Wren’s Sheldonian Theatre at Oxford (1663-1669 - 51º45'N) (Figure 3). In environmental terms these buildings stand either side of a fundamental line of demarcation. At the end of the

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*Fig. 3*

Christopher Wren, Sheldonian Theatre, Oxford (after Loggan, 1675).
16th century, the date of Hardwick, there were no tools for the measurement of the environment. Knowledge of climate and its relation to building, as would have been possessed by Smythson, was therefore, entirely empirical and subjective. Nearly a century later Wren was a scientist before he became an architect and made important contributions to the ‘mathematical sciences’, to astronomy and to the development of the science of meteorology. In 1662 he demonstrated a design for a ‘weather-glass’, a portable meteorological station, at a meeting of the Royal Society in London, just a year before he presented his design for the Sheldonian to the Society. Wren therefore lived in a world that was measureable. I suggest that the Sheldonian may be offered as one of the first buildings whose design was informed by what we now describe as ‘environmental science’.

The environmental sophistication of Hardwick is revealed by its plan. This is a rectangle elaborated by the addition of six towers, one at each end and two each on the long sides. The long axis is orientated almost exactly north-south and a spine wall of masonry runs the full length, just off the centre-line. Hardwick astonished its first observers with its, for them, extensive glazing. “Hardwick Hall more glass than wall” was the cry. The glassy perimeter was, in effect, compensated by the warmth of the twenty-eight fireplaces in the masonry core, whose presence is declared by the tall chimneys visible above the parapet. These are, perhaps, as much a symbol of the house’s environmentalism as Louis Kahn’s ventilation ducts at the Richards Laboratories in Philadelphia (1957-1965). When we examine the disposition of apartments in the building we discover a further dimension to Smythson’s environmental understanding. The rooms occupied by the Countess and her immediate household are at the south end of the first floor, where they are most sheltered from the outside and enjoy the best of the English sun. Below is the nursery for her resident grandchildren and above on the south-western corner, the grandest ceremonial room, the High Great Chamber (Figure 4). The Long Gallery, where indoor exercise was taken on inclement mornings, occupies, appropriately, the entire length of the east front (Figure 5).

The Sheldonian Theatre was designed primarily as the setting for the Encaenia, the university graduation ceremony, but it was in modern terminology a ‘multi-purpose’ building. The principal space was also used for dramatic and musical performances, as it is to the present day, and even for ‘the dissection of bodies’. The ground floor and basement housed the university printing press, with the attic used as a store for printed books.

The Encaenia is customarily held in the third week of June, the week of the summer solstice. Throughout the day-long ceremony the theatre is packed with people wrapped in heavy academical dress. This presents considerable problems of thermal comfort, lighting and acoustics. I suggest that Wren’s masterly solution of these demonstrates the application of his scientific understanding. The D-shaped plan of the theatre derives from classical precedent the Roman Theatre of Marcellus, as this was represented by Vituvius and Serlio. Unlike the original, Wren’s roofed space is lit, not from the sky, but by high windows that surround the room above the gallery seating and a series of lunettes above the lower banks of seats (Figure 6). The orientation of the building was almost certainly decided by its setting in relation to the adjoining Bodleian Library and the Divinity School to the south of the site, but it has another, environmental logic. The effect is to provide some shading to the formal, pedimented south façade, with, therefore, some benefits on warm summer’s
Fig. 4
Hardwick Hall, High Great Chamber.

Fig. 5
Hardwick Hall, Long Gallery.
days, whereas the curved exterior of the amphitheatre nicely controls its exposure to east, west and north. Cross-ventilation is provided through the windows surrounding the galleries. Robert Plot described these in great detail in *The Natural History of Oxfordshire* (1677).

> The great bivalve wooden windows in the upper gallery … are so ingeniously contrived, that notwithstanding their great weight, yet can never sink so as to be brought out of square, as it is usual in such windows … Nor are the round windows below unworthy of consideration, being contrived to admit air in foul weather, yet not one drop of rain …

From the centre of the Theatre the high windows present an almost continuous band of light, brilliantly illuminating the Encaenia and the diverse events that have and continue to take place in the building and, by virtue of their orientation keep heat from the sun to a minimum. The building was officially opened with a ceremony on 19 July 1669. This was attended by the diarist, John Evelyn, who recorded that the event lasted from 11 in the morning till 7 at night. It was also recorded that the acoustics were considered satisfactory for both speech and music, both of which were heard with ‘pleasing purity’.

Both of these buildings may be seen to be a complex synthesis of the architectural with the environmental, as these terms would have been understood by their respective creators; Smythson empirical, intuitive and exploratory; Wren scientific, objective and classical. But in spite of their differences of thought and architectural style they both provide environments of the greatest sophistication in the service of their very different purposes. They are simultaneously technically assured and deeply poetic.
Case Studies: The 20th Century

To develop my argument I step forward to the twentieth century and offer analyses of masterworks by some of the most important architects of recent times. I have selected cases from across Europe, from Scandinavia to the Mediterranean in order to capture something of the climatic and cultural diversity of our continent.

Asplund and Jacobsen: Gothenburg and Aarhus

In The Environmental Imagination I suggested that a particular environmental sensibility informs the work of Nordic architects in the twentieth century. I argued that this is the outcome of the specificity of these architects’ response to climate, in compari-

Fig. 7
Erik Gunnar Asplund, Law Courts, Gothenburg.

Fig. 8
Gothenburg Law Courts, Plan and Cross Section.

Fig. 9
Gothenburg Law Courts, Great Hall.
son to the universality of the environmental theories (if not the practices) of architects like Le Corbusier and Mies van der Rohe. One of the buildings that I chose to support the argument is Asplund’s extension to the Law Courts at Gothenburg (1913-1937 - 57º 45’N) (Figure 7). Peter Blundell Jones has comprehensively described the complex evolution of this project. My specific environmental analysis focuses on the relationship, in plan and section, between the existing neo-classical building and Asplund’s addition (Figure 8). Asplund’s extension adds a second courtyard, known as the Great Hall, to the north side of the original building, but, as the cross section shows, this is covered, not open to the sky. In addition, Asplund rebuilt the wing that forms the link between the two courtyards. In contrast to the solid masonry construction of the old building this has an open frame structure with a two-storey high glazed wall facing the open courtyard. A continuous, south-facing rooflight lights the new courtyard. The effect of this and the transparency of the linking wing is to bring warm southerly light into the space. This, in combination with the tones of the Oregon pine panelling, invest the space with unexpected warmth, both visually and, to some degree, thermally (Figure 9).

The Town Hall at Aarhus (1937-1942 - 56º 09’N) by Arne Jacobsen, in collaboration with Erik Møller, was the outcome of a competition (Figure 10). The design was influenced at many levels by Asplund’s recently completed building in Gothenburg. Indeed Jacobsen made a visit to Sweden where he made an extensive photographic record of the building. There are clear stylistic similarities between the two buildings, for example in their use of frame construction and their materiality, both outside and in. But I want to draw attention to their shared environmental sensibility.

At Gothenburg the Great Hall is the key to the environmental qualities of the entire building. Asplund’s emphasis on south light invests the space with a sense of enclosure and warmth at the heart of this civic building in the centre of the city. At Aarhus the building is entirely new. The site, an old cemetery, lies close to the historic city centre. A feature of the site was an avenue of linden trees running from north to south. A masterstroke of Jacobsen and Møller’s design was to retain this and to exploit it as a vital element of their environmental strategy (Figure 11). The plan is based on a sequence of inter-connected top-lit spaces. At the fulcrum of these is the entrance vestibule, which is lit by a translucent day-light. The office wing, which opens directly off the vestibule, is centred upon a six-storey galleria covered by a continuous lantern light. To the west of the vestibule lies the main public hall. In effect this and the vestibule may be considered to be a single, complex space, since they are separated by an open frame structure that is reminiscent of Asplund’s stair hall at Gothenburg. The hall is rooflit by five, east-facing rooflights, elegantly curved within the concrete roof form. Then the entire, west-facing end wall is glazed, wall-to-wall and floor-to-ceiling. The linden trees of the old cemetery press close to this and provide protection from the heat and glare of the low western sun (Figure 12).

As at Gothenburg, the interiors of the principal spaces are lined in timber. The vestibule and the hall have panelling of slatted beech that brings warmth to the light as it spills down from the rooflights and through the west window. At Gothenburg the architect designed all the artificial light fittings. We find just the same attention to this fundamental aspect of the environment at Aarhus, where a wide variety of fittings meet the differing requirements of the spaces. A further environmental similarity is the sophistication of the heating and ventilating systems and, in particular, the refine-
Fig. 10
Arne Jacobsen, with Erik Møller, Town Hall Aarhus.

Fig. 11
Aarhus Town Hall, Site Plan.

Fig. 12
Aarhus Town Hall, Interior.
ment of their physical integration into the structure. At Aarhus the timber panelling between the exposed concrete of the structural frame conceals service voids that discreetly house all the principal services.

The environmental achievement of these two buildings rests in their comprehensive synthesis of technics and poetics – my key words. Their reinterpretation of the language of Modernism - the ‘other tradition’ as Sandy Wilson has defined it 15 - embraces a specific response to the environmental conditions of the climate and culture of these northern latitudes.

**Scarpa and Fehn: The Sheltering Environment**

A further theme that I explored in The *Environmental Imagination* was that of ‘The Sheltering Environment.’ This comes from the recognition that, even in times when advanced technologies are almost *de rigeur* in the environmental conception of buildings, it is possible, even relevant, to disregard these in the creation of remarkable environments. To explain this idea I offer Carlo Scarpa’s Gipsoteca Canoviana (1955-1957 - 45 51’N) (Figure 13) and Sverre Fehn’s Archbishopric Museum (1967-1970 60º 47’N) (Figure 14).
Scarpa's buildings are almost all located in the Veneto, that marvellous region lying between the Adriatic and the Dolomites – the landscape of Andrea Palladio. The Gipsoteca stands in the grounds of Canova's house and studio at Possagno, in the foothills of the Dolomites. Scarpa's building is a new wing to an existing neo-classical gallery by Francesco Lazzari (1832-1836). It consists of a principal, cube-like space to the west of Lazzari's building from which a low, tapering space extends to the south. The building is, in every respect, of its time, compositionally and constructionally it could be of no other. The natural light is its most immediately striking environmental quality. Scarpa's invention of the 'tri-hedral' windows that occupy the four corners of the cubic space produces an original and magical light, ever changing as the days and seasons pass. In this the white sculptures seem to come alive. The sculptures, which are Canova's original plaster works, from which marble copies were made, are robust in the bright light, not requiring the careful protection of paintings and textiles. They are similarly tolerant of temperature variations and the building was built without a heating system. The environment is, therefore, the product of the interaction of the building, its form and material, with the climate of the region. This is precisely the strategy of Palladio, working four centuries before in this very place.

Fifteen degrees of latitude north of Possagno stands Sverre Fehn's Archbishopric Museum at Hamar. This is also an addition to a historic structure, the remains of a medieval palace. Here, however, the new work is almost entirely contained within the old building, not an extension to it. A simple tiled roof, supported on a modern timber beam.
structure covers the footprint of the building and within Fehn inserts a sequence of ramps, staircases and enclosures of insitu concrete. As at Possagno most of the artefacts on display in the museum, which include agricultural implements, machinery and domestic utensils, are environmentally robust. As the museum was planned to be open to the public only in the summer months there was no need to provide heating for the cold northern winter. There is a small part of the south wing of the building that houses delicate and precious artefacts, where more complete environmental control is provided, but the major part of the public space is unheated. The interior is also mainly naturally lit. Very simple glazed ‘tiles’, carefully set within the roof tiling, bring light in measured quantities to the diverse spaces of the interior, with small, original south-facing windows admitting brighter highlights. There is some judicious artificial lighting that brings special emphasis to selected artefacts.

The lesson of these projects is that we should question the modern assumption that buildings need the full array of environmental services. There are many conceivable circumstances in which the fundamental, maybe we may say the ‘primitive’, method of environmental response of the form and fabric of building is all that is needed. This insight is indeed a form of innovation.

Moneo and Zumthor: Two Museums - Palma and Cologne

The art museum is one of the most important building types of modern times. Since its emergence at the beginning of the nineteenth century it has been quite fundamentally environmental. One of the earliest purpose-built public art museums, Soane’s Dulwich Picture Gallery in London (1811-1813) is a masterly essay in constructing a precise relationship between the work of art, its viewer and its environment. These relationships remain, in some degree, the central question of the contemporary museum. For my concluding case studies I have chosen museums by Rafael Moneo and Peter Zumthor, respectively. These are the Pilar and Joan Miró Foundation at Palma, Majorca (1989-1992 - 39º 35’N) (Figure 15) and the Kolumba Museum at Cologne (2003-2007 - 50º 56’N) (Figure 16).

Rafael Moneo’s building at the Miró Foundation is designed specifically to display the works of Joan Miró. This engenders a most particular response from the architect in a building that is a unique contribution to the continuing evolution of the building type. In writing about his design Moneo voiced a passionate reaction to the surroundings of the site that, since Miró and his wife, Pilar, first made their home there in 1956, has become engulfed by the suburban expansion of Palma.

The building reacts with energy to the hostility of the environment. The countenance of the star-shaped volume is like a fort, ready to defend itself against supposed enemies on the horizon.

The ‘environment’ to which Moneo refers so critically is the all-to-familiar outcome of poorly regulated urban sprawl, rather than the more beneficent, but often challenging, climatic context that is our subject here. The response of the building to this is equally rich and subtle. The building and garden are an ensemble that provides a setting for the presentation of Miró’s works in all media (Figure 17). The ‘star-shaped volume’, which is the main exhibition space, is an original and protective environment.
Fig. 15
Rafael Moneo, Pilar and Joan Miró Foundation, Palma, Interior.

Fig. 16
Peter Zumthor, Kolumba Museum, Cologne, Interior.

Fig. 17
Miró Foundation, Exterior.
for the display of paintings and prints to meet the modern need for the conservation of such works. There are also a number of sculptures sharing this subdued environment and more of these are found in the garden, where they are juxaposed with nature, illuminated by the bright Mediterranean light.

In the design of the ‘hall’, Moneao’s aim was, ‘… to create a spatial atmosphere true to the spirit of Miró’s painting … ’. The conventional priorities of the art museum are rejected in pursuit of this over-riding objective. Generalisation is replaced by the specificities of this unique art and place. The aim is the poetic ‘atmosphere’, not the technical ‘environment’. At first encounter the ‘hall’ offers none of the familiar clues of
the environmentally centred space for art. We are presented with a layered, descending territory in which the art works, paintings and sculptures stand, grouped by the logic of medium, material and dimension. As we move on, and as the eye adapts to the subdued light, another order becomes apparent. The room is lit from both natural and artificial sources. Moments of strong daylight enters through shafts that rise above the roof and a small, directional ‘light-box’ cut into the west wall, that allows light but not view. These are juxtaposed with a screen of translucent alabaster that fills almost the entire southern edge of the room. This is shaded on the outside by an array of concrete louvres that moderate and further diffuse the strong south light, casting a mellow glow over the space and the art it contains. Beneath the screen, and below eye-level, is a continuous strip of clear glass. This allows glimpses of the ground outside, but avoids glare and visual distraction. Artificial light consists of simple adjustable spotlights on ceiling tracks. These allow individual art works to be highlighted. The result is a rich, diverse field of light in which the visitor and the works of art become one.

The Kolumba Museum in Cologne is close to the city centre. Zumthor’s design is probably his most urban project to date. Cologne is quite unlike the towns, villages and moutainsides of his native Graubünden. Here, unlike at the Miró, the art works are diverse in period, genre and media, but are unified by their common representation of the sacred. Whilst the collection is permanent, the works on display are rotated and re-hung over time. Cologne was extensively bombed in the second world war and the site for the building was in part occupied by the ruins of the medieval church of St. Kolumba. This is physically incorprated into the fabric of the new building and becomes, in effect, an exhibit alongside the fine art.

The building is absolutely of its time, and adopts advanced technologies of construction and environmental management, but there is none of the elaborate technological display of so many contemporary designs. The material palette consists of external walls of light grey brick, upon which steel windows frames are placed, “like brooches”20. Inside there are walls of clay plaster, floors of Jura limesotne, terrazzo and polished concrete and ceilings of poured concrete. The physical properties of these, their thermal mass, play an important role in preserving the temperature in the rooms.

The largest space and the first encountered in the journey through the building, is the enclosure above the ruins of the ancient church (Figure 18). An array of slender concrete columns support the concrete slab high above and delicately penetrate the lowwalls of the ruins. The space is traversed by a zig zag, timber bridge suspended above the ruins. The environment is original and remarkable. The upper part of the external walls is a brick honeycomb that admits light and air and the sounds of the city. The flickering daylight is supplemented by powerful beams from as series of downlighters. The room is cool, with no mechanical environmental control, the light is diverse and ever-changing and the sounds of the modern city contrast with the solemnity of the ancient stones. This marks the beginning of an intriguing environmental journey.

A narrow stair leads from the foyer to the first floor galleries that are, surprisingly, windowless – a ‘basement’ above the ground. This is where the most environmentally sensitive works are displayed. From the foot of a second stair there is a glimpse of daylight ahead that announces the different, daylit world of the upper galleries (Figure 19). Here there is a subtle combination of top lit and side lit spaces in which the works
of art are displayed (Figure 16 & Figure 20). One moves from a ‘core’ of side lit rooms, from which you enjoy views over the rooftops of the city, into the three clerestorey lit ‘towers’. Each of these, which have different orientations, north, east and west, is approached through a small windowless ‘vestibule’ that heightens the sense of light and space of the destination.

In these quite different contexts and with different architectural conceptions Moneo and Zumthor make two utterly original, but absolutely appropriate settings for the encounter between the viewer and the works of art that these buildings contain. In both the conditions of climate, Mediterranean and central European respectively are acknowledged and interpreted in the manner that we have seen in buildings from the English renaissance by Smythson and Wren, the ‘other’ environmental sensibility of great Nordic architects, Asplund, Jacobsen and Fehn, and Scarpa’s masterly reinterpretation of the climate of Palladio’s Veneto region.

**Conclusion: The presence of the past**

At the outset I proposed that, in parallel with the necessities of quantification and technology, environmental design in architecture, and hence its teaching, should also embody a knowledge of its history, of the existence of an ‘Environmental Tradition’. I owe a great debt to the pioneering contribution of Rayner Banham in *The Architecture of the Well-tempered Environment*, but I have sought to extend the analysis of the history of environment from his essentially technical focus to embrace its poetic dimension. My argument is that environment, in its most comprehensive definition, both its **technics** and **poetics**, sits at the very centre of design in architecture. It is in this environment that we perform the myriad functions that are, ultimately, the reason why we build.

**References**

1. I use this term to try to establish a distinction between the common definition of **environment**, as, ‘the surroundings or conditions in which a person, animal or plant lives or operates’ (*Oxford English Dictionary*), and the more specific and, in some respects, more complex meaning that applies in architecture. Note that, in addition to dates of design and completion of the buildings that I discuss, I also give the latitude of each location. For environmental analysis in architecture this is, I suggest, an essential fact. The data are from ‘Google Earth’.


8. Plot, R 1677, The Natural History of Oxfordshire, Printed at the Theatre, Oxford. Note that this volume was printed in the building under discussion.


13. See my discussion of these in The Environmental Imagination, op cit.

14. A description of a number of these fittings, including working drawings, may be found in Møller, E 1991, Aarhus Raadhus, Arkitekten Forlag, Copenhagen.


17. I discuss this in The Environmental Imagination, op cit.


19. Ibid.


21. This phrase is taken from T.S. Eliot’s essay, ‘Tradition and the Individual Talent’, The Egoist, Vol. 6, nos. 4 & 5, 1919 in which he argues for the value of historical knowledge in writing new poetry, the need for ‘... a perception, not only of the pastness of the past, but of its presence ...’

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Rigorous Creativity through the Integration of Parametric Design, Performance Analysis and Digital Fabrication
Architects frequently understand and experience design and creativity as a personal, lonely, and mysterious activity. The heroes of the modern movement have firmly instilled the myth of the lone genius architect who emerges from his isolation with an inspired design that he bestows on his client. As the concerns of clients shifted to issues of social responsibility, environmental impact and fuel shortages, architects increasingly found themselves marginalised and unable to continue to propagate the myth of "architect-knows-best". The cultural shift necessitated a fundamental change in how architecture is taught and practiced. Starting in the 1970’s there was an increasing pressure on architects to collaborate with others, through participatory processes, in the design and construction of buildings and to consider the environmental impact of their design decisions. This movement, that started about 40 years ago, has resulted in the current focus on using modelling and simulation techniques for building performance analysis.

In the meantime, computer technology was developing at a rapid pace. A few visionary researchers saw the potential of using computers in the design process as better replacement for drawing implements (Sutherland 1963), but also as a comprehensive interactive design aid and environment for creating virtual building models (Engelbart, 1962). This parallel movement has resulted in the current focus on using building information modelling (Eastman et al, 2011), and parametric and generative design in architecture (Woodbury, 2010, Jabi, 2013). Furthermore, the advent of digital fabrication technologies has enabled architects to directly translate these parametric constructs into physical form (Kolarevic, 2005).

The advancements in parametric design software, building information modelling, digital fabrication, and building performance simulation engines have sparked an interest in the integration of these technologies such that analytical methods are tightly coupled to the design process. The premise of this effort is that rigorous building performance analysis can enhance creativity in the design process. The remainder of this paper will focus on the issue of ‘rigorous creativity’ and describe a case study that exemplifies how a design process could integrate parametric design, analysis methods, and digital fabrication to arrive at a very creative and high quality design response to an architectural problem.

**Digital Methods and Creativity**

Digital technology is intricately intertwined with the creative and social aspects of the emerging practice world. A prime example is the use of digital fabrication technology and building information models to directly transfer information among architects, contractors, fabricators and consultants. At the same time, the discipline and practice of creative design is increasingly seen as a valuable cognitive skill, to be emulated, tapped, and understood by other disciplines in various settings. Fields outside of architecture and governmental granting agencies have shown strong interest in understanding, rationalizing and importing the creative design process that architects engage in. The obstacle, however, has been that architects and designers are rarely able to explain their processes in a manner understood by others. The advent of digital tools and social computing further complicates the issues of how designers design with such tools and how designers design with others (Lawson, 2005). The discipline of collaborative digital design still lacks clear conceptual frameworks, methodolo-
gies, and epistemologies. The goal of these frameworks is two-fold: 1) to formulate a discipline of digital design based on sound theoretical and pragmatic underpinnings, and 2) to elucidate the processes of digital design so that we can better communicate them to other disciplines and thus engage more effectively in interdisciplinary research. Further definition and refinement of the discipline of digital design requires a focus on three themes consisting of: 1) Ubiquity, 2) Parametrics, and 3) Tectonics. In simpler terms, a discipline of digital design should concern itself with people, rules, and things.

The first foundation, ubiquity, refers to the fact that digital information is rapidly becoming embedded in our daily lives. It enables collaborative interactions. Collaboration starts with simple casual interactions such as asking a question. It develops further within an organization through intra-disciplinary work – such as a team of architects and designers working together on a project. For larger and more complex projects, we often witness inter-disciplinary collaborative and coordinative processes among individuals with various backgrounds and training. Especially in the field of architecture and urban design, we also witness the users of and stakeholders in these projects get involved in what is usually called participatory design. Ron Wakkary and Leah Maestri, for example, have emphasized this aspect in their research by using the term everyday designers (Wakkary and Maestri 2007). They argue that all of us contain innate design abilities that allow us to participate collaboratively in the formation of a project that affects our daily lives. Ubiquity enables synchronous and asynchronous collaboration. It can take place in the same location (co-located) or at different locations (dispersed) – aided by real-time communication technologies and persistent databases. The physical, ergonomic, and social settings of collaborative work have a direct relationship to the type of work being done. Lastly, in a collaborative process, it is useful to analyse the individuals/players involved, the tasks they perform, and the artefacts they produce and study.

The second foundation, parametrics, concerns itself with the rules governing the design process. Starting from George Stiny and James Gips’s Shape Grammars research (Stiny and Gips 1972) and evolving through the newly found interest in parametric design and generative algorithmic processes, parametrics is increasingly becoming not only a method, but a design philosophy. A parametric understanding of the design problem has opened the possibility of investigating the deeper conceptual as well as tectonic structures of our proposals and has offered users and clients a realm of possibilities rather than a dictated solution. The field of parametrics has also allowed us to re-visit and discover the geometries of previously built works and more rigorously understand their design and construction rules.

The third foundation of digital design, tectonics, is concerned with the relationship of process to product. It advocates the view that architecture will always be embedded in its tradition of attention to material, assemblage, and detail (i.e. the tradition of making). The term digital tectonics (Leach et al 2004) expands this traditional notion into the current digital environment; thus making an argument that, while perhaps earlier computer-based work has ignored the architectural tradition of making, digital tools and technologies are not incompatible with a concern for materiality and craft. Indeed
they facilitate a powerful reformulation of design processes through parametrically constrained digital fabrication models and bring their own poetics to the equation. Architects have started using parametric and digital fabrication technologies to exert precise control over their design intentions through investigations that intersect the boundaries of algorithms, form, performance, material, and technique. A digital fabrication model can be used to more effectively investigate the impact and sequencing of production and assembly in the field and can communicate the above boundaries directly to others. A precise digital fabrication model can be transferred and translated digitally thus avoiding interpretation errors as it frees us of the need for representational annotation.

The next section describes two exemplary case studies. The first case study involves a generative parametric design process that was integrated with a structural analysis engine, a genetic algorithm, and innovative digital fabrication techniques to arrive at a truly rigorous and creative design solution. The second case study describes ongoing software development efforts to integrate parametric design methods with simulation engines.

**Case Study 1**  
**Genetic Stair by Caliper Studio**

The Genetic Stair was designed to be the centrepiece of a renovated apartment and art gallery in New York's Upper West Side (Figure 1). The goal was to create a slender stair that would only be supported at the bottom and top, and that would turn three times to climb 4.6 m. The design required a rethinking of both the design process and the role of the architect. At the beginning of the process, agreed design details and their limiting factors became the driving geometric constraints for the stair's overall parametric model. Custom software was created and integrated with McNeel's Rhinoceros 3D software to generate potential arrangements for the stainless-steel hollow pipes and solid rods that formed the structural latticework under the stair (Figure 2). The candidate solution was then passed, as a series of centrelines, to a structural finite elements analysis (FEA) system. The customized software used the FEA results within a genetic algorithm to 'breed' strong members and remove weaker ones. The final form of the stair was reached after several iterations of this analysis of the structural performance of members, which selected strong ones and eliminated weaker ones while adhering to strict fabrication constraints (Figure 3). With this process, the architectural team was able to remove the design and fabrication of the stair from the purview of the contractor – a rarity in traditional architectural projects. More importantly, however, and in a reversal of a traditional design process, the fabrication team collaborated on the details of the stair from the outset of the project, and the designers were active throughout the fabrication phase.

In order to build the complex intersecting latticework with sufficient accuracy, formwork panels were digitally derived and fabricated to guide the placement of pipes and rods (Figure 4). Intricate intersections between pipes and rods were unfolded from the 3D model and printed on paper templates, which were then wrapped around the steel members to act as guidelines for hole and edge cutting (Figure 5).
Fig. 1
Genetic Stair within the space. Photograph © Ty Cole. Used with permission.

Fig. 2
Close up of stainless-steel hollow pipes supporting the stair treads.
Fig. 3
Flowchart of the algorithm that generates and analyzes the structural members of the staircase.
This resulted in very accurate and clean joinery of the structural elements. The result is a beautiful, free-standing structure, which integrates parametric, material, structural and aesthetic concerns. As Caliper Studio’s Nicholas Desbiens explains, the Genetic Stair is made of ‘48 unique stainless-steel pipes with 1,400 angled holes, 253 connecting steel rods cut to length, 22 translucent Corian treads, 18 plates of glass and over 250 miscellaneous connecting components. The tubular-steel frame is punctuated by varying densities of diagonal struts as it turns its way unsupported through 270 degrees in a visual language that speaks to a controlled complexity inherent to the process by which it was designed.’

Case Study 2
Linking Performance Analysis to Parametric Models in the Early Design Stages

In the field of architectural design, parametric design tools have matured to the point where they are routinely used to explore design solutions and formulate basic design principles and rules that can be exercised to explore a design solution space (Woodbury and Burrow 2006). Parametric tools and associative thinking allow designers to maintain both creativity and rigour starting at the earliest stages of design. However, parametric tools have largely been focused on aesthetic and geometric form-finding with little regard to the performance of the suggested design solution (Pottman et al 2007). Any optimisation is usually either applied much later in the design process or not at all. Advanced building performance simulation software systems have also
matured to the point where their results can be verified against real-life measurements (Reinhart and Andersen 2006). Yet, simulation software is complex to understand and operate requiring specific input parameters and models to perform the analysis correctly. The complexity of the software can stifle creativity and postpone its use to later stages of design where it may be too late to affect any design changes. Furthermore, building performance analysis algorithms are usually time-consuming which discourages their use in the early stages of design. Finally, the outputs of some analysis software are complex, verbose, and textual in nature to the point where the data is opaque to the more visually oriented designers and architects. Visualising this data remains a difficult challenge to overcome. Finally, the linkage of analysis results as input parameters to design constraints is poorly investigated. Due to the disjunction between design control parameters and analysis results, designers often fail to understand the parametric link between performance data and control parameters. This situation usually results in an inefficient test-analyse cycle where it is left to the designer to guess or estimate what design parameters to modify such that the results of the performance analysis data are affected.

Several steps are needed to overcome the above shortcomings and more tightly couple creative parametric design tools and rigorous building performance analysis tools in the early stages of architectural design:

• Create computer-based systems that maintain and support design creativity.
• Maintain the fluidity and speed of the design/analyse cycle to the extent allowed by current technology (Investigate computing in the cloud and high-performance computing).
• Create appropriate geometry for analysis, but avoid forced simplification of the actual building design.
• Derive useful performance data in a timely manner and visualise it using appropriate methods for designers and architects in the early phases of design.
• Study the relationship between and tightly couple performance data and input design parameters.

Design Performance Assistant is a software implementation that the author created to investigate the above objectives. It links a simple compliance tool with parametric design software using custom-developed scripts. The assumption is that compliance software can provide quick design feedback that uses ‘rules-of-thumb’ methods that are fast to calculate. In addition, the software uses built-in functions for pattern detection that compute and display certain performance indicators. The benefits to the designer include instant feedback and visualisation of results in a native three-dimensional design environment. The software implementation uses the MAXSCRIPT scripting language that is part of the Autodesk 3ds Max software. Its goal is to provide the user with a simple schematic design system that gives an indication of design performance in real-time or near real-time. The software allows the designer to build a simple massing model and add windows of any shape to its surfaces. As the user manipulates the mass and its surfaces, a series of indications are displayed on-screen (Figure 6). Mainly, these are:

1. CO₂ emissions per sq. m. per year. This calculation is provided in real-time through linking the model to a simple sensitivity tool that carries out the calculations in the
background (Crobu et al 2013). The calculations of the linked tool are based on the United Kingdom Department of Energy & Climate Change's Standard Assessment Procedure (SAP). These 'rules-of-thumb' procedures that require a simplified model of a residential building can provide good indications of the performance of a design in the early stages.

2. Glazing ratio: This calculation is computed directly in real-time the software as a ratio of the total area of windows over the total area of vertical walls. Obviously, glazing ratios give a visceral indication of the potential of improving the thermal and daylight performance of a building.

3. Sphericity: This calculation is computed directly in real-time in the software as a measure of how round an object is. Sphericity is defined as the ratio of the surface area of a sphere (the most efficient shape to enclose a volume), with the same volume as the given object, to the surface area of the object. Obviously, the intent here is not to encourage spherical designs. However, sphericity can be a good measure of the compactness of the design that in turn can give a good indication of the thermal efficiency of the design (by enclosing a volume with less surface area).

4. Thermal bridging: This calculation is computed directly in near real-time in the software as a measure of the potential for (non-repeating and linear) thermal bridging problems. As the CO₂ computation described above, this calculation uses 'rules-of-thumb' computations by recognising edge conditions in the design project. The software gives an indication of the Psi (Ψ) value which is a measurement of heat loss, in Watts/meter. Kelvin (W/m.K) across a given junction between the external wall and another element (Energy Saving Experts 2011).

5. Over-shading: This calculation is computed in near real-time in the software as a measure of the amount of daylight each surface receives. Over-shading can also

Fig. 6
Screen capture of the Design Performance Assistant software interface.
be used to analyse rights-to-light within an urban context. The algorithm emits a certain amount of rays from the centroid of each surface and computes their intersection with adjacent surfaces (Figure 7). The result is computed as the ratio of the number of rays that intersect other surfaces to the number of rays that do not intersect any surfaces.

The emphasis of the software is on a visual display (using linear bars) rather on numeric data in order to give a more informal and easily readable sense of performance indicators. The assumption is that, in the early phases of design, numeric accuracy is neither achievable nor desirable. Instead, the designer is presented with a dashboard of performance indicators that are increasing or decreasing in real time as he/she interacts with and develops the design project. The goal is to provide fluid and rapid feedback that fits within the designer’s work methods in the early phases of design.

Concluding Remarks

In this paper a case was made that the integration of rigorous analysis methods and parametric design processes can lead to a more creative solution that is concerned not only with complex form-making, but also with the performance of the proposed solution. The argument is made that rigour can help rather than hinder creativity. The first case study of the genetic stair exemplified how a design process that integrated performance simulation, a rigorous and creative search method, and digital fabrication can yield aesthetically creative design solutions. On the other hand, the described software development efforts, while still nascent, point to the future of parametric software that moves beyond an exclusive concern with geometric parameters to include building performance and other environmental parameters. Below is an at-
tempt to classify and explain these parameters in the hope that it will serve as the foundation of future research projects with the goal of inventing more versatile tools to address this glaring deficiency in the current generation of parametric systems.

**Mathematical parameters** are the most basic type of parameter that are already understood by 3D modelling software: numbers, logical values and even strings of characters (which are represented internally using numbers). Many parametric systems, such as spreadsheets (which are undeniably powerful parametric systems in their own right), only need this level of parametric input in order to calculate very useful outputs.

**Geometric parameters** are higher-level entities that are built out of the lower-level mathematical parameters. Examples include points, lines, surfaces and solids. Most current 3D modelling software can represent and parametrically modify geometric constructs of various types.

**Topological parameters** describe how two or more entities relate to each other: connected to, above, below, is near to, looking at, is within, is outside of, etc. Most modern parametric systems excel at precisely these types of parameters. For example, a diagrid pattern is a topology that divides a surface in a consistent manner regardless of the exact geometry of the parent surface or the resulting pattern. This allows us to disassociate topology from geometry while maintaining the consistency of our design intents. Topological parameters allow us to consider issues of form, composition and fabrication, and they open the possibility of further analysis as they more precisely define our design intent for how the parts relate to each other and to the whole.

**Representational parameters** describe and abstract entities outside themselves. Examples include computer representations of walls, windows or columns. Building Information Modelling (BIM) was invented in large part to address the need to represent ‘real’ objects. In BIM, a distinction is made between an isolated geometric construct such as a cuboid, and a brick wall, that knows how many bricks it has, its own weight, structural strength, cost, etc. Representational parameters allow us to describe some if not all of the physical properties of what we are modelling. They also allow us to aggregate that information so we can report overall values and quantities.

**Material parameters** build on mathematical, geometric, topological and representational parameters by adding and connecting several physical attributes: weight, tension, friction, elasticity, structural strength, U-value, reflection, refraction, etc. This class of parameter begins to remove us from the realm of self-referential geometric games and into the physical world of materiality. Good examples of parametric systems that accept and consider topological parameters are tensile membrane form-finders, biomimetic explorations, and particle and physics engines that can encode, almost at a cellular level, the physical properties, collision, velocity, gravity and structural stresses that a system is undergoing. Future systems for parametric design in architecture should encode materiality and physical parameters, as this will allow us to model, predict and thus parametrically explore the performative aspects of our design proposals before they are actually physically built. Analysis software that precisely models
structural or thermal properties should more fully integrate the essential material and physical properties in our geometric and representational constructs, such that they fluidly react to, propagate and give us feedback on constraints and interactions within the overall parametric system in real or near-real time. For example, very few current parametric systems can represent the time-based effect of prolonged exposure to fire on a structural system or a particular building material. Physics-based computer games and bioengineering research, however, have reached that stage and we would be wise to learn from their techniques in the field of architecture.

Environmental parameters include the frequently invisible and fluid forces that surround us. Time, wind, thermal variation, vistas and views, the movement of light and shadow, magnetic fields, Wi-Fi and GPS signals, growth and erosion are all examples of environmental parameters. Not many of us can easily imagine the path of a shadow as it travels during the day or the undulations of a field of sunflowers as they follow the path of the sun; this is why we find time-lapse photography so fascinating. Interactive façades that respond to environmental conditions (usually the path of the sun) are a good start. However, we need a deeper understanding of the totality and complexity of environmental factors so that we can optimize our design solutions, given complex and competing constraints.

Human parameters form the seventh and most challenging class of parameters. Architecture’s purpose is, after all, to shelter humans from the elements. While we share many physical attributes and needs, we also differ in profound ways both ergonomically and psychologically. If we are to create humane architecture and one that creates truly customizable spaces, we need to be able to model our clients, their intents and desires, and incorporate that information as parameters in our design systems. It is truly shocking that, in many cases, incorporating the human parameter in our design projects and renderings does not go beyond the inclusion of a scale model of a person. That is only a start; masterful architects know how to address and resolve multivalent parameters. We truly need to learn from the field of ergonomics and especially the advanced systems that office furniture, automobile and medical equipment manufacturers use to model human beings. A good development in our field is the increasing incorporation of simulated crowd systems. Sadly, while effective at simulated fire egress, the simplifying assumptions of such systems, which reduce the complexity of human behaviour to that of a robot, render them useless to predict common human behaviour such as where clusters of people might gather or pause on a sunny afternoon. As the computational capability of our systems grows, so will the sophistication of these simulations.

Incorporating all seven classes in a parametric design system is not only a tall order, but not always advisable given the design situation. Knowing how to abstract a situation and build a conceptual model in which extraneous parameters are excluded but essential ones are included is part of our irreplaceable skill as designers. Parametric modelling lets you capture that conceptual model and make it explicit. This shifts the conversation. The challenge is not one we can shy away from if we aim to be precise about our design intent and, perhaps more importantly, strive to understand the con-
sequences of our decisions before we actually build them. Parametric systems are only one step in that endeavour.

Several interwoven theoretical approaches must be employed and integrated to fully realise this research agenda and expand our understanding of rigorous creativity:

- A humanistic approach (a concern for technology’s role in and effect on human praxis).
- An algorithmic/rule-based approach (parametric, generative, novel software systems).
- A social/collaborative approach (HCI, ubiquitous computing, CSCW).
- An academic/pedagogical approach (studio culture, inter-disciplinary design studios).
- A practice-oriented approach (building information modeling, workflow strategies, liability, legal and practice issues).

Discovering a rigorous set of guidelines and a framework for the issues involved in the integration of digital design methods will encourage us to be more explicit in our discussions and descriptions of creativity and digital design. The maturity of this research agenda will enable us to arrive at a creative and productive design process where a creative architectural idea is enhanced, not hindered, by rigorous analysis.

Acknowledgements
I would like to thank the following colleagues for their help with various aspects of this research programme: Simon Lannon, Enrico Crobu, Ian Knight, and Clarice Bleil DeSouza.

Notes
1. This case study was previously published in (Jabi 2013).
2. The taxonomy of parameters was previously published in (Jabi 2013).

References
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Architectural Research for Sustainable Environmental Design
While much international research over the last forty years focused on energy efficiency and the engineering of environmental design, little of this dealt directly with architecture or answered any of the environmental questions commonly encountered by architectural students in the course of their studies. As a result, doubt, ignorance and preconception still prevail and need to be addressed in architectural education as well as in practice. Providing alternatives to the universal architecture and brute force engineering that are still the norm for architects in most countries requires new knowledge on what makes a good environment for inhabitants and how architecture can contribute to this, reclaiming and enhancing its historical role as a tool of environmental design.

The urban environment

By getting in the way of pre-existing energy flows, buildings alter the energy balance of their surroundings, interfering with solar radiation and wind directed toward other buildings, forcing microclimatic changes in their vicinity as well as impinging on pedestrian activities. Moreover, whether heated or cooled, free-running or mechanically controlled, buildings will release all of the energy used in them into the urban environment around them in the form of waste heat, thus constantly and relentlessly warming the surrounding air, acting like giant heaters for the city. In these ways urban morphology has a dramatic influence on the climates of cities. The outcome is the fragmentation of the urban landscape into what appears to be a random assemblage of accidental microclimates. It is these microclimates we encounter walking in the city between its urban blocks and terraces, its parks, squares and rooftops. At any moment, as well as over any period of time, the air and surface temperatures, sunshine and wind we might experience while walking through any of these microclimates are likely to be quite different to those on which the buildings that are housed there would have been designed. Even if we did design environmentally architectured buildings, they might still fail badly unless we could account for the climatology of their site (no wonder that many recent buildings failed to live-up to their environmental expectations). This is the environmental inheritance of the contemporary city, an outcome of the architecture and urbanism of the last century.

Learning environmental design

The conditions for a symbiotic relationship between buildings and the urban environments they form and occupy are the main concern of the Masters programme in Sustainable Environmental Design (SED) at the Architectural Association School of Architecture in London. Knowledge and understanding of the physical principles underlying this relationship, along with the conceptual and computational tools to translate them into an ecological architecture and urbanism, form the core of the taught programme. Key objectives are to improve environmental quality in cities, achieve independence from non-renewable energy sources and promote an architecture of sustainable environmental design. In the last five years the programme’s continuing research agenda on “Refurbishing the City” has initiated over 350 student projects in 70 cities and some 40 countries, both north and south of the equator, encompassing a wide range of building types and climates with proposals for both new and exist-
ing schemes. The briefs of these projects combine on-site observations and measurements with design research that makes use of computational tools calibrated with measured data. For architectural students the undertaking of case studies of occupied buildings provides valuable insights on fundamental environmental issues that affect the comfort and wellbeing of occupants as well as the environmental performance and energy use in buildings, and which are of an architectural origin.

Fig. 1
Robin Hood Gardens, an iconic scheme designed by Alison and Peter Smithson in the late 1960s which is now being demolished. Measurements and simulations performed for this scheme highlighted both the ingenuity of its complex interweaving of dwellings (coloured section, right) and the environmental weaknesses this built form and its “streets in the sky” (left) entailed (Calleja et al 2011).

The combination of on-site empirical studies with analytical work provides students with the means for testing theoretical propositions, as well as supporting design research and its generative processes (Fig. 2). The empirical work consists of short-term measurements of environmental parameters, surveys and interviews (with occupants, architects, engineers, building managers). Measurements provide comparative indications of the envi-

Fig. 2
Generative processes for new residential development showing the evolution of site layout and building form based on environmental studies, mixed-use requirements, on-site food production and links with adjacent urban setting in Brixton, South London, UK, 51° 30' N  00° 07' W (Guzman et al 2013).
rnodmental conditions achieved and how these have varied over time, as well as between
and across different spaces. Surveys and interviews provide useful information on how
things work in practice, highlighting key issues identified by the measurements. Data
collected this way on environmental conditions, occupancy schedules, usage of appli-
cances and on other operational characteristics, form a useful environmental profile of the
case study buildings. They also provide the inputs needed for the calibration of digital
models. There is no substitute for the knowledge acquired by students this way and even
if such case studies were to be undertaken solely as an environmental exercise it would
still teach students more about architecture than any lecture.

The role of computational simulation

Simulation software is introduced early on, so that students can use it on projects as
soon as they have a reasonable grasp of the principles. Environmental simulation soft-
ware has improved over the last ten years, having become more visual in its interfaces
and easier to use, as well as much faster to run. It still leaves a lot to be desired, lacking
the capability to deal with all the main environmental processes interactively, being
limited both in what is covered and in how the output is given. While such limitations
are a source of confusion and disappointment for students (who are generally ex-
tremely ambitious in their approach and expectations), they are also useful reminders
that it is the knowledge and judgment of the software user that designs the buildings
not the software. Experience with the teaching of environmental software over the
last thirty years has shown that architectural students, both undergraduate and post-
graduate, can master the mechanics of software of any complexity very quickly. The
task of creating digital models of real or virtual buildings for the purpose of environ-
mental simulation is akin to designing a building and commissioning it to its intended
functions. The process of preparing and running simulations is also akin to the tasks
of the architectural design process. Thus up to this stage architectural students are by
far the most capable users of such software. On the other hand, the predictions of en-

Fig. 3
Simulated air and surface temperatures in urban blocks exploring potential for microclimatic
improvements by planting in the central courtyards, Athens, Greece 37° 58 N 23° 43 E (Kapsali
2012).
Environmental conditions that result as the output of simulations are new and unique outcomes. They provide critical knowledge never previously available to architects that characterises a design and its constituents in new ways (Fig. 3). Understanding and interpreting these predictions allows students and their teachers to assess a design and, by varying its specifications, to modify the design and improve environmental performance, thus employing the outcome generatively. Such predictions can now be made with a high degree of accuracy and at great speed with any of the several mature software readily available on the educational market.

A first round of modelling is typically simple in order to recreate the existing conditions of the buildings being studied. This is followed by parametric and sensitivity runs aimed at answering questions that would have arisen from building visits and occupant comments, and potentially also more widely from presentation of other recently completed buildings in the architectural literature. Subsequent simulations can then pinpoint the effect that different design features have on occupant thermal and visual comfort and on energy use. Students will typically consider the geometry and exposure of individual spaces; the position, shape, orientation and surface area of openings; the thermal and solar-optical properties and solar protection of glazed surfaces and other external building elements; occupancy profiles and occupant activity and use of home / work appliances. Some understanding of the environmental design principles is essential at this stage in order to avoid wasting time and getting frustrated by performing meaningless runs. With guided practice students can learn to orient themselves productively so as to obtain useful results quickly. Simple models of real or virtual buildings can be run hour-by-hour for a selection of periods in seconds. Environmental simulation then becomes a natural extension of the design process (Fig. 4). Moreover, within the limitations of its theoretical principles, each software

![Image](https://example.com/image.png)

**Fig. 4**

Extensive fieldwork and simulation studies were undertaken to assess the potential from passive techniques and protected transitional spaces as alternatives to all-year airconditioning in the hot-dry climate of Kuwait City, 29°22’ N 47°58’ E (Dib 2013).
is an excellent tool for learning how the principles on which it is based apply to a climatic context and set of design conditions of the user’s choice. With practice, by the time students come to apply the software on a second or third project, they will have become capable of anticipating the general outcome of the simulations; running the simulation then simply fills in the detail. Acquiring this skill reduces dependence on the software thus freeing time for other tasks.

**Adaptive Architecturing**

The knowledge gained from field studies in real buildings and from running simulations of solar, thermal, airflow and daylighting processes shows that designing near zero-emission buildings is now feasible in most climatic regions. It also shows how important the role of architectural design is in providing good environments. As architects we have always claimed that. Measurement and simulation help objectify such claim. Architecture is environmental design, but it needs the knowledge to provide sustainable environmental design. If we are to have free-running buildings, that do not depend on mechanical heating and cooling systems, they need to be capable of

![Fig. 5](image)

**Fig. 5**

Design proposals for office building in Santiago, Chile, 33° 26 S 70° 39 W, show built form resulting from functional and environmental considerations to suit new work relationships and with window positions and sizes optimised parametrically (Swett 2013).

![Fig. 6](image)

**Fig. 6**

Project for a site outside Florence, Italy, 43°47 N 11°15 E, exploring a future scenario of portable appliances and multiple adaptive opportunities for occupants to enjoy environmental diversity provided by passive techniques at different times and in different parts of the dwelling (Weber 2013).
matching daily and seasonal variations in occupancy and weather by acquiring their own variable properties and adjustable components. I have referred to this task elsewhere as *adaptive architecturing*, a generative process by which we aim to provide the means to adjust the built form and its properties to suit occupant activities inside and the daily and seasonal cycles outside (Yannas 2013). The projects undertaken for the AA SED Masters programme have demonstrated that this is applicable to all building types and built forms in all inhabited locations and climates. They also highlighted a number of research topics of global interest, as well as local issues arising directly from particular urban contexts and design briefs. Of primary importance among the former are fundamental design considerations such as plan depth, room geometry, the relationships between spaces in plan and section, the admission and control of sunshine, daylight, airflow, and the adaptive mechanisms to occupants for thermal and visual comfort and indoor air quality (Fig. 5). The occupation of spaces, the nature and energy intensity of occupant activity and the use of appliances have a strong bearing on these questions, as well as introducing further issues arising from lifestyle trends and technical developments (Fig. 6). While all of the above might be of equal interest wherever a building may be located or however its spaces may be occupied and used, their implications on environmental performance and occupant comfort can be very different depending on building function and location.

Fig. 7
Most architects and engineers tend to give-up on passive design when considering projects in Dubai, UAE, 25°15’ N 55°18’ E. Yet when studied closely the city’s climate is actually quite mild and nice for some six months of the year, while its more extreme periods sets design challenges well worth pursuing as attempted by this scheme for a university campus where the layering of spaces and building elements smoothen the transitions between inside and outside (Mogali 2012).

Fig. 8
This proposal for self-sufficient social housing in Bangkok, Thailand, 13° 45’ N 100° 29’ E, draws its inspiration from the life and built form of the Thai vernacular; it eliminates the use of glass on external elevations replacing glazing with screens that are permeable to airflow and light while protecting from direct sun (Tedkajorn 2013).
A shortlist of essentials

1. **Learning from precedents** by taking existing buildings as case studies, combining fieldwork and computational studies. What makes a good environment for occupants, what worked, what did not turn out as expected.

2. **Learning the principles** with a taught course covering the basics is essential and must slightly precede the introductions to any software.

3. **Learning from computational tools** as the fastest and most effective means for contextualising knowledge and for generalising the findings from other sources. However, skills development and meaningful application critically depend on experienced support. To be introduced from first year.

See also the following:

4. **Basic numeracy is essential** as protection from errors and to help provide direction.

5. **A sense of judgment** to avoid splitting hairs and wasting time.

6. **Global principles, local applicability** something working well in one context may not work the same or at all elsewhere or in the future.

7. **Understanding the climatology of the urban environment** millions of buildings and urban blocks around Europe requiring urgent attention.

8. **Daylighting & solar control** these are generally poorly understood by students and will require special teaching effort and support.

9. **Thresholds, transitional spaces, boundary conditions and variable properties** where architectural and environmental becomes one and the same.

10. **Lifestyle trends, technical developments, climate change** good topics for imaginative speculation and futuristic architectural utopias.

References


Education:

Top Ten Environmental Objectives for Studio Design

The range of knowledge and skill needed in environmental design is so great that a normal undergraduate course in architecture can hope only to sample it.

Nevertheless, studio teachers can make students aware of a set of environmental objectives that should become second nature for them.

This theme asks for a shortlist of essential objectives that will equip students to design buildings fit for the future.
I Know that I Know Nothing; the Need for Scepticism in Environmental Design Education

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This paper argues that the way environmental ambitions are presented to architectural students should change, and suggests a possible shift in approach. It is a personal view drawing on the combined experience of three course leaders from the environmental design masters suite at the Welsh School of Architecture, Cardiff University, which has reached its 20th anniversary this year. Between them they span three stages of the suite’s development from its inception to the present.

Whilst the case for giving attention to environmental issues in design has become increasingly compelling over the last 40 years, it has gone in and out of fashion amongst students, each new enthusiasm eventually waning. At present it would seem that the necessity for environmental design is widely recognised, and at the same time there is an apparently sustained fashion for it. So it might be thought that the hardest part of the work of environmental education is over. However, this does not seem to us to be the case. As we see it, the popularity of environmental design has itself given rise to endemic shortcomings of two kinds:

• a superficial espousal to the notion of sustainability by designers who lack true commitment (which takes various forms depending on the designers’ real motivation, such as publicity green-washing, obfuscating techno-babble, political cynicism, inspiration taken from false leads, and box-ticking for environmental assessment);

• poorly performing proposals from those designers who do have true commitment (again with varying explanations, such as design incompetence, misinformation or poor data, failure to predict future change of one kind or another, inability to take into account how the occupants choose to behave, use of non-validated simulation software, unrecognised problem complexity, and intrinsically insoluble problems).

We see these shortcomings in student project work, even in the work of students who have chosen to specialise in environmental design at master’s level, and continuing through into practice. Sadly, there are always students who appear to have misunderstood at least part of what we teach when they reach the end of the course, even as we adapt the syllabus and the teaching methods to reach them. We believe that it is a good time to ask whether more radical change is required, focussed on what we should be telling students that environmental design is really about.

The suggestion we are making is that environmental design should be taught through an appreciation of the risks, difficulties and unknowns, rather than through the pursuit of apparent certainties. Although this may, at first encounter, imply a jaundiced view of environmental design education, our aim is to restore the specialism’s image and substance in both professional and epistemological terms.

**Twenty years of pedagogic experience in environmental design**

We hope that what we suggest will have relevance to the teaching of environmental design in other places, but we cannot know that it is not already the common approach elsewhere. Before explaining our suggestions for change more fully, we should outline our own present approach to teaching environmental design. We began in 1993 with a single master’s course on the environmental design of buildings. This was later joined by a second course that gave greater emphasis to the sustainability content and a third that expanded the modelling content. Two new courses majoring on mega-buildings and on historic conservation respectively, are to follow shortly. So far,
we have two streams in each course, one for formal tuition and one for project work. There is a core set of modules in the teaching stream common to all the courses. The taught modules tend to emphasise more holistic approaches to site, fabric and services, over more analytical ones to heat, light and sound, but inevitably treat the detail of lighting, thermal and acoustic design separately. The project stream invites students to learn by design on whole projects. They have a good deal of freedom to choose their own sites and specify for themselves the activities it is to house. The over-arching briefs emphasise analysis and resolution of mismatches between what is available on the site and what is required for the activities. Assessment is focused almost exclusively on environmental matters.

We have always been respectful of the uncertainty inherent in this field. But students are in the habit of expecting firm knowledge and definite appraisal, and we have been complicit in attempting to deliver them, or what passes for them. At the same time, the advancing availability of sophisticated software increases the illusion that accurate predictions can be made of how building designs will perform. Adapting to this pedagogic regime, students tend to base their design decisions on just those issues they have the means to address, whilst underplaying those they have no software to tackle.

Such dependence on formulaic solutions seems unreliable to us. We prefer to believe that students should base their proposals on the best evidence available, where ‘best’ refers to that most appropriate to the question being asked, as argued by Moore and Geboy (2010). This leaves the door open to a wide variety of legitimate sources. Only where these sources can provide objectively determinable outcomes, should such outcomes be sought. Where the best available evidence will lead to more uncertain outcomes, then this is appropriate.

The idea for this paper was based on persistent inadequacies in student performance. One of the most significant shortcomings observed in student projects is reluctance to consider complexity that is likely to be caused in the built environment by variations in spatial use taking place through time or by interactions between the environmental requirements of these activities. Consequently design ambitions are not clearly stated and limitations of design approaches are rarely acknowledged. This deficiency in diagnosing the breadth of the environmental design problem results in superficial prioritisation of design aims, blind reliance on software output and allied reduction in true understanding of environmental challenges and associated design responses. The resulting design not only has an environmental performance destined to disappoint, but also faces an identity crisis, as it has shifted towards a new and promising direction but has stopped part way.

These defects make assessment and feedback preparation a challenging task for educators. That they occur in dedicated postgraduate programmes is a particular concern. It might be taken to suggest that more should be taught on such courses, or that project work should call on students to demonstrate more of what they are taught. This does not seem to us to be the most pertinent solution. Exhaustive application of all taught concepts into project work is neither possible nor appropriate. This is even more true for undergraduate courses than for postgraduate courses. But if there is a danger in undergraduate courses that students attach too little importance to environmental matters in projects, there is a corresponding danger in postgraduate courses that they attach too much, making them oblivious to other contradictory issues that would need resolving in practice. The main challenge for instructors is to main-
tain the emphasis on a broader perspective while encouraging the use of techniques that provide in-depth answers.

Embracing volatility

The environmental brief

The first strand of the suggested approach concerns the presentation of the project aims. It proposes framing the environmental brief, in parallel to the architectural brief, as a scenario describing the uses to which spaces are put and their variation through three-dimensional space and real time. For the environmental designer this would imply a dynamic situation, ask for a more detailed inspection of variants, and bring emphasis to aspects of environmental need that go beyond the usual set of engineering targets for light, heat and sound.

A call for a more focussed environmental brief is not new; Hyde et al (2007) have discussed the significance of the environmental design brief in achieving truly green design. What they portray is an “orderly design process” (2007: v) that leads to “the adoption of ecological principles to underpin the architecture” (2007: 5) in contrast to practices that are “superficially green” (2007: 16). In their suggested method, the formation of the environmental brief starts with preliminary brainstorming sessions between all parties with an interest in the building construction. Then policy targets or environmental assessment tools become the vehicle through which the brief is shaped and communicated to the multidisciplinary team or to clients. However we take this concept even further, highlighting not just the importance of holistic design approaches, but also the value of volatility, which is a crucial characteristic of the built environment. Hence our emphasis on what we call a ‘scenario’ for the activity, which attempts to embrace as far as possible the many directions in which that activity might want to move.

The activity scenario can be seen as a model of activity in space and time. There are obvious difficulties in trying to present necessarily unpredictable behaviour as a time line, and an analysis of the frequencies with which different situations arise would be an alternative way of presenting the data. The environmental parameters that impact on the behaviour should be examined as widely as possible, hour-by-hour through the year, from place to place, taking in the whole of the space, and different occupancies and occupancy patterns. Initially the objective is to expand the designer’s awareness of possible needs. From that position, the designer needs to set limits on parameters which will influence the building design, and prioritise those parameters to which the design should give emphasis.

The benefits of having such a model are that, when it comes to design, it holds the promise of investigating the interaction between the activities and the varying patterns of light, heat and sound in the space in far more depth than is usual. We look forward to a time when appropriate software has been developed for doing this comprehensively, but its absence should not be an excuse for failing to attack the issues. The driving aim of this approach is to lay bare the uncertainty behind design specifications and the difficulty in meeting all of them. There is a creative aspect to this. A useful scenario will be one that offers an understandable representation of the activity, but whose simplifications are robust to its needs.

Uncertainty can give rise to complexity, in that at every node of uncertainty, there are several possible branches, which have to be related to the several possible branch-
es from other nodes of uncertainty. There are two ways of coming to terms with this. The first is to contain all the uncertainty in a straightforward deterministic package which speaks in broad terms of what we can be certain of – this is the business of manual calculation and energy balance techniques. The other is to acknowledge the uncertainty, as revealed in more detailed modelling, but to learn ways of presenting it without falling into confusion - a scenario approach seems promising in this respect. The point is that students should be approaching their investigations of performance at both levels at the same time, one looking at invariant packages, the other at the alternative futures at work within them.

It may be argued that a similar scenario-based approach to establishing design objectives would benefit all members of the design team. So its success would be highly dependent on recognising clear distinctions between the roles of the environmental designer and that of other professions in the common pursuit of sustainable design. The imaginative contribution to designing futures made by the environmental designer should be different to that of other professionals, in order to facilitate a productive exchange of ideas between them as they work towards a common vision. This aspect draws attention to a supplementary need on courses for innovative teaching to establish awareness of what other disciplines are meant to be doing and what problems are likely to be encountered around the design table:

- should we be training environmental designers for a separate role from that of more established professionals?
- where are the differences in responsibility between professionals and what are the gaps between them?
- what is the balance of interest in cases where conflicts arise between the different professionals’ analysis of futures and their consequent preferences?
- what are the criteria that should ideally be followed in making a choice between them?

It may be challenging to convey something which is not even clearly resolved in current professional practice but there is value again in discussing the uncertainty. In the broader sense, establishing a clear role for environmental design gives it a firmer place in the principal design arena. Expressing that role in terms of satisfying a design scenario offers common ground.

Returning to our present courses, it may be helpful to underline differences between what happens on them and what we are suggesting here.

The preparation of an activity brief is left to the students, who usually choose for themselves what they will design for. A constraint that is given in many project briefs is that the activity and the site they choose should have a manageable degree of environmental incompatibility, so that there is a design problem to be overcome.

Our project briefs always already ask students to think hard about the activities they are designing for. The notion that the raison d’être for environmental design is to improve conditions for people is emphasised (and that the consequences that arise for the wider environment themselves matter because of the longer term interests of people). The assessment allocates marks for establishing the requirements for the activities that have to be met. And yet in many students’ work we see only lip service to users and their needs, and we see very little description or depiction of their likely activity. Instead we get numerical targets quoted from engineering guides, regardless of whether they have any relevance in designs which may be without building services.
Investigations of activity, then, tend to be relatively shallow and, indeed, the momentum developed by the project seems to militate against a milieu in which tools suitable for digging deeper would emerge. Students sometimes do present variation of activity with space and time, and this is welcomed. But reflection on any conflicts to which this variation may give rise and the allocation of priorities to assist design is rarely handled well.

The activity briefs we are shown seem sometimes to have been written solely for the presentation, and to have little relevance to the proposal. Or in some cases, the requirements they give are only those that come as part and parcel of a procedure available for making decisions. To some extent we are culpable in this, as we take the pragmatic stance that there is no point in collecting a lot of preliminary data that will not prove to be useful, and suggest a cyclical approach to design that will gather the data needed at each turn. Whilst this does not contradict the suggestion we are making, it does tend to put more emphasis on the proposal.

Our projects do emphasise environmental design over other aspects of design. They are written for students from varied professional backgrounds, for whom environmental issues are the only common ground. There is teamwork in some projects to take advantage of this, but for most projects the imbalance between environmental design and all other aspects of design goes uncommented.

It is suggested that a change in emphasis towards an activity scenario in the project brief could shift the balance between students’ various interests in different aspects of their work. By being more specific about the form the scenario should take and the kind of information that it should contain, we would expect students to give more attention to it. This should in turn place emphasis on prioritising and then planning to allow both for those aspects that can be satisfied definitively with performance simulation and for those that will need a more finessed approach.

Learning outcomes and the assessment procedure

The second strand of the suggested approach concerns the assessment of the students’ proposals. We suggest that students declare how they have handled the many possible environmental issues thrown up by the activity scenario in their environmental briefs. An explicit analysis would involve creating a ‘map’ which lays out all the issues and their resolutions as comprehensively as possible. Its comprehensiveness stems from all that is implied by the scenario rather than from only what has been included in the final proposal. The students would assign priorities to the different issues according to their relevant importance, the difficulty their analysis presents, and the confidence that can be given to the results. They would show how they have used this analysis to orient them in making their proposal. In this way, they would present us with a map of the connections between the scenario and the proposal. A more discursive analysis would come from keeping a reflective record of their design progress, with the same objectives in mind.

For some issues, the path from scenario to proposal will have full data and comprehensive software, enabling sound prediction of performance. For others, these tools will not be available. But if the analysis nevertheless demands that attention be given to them, other means will need to be found. We see this as a strength of this approach. It should restore confidence in alternatives such as manual steady-state calculations, in qualitative or descriptive methods, in the considered use of relevant precedent, in
benchmarks and standards, and in experience. For example, precedent can be regarded as a type of ersatz experience in situations where a full analysis is not possible; used reflectively it can indicate what is robust about that situation and what is fragile.

These more ‘fuzzy’ alternatives are invaluable to designers. They should in any case be used routinely to anticipate the results of more sophisticated methods; where the computer output deviates from what is expected, the reason (poor data, mistakes in setting up the model, unreliable software) is to be sought.

Students’ work is then assessed on the skill of this analysis and on how well the proposal has followed its priorities. This process encourages students to talk about being uncertain, and to admit when something could not be done. And by acknowledging the full range of needs progressed from the scenario, they are able to make sure that they have not misled themselves into making false claims.

As mentioned above, important in this is record keeping. In Hyde et al’s work (2007: 14) this is expressed in the notion of a “living document” that allows for transformation of the brief using a reflective process. In our proposed method the concept is similar but is pertinent to the educational process. The students are asked to acknowledge the weaknesses of their proposal by critically evaluating the outcome of all demands that the activity scenario makes and by documenting the assumptions they make in reaching them. Note that this does not necessitate a trace being kept of the actual decision process, although this is one of the options allowed, but rather critical links being found and defended between issues and solutions. Whilst this will emphasise the risks involved in building performance evaluation, it is expected to offer the broader benefits of restoring confidence in manual calculations and underlining the advantages of qualitative or descriptive approaches.

If students are to be expected to undertake this kind of analysis honestly and openly, there has to be a basic contract struck between the student and his or her assessors, to the effect that a defensible weakness in a design does not necessarily imply a weakness in the student’s achievement. On the contrary, if there is a weak link between a priority in the scenario and some aspect of a student’s proposal, the student is demonstrating a mature level of skill if he or she is not only aware of it but can show that the weakness is inherent in the discipline and has been compensated for in the best manner possible in those circumstances.

Returning again to our present courses, their project briefs set out criteria for assessment. Even though students can usually choose what they design, there are definite objectives that they must meet, which vary from project to project but generally run along the lines of deriving a set of requirements from the activity and the site, following defensible procedures for meeting them, finishing with a viable proposal, and presenting all this clearly.

At first sight this may seem to be little different from what we are suggesting in this paper. The difference is partly in the starting point: the scenario would be a more clearly articulated spring board for scheme development than the normal set of requirements that students offer us. But there is also the difference of having a map for plotting how the priorities arising from the scenario have been dealt with in developing the proposal. This serves as a template for assessing the work which adapts to the peculiarities of each student’s own project, different though it may be from the others.

The map sets up the design objectives for each student. It provides a firmer basis for assessment than we have at present. It reduces the problem of having to base
assessment not only on what the students have actually done but also on the rather speculative and invisible extent of what they have not done and could have done. This particular confrontation between certainty and uncertainty is never helpful for students, to whom the ‘might have been’ is difficult to explain.

Instead, a more visible dialogue between what can be done with some certainty and what cannot is put at the heart of the assessment process.

**Summary and conclusions**

Based on our 20-year experience in teaching environmental design at a masters level, this paper proposes a new pedagogic approach for overcoming shortcomings in student performance.

We observe that many current students are not inclined to state their ambitions clearly, or to prioritise the issues to be dealt with in their design briefs. They have become unwilling to acknowledge the limitations of some design approaches. They often show blind reliance on software output. Their designs promise more than they used to, but in the end disappoint. Moreover our assessment procedures tend to accommodate these shortcomings.

But do these issues suggest failure of our pedagogic practice?

Our view is that they are signs of the advances taking place in our understanding of environmental design; an over-reliance on certainty is a trend that has emerged as the discipline becomes more mature. However our teaching delivery and assessment methods need to catch up and we believe that solutions can be identified through reflective criticism.

The suggestion we are making is that environmental design should be taught through an appreciation of risks, difficulties and unknowns, rather than through the pursuit of apparent certainties. We propose framing the environmental brief, in parallel to the architectural brief, as a scenario describing the uses to which spaces are put and their variation through space and time. The students are asked to assign priorities to different areas and declare how they can best meet the environmental issues they throw up. Students’ work is then assessed on the skill of this analysis and on how well the proposal has followed its priorities. This process encourages students to talk about being uncertain, and to admit when something could not be established with certainty, which should ensure that they have not misled themselves into making false claims.

Realising this aim in the teaching process does not require a transformation of student project work (and assessment) into an onerous task. On the contrary, it helps to ensure that students’ (and tutors’) investment of time and effort will reach desired results. It is not about over-complicating the environmental problem but rather about gaining control of its complexity. We anticipate that this method would help students develop both a truer understanding of environmental challenges and an ability to make more appropriate design responses.

**References**


Eco Strategies:  
10 Imperatives  
for an Ecological Approach
The 1973 petroleum crisis demonstrated the dearth of natural resources. The greenhouse effect, the CO₂ emissions, the exhaustion of fossil fuel in the next 40 years, the energy problem and pollution have become fundamental themes of the awareness of every single person that populates our planet. The designer cannot prescind from this. The range of knowledge and competences that concern the environmental design is very broad but there are unavoidable objectives that every didactic proposal, therefore every project, should establish to do.

Concerning this, a methodological proposal for the environmental design is presented: 10 imperatives for 10 objectives to pursue in didactics.

This proposal arises on the basis of the experience gained previously as a student and later as a PhD candidate and teaching assistant in the design and computer courses coordinated by Antonino Saggio professor at the University “La Sapienza” of Rome. Other essential experience for this paper was the Master 1: cultures constructives et éco-habitat, at the ENSAG (École Nationale Supérieure d’Architecture de Grenoble).

### 1. Think like Part of a System

For human beings the fact that the world in which we live is a complex system in which geological, ideological, atmospheric and human phenomena represent an interactive set of forces and forms has to be a fundamental argument.

According to the 1866 definition of the German biologist Ernst Haeckel, Ecology, a term that is often overused, is exactly the “science of the relations of the organism with the environment, including, in, in the widest acceptation, all the conditions of existence.” But the systemic conception of the environment belongs to modern ecology and was theorized by the English ecologist Arthur Tansley in 1935. The first scientist, however, to theorize that the earth was a giant organism in evolution, in his book The Biosphere, was the Russian mineralogist, radiogeologist, geochemist Vladimir I. Vernadsky in 1926.

We have to imagine our planet as a network, “an extraordinarily complex and interlinked set of phenomena in continuous evolution”, of elements and/or subsystems, that cooperate by means of reciprocal relations and behaves as a whole, according to its own general rules. To vary an element means to vary the whole system.

All modern history has been characterized by an anthropocentric vision of reality according to which man is above nature. A mistake that is often still made today and that led man to exploit the resources of our planet unlimitedly. It is necessary to contrast to this a vision that sees the human being as a simple part of whole, much bigger, no longer lord and master but “defender of nature and of life”.

As regards this, human habitat has to be considered as an extension of the Gaia conception moving the mechanistic paradigm towards the systemic one: “from a conception of architecture as a machine to live in to another that sees architecture as a living organism immersed in a network of relations able to influence it”.

### 2. Contain the City

The city has lost its borders and the territory seems to be submitted to a “settlement dissemination”.

The city has lost its borders and the territory seems to be submitted to a “settlement dissemination.”
While the cities continuously expand wasting agricultural land and valuable areas, the “down areas” increase. The unusable empty spaces, the concrete skeletons and abandoned building, the ex industrial and productive places (brown areas), the old quarries, the degraded areas crowd the city. Only in Rome, the abandoned buildings occupy an area of 1200 hectares. Besides this it is necessary to take account of the existence of an underground world, already widely structured, totally unused.

The recovery of these “urban wreck”, together with the use of the subsoil, can represent a necessary strategy to block the incessant consumption of the soil and to requalify fragments of the city or entire cities often lacking in services, in meeting spaces, areas used as parks, places of residence for young people rather than structures for the treatment of waste or atmospheric pollution and the production of renewable energy.

The above-mentioned areas represent above all an occasion for the processes of densification that do aim at revitalizing accurately these urban voids through hybrid projects, multifunctional, able to activate new ecological, economic, social and productive processes, but that above all represents an urban strategy for the transformation of entire cities in self-sufficient “eco-cities”. In fact, the urban void, if interpreted as the knots of a net, can represent those key points, diffusely spread on the whole metropolitan territory, where it is necessary think about interlinked smart-projects, structures able to produce energy and to dump waste produced by the urban metabolism, totems that moreover represent the paradigm of a sustainable contemporary city.

Many European capitals are moving in this direction.

3. Rebuild Nature

The landscape as an architecture and urban contemporary paradigm, inevitably, leads to the reflection that architecture can respond to the programmatic, functional, structural and aesthetic needs as well as the environmental ones. Reconstructing nature as a work program, as a reminder of ethics, is necessarily among the main educational objectives of the architect, who has the ability to pay off the debt incurred in the modern era with the Planet. If the industrial society had to dominate and exploit the natural resources, the society of information can enhance it. Artifice and nature in this sense can hybridize making it difficult to reap the limits.

The architectural and urban project must be the occasion for the recovery of the biodiversity context, for the establishment of ecological corridors, for the continuity of vegetation or simple green lungs for the decongestionated cities. You can create hybrids capable of constituting a new contemporary landscape in which nature plays a fundamental role in cities and predominates them: an integrated city when the activities of contemporary society are intertwined with a substantial presence of nature.

But be careful. This is not to design the decorative element, the roof garden of Le Corbusier or the enclosed park of the zoning. “The nature of landscape in this concept is not the floral or liberty one, not even that of the masters of organicism. It has become much more complex, much poorer, more hidden, as Heraclitus already said, and is probed also by architects with an anti romantic eye through the new formalisms of contemporary science (fractals, DNA, atoms, the jumps of a expanding universe, the relationship between life and matter, etc.)”. In this regard it is necessary to study the logics that govern it, to investigate the evolutionary and relational mechanisms.
to conceive new projects that include the reasons and dynamics both from a material and an expressive point of view.

But architecture after becoming landscape itself can become a natural landscape as well as a reactive, animated and live landscape.

4. Design Smart Creatures

On the origin of species of 1859 Charles Darwin hypothesized that the individuals over the generations evolve to adapt to the environment. Physiology instead studies how organisms that are in extreme conditions adapt their body so they can survive. In the same way the individual behavior and social habits of the population adapt to the conditions in which they are.

To think about the project, whether it deals with processes or a building, as an organism that interacts or adapts to the environment in a way not different from that of human beings, has to be a challenge for every designer considering the awareness of the preservation of our planet. The intelligent use of computers and a creative use of technologies make it possible to conceive smart-creatures, performative architectures able to respond, change and evolve in relation to multiple context parameters in order to preserve the different existing ecosystems. External inputs are perceived and processed and give origin to outputs that represent the final behavior. To absorb fine dust, produce energy, vary interior spaces or even move in relation to sunshine or lighting are only some of the behaviors that may characterize the building.

Therefore architecture has to become an “intelligent thing”, attached to the context, technologically efficient, a form that facilitates the effective and responsible behavior towards the environment and the community.
5. Conceive Relations

In this logic, the architectural object can not be the modern abstract object indiscriminately placed on a tray or any preconceived typology but the result of a procedural approach that shows the role of the “genetic code” of the project in the diagram. The designer must think of the architectonic object not in absolute terms, but in terms of relationships within a “dense context of numerous, multi-layered factors”11.

Architecture must be parametric. And by “parametric” we do not mean a mere formalism, or the application of advanced digital technologies, or the use of specific software in the conception phase of the project as mistakenly you can think, but “a different way of thinking in relative rather than in absolute terms. To define geometry as a system of relationships rather than fixed dimensions ... [The architect’s work must be designed] through multiple geometric and relational pegs - different elements appear as to influence each other - in order to develop this and overcome a purely sculptural [or typological] outcome”12.

In the 50’s, even before any parametric software was available, the Italian architect Luigi Moretti along with the mathematician Bruno de Finetti had defined parametric architecture. They refused typological references, pursuing the idea of generating the shape through rigorous geometric relationships between quantifiable parameters, relative to the optimal viewing.
6. Create Model

This first decade of the twenty-first century has been characterized by the development of parametric software that revealed, on the ground of a previous theoretical basis, the importance of the process in architecture, offering many possibilities to the designer and always more accurate tools.

The big news that the computer revolution has brought is not only the possibility to create projects conceived as a complex system of relationships, which should be a well-established practice by now, but rather the creation of models that actually are nothing more than complex algorithms able to describe various phenomena.

The objective of teaching, and therefore, of the designer, must not only be the development of an individual project able to solve the crisis in question but, rather, the development of models on one side as strategies or modi operandi to attack the problem and on the other as real hierarchical computer models able to interconnect and control a large amount of information for a better optimization. Intervention strategies and models that, as the scientific ones, do not provide the specific solution but a list of solutions to changes in the parameters examined. “The interaction and adaptability of computer modeling make the process of optimization smooth and uninterrupted: within a developed diagram one can swap, exchange and transform continuously the data and point of view, without in any way affecting its functionality and efficiency...of process via: data entry - analysis - generation - testing - to then return to the upgrading of the equation with a new wave of updated data and targets in order to reach the required optimization.”\textsuperscript{13}

Ben Van Berkel stresses the importance of the models even talking of “Digital Sustainability”: “Managing the mother model reduces the risks of mistakes and miscalculations; it helps to achieve an economy of materials, and make the building process controllable. It is called digital sustainability”\textsuperscript{14}.

Fig. 3
Laboratory of architectural design, Gabriele Stancato student project, Antonino Saggio professor, Rosetta Angelini, Gaetano De Francesco and Giovanni Romagnoli teaching assistants, University Sapienza of Rome 2013.
7. Reduce, Reuse, Recycle

Every project, whether it is territorial, urban, architectural or design, has a relapse in terms of environmental as well as social and economic development in the area. A good project maximizes the result aimed at minimizing consumption in order to preserve the economic and natural resources. To evaluate a project means considering its entire life cycle, from design, production, use and disposal, the actual costs for the community. Breaking down the costs of a project for a community means to exploit local resources, possibly natural, promote a zero kilometer supply chain and green building, involving companies and craftsmen of the place.

European policies are driving more and more towards the reuse and recycling in order to avoid compromising the resources of future generations and also create new jobs. The principle of the 3Rs should be a foundational architecture strategy that needs to rethink how to reuse material, artifacts and industrial components and recycle the waste of society. Currently Denmark, Holland, Belgium occupy the top ranks among the largest recyclers in Europe: in the construction of their buildings they use 90% of recycled material.

Moreover, today, there are many experiences, above all education, of self-constructing new housing models, participatory processes, contemporary metaphors that appropriately regulated could represent a viable alternative to the housing problem. This subculture that is based on the principle of do-it-yourself for greater economy and ecology expresses a renewed ethics towards social needs and the environment.

Fig. 4
Wood prototype construction, Master 1 Cultures constructives et éco-habitats, Pascal Rollet professor, Grands Ateliers Isle d’Abeau, ENSA Grenoble 2011, Alice Gras photo.
8. Look at Technologies

The continuous technological research should be common practice among architects. Architecture is confronted with the most advanced research, from biology to engineering and new fertile areas of overlap between multiple fields such as morphogenesis, bioengineering, nanotechnology, which offer advanced possibilities that were unthinkable in the past. The advanced scientific research often generates imaginative shots that lead to entirely new original architectures in which technology itself often becomes the unquestioned leader in the project.

Information technology and the continuous technological development, with an increasing miniaturization and robotization, make architectures more and more efficient. Embedding the most sophisticated technology in construction transforms the building into a complex robotic machine in which building components, such as cells of an organism, are small processors of information that aggregated together constitute the entire body of the building which thus becomes adaptive and reactive.

Piezoelectric systems for energy production rather than the simplest photovoltaic cells, photobioreactors based on algae, microalgae for the production of hydrogen, sands coated with oxides of graphite to make the water potable, poliuretanic treated foams with nanotechnology for the purification of the same, micro wind turbines, concrete that absorbs CO₂, Etfe membranes filled with nitrogen for solar variation, fluorescent paints, self-cleaning, Arduino boards for interaction, are only technological examples that can be part of the architectural design.

9. Look at Tradition

In addition to the most advanced technological research, an attentive eye to the traditions rooted in the culture of the people, is necessary. The recent attention to the environment has led to the reopening of a very interesting research that sees architects, engineers and craftsmen strive together for a common cause. To resume construction techniques, typical of spontaneous architecture and reinvent them in what are very often defined bioclimatic solutions, is a growing custom of great architects.
The agricultural society has adapted its way of living to the environment, while the industrial society has forced the environment to its way of life. The spontaneous architectures have been able to operate a successful synthesis between climate, form and matter obtaining everything you need from the surrounding environment and experience. The Master American architect Frank Lloyd Wright said: “All the popular buildings belong to the ground, natural though often fragile, and their qualities are related to the context, the authentic life of the people.”

The spontaneous architecture designed and built by the community, families and individuals, linked to environmental contexts, the specificity of the place, the resources available, in harmony with the values, with the economies and lifestyles of cultures that have produced it, now represents about 80% of the existing buildings in the world. More than two billion people in 150 different countries, about a third of humanity lives in dwellings such as raw land. In the West, the planning provisions restrict these buildings. Unlike Asia, Africa and Latin America where the spontaneous architecture is still alive and the traditions of our ancestors are not marginalized, lost or abandoned.

The Iranian wind towers, the trulli of Puglia and the dammusi of Pantelleria, the Andalusian cliff dwellings and caves of Matera, the Chinese underground dwellings, the Eskimo igloos, the Japanese Minka, howitzer homes for Mousgoum ethnicity, Yurt of the Mongolian nomads, the Tongkonan of Toroja people, the Peruvian houses Uros, must be a source of inspiration for architects.

10. Cooperate

Too often we fall back into the sectoralisation of knowledge that if outdated conceptually seems triumphant in practice. It is necessary to promote an integrated composition aware of the issues of sustainability in its many forms. The approach must be induced to the complexity of the many facets of the topic, from the social up to the economic ones.

The traditional figure of the architect, in his study to design his own project, should be replaced by the contemporary one that is continually confronted with the
multiplicity of professionals involved in the design process and the various disciplines: a “nerd architect” can handle a large amount of information employing complex models, parametric, through which he can entirely control the processes of designing, verifying their accuracy in real time together with the different engineers brought up, and the processes of construction, in order to optimize an architecture that must become more and more an ecological machine label.

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A ´Laboratory Approach´ to Integrate Sustainability into Architectural Education
Teaching sustainability in architecture can only be successful if sustainable thinking and design methods are integrated in the architectural program across a School of Architecture. ‘Add on courses’ and ‘add-on programs’ proofed to be insufficient on many occasions for generating a sincere profile.

In consequence, the process of integration of sustainability is a team process. Teachers in sustainable architecture can only reach high goals in the implementation of sustainability by seeing themselves not as something ‘different’ or ‘special’ in the curriculum (which would only correspond with the not working add-on mentality) but as the ones who connect diverse and various sustainable agendas with different programs, studios and projects across the school. Like architecture, sustainability is a question of culture, how we respond and engage with our natural and social environment. Architecture primarily is about space and not, as seen so many times, about isolated technology. The same must be said about all sustainable architecture that wants to mean more than an empty green-wash label. Schools of Architecture must not educate ‘better engineers’, but designers with artistic, social and political ambitions as well as team players with an understanding for radical approaches and new forms of transdisciplinarity outside the mainstream. This does not exclude the transfer of knowledge in technology on an advanced level! – but it requires a strong discussion and understanding about the relationship between space and technology. It requires the need for training complex and integrated design processes to achieve more sustainable results.

Seeing the changes in the profession to come, with locally high rates of unemployed architects or architects marginalized in their impact on decision making for the built environment - students must further be prepared to radically new forms of practices: Challenges and needs of sustainable architecture not always have a ‘client’ dropping into an office - on the other hand billions of people around the globe have a growing necessity for sustainable design solutions on affordable dwellings, sanitation, urban design including food production, just to mention a few. But they have no access to a designer.

The master program ‘Laboratory of Sustainable Architectural Production’ (LSAP) at Umeå University was developed in that spectrum since it started 3 years ago: We work on all scales of design and in close relationship as well as in critical distance with cities and towns who want us to help them developing a ‘sustainable profile’.

We do the exercise ‘integrate design methods’, by forming transdiciplinary project teams of students and teachers of architecture with students and teachers of engineering, sociology, biology, economy and medicine. This pushes forward the architectural projects as well as their environmental content, demonstrated by some examples in this case report.

Besides working with most advanced digital simulation tools, we built up a physical laboratory equipped with an LED daylight studio, a heat chamber, soon a wind channel and an energy independent aquaponic plant.
Philosophy of LSAP

‘The pluralism of sustainable architecture(s) is, no doubt, a perceived obstacle to those who would standardize a set of ‘best practices’. Our position is the opposite, that the diversity of tectonic practices is – like biological diversity itself – a necessary if insufficient condition to construct a sustainable built environment.’

Simon Guy and Steven A. Moore, ‘Sustainable Architectures: Natures and Cultures in Europe and North America’ (Routledge 2005)

Taking this for granted, education and research in sustainable architecture must immerse into all fields of architecture and into a universe of different disciplines, connected to our built environment.

It is a statement against predominant simplifications of the complexity of architectural strategies in their relation to society and the environment. Schools of Architecture with a serious sustainable agenda must oppose ‘tick-box thinking’, regulatory madness and the idea of unifying ‘sustainable norms and codes’.

To bring it to the point: ‘Labeling’ helps money business, but improves neither architecture nor the environment. So why teach it as a tool instead of revealing its unproductive character?

We wrote on our homepage:

Sustainable Architecture is not about buildings as such. It is about the living conditions of humans now and in the future. In its essence, sustainability is about survival, although at the moment it is the most misused term not only in the building sector.

On the field of research in sustainable architecture, which should be the base for education, we find a growing number of interesting papers, books and conferences.

However, it seems to us an obvious obstacle, that the majority of the themes and activities of these papers and conferences exclude architectural space and predominantly focus on energy efficiency, sustainable materials, green roofs etc. This research, though useful for different aspects of architectural projects, in many cases misses the artistic potentials, the creativity and innovations needed to generate truly sustainable cities, buildings and environments.

When narrowing research as well as education to these fields of what I call ‘environmental symptoms’, the architects/researchers/students involved tend to act like ‘advanced engineers’ for sustainable construction. No doubt there are merits, but it cannot produce sustainable architecture, where art meets science.

It seems comprehensible, that such a technological focus is not attractive to future designers with artistic, social or and political ambitions – among teachers and students. It is a key task in our education, to widen the angle, to promote sustainable architecture as a necessary intertwining between cultural, environmental, social and economic goals on all architectural scales and in all phases of the design process.
Recently, ‘climate responsive design’ became a new slogan. But what does ‘climate responsiveness’ mean and how should it develop without the urging context to what I call ‘resource responsive design’ and ‘social responsiveness’?

Is a zero energy building using toxic materials or built in a polluting building process ‘sustainable’? How do people accept or like these buildings? – which is one of the preconditions to keep buildings long life. Can people afford these buildings?

The challenge of educating sustainable architecture starts when we enter the field of art, but we cannot avoid entering this field if we seriously talk about architecture.

Architecture is art and science. They both produce new knowledge. Architectural design condensates knowledge, experience and skills into something new and at the same time in a dialectical process, it is an autonomous form of knowledge production by testing.

Our ‘Laboratory of Sustainable Architectural Production’ is in the first instance a laboratory, a space for experimenting, for testing, for looking into the future, for bringing things together which are commonly separated.

ignore conventions!
start something new!
dare to be wrong!

This appeal of Nobel Prize winner in medicine of 2009, Elizabeth Blackburn and John Michael Bishop, describes our motto. Design is always a balance between ignorance and expertise in a complex subject. It works on the conflict between spatial, organizational, scientific, technical, artistic and economical dynamics. In LSAP, we do teach our students what commonly is seen as the ‘state of the art’ in ‘green building’. But only ignoramuses may think that today’s ‘state of the art’ is good enough for a sustainable future in a world of 7 billion people, according to UN every 4th living in an informal settlement.

Secondly, LSAP includes the word ‘architectural production’. We ‘produce’ sustainable architecture, it is about ‘doing’ projects, strongly connected to society, in some cases ‘hands on’ and in scale 1:1 - and we communicate them to society.

Architecture should be regarded as a form of intervention in the environment, and architects have the ability to affect people’s physical surroundings. Architecture is an aesthetic practice producing physical objects and structures to enable and improve everyday life. For that reason architects have an aesthetic and social responsibility to participate in the development of a sustainable future.

(homepage Umeå School of Architecture)

Curriculum and structure of LSAP

LSAP is a 2-year master program at Umeå University which started in autumn 2010. The master program began only one year after the new Umeå School of Architecture opened with its 3 years Bachelor’s program. Therefore all master students at the be-
ginning were ‘external’ from 12 different countries. The whole master education of LSAP is in English and limited to 30 students each year.

Students apply with their portfolios. Out of these applicants, we had accepted about 25% for the program in the last 3 application periods. Students from countries in the European Union do not have to pay study fees in Sweden, while there is a very high study fee since 2011 for students from outside EU.

**LSAP semester 1**

The education starts with the introduction lectures and a seminar about theories on sustainable architecture. Philosopher, biologist, climatologist, urban economist and architect present ideas and research in sustainability. TED - lectures with very contradictory opinions are collectively debated. Each student prepares a poster presentation what she/he considers a great piece of architecture of their home town, no matter what use or when it was built.

After this ‘warm up phase’, we step into the project phase. All education at UMA is based on project based learning. It is a specialty of semester 1, that we run 2 very different but intermeshing projects parallel. This was seen with great skepticism by some teachers but it proofed to be successful over 3 years now:

‘eco commune’ or ‘eco city project’

We start with a large scale project, where students investigate a town or city from all angles. Each year, we choose a different Swedish town, all of them with a proclaimed ‘sustainable agenda’. All assets as well as the specific problems of these communities were investigated and documented. The final outcome is often radical strategies for sustainable transformations and interventions, discussed with politicians, city planners and in meetings with inhabitants.

This ‘eco commune’ project is the common thread of first Master’s semester but it is interrupted by a 5 week bloc of a ‘typology project’, closely connected to intensive workshops about different tools for quantifying sustainable goals.

‘typology project’

The ‘typology project’ is an ‘analytic project’ with no design assignment. The students analyze existing and ‘prototypic’ buildings such for example the Unité d’habitation or the Viennese Karl-Marx-Hof or vernacular buildings in a hot climate. They study the history, ideology, context, spaces, use and change, construction and material use, economy etc. of these projects and their impact to architectural history as well as to the environment.

Along these projects and as part of the analysis, they learn 3 professional tools presented by external specialists:

a) Life cycle assessment with software of Technical University Darmstadt (Joost Hartwig / chair Prof. Manfred Hegger).
Fig. 1
Model of Umea city center in scale 1:50, total size 20 x 13 meters, situated in the entrance hall of Umeå School of Architecture. By the scale and size of this model, the students could work physically in different courtyards and urban waste spaces, which they had chosen for their interventions.

Fig. 2
Umea school of Architecture has the first daylight studio worldwide run only by low energy LED. This was developed with ERCO and was itself an experimental project.
b) Thermal simulation of the buildings, from 2011 with advanced software ‘transys’ by transolar Stuttgart/Munich. Here the students also learn in a playful way how the same building performs in different climate zones. The workshop is accompanied by practical exercises with thermographic cameras.

c) Daylight simulation and investigation in the daylight laboratory.

d) There is a wind channel in preparation phase, which gives our students the opportunity to test turbulences and natural ventilation of their physical models during an ‘aerodynamic workshop’.

By discussing as well as simulating buildings, which are not commonly considered being ‘green buildings’ from all those different angles, the students reflect on the (sustainable) substance in historical architecture from a holistic point of view and question unproductive and artificial divisions between ‘green buildings’ and architecture.

A further-reaching educational goal is to enable students applying these tools in their own architectural design projects.

**LSAP semester 2**

The building design project of semester 2 is based on the ‘ecocity project’.

Therefore the students know already the context and all aspects of the site, which they were free to choose. They are asked to develop a coherent program for their site, based on public needs they found during semester 1.

Most students in the past developed hybrid buildings like schools connected to a food market, the upgrading of buildings at a neglected water front or a ‘body and spirit’ project, connecting a much needed library to a much wanted public swimming pool. Together with the large scale proposal of the first semester, the students present and exhibit these projects in the town they were developed for. This was leading to very successful exchanges of ideas with politicians and a relevant number of inhabitants.

From 2012, we formed transdisciplinary student teams between our students of LSAP with students of structural and energy engineering of the technical faculty. There were start-up problems, which reflected a common attitude that engineers start ‘calculating’ only after a design concept was presented. They were not prepared to be a player in the design process from scratch, developing these concepts in a strongly collaborative way from beginning.

When overcoming this barrier, I am confident we find a solution for another major problem:

Most design projects had a strong idea of cultural and social sustainability as well as a fresh aesthetic. But environmental sustainability was not on the same level. The advanced simulation tools the students had learned in semester 1 were rarely used parallel in the design process for generating buildings with optimized environmental performances. The thermal simulations or daylight simulations, delivered with the final projects, were rather a documentation of a status quo than a dynamic generator in a creative process.
Fig. 3
Proposal for interventions of densification in Umea city center, including documentation of simulations.

Fig. 4
Testing the thermal performance of ‘Lupotherm’, only 3 cm multilayered thermal insulation equivalent to 35 cm conventional insulation. The material is based on the principles of thermal reflection. The long-term test was done by students with our self-built heat chamber.
Fig. 5
Bridge over a river in Virserum/Sweden with 12 meters span and 16 meters length, out of boards 16 x 4 cm, only applying geometric connections and using hand tools. The bridge was designed, built and set on place in 6 days.

In the second semester, we offer 3 workshops and an extensive study trip. The workshops are on structure, construction, detail and material use, each 1 week long. Again, these workshops are closely connected to the semester project.

a) Optimizing structures.

b) Building materials. The students experiment with natural as well as ‘high-tech’ building materials like hempcrete, rice paper or thermal insulation based on heat radiation.

c) A ‘wood workshop’ as a 1:1 hands on project. In groups, the students design an experimental structure like a bridge or a tower, with minimized wooden elements, only using geometric connections and strictly avoiding nails, screws, angles, glue, ribbons etc. The structure must at least be load bearing for a testing person of about 80 kg. This is an autonomous project.

LSAP semester 3

‘Transformation’ is the focus in the curriculum for 3rd semester. The students work with an existing building inside an existing urban fabric. Reevaluation, reprogramming, retrofitting, restructuring, extension, concentration, rehabilitation, increase etc. are key activities and the students get inputs on ‘old-new’, retrofitting strategies, project management and complex logistics of such a transformation.

We interleave this assignment with the agenda of ‘hygiene and health’. It is a dilemma in developed countries, that hospitals as buildings for healing are the most unhealthy
and contradictory buildings to the environment concerning their energy consumption, waste, problematic material use, impact on transport etc. The goal is to mitigate these negative impacts and to balance contradictory parameters.

The semester starts with a one week workshop ‘healing environment’, where our students together with medical students, future nurses and students of engineering go into a hospital and analyze the patient rooms as the core of a healing environment.

Based on manifold inputs in research on ‘healing environments’, a radical new patient room is developed by the students during this workshop. This workshop is the basis for designing a transformation of a whole ward inside an existing hospital complex.

The semester outcome is supposed to be a complex and evidence based architectural project, whose feasibility, logistics and applied building methods must be tested and proved to detail scale.

This 3rd semester project is ‘interrupted’ by 2 autonomous workshops:

a) a preparation workshop for the master thesis including an introduction to academic and critical writing.

b) a 2½ week intensive workshop (including a 9 days study trip to India) on the theme of ‘water and sanitation’. Human feces and urine were handled as a resource for food and energy production and not as a tabooed and polluting ‘waste’.

Fig. 6
A student presents his hospital retrofitting project for Malmö hospital with models and drawings from scale 1:1000 to scale 1:20 to the head nurse and the responsible politician for health affairs.
This was done in the context of a Swedish city with its abundance of fresh water and in context of a semi-informal and over-populated settlement in India.

The outcome of this workshop was of an inspiring variety and it gave a hint for the need for rethinking and research of alternative water and sewage infrastructure for cities as well as on building scale.

Fig. 7
Testing prototypes of low tech composting toilets built by Indian potters in collaboration with our students during their study trip to Mumbai.

Fig. 8
Mapping of existing water and sewage system of Umeå with student’s proposed strategies for water and sanitation, including grey water use, warm water recycling and different forms of energy production.
LSAP semester 4 - master thesis

In principle, the students have full freedom of choice for the themes of their master theses, which they have to finish in one semester.

Nevertheless, based on our repeated experience that master theses had so much more substance when students chose themes they had been intensively prepared during their master course, we strongly advise and support master theses which work ‘in depth’ to these topics.

Generally, the Master Theses in LSAP consist of five different and inseparable parts:

a) a written description of its theme with reflection on its sustainable impact,

b) a profound, well documented and multidirectional analysis and research,

c) a written critical reflection on spatial, social, environmental and cultural impacts,

d) a complex architectural project,

e) a professional presentation and defense of the thesis.

We wrote in UMA’s regulations for LSAP master thesis:

*The Master Thesis is a substantial research based design project that provides an opportunity for the students to investigate in depth a subject area of personal interest related to the Master education at UMA. The Master Thesis is a self-managed design project with tutorial guidance…*

and:

*By presenting the final thesis as well as during the thesis process, the student must show artistic skills in creating space as well as evidence how this space can be seen as sustainable in a cultural, social, environmental and economic way. At all stages of the thesis process - when choosing the theme, doing the analysis, developing the architectural project, writing a holistic reflection on the impact of the project and presenting and defending the thesis – the student focuses on the conjunction between art and science.*

The first masters of LSAP graduated in 2012. Some themes were:

‘healing hospitals – upcycling the old for a healthier now’

‘dialogue between cultures and exiles’

‘Umeå wants more!’

Among others, the thesis ‘a contemplation on the rural - the mediating fish in Silva Nortica’ - is a very good example, how philosophy and methodology of LSAP are reflected in the outcome of a master thesis.

A global problem (food and overfishing) was connected to aquaponics (an alternative, semi-industrial production of fish, making use of the symbiosis between special plants with different fish). The project was placed exactly on the national boarder between Bohemia and Austria with its historic fish ponds, thus regenerating regional awareness and a win-win collaboration in a region that is divided into 2 states (till 1989 by the ‘iron curtain’).
Before starting with his design, the student did extensive investigations in such different fields like regional development and the problem of boarders, European history and political agendas in the past and now, fish production as well as an evaluation of many different sites. He showed his ability to network with politicians, fish producers and scientists. Testing a high number of variations, he designed a complex and hybrid building, comprising fish production, a fish research department, a fish restaurant and exhibition spaces. The building has a sophisticated but appropriate material and energy system and its architecture makes the concept visible and its different agendas spatially tangible.

Fig. 9
Testing phases in the four-month period of the thesis project the building responds to the state boarder which meanders at the site (red line). It excites visitor’s curiosity for exploration. In its architectural formation, it congenially misses all ‘standard attributes’ of ‘green buildings’.

Fig. 10
There is a practical outcome of this master thesis: a group of students in collaboration with students of biology have built an experimental ‘homemade’ aquaponic equipment growing fish and tomatoes simultaneous: parts of the plants feed the fish while the fish produces fertilizer for the plants. The next step this year is designing a building and build its prototype 1:1, wherein this process could work energy independently in cold Swedish climate over the whole year.
Conclusion

a) LSAP does not offer a catalogue of ‘top 10 environmental objectives for studio design’. We work on projects in Sweden and in India and we work on all scales. Because of this different cultural, climatic and social context, we focus on various issues: in one project it is water and hygiene, in another dwelling, density, transport, food and biodiversity – in a third comfort, energy, material and finite resources just to mention a few.

In any case: Architecture emerges in the conjunction between art and science. And Universities are the place to test new forms of collaborations.

‘Logic brings us from A to B, imagination brings us anywhere’ (A. Einstein)

b) We consider and support the investigations, ideas, testing and discoveries of the master students as ‘low-key research’. This accumulated knowledge becomes a generator for more profound and more extended research by teachers and PhD students - reacting upon education.

c) Our goals in implementing relevant aspects of environmental sustainability into inspiring architectural projects were only partly reached but team projects with students of scientific disciplines raised the quality. Nevertheless, the productive use of physical and digital tools of our laboratory must be strengthened: The workshop character for specific competence transfer is successful but needs post-processing during the design phase. This is difficult in practice, when qualified workshop leaders are from distant locations.

d) The direct and regular interaction with politicians, stakeholders, practitioners and inhabitants as well as the collaboration with other disciplines were not only a source for getting specific knowledge but also a stimulus for more intense work. It helps asking the relevant questions instead of starting with preconceived answers. Its results have an impact to the public and it is an exercise for communication skills.

e) The master education of LSAP is intense and focused on sustainability - there is no time and space for compensating general deficits on basic aspects in architecture of the bachelor education.

f) All graduates of LSAP so far got immediate employment in interesting architectural offices. Two started an own practice in their home country, two were accepted to prestigious postgraduate programs and one became an adjunct teacher for sustainable architecture.
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Environmental Design as a Research Topic in Architectural Education
Global socioeconomic situation has come to a turning point. A world of abundance is becoming short in vital essences. Environmental degradation is affecting multiple aspects of our lives especially in developed countries. It has become clear that the construction industry has been affected by the global circumstances, while at the same time has contributed deeply and still does, to the environmental problems. The interaction of the natural and built environment is an indisputable fact but balance has been perished. In times such, architectural practice has become more challenging since it has to respond to many different aspects that underpin our contemporary cultural and social endeavors. Building design and construction are indispensably interconnected with the natural environment. All the stages of its process have environmental implications. Architecture should reflect current needs of a society, without inhibiting the possibility of adapting on future changes.

Sustainable design is a multidisciplinary task which relates nature with buildings and invokes underlying themes that affect many aspects, political, economic, social, and cultural. How all these aspects are implemented and researched through design has more or less become apparent in the recent years, with assessment and evaluation systems, that are currently forming architectural and environmental practice.

Environmentally responsible design is a holistic approach that should respond and resolve many conflicting issues and fundamental challenges. These include the reduction of energy in use along with embodied energy, resource depletion, the minimizing of pollutants such as CO₂ emissions and waste, enhancement of the quality of the internal and external environment and the well being of the users. All the resources that will constitute a building should be considered and their impact on the environment be evaluated, while the relation with nature should be constantly redefined. Every step of the design management should be based on long-term life cycles without negotiating living standards.

**Education - The Lecture Research Project**

Apparent the architectural education should hold a leadership in this profound and constantly advancing situation and produce leading research towards that direction, aiming at innovative design that always focuses on producing buildings of profound architectural and environmental quality.

In the last two decades most architectural educators delivered courses on climate responsive design that focused mainly on lowering the energy needs in the functional life of a building. The drive is still to conserve energy, increase efficiency and create low carbon buildings, but the broader implications of sustainability only recently have become mainstream issues at the teaching procedure. Schools of architecture should provide students with all the essential tools and theoretical background that will enrich and strengthen their abilities to respond to the interdisciplinary challenge of environmental design. All these aspects should be incorporated and diffused in all disciplines of their education.

The area of Architectural Technology at NTUA, School of Architecture, has a long history on courses related to climate responsive design and energy efficiency that initiated in 1989 with an elective course on environmental design which focused on the tools and parameters of environmental design that affect the design process. In the recent years, we try to develop an educational strategy that focuses on three basic disciplines:
1. Implementation of the environmental parameters and all its constraints in the architectural design process of new structures.

2. Refurbishment and energy efficiency upgrade of existing building stock in urban areas, focusing on improvement of their environmental footprint.

3. Application of such systems and upgrades in traditional and historic buildings in protected areas, such as traditional settlements and areas of preservation.

These are delivered through both core and elective courses, which are; on the 5th semester (3rd year) the core course “Building construction study with emphasis on sustainability”, on the 8th semester (4th year) an elective course on traditional building restoration, and on the 9th semester (5th year) the research lecture project. In all three of them we try to exploit an array of issues that should be implemented on projects of new buildings as well as projects of restoration and refurbishment. These include among others, life cycle analysis of buildings and building materials, implementation of strategies for repair-reuse-recycle, ecology of building materials, environmental assessment classification systems, etc. The purpose is to educate students and help them comprehend the environmental issues and their implications and the diversity of urban ecosystems in order to sustain its balance. The objective is that they will be able to pass through such values to potential clients and institutions. In this paper we will present the research lecture project of the 9th semester. We consider this course very important since it is the first contact of the students with the research process. At this stage, they are mature and have coalesced many issues of their field of study and are ready to pursue a thorough investigation on a specific subject. During the lecture research project, they familiarize themselves with research methodology which includes extensive and elective reading of both Greek and foreign bibliography, consultation and collaboration with experts from other areas of scientific knowledge, as well as primary research (questionnaires, work on site, measurements). The most demanding part of the work is the writing stage where all the information should be expressed in an elective and eloquent manner enriched with the required illustrations and tables. The written survey is printed and presented in front of the committee and open audience.

The whole project is developed under the supervision of one or two professors. It is worth mentioning that to date, the material collected from this course represents a valuable database on numerous subjects related with environmental design which is available to future students during all years of their study. So far in the area of architectural technology we have filed a significant amount of approximately 80 research projects on environmental design that serve as a valuable academic reading for students working on their research or other projects and need further reading related with these issues.

The Essential Objectives

In the course of lecture research, the students choose a subject to pursue their research, among many, most of which constitute essential objectives on environmental and holistic design. Many of these issues where introduced and discussed in the aforementioned 3rd year core course, but a one-semester course can only deliver implications on an array of subjects while the lecture research project dictates focusing on a specific issue and elaborate extensively.
We believe that projects so far, cover a significant portion of issues related with the environment and architecture. We will present an array of them that are listed under the following essential objectives, that we consider fundamental for the current architectural practice.

**The building envelope**

Most of the primary elements of sustainable and climate responsive design relate to the building envelope\(^\text{1}\). These are the basics, i.e. thermal comfort, climate analysis, passive heating and cooling, sun motion, ventilation and the tools i.e. materials, form and orientation, sun controls, environmental controls and conflicting variables. All these parameters have been presented with extensive theory on the core course of the 5th semester and most of them have been implemented in their studio work. However, the lecture project delivers the opportunity to investigate further and in depth each one of them separately. Some of the projects that students undertook were: Solar energy and the building energy (1978), Passive Solar systems In Greece (1986), Natural lighting from roofs (1989), The use of green for shading and cooling in buildings (1992), Implementation of bioclimatic elements in houses (2008), Shading – a parameter of bioclimatic design (2011), Flat roofs and passive cooling (2007), Photovoltaics – use and implementation in building envelopes (2008), Shading devices in office buildings (2000), Building cooling through vertical elements (2010), Glass facades (1978), Bioclimatic educational buildings in temperate climate (2010), and many others.

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Fig. 1a
Flat roofs and passive cooling.

Fig. 1b
Building cooling through vertical elements.
The environment and the city

This objective has broad implications and the discussion develops in two directions. The first direction investigates the challenge of implementing environmental and bioclimatic design in the city, and the parameters which affect the urban ecosystem. Many students investigated issues such as the effect of the plazas or shaded areas in the city, small interventions, etc. The second direction stresses the need to develop the fundamental criteria in order to evaluate the built environment in all scales, targeting in energy efficiency upgrades. It has become apparent that a vast amount of work in the construction field from now on will have to deal with the energy efficiency refurbishment of the existing building fabric and thus is of prime importance to define the role of architects and the direction of legislation towards that direction. Projects related to the above, discuss: The role of the architect in energy efficiency upgrades (2013), Sustainable interventions in existing buildings (2005), Energy efficiency upgrades of Neoclassical buildings in Athens (2011), Thermal insulation in existing buildings (1979), Thermal behavior of atriums and arcades with flat covering (1994), Bioclimatic elements of the classical “peristilio” (2000), Thermal comfort under shelters in urban areas (2001), Thermal comfort in central Athens’ plazas (2003), Water as a regulatory factor of the microclimate in central Athens’ plazas (2009), Sustainable interventions in existing buildings (2010) etc.
Fig. 3a
Sustainable interventions in existing buildings.

Fig. 3b
Thermal comfort under shelters in urban areas.

Fig. 4a, b
Thermal comfort in central Athens’ plazas.
Life cycle analysis of buildings and building materials

Life cycle analysis has been recently introduced in the design agenda. It evokes many different conflicting and multidisciplinary issues that relate mainly to new construction and has many implications that architects should be aware of. The analysis examines the environmental impact of every component of a building during its entire life (extraction, production, distribution, use and disposal), by means of energy and raw materials consumption, waste and pollutants to the ground, water and air. All these parameters should be considered, from the initiation of design, during construction and use of building until the end of its functional life. Life cycle analysis is an important tool and most of the times plays a decisive role in the architects’ decisions. Therefore it should be evaluated accordingly along with cost and operating requirements. Research projects on this subject have only recently starting to evolve and thus are very few. Life cycle of buildings, a decisive parameter of environmental design (2012).

Implementation of strategies for reduce-reuse-recycle

Minimizing the need for new construction is one of the fundamentals of sustainability along with the design and construction of buildings that respond to current needs while they are able to easily adapt to future ones. Reduce, reuse and recycle are directives that respond to this philosophy, since the aim is minimizing energy use, environmental degradation from waste (new construction and demolitions), air pollut-
eans from factories and transportation, and depletion of natural resources. Reduce, reflects the use of raw materials, energy and production of waste. Reuse addresses both the whole building and its components and materials and is the ability to reuse the same entity for the same or other use. A building could be reused with no change of its initial form and with minimal interventions on the same site. Materials should be able to be reused with minimal processing if dismantling has been taken into account from the beginning. Recycle is used in architecture with a dual meaning. It can refer to the disassembly of a building in order to rebuild it somewhere else, or the use of its components in another structure. The other option is to recycle the materials for a completely different application.


Fig. 6a
The transformable and the transportable.

Fig. 6b
Design for disassembly.
Ecology of building materials

Environmental design demands sensible use of materials and reduction on waste during production and construction. Selection of the proper materials can be a challenging task since it depends on many variables and wide range of knowledge is needed. Among the issues that must be taken into account are the environmental footprint and the resource consumption during production and use. Building materials affect not only the environment, but also the interior space in means of thermal and optical comfort and influence the health of the users and construction workers. Decision making depends on conflicting variables; Natural materials or smart and high-technology, the implication of both in the design process and the construction market, as well as their impact in the built and natural environment during their life cycle (production/collection, process, transportation, recycling or disposal). Their cost and how does one get the criteria for evaluating the right choice that serves both the environment and the quality of the architecture produced. Research projects challenge many of these questions through the investigation of use of both natural materials such as wood, earth, etc. and the ones produced with high technology: The use of glass in building envelope (1998), Wood as a building material in contemporary architecture (2013), Earthen structures and construction technology (2013), Investigating the use of high technology materials in building facades (2013).
Vernacular precedents (implemented environmental attributes)

Traditional pre-industrial buildings are considered sustainable by definition since when originally built, climate was taken seriously into consideration in the layout and orientation of the building. They were usually built with local materials and most of the times fulfilled lasting needs. It has been long established that these structures have delivered valuable lessons regarding the sustainability and climate responsive design to contemporary environmental design. For that reason examining and analyzing the bioclimatic and sustainable elements of such buildings and of traditional settlements as an entity, can provide architects with important clues of a wide range on how to build in accordance with climate and place, be prudent in the use of materials and space, respect the environment and neighbors and finally use natural and renewable resources of energy. Preindustrial societies, succeeded in balancing culture, available materials and climate.

Vernacular precedents should be studied for another important reason. It helps future architects to respond in the most suitable way to restoration, and refurbishment tasks, with respect to the place, climate, culture, and the built environment. In other words it helps them develop the necessary criteria for evaluating and interpreting the ecological attributes of the protected natural and built environment for implementing conservation acts and low impact interventions.

Historic and traditional buildings reflect the cultural heritage and identity of a country. Preservation of these buildings is a narrative for every society since they inhibit valuable social, cultural and architectural qualities and most of the time environmental attributes. Energy efficiency upgrade of historic and traditional buildings should focus in preserving its qualities, along with their architectural and heritage value and maintain their ability to adapt to future changes of use and energy demand. Improving their thermal performance will improve the thermal comfort of the inhabitants and visitors and help them sustain their use for a long period of time, while at the same time reduce pollutants and accomplish energy savings. Last but not least, by maintaining old structures that constitute part of the cultural history of a country we succeed in satisfying a basic principle of sustainability especially in protection areas which is the recycling/reuse of buildings or building components and reduce the need for new structures. Energy efficiency in historic buildings is a complex and demanding task as they are protected from strict legislations that differ from country to country. No standard solutions can be applied; interventions should implement interdisciplinary actions since the building configurations and characteristics differ in many ways.

During their studies, students at NTUA have the chance to study Greek vernacular architecture, on the 5th semester (core course Analysis of a traditional settlement) and by the time they initiate their lecture research project they have developed a wide knowledge and comprehension of the vernacular building systems. We consider restoration and refurbishment a valuable and important field of architectural practice and we welcome with great pleasure the students that want to take on research in this area. So far, we have developed a significant database for many areas in Greece: Natural ventilation in Santorini (1992), Investigating thermal comfort in the yards of houses in Rhodes (1994), Thermal comfort in the yard of traditional houses in Mani (1997), Investigating thermal comfort in the yards of traditional houses in Cyprus (1994), Environmental behavior of traditional houses in Kastoria (1999), Thermal and optical
comfort in traditional architecture of Pelion (1999), Thermal behavior in summer of the Cretan house (kamarospito) (2000), The parameter of bioclimatic design in the architecture of Ampelakia (2002), Thermal comfort in the yards in traditional villages at Rethymno Crete (1998) and many more.

**Analysis of existing buildings**

Examining and assessing the bioclimatic elements of built examples or the work of well known architects is another important aspect that may deliver valuable information when researched. Such buildings may combine both simple and sophisticated technology systems and demonstrate efficiency and moderation in the use of materials, energy and spatial resources. In these projects students assess the bioclimatic elements, the sustainable attributes and finally, the impact on the environment according to all the parameters discussed previously. The quality of the form and function of the buildings under study is highly appreciated. Equally profitable is the assessment of the overall work of well-known architects regarding the consideration of climatic and environmental elements in their design. Students have chosen to study

Conclusions

Architecture educational programs should aim at providing scientific and technical foundations that will help students develop the necessary criteria to evaluate the multidisciplinary task of environmental design. The basic tools and essential objectives of environmental design should be introduced in the early years of study, in order to practice and develop the skills of implementing them in the design studio with all the other parameters.

Environmental design has become an undisputed discipline in the production of the built environment. Implications and interrelations between the environment, the society, human needs, values, economy, technology, production, and research are numerous. All these issues constitute an enormous area of knowledge impossible for students to assimilate in a five-year undergraduate program, having so many other
endeavors to pursue. Therefore, students should be encouraged to explore further the acquired fundamentals on personal small scale research and learn the methodology and research tools during undergraduate studies.

In a rapidly evolving world, we need to comprehend, that research and continuous education should be an ongoing process in every scientific field. Universities should produce research and prepare future architects to continuously broaden their knowledge, in order to respond to both current and future needs, constantly aiming at innovative design that produces architecture of high quality.

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Environmental Technologies for the Design of Public Space
The urban environment is characterized by a system of entities (objects, spaces, functions, users) and relationships (social, historical, cultural, architectural and urban) that interact in complex ways. This is even more evident in the historic city. In the different actions of the urban transformation, design of open space modifies the private / semi-public / public continuum. It affects the quality of the relations of viable and liveable urban societies.

It is necessary to develop appropriate design solutions, focusing on an environmental conception reading synergistic relationships between both the artificial and natural cycles and human behaviour.

These must be guided by the analysis of intense and complex starting conditions, based on three categories: environment, technology and perception.

The design will be directed to the achievement of a balanced relationship between both natural flows (water, vegetation, air, sun, light / shade and sound) and urban morphologies and desires of the inhabitants and the architectural quality of the new artefacts.

The objective is producing environmental systems and micro-landscapes that evolve adapting to changing requirements and environmental conditions: This determines significant multisensory stimuli that make comfortable and pleasant urban spaces.

The didactic experience of the Laboratory of Technological and Environmental Design in the fourth year is aimed on these issues.

During this course, fifty students were involved to design the adjustment and upgrading of a public space in the urban centre of Aversa (Municipality located to the north of Naples, with about 50,000 inhabitants).

The theme involved the technological and environmental integration of flexible, energy efficient and lightweight micro-architectures. These installations, with innovative technologies, propose appropriate responses to the development potential of the area, identified in the preliminary analysis and set during the meta-design phase.

The course is divided into three steps: the first based on the analysis of context data; the second on the definition of design objectives and the third on the architectural and technological specification of microarchitecture.

**Interpretation of the context data**

*Mariarosaria Arena*

**New sceneries for integration of renewable energies in the built environment**

The theme of the course links to fields of interest characterized by peculiar epistemological specifications: the project of the urban open space and the morphologic and performance integration of solar energy collection and production systems within structures and components lying in the urban between spaces, thus characterizing them. The first relates to the urban environment project, the second is more tightly connected to the technical and performance-related aspects of building.

During the planning the idea was to overcome a logic only based on technical and energy requirements and to develop a systemic approach referring not only to the cultural values of the physical environment, but also to methods of evaluation and forecast of the transformation and the building processes and to the virtuous normative and process contributions typical of the best practices.

Concerning the planning tools, the focus was on guidelines and analysis methods of the environmental/urban context taking into account the climatic resources, the
potentialities and the morphologic and material constraints to integration \(^1\), with special attention to the linguistic potential of innovation \(^2\).

The design theme is conceived to be a complex system where different approaches going beyond planning converge and meet: planning of open spaces, attention to microclimatic and environmental comfort, psycho-perceptual and cultural qualification and of the urban environment, the integration of energetically self-sufficient micro-architectures.

**The public space: the squares**

The case study analysed during the course concerned, as mentioned earlier, the regeneration of a microurban compartment in the historical centre of Aversa. The proposed squares composing it are connected among them yet presenting totally different morphological and usage characteristics.

The first, Piazza Principe Amedeo, is a space lined with trees, with alleys, relax area, gazebo and play area for children. Overlooking this square there is the city theatre, although hidden by the trees, without any space in front, hence losing its urban role.

The second, Largo Don Diana, is a between space in front of a building that used to be a school and is now abandoned. At present it is used as parking at service of the City Hall and car crossing.

The third, Piazza Municipio, comes as a result of the opening and transformation of the Sixteenth century cloister of the religious ensemble still present on the western side. It is characterized by the prevalence of the building wings and by the functions hosted in the buildings nearby, especially the City Hall and several cafés also having “provisional terraces” for the customers.

**Reading the public space**

The knowledge of the places has been built by using a procedure developed during a research project named *The systemic integration of technologies from renewable sources within the built environment* \(^3\). The students have been guided to the use of a reading method structured on the scientific model of the systemic analysis, with reference to the composition of the environmental and technological sub-systems of the urban open space \(^4\). The reading has been structured on levels of in-depth analysis tanking into account the material and immaterial aspects characterising the urban space, where the relationship dynamics are prevalent compared to the simple function articulation.

The survey protocol developed during the research has structured the analysis based on stages, each one of them is referred to a specific aspect of the urban system. Data referred to environmental and climatic aspects, to the morphological and technological aspects, to the cultural and perceptual aspects of places, have been collected and analysed. The collected data have been formalised into graphic representations and formed the basis knowledge for the students’ projects.

Some of the information has been provided as course material, in particular dwg files of the area, the volumetric plan representation of the urban site, the solar radiation and the factor of sky view. Also the addresses have been provided for the exigencies analysis and the identification of the reference functions.
The students have been asked to identify and rework the context data, with specific aims for each one of the squares taken into consideration, with reference to the singular aspects. Organised into survey macrogroups for each square, they have collected and reworked the data from the places. The survey has been led starting from the topographical and climatic data provided as course material and have been expanded with the information suggested by the protocol, collected through an enquiry on the field. In this way they came to a description of the characteristics of each square, serving as a basic knowledge necessary to the definition of the criteria that each group endorsed for their project.

**The conclusion of the analysis: the workshop**

The results from the analysis have been shared within the workshop organised in an intermediate stage of the course. Indeed the workshop allowed the socialisation of the knowledge data and the tools used to acquire them. Also, it represented a crucial moment of confrontation for the first approach to the metaproject.

The compositions by the macrogroups during the analysis stage have been: a scale model of the area, the photographic and material survey of the horizontal and vertical surfaces of the living space, the survey of usage typologies and the daily and seasonal level of occupation, the morphological survey of the facades (wings) in 1:200 scale.

Fig. 1
The aims of squares enhancement (A - Piazza Principe Amedeo; B - Largo don Diana; C - Piazza Municipio) with reference to the critical aspects and the potential of each one of them.
Fig. 2
Largo don Diana. Material survey of surfaces.

Fig. 3
Largo don Diana. Survey of usage typologies.
Fig. 4
Largo don Diana. Survey of the functions.

Fig. 5
Largo don Diana. Psycho-perceptual analysis.
A useful instrument of observation and reflection was the use of the in-scale model. It allowed for an empiric yet direct of the solar exposure of the analysed area. During the study stage the students have placed in the living-areas the models of the elaborated projects in order to evaluate the energetic performance and the volumetric impact of their design hypothesis.

**Transitional architectures for the redevelopment of urban space**

*Antonio Bosco*

Redevelopment projects of urban open spaces may have different connotations depending on the particular characteristics of the operational areas, different criteria will guide, for example, projects in peripheral areas rather than in central areas or in modern sectors than in historically consolidated areas.

From the educational point of view it is essential to teach students to recognize the quality of each urban place, emphasizing that no place, beyond the intrinsic value, can be considered a *tabula rasa* where it is allowed to act freely. Even in the case of degraded area and low-quality environment, the assumption of the *tabula rasa* may never be regarded as lawful. Even in an urban place with health and social problems you may find, in any case, emotional relationships between people and things, interference between the material structures and environmental features and, ultimately, a mutual dialogue between the community and the surrounding space. For these reasons, even if the site looks, at first glance, anonymous and insignificant, it is necessary that all elements of the place and the relationships developed between them and the inhabitants are adequately considered in the analysis and design.

Fig. 6

In-scale model of the three squares system. The solar radiation conditions have been acquired by exposing the model in the open-air, in Aversa, according to the real orientation of the places.
The example of the *favelas* of South America, may help to comfort our thesis. In some of them they have in fact tried to improve the standard of living of the people by implementing a complete redesign of the site, for example, by building residential towers, equipped with good facilities and plenty of space, instead of the existing shacks. These experiences have not been successful, radically contradicting the current lifestyles. Instead, the winning approaches are those who have met the wishes of the people and their desire for autonomy and freedom. In these cases, the most appropriate intervention was to allow each family to renovate the house with durable materials and facilities. Every family has continued to enjoy its open spaces used as a vegetable garden, or for the breeding of small animals.

The lesson that can be drawn from experiences like these is that the project of urban space cannot be separated in any way from the human component, which includes intangible factors of crucial importance such as history and social customs that develop, in every place, according to different paths.  

In city centers to the above factors are added, increasing the difficulty of approach, the intrinsic values of the places whose beauty and history require additional care in the preparation of projects. In these areas, even the inclusion of marginal elements of street furniture to meet new needs, may alter habits and change the character of the microlandscape. Often, in such cases, changes generated lead to the progressive decay of the place due to the simplification of forms and consequent user behavior. The architecture transforms places and determines new ways to use the city that affect the life of the community, for better or for worse. The awareness of this "delicate" power should be cause for reflection for architects that too often do not know about it.

The above considerations led us to define some guidelines of a general nature to be used in interventions on urban open space, these lines have guided the work of the students during the workshop organized within the course. The proposed work to the students on this occasion led to further difficulties in the project due to the fact that the theme to be performed provided for the inclusion of micro flexible and reversible architectures within urban areas of the historical center of Aversa. The micro buildings, designed to accommodate functions compatible with the improvement of the usability of urban spaces, according to the results of the analysis phase, had to meet the requirement of energy self-sufficiency by making use of renewable energy.

The flexibility and reversibility of micro structures and the extraordinary nature of their use in the urban context, could wrongly lead students to carry out projects paying little attention to the values of context, completely contradicting the objectives of understanding and respect for the existing values that are instead intended to achieve. For this reason the students were told that even the placement of temporary structures in urban places involving a change that repeating itself over time, eventually acquires a character of permanence. An example would be the adoption of illuminations in the festivities or during the Christmas period, in those periods, the urban landscape is markedly defined by the presence of these structures, their shape and arrangement and the lighting effects induced. The crystallization of such images in the minds of users has effects on the perception of the place comparable to those induced by permanent elements.

The Urban Area is physically characterized by the plot of the roads (regular or irregular), the shape of the places, the height and continuity / discontinuity of building facades: these factors determine particular environmental conditions depending on
the periods and climatic peculiarities of the place, generating shadows, ventilation or bubbles of heat which, in turn, determine the behavior and affect the ways of use of the urban space. The students had to preliminarily analyse and describe graphically these local conditions to justify the particular design choices.

The identification of elements and buildings of historical and artistic interest in the urban area was another element in the assessment of the site, assuming that any type of design choice should emphasize their presence, encouraging the use and keeping them as visual landmarks and symbols.

The height and shape of the micro-buildings as well as the integration of renewable energy systems must interact with the surrounding environment, respecting the geometric and dimensional relationships and the symbolic value of the existing elements. The elegance and architectural coherence of the places assigned to them by history, should not be altered by the objects designed by the students and for this reason they had to meet specific requirements of aesthetic and functional characteristics.

The use of materials and the adoption of flexible and reversible construction systems have been crucial to judge the quality of the work, so to ease the assembly / disassembly and the possibility of easy distribution / location in the sites determined the final decision on the projects. They were especially appreciated the projects that have shown flexibility in the aggregation of basic modules and capabilities of transformation according to the needs of use and location. The best design solutions have predicted energy systems fully integrated into the structures, and in some of them the energy devices have become an integral part of the architectural structure.

The experience of the workshop led to an increase of the analytical ability of the students, contributing to an understanding “on the field” of the complexity of the project which is not necessarily commensurate with the size of the structure to be designed, but rather to the complexity and value of the environment in which it is located.

**Microarchitecture project for urban open spaces**

*Sergio Rinaldi*

The aim of the educational experience was to guide students toward knowledge and application of innovative technologies for the architectural design.

In particular we examined technological and morphological potentialities of light prebuilt buildings appropriate for realization of flexible structures, suitable and easily removable.

Project hypotheses, proposed by students, were explained and sustained through a careful phase of meta-design supported by analysis of services and by application of standards behind an eco-friendly approach of the project.

What was required in advance from students was: knowledge of basics of architecture technology and the ability of designing a project accordingly of all different scales from 1/500 to 1/10.

The modalities for the educational interaction were: a few frontal lessons based on methodology, examination of examples of realized architectures, tutorial activity supporting the themes of the project, collective discussion of results. The development of a week workshop was fundamental. The workshop was aimed to the elaboration of the meta-design hypothesis.
**Rules of the project**

We pointed out some rules for the development of the theme, with the aim of teaching students the practice of respecting the binding constraints for the project.

In particular the instructions were:

- To reduce as much as possible the volumes of objects, which even if do not consider peremptory limits, were limited to the less possible related to the function required. Anyway it was necessary to expect the possibility of housing one operator for some hours a day, guaranteeing the necessity of minimum hygienic service.
- To use only light dry stratified construction systems. These systems could expect the usage of volumetric modules entirely realized in laboratory or of sub systems and/or components to build during the process with fast and easy procedures.
- To realize objects, light and flexible, characterized by casing with variable configurations able to modify according to the different requirements bound to seasons, time and/or usage conditions.

**References**

In order to contribute to the development of a list of reference design solutions for formal and technical building choices, examples of fulfilled microarchitectures were provided, as starting points and suggestions.

In fact, during the training of the architecture student, it is useful to encourage the emulation exercise. It will never be a sheer copy of the original, but, as it will be necessary to consider the localisation of the designed artefact in a specific context and to take into account well-established rules, it will most definitely give rise to an original product. Furthermore, considered the artefact typology and the expected building technologies, it is predictable for students still in training to be difficult to propose entirely original solution that are, at the same time, functional and convenient from the performance and ecological point of view.

Therefore, during this stage of training of the student’s skills, the reference to other’s projects could be very useful, as long as it is preceded by a metadesign stage defining the concepts of the architectural and technological design.

The examples (Fig. 7) have been chosen with reference to the design theme (microarchitectures conceived to host function for the public space) and/or with reference to projects of variable set-up envelops equipped with kinematics and programmable expansion systems. 6

**The results**

At the end of the described training process, the results were substantial, with a very good average quality of the designs, with regards both to the proposed solutions, some of which were very interesting, both and more significantly to the methodological process, basically acquired by all students.

To sum up, the design hypothesis developed proposed the “densification of functions and performance” in order to reduce the overproduction and superposition of signs and objects that often characterize the public space in our cities.

The new functions and the corresponding artefacts inscribed within the reference urban context, have been conceived with the aim of enriching the appeal and agreeableness of the public space.
Some reference examples:
1. Macro - Micro, design of a diffused urban park in Guben,
2. Kiosk bar in Warrior Square Gardens in Southend on Sea, (GB),
3. The kinetic house in Mondsee (A),

Kinetic envelope solution: it arranges a system of Chinese boxes repeated in three volumes extracted with a box system, the cabin has been conceived to host info-point activities, laboratory, video and photo exhibitions. A folding platform with a sliding system can host little show and can also be transformed in a projection video with its totem, the north and south facade transform into gazebos, ideal for shade during sunny days and could also host some seating.

Design by: A. Barracca and F. Rauccio, students.
The architectural characteristics of the proposed artefacts can be divided into three typologies:
- With kinetic envelope, with mobile external closing system able to determine variable configurations and ways of use on the basis of different requirements;
- With folding elements and components, compacted in order to reduce the transported volume and to be deployed during assembly and collocation;
- With monofunctional microunits connected among them by equipped paths.

Fig. 9
Solution with folding elements and components, compacted in order to reduce the transported volume:
1. Basic module prepared for transport and assembled in-situ
2. Planimetric alternatives
Concerning the integration of energy production systems, they have been mostly conceived as architectural elements replacing sub-system and envelop components. They made reference to strongly innovative products, characterized by the progressive dematerialisation of the solar receptors and the availability of new colours and textures. In this way, the issue of energy self-sufficiency of the artefacts became the opportunity to experiment new morphological and technological possibilities.

Hence, the aim was to identify and bind the performance aspects, linked to the energy production, with the peculiar aspects of the urban open-air spaces and of the artefacts intended to the improvement of their environmental and enjoyment characteristics, according to the principles of potential compatibility, of maximum integration and non-interference with the attested uses.

Notes
1. As a reference for the identification of the environmental requirements we found the documents: “Requisiti per la sostenibilità ambientale degli edifici” by Environent Park (2005) Torino, and “I requisiti tecnici e prestazioni degli spazi esterni” in the guidelines of the region of Emilia Romagna for drafting the local building regulation.
2. A research conducted by R.L. Knowles focuses on the relation between building and urban morphology and solar and social factors, in Knowles R L, Energy and shape and, for the most recent studies: http://www-bcf.usc.edu/~rknowles/
3. PRIN 2008 research, national coordination Prof. Gianni Scudo (Politecnico di Milano) Operational unit of Seconda Università degli Studi di Napoli (Manager Prof. Sergio Rinaldi).
4. The analysis tool used is the “survey protocol” developed during the PRIN research. For the complete structure of the protocol cf. Analysis of potential quality, Arena, M, in Design tools in urban microlandscape, collected by Bosco, A, Rinaldi, S & Valente, R 2012, Firenze, Alinea.
6. Among others we recommend, for the first point: Macro-Micro design of a diffused urban park in Guben (D) by Fontaine Vanhaebebruck Architects, the kiosk bar in Warrior Square Gardens in Southend on Sea, (GB) by Magma Architecture (2010); for the second point, the kinetic house in Mondsee (A) Arch. Hans Peter Worndl (1993), and the Sliding House in Suffolk (GB) dRMM architects (2008).
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Integrative Teaching
Teaching Design Studio
with Environmental Conscious
Possible Reality
The Lyon School of Architecture has restructured its curriculum to respond to the European model: Bachelor, Master, and Doctorate. The first degree, the Bachelor of Architecture program (BArch.) is divided in six terms.

The last term of the BArch., semester S6 has as a title “Materiality and scales of a project” and proposes as its studio program “a small institution in the urban fabric”.

In semester S5, the term before S6, students develop an urban design for an area of the greater Lyon metropolitan area and propose a potential location within the area for the institution that will be the focus of their next semester, the S6.

After having set the major principles of the term, Benoît Crépet put the team together to run the S6 design studio. We feel that the pedagogical approach, that we have chosen, is fundamental to teach future architects good design. The approach is based on the respect of the context; it reflects ideas about institutions in our society, and imparts the skills required to design an environmentally conscious possible reality.

To achieve this environmentally conscious design approach, it has been paramount to adopt an interactive practice to studio teaching. As a small group of eight staff, we agree at the outset to share principles and attitudes concerning the teaching of architectural design.

The first day of the S6 term, we require students to accept a pedagogical contract whereby they will engage fully in the teaching experiment and agree that they will meet certain objectives every week. Indeed interactive teaching, with collective objectives, has been at the centre of our pedagogy.¹

Our design studio revolves around three significant pedagogical themes:

1. The development of an architectural idea and the process of design development;
2. A team approach to teaching;
3. The link between history, theory, and design.

The three pedagogical themes help to define the most significant environmental objectives for environmentally conscious design.

**The development of an architectural idea and the process of design development**

To gain insight in this first pedagogical theme, we present a brief overview of the term. The term has been structured to enable the students to develop a methodology of design from ideal to details, while maintaining a clear architectural position while developing an environmentally conscious possible reality.

**The term structure**

The term structure ensures that students learn progressively how to integrate all the parameters involved in architectural design from the earliest stages of design development. We aim to establish a method where design process is always consciously related to a possible reality.

“For us, there is not a problem of form, but rather problems of construction. Form is not a goal, but the result of our work. Form does not exist in isolation. Thus in this
sense by liberating construction from aesthetic questions, we make it what it should be, by definition: the knowledge of building.  

We strive to reach a level of spontaneity in the awareness of the relationship between an architectural idea and its possible material reality.

We believe that this spontaneous awareness can only be achieved if the students by themselves understand and believe in the necessity of that search for the possible materiality of the idea. This technique arises from A.S. Neill’s theories and practices, where we search to empower students to learn voluntarily what they need to know academically or professionally rather than impose lessons on them.

The periods of the term, the rhythm of the studio days, enable the students to regulate their own work, combining it with the necessary common sense of putting together a building.

The term is organized in four stages:

1. The ideal
2. The general arrangement
3. The design process and the raising of consciousness
4. How to synthesize the first three stages

The four stages run in parallel to lectures by teaching staff as lectures and case study presentations by student groups. The staff lectures introduce sequences of the term while the case studies are presented weekly throughout the term.

The staff proposes a list of case studies. The list is distributed the first day of term, and each group know from the outset when they will present their study. Thus the students understand which sequence of the term their case relates to.

The case studies serve to enhance the culture of project references shared by the class and enable students to analyse an institution in depth while designing their own projects.

*The ideal*

We ask students to search for an ideal that would respond to their understanding of the site and their interpretation of the program. The ideal should enable them to query *what* to do before we reach the design process of *how* to do it.

Our aim is to get students to always begin a project with an ideal in mind: a concept that would be a guiding expression of their architectural ambitions, in light of the detailed program that we have provided.

In the first two weeks, students create a poster, and a “logo” model that can be contained in a matchbox. Together the poster and logo model will convey their first ideal intentions.

A set of reviews is conducted, bringing together two staff and thirty students. We review the poster and the logo model together and we look at the urban design from the first term. This review does not aim to repeat the S5 semester but to analyse the problematics set by the first term urban design schemes, in light of the qualities behind the poster and the models. The ambition is to set ideals and references for the students’ work term.
General Arrangement

After having established their founding intentions with the poster and logo model, students develop a preliminary design, which responds to environmental notions. We search for an environmentally conscious design. This part of the work is arrived at in a five-week exercise, including the review session. The aim is to have a General Arrangement ordering the major components of the program on the site.

The proposal for an overall order of the project raises three major points:

• How is the project integrated in the context?
• The organisation of the main components of the program as rethought by each student;
• A first attempt at revealing the student’s architectural position.

The teaching staff help students to become aware of their architectural position by looking at the relationship between major and minor elements, servant and served spaces, and the impact on resources. Why and how students have ordered the building, its link to a school of thought, and the deployment of resources the project implies. The students prepare presentations of a project at 1/200 (plans, sections, elevations, and models).

Students make an individual presentation of their scheme. Enriched with the critical comments of staff and students, the student then develops the scheme by focusing on a specific place within the project.

Of course a large number of projects have problems in General Arrangement. This is the point at which most students will have difficulty progressing or gaining a durable experience of spontaneously thinking about design.
Working at the General Arrangement scales of 1/500 and 1/200, the majority of students will only produce projects that are wishful dreams, detached from common sense. They will often be the poor illustration of schematic issues that do not help the student in understanding how to regularly integrate aspects involved in designing a possible reality, including environmental issues. By continuing to work at the General Arrangement scales, students often cannot clearly comprehend the strengths or weakness in their sketches.
The design process and the raising of consciousness

In a traditional design process, students progressively increase the scale of investigation. Our pedagogical approach requires that each student choose with the staff, during the review mentioned above, a part on which, they will develop a 1/50 section with details at 1/5.

We believe that students become aware of the possible reality of his conceptual decisions if they develop the project with a pragmatic understanding of its component parts. Drawings and models are therefore developed simultaneously at the contrasting scales described above.

Fig. 4
Study model of the relationship between two major parts of the project.

We leave behind the General Arrangement scale in order to move to a scale that enables us to detail structure, light, and materials. Thus we move from thinking of what to do to how to do it.

Once students have come to terms with “what” they wish to do (often with all its clumsiness), we work as directly and pragmatically to get them to understand “how” to achieve their objectives.

The relationship to the ground, the role of a structure in ordering places, the quality of the skin of the building, the existing environmental controls, the recycling of air, the light qualities, the construction site management are some of the aspects that are worked on during this phase.

The place chosen for development is significant in the hierarchy of the idea behind the project. This place is often at a critical transition between elements of the project. Each such place is investigated in plan, section, interior and exterior elevation, models, and references. Students analyse the components of the place in order to integrate their individual projects.

During the design phase, the studio takes on a new rhythm. Students learn to investigate an architectural idea while keeping in mind significant physical and environmental issues, thus reaching a spontaneous awareness about the design process.

At the second review, each student presents the detailed study of the place that they have chosen. They also present the challenges that the work at a detail scale has introduced to the conceptual scale. 
Fig. 5
Study of a place between two major parts in section, perspective and detail.

Fig. 6
Study of a place in plan section and perspective.
How to synthesize the project

Following the second review, students go back and rethink the overall design in light not only of their original intentions and architectural ideas, but also increasingly aware of the detail implications of their ideas with in mind an environmentally conscious possible reality.
The detail design work gives students consciousness of the impact of their ideas on many issues involved in design, particularly the issues related to the physical reality of the building. They reconsider the overall integration of the building in its environment with a better knowledge of the material implications of address and services, of façades and orientation, of the attachment to the ground and silhouette to the sky only to name a few.

As it is not possible during a sixteen-week term to design an entire building, we teach students a process of thinking, a methodology that will enable them to become more active and aware of how they look at architecture. And therefore we believe that we lead the students to a design process that is more participative and environmentally conscious.

Fig. 9
Two models showing the transformation after the detail study of a place.
A team approach to teaching

At the outset of S6, we present the subject, the pedagogy and the objectives and expectations for the term. Then the class of 120 students is divided in four studios of thirty students. Each studio works with two studio staff. The interaction between the 120-student class and the eight studio staff is organized to offer many types of exchanges.

The class as a whole comes together for lectures and case studies. The staff rotates for reviews and comes together for final marking, which is a long and arduous process.

During the detail design phase, the studio, as we remarked earlier, takes on a particular rhythm. The group teaching involves the students. Once a week, the studio pins up all the work done by the students during that week. At first, students hesitate, and then understanding that group consultation is part of the teaching process, and that no one is treated pejoratively, they become active members of the exchange, in respect of the pedagogical contract described at the outset.

The staff and students take time to look at what is on the wall. A few students volunteer their work to serve as examples for significant issues, on which the group is working. Staff draw the issues that are significant behind the questions that the students are asking. They also use this format to clarify the link with theory; to detail some points related to construction; to explain principles that remain unclear. Sometimes the staff brings in the shy or weak students to participate by helping them to present potential qualities of their work.

The ambition is to show that an atelier is a collaborative effort, that all work is work in progress, and that we all learn from one another. The first part of the pin-up, which takes a few hours, sets the tone for the stage of the work underway, and highlights links between an idea and its possible resolution, which reinforces a methodology linking all scales of the architectural project.

The second part following the pin-up is a traditional studio where students draw at their desk on paper or on computer (we require both), and where studio staff participates in the students’ patient search. The main obligation is to work simultaneously at contrasting scales. For instance if a student is drawing a section at 1/50 they will also explore details in sketches at 1/5, so that every line is an idea, a figure, and a material.

Often small working groups are brought together in a collaborative manner to search for resolutions to a design question.

The link between history theory and design

When the class is divided in groups of four or five to prepare the case studies, an introductory lecture is given by one of the teaching staff to provide the framework within which the case studies will be carried out. Two or three cases are presented each week. Cases are analysed through drawings, texts, photos, and models and are presented as an on-going part of the design process.

After the student presentations, the teaching staff use the examples presented to link between history, theory, and design, pointing out issues related to the project. The staff demonstrate how in each case study, the design reflects a set of architec-
tural decisions that are backed by the architectural position of the architect, and also how the architects have managed to integrate environmental objectives in their construction.

These cases studies form a small common culture of project between all the students and between the staffs and the students. They become referents from which we can draw lessons, and propose to measure part of the student design with.

The possible reality and the environmental targets

What are the top ten environmental objectives that matter and which students should be encouraged to meet as a matter of course in their designs?

To answer this key question, we must restate the targets for sustainable buildings.

Construction

A harmonious relationship between the building and its direct environment

Students are asked to develop a building design that is well integrated in its context. In the first term of the third year, students participate in an urban design studio where they design a new sustainable neighbourhood in the Lyon area. In that design they propose the location for a small institution. That small institution provides the design subject for the second term of third year.

The issues related to the integration of a building in its environment are as follows:

The first question is the appropriateness of the institution in its context, with respect to the social meaning that institutions have in our society. Questions of relevance of scale, the approach to the building, the relationship between the institution and the surrounding public places are addressed.

The next issue is the economy of means. The position of the building in its context must ensure appropriate light levels in the various spaces, therefore reducing the need for artificial light, while bringing natural light and ventilation to rooms and spaces in the building.

Another issue is the position and the figure ground of the building, and the provision of adequate access and servicing.

Indeed if a building can be adapted, modified, or transformed, what cannot be modified is the building’s essential relationship to its direct environment. This is why the first design decision is paramount. It affects the relationship between the building and its direct environment but also has major, irretrievable impact on the quality of the building specially its environmental qualities.

Integrated choice of materials and process of construction

From the outset of the design work, we stress the relationship between space, structure, light, and materials. This is explained in the case study presentations, in the design studio, in the studio group critical debates, and in the reviews. The teaching staff helps students to understand that there is always a clear and understandable link between a constructed project and an architectural idea. The order of a project, the relationship to structure, the role given to light, and the hierarchy of materials and prod-
ucts implies a specific process of construction and this integrated choice is developed with each student’s position with respect to their work.

In some cases, we have encouraged students to develop a position that we may not entirely agree with, but that we find rich and interesting. Often this will allow us to introduce historical lessons that would not have been presented, and it also allows for other members of the students body to propose possibilities that they may not have otherwise encounter. We wish to allow and cultivate diversity of architectural positions and encourage initiatives.

The positioning and the articulation of the various elements of the program is a fundamental issue. It leads to what we could call a healthy plan. The healthy plan is one that guarantees natural air circulation, appropriate acoustic separation, optimal servicing, suitable heating and cooling; these are aspects affecting the environmental quality of a building. If a plan is healthy, these environmental goals will be achieved without any difficulty.

**Management**

It is our experience that management targets are not feasible topics to explore within a 16 weeks design studio, and they therefore are not really touched on in our S6 curriculum. Students have the opportunity to learn about building management while doing their practical internship.

**Comfort**

*Hygrothermic comfort and healthy spaces*

Hygrothermic comfort is addressed when the design work touches on the positioning of service rooms, and service distribution networks. A large part of the design of each project deals with questions related to the building envelope: the vapour barriers, waterproofing, insulation, cladding, the choice of roof forms and assemblies. The purpose is not for students to produce enormous quantities of details. The key is to understand the role of each of these elements so that they can deal with them while simultaneously maintaining their architectural ideas. The skin of the building must deal with climatic control, and ensure a healthy comfortable environment.

During the phase described above as “The design process and the raising of consciousness”, we define sets of parameters related to insulation, heating and cooling, to provide a framework for “healthy” places.

The detailed study of each place will help us to raise the awareness of students of the two following targets: acoustic and visual comfort.

**Acoustic comfort**

The program of the design studio is a cultural centre, including a small music school. In the lectures, case studies, and studio exchanges, we analyse parameters that affect the acoustic quality of a project. We speak of the healthiness of the plan, as indeed the position of the music school raises issues related to acoustic levels and separation. The role of the structure also participates in the acoustic isolation of elements from one another.
We also look carefully at the geometry of places, as they impact musical practice and appreciation. The interdependence between structure and infill is a topic of investigation as the infill can allow the sound to travel throughout the multipurpose room without transfer via the outside structure. And discussion and experiments are conducted regarding the materials that have appropriate acoustic characteristics.

**Visual comfort**

One of the goals is that each room should have natural light. This opening to the outside offers visual comfort, but also allows visual connection to the outside world. It is our premise that a practice room in a music school should have a view, allowing musicians to connect with their context.

Two aspects are treated: the light entering that enables users to occupy a room without recourse to artificial light; and the view from that room ensuring connection and an awareness of distance.

**Health**

*Sanitary quality of the air and of the water*

Although we touch on quality of air and water, we do not dwell on technical evaluations of these elements. The above-mentioned openings are also designed to bring natural air, and allow for air circulation.

Fig. 10

The presentations of 120 students class models at the end of term.
We conclude in stating that we believe that the most significant environmental objectives to be taught in our design studio are:

Buildings link to history; a harmonious relationship to the direct environment; integrated choice of products and processes of construction; hygrothermic comfort; healthy spaces; acoustic and visual comfort.

As architects we are responsible craftsmen; as teachers we are dedicated to the transmission of knowledge. Both must be done with passion to provide students with autonomy and independence. This is why we believe that above all, our students have to gain a design process that explores how their buildings may be "healthy" internally and externally as environments, for the context in which they are integrated.

This experience, which our teaching team has conducted for more than five years, has brought positive results, as our graduating B.Arch. students are able to develop very detailed projects, while remaining true to their intentions, and while understanding their positions within the recent history of architecture.

Notes
2. 11/ Mies Van Der Rohe, Bauern, G n° 2, September 1923 one of the quotes given to the students with the term papers.
   “I answered that one learns to live, not by hearing of other lives, but by living, for words are infinitely less important than acts.”
4. These terms are used to differentiate between "detail scale" = 1/50, 1/5 and "conceptual scale" 1/500, 1/200. However it goes without saying that details are conceptual.
5. The introductory lecture develops the following topics:
The site; the program; the overall composition; the rooms and places and their articulations; the places and the structures, and different qualities of light; the structure and the skin; the materials and the skin; the light, the materials, and the spatial qualities; the nature of the details...
6. Of course it is also our task to show when this is less successfully done, and the impact of such situations.
7. This was already implied in the notion of the permanence of the plan developed by thinkers such Lavedan, P 1959, Histoire de l'urbanisme, Antiquité, Moyen-Age. Paris, H. Laurens.
8. “A great American poet once asked the architect, what slice of sun does your building have? What light enters your room? – As if to say that the sun never knew how great it was until it struck the side of the building.”
   “No space, architecturally, is a space unless it has natural light.” Louis Kahn quoting Wallace Stevens in his lecture for the 1971 Gold Medal at the American Institute of Architects.
A Design Studio Experience for what if an Architectural Pattern is Organized with its Place
In today’s world in general and in Turkey in particular, the architecture and interior architecture schools focus on intensive debates of design educational concerns. The essential challenge of design education evolves generative process with methodological research for innovative design strategies. Every design aspect is apparently evaluated as a part of creativity. So the last product, course and multi-ways of creative thinking are being valued in this context. The institutions require to re-think their design education program and design class contents to build up and to stand on alternative design studio processes.

Clearly we know that the introduction of design education has essential importance for the first term students who actually lack educated-minds experienced in artistic and environmental thinking. That is why our interest lies –especially for Turkey–in the first term studio program which inspires creativity and brings forward a bottom-up process from an architectural pattern to its tectonic model within a project. Although the education strategy following as an algorithm, the concern of this paper has a novel characteristic; there is not only one absolute solution to get ideal responses.

Actually, the experience of architecture education worldwide as well as in Turkey revolves around the specs concern accounts for the innovative capacities of students. So, the theoretical courses and the executive design activities are primarily based on the fact of ambition catalyzes the inspiration triggers. By this means, the studio works become forward where we develop the strategies to demonstrate a problem and make it clear to be understood by the students. More than the other years the first year acquirements of undergraduate education have an effective role to obtain thinking way by using peculiar concepts which have not countered before. Furthermore, what makes the teaching process work smoothly, entirely depends on the hardest bias of each student which is aimed to be overcome.

With this respect of the primarily frame, we discussed the design studio’s drifted role to develop creative thinking. So the discussion starts on building creative minds and how the design studio contributes to the emergence of perceptional-cognitive awareness.

In architectural education, creation and design can’t be considered free from the process. This approach supports that creativity can be achieved through the logic of design process. Inevitably, all design activities have to stand on a creative base as the outcome of a novel idea. In this aspect the concept of creativity shows itself in design studio which implies a strong indicator of design and creativity dualism.

Design studio is the place where things like communication between students and teachers, learning a method of design (practical or theoretical) take place. Therefore, all experience in design studio is primarily an important step for architectural design, because it generates creativity thinking and improves in the design studio as a context of creativity.

At this point we conclude that it is required to multi-dimensional process collaborations to have to meet in the common-strata of the design studio. The sum up at a design studio program which is suggested in algorithm emerges the processes. The study is going around the duration of program, which are gradually integrated, facilitate ‘the evolvability in design’. Eventually, the studio model is being the content in the first term design project under the main title of ‘the generative process’. Besides
the project, two integrated student works are performing simultaneously at studio and site-visiting and the paper is going around their processes which are entitled mainly as ‘the exploratory and experience processes’. And at the conclusion evolvability is brought out as the fittest capacity to a living environment by enhancing a well-understood dialectic thinking of architectural pattern which is organized with its natural environment.

**Evolvability in Design**

Evolvability is the capacity of a living environment, which crucially depends on genetic variations. Although, there are many types of varied forms, each form proceeds its earlier simplest- forming corporate commons with all others. In other words, whenever we see a structure in our world, we know it has changed over processing its rules for generating information. Kirschner, as a foremost biologist who has an enduring contribution to evolution strategies, deals with the process of generating structure and brings out this process which has to be incorporated in these progressing rules. Kirschner (2009) underlines the gene diversification where the differences arise in such a similar environment. With this respect, Kirschner’s biological strategies of evolvability are going to follow in order to get base to re-stand. The sum up of the three characteristics of biological evolvability which he has brought together can be listed as:

- To maximize variation in the amount of variation,
- to suppress the fallacy of variation produced,
- and the provision of useful variation.

On the other hand, today’s pioneering academics such as Weinstock, Hensel, DeLanda are primarily concerned with how an environment generates its nature and builds civilisation. Weinstock (2010) defines architecture in all the forms of nature and of civilization and points out their arrangement of material in space and over time. De Landa (2001) uses the genetic algorithm in Architecture implies the deployment of three forms of philosophical thinking as populational, intensive and topological thinking.

Nature and civilization evolve together by building up tectonic places of our living environment. That implies also why we try to find a way of architectural thinking which can meet for the creation of organized place and generative forms at common stratas.

For over a decade, architectural research has been established on the work of educational strategies by the contribution of the designer-scientist. The evolutionary processes are already used for computer programs and are established as automatically performing tasks which are collectively known as “genetic algorithms”. However this study does not deal with computer programs but a design-studio algorithm is projected and the education methodology that comprises this algorithm is described. The systematic is operating within the processes. So the algorithm is used to manipulate the project, additionally the evolvability capacity of the project’s outcome refers to coordinated processes of the design-studio.

The structure of the project is generated mainly at ‘Generative Process’ which is also figured out at the center and it is supported by two sub-processes (table 1). The
project is defined gradually as main process and it will be deemed to be final. During the term, students improve their project with the extra-performances of outdoor working and studio tasks. Those works are referred to achieve the project: the studio tasks inspire thinking to explore the new ways of form-finding in order to create a module of pattern, besides this the site-visiting and sketching workshops maintain periods to be experienced for understanding how those patterns emerge and evolve in their environment.

The systematically oriented design for the built environment can be achieved by studio and site-seeing sketching as well as with case studies preceding modeling.

**Generative Process**

The project of the first year design studio is derived from the spatial provisions and develops an algorithm, just a way of understanding how to commonly use the pattern of modular units knitting and organized with their natural environment. As the spec of the design studio, the stages of algorithm are defined in triple qualities (table 2).

Each stage of algorithm implies the project’s guidelines evolving from the simplest form of a modular structure through a complex pattern and eventually a morphological adaptation as a model of place.

- The first stage of the algorithm defines a strategy to maximize the catalysis of varied forms. The morphogenetic units emerge in many more possibilities free from the constraints of construction concerns. Simply, the studio works start to create an innovative pattern, how it can be most varied at a planar surface free from the topography tectonic. Without any provision of environmental-tectonic the folded-units emerge as the spatial structures. So the main problem focuses onto exploring the thinking way of how an earliest-form of generative structure emerges.

- Following in tandem, the second stage of algorithm defines a strategy to suppress the lethal variations accepted not to be transforming in pattern. The units have to be considered modular to assemble the spec of a pattern. The patterns optimize the form of modular units according to their relations with each other and so they accommodate the changes to transform modules (Fig.1).

- The final strategy guides to integrate each pattern according to well-directed provisions of the tectonic. The last one charges a kind of topographic model of patterns with a capacity to evolve with a manipulated code of unit replication (Fig.2).

However at the mid-term of studio, the students are confronting with a new curious problem – what if your morpho-genetic patterns are organized environmentally, indeed. That fires a collective thinking to make a super-natural form to a natural form, by re-modeling the patterns with the natural environment which are re-created. Clearly, the problem at the beginning builds up and charges the students to create the environmental-scenario for each architectural pattern. Each tectonic model is also demonstrating the own scenario of each pattern to become an evolved place (Fig 3-4).

The generative process is figured out at Table 3. The guidelines of the algorithm follow evolution in structures which are sought from a spatial-volumetric unit to a pattern and its assumed environment model. Also the flow charts, beside the stages of the project, define each strategy as task and its instruction as how-to-do.
Exploratory and Experience Processes

The students develop the project by supporting processes which are derived from an associative thinking. The studio works are analogical in form derive from the architecture where they make site-visiting and sketching case-study in tandem. That is why the studio task and site-visiting task are demonstrating together at one flowchart. Additionally, the inspirations of stimulants as forms and environmental responses are also defined at the parentheses which are written beside the case-study of each site-visiting/sketching task.

The teaching method processes on the site-visiting of case-studies following the studio works, counterproductively, ambitious producing units to grow in more complex patterns. Besides sketching modeling is also employed effectively with simplest techniques of cutting, twisting, wrapping, knotting, and rotating.

Table 1.
The processes of design-studio.

Table 2.
The algorithm’s stages imply the project guidelines.

Table 3.
The algorithm’s stages imply the project guidelines.

Fig. 1

Exploratory and Experience Processes

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Fig. 2
Student work-
Murat Gürsu (2010)
Generating a new
tectonic model.

Fig 3-4.
Student Work-
Sevda Dölek (2011)
Tectonic model
demonstrates an
evolved place.
Conclusion

Design studio aims to improve the ability of critical thinking and comprehension, to generate two and three dimensional models, sketches, graphics and it puts forward a new idea for design problems. However, in the current discussion we have to retool our existing knowledge about creative methods for design education. Today architects use computer program logics in design and are inspired digitally by the configuration of geometrical model of patterns. The patterns are being generated in modular repetition and variation generally from what we deal neither with the place nor the cultural environment where nature and civilization life are going around together in an architectural sense. Focusing on this concern, the design studio experience which is put forward in this paper implies a productive use of genetic algorithms, where the project evolves from the simplest modular form to a complex organism as morphological model of the environment. So the tamed problem arises in the first term design studio. How we represent the project in terms of the process that generated and how those processes progress in well-defined sequence of strategies. However, the studio works refer to the collective known of Folding architecture, the genesis of form which settles a natural environment as a tectonic model is being brought together for the final project.
Table 4
The flow charts of Exploratory and Experience Processes.

References
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Teaching Design and Technology through Basic Environmental Objectives, at the National Technical University of Athens: Towards an Integrated Approach
During the fourth year of architectural studies at the School of Architecture of the National Technical University of Athens, the curriculum offers a combined core course between Synthesis and Technology investigating a public service multiple functions building, its organization and structure and its relationship to the urban tissue.

The course assumes equal collaboration of teachers between the Departments of Architectural Composition and Architectural Technology with the aim of “horizontal” and dialectic “osmosis” of different disciplines. The students involved have an adequate level of knowledge in both required fields, completing already six semesters with projects in Architectural Design and five in Architectural Technology.

It is essential that this compositional course takes place just before the end of their studies and their design thesis thus requires the student’s awareness of all prior knowledge. The aim of the course is mainly the dialectic relationship and integration of different cognitive areas, and the formation and combination of this knowledge to a scientific “whole”.

The present paper focuses on key points arising from the application of this interdisciplinary studio work, the importance of cooperating teachers from different departments and scientific fields and the evaluation of student issues of combinatorial class collaboration (fig. 1).

**The framework of the Course**

The School’s objective is students’ education in the theory and practice of Architecture and space in general, focusing on humanistic, technological and environmental issues. As mentioned before, the core course of Architectural Composition at the fourth year is based mainly on the design studio, including additional theory support on several fields.

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During the design studio (Prof. Costas Caradimas and Sofia Tsiraki).

Model (sc. 1:100). (Prof. Costas Caradimas and Sofia Tsiraki)
Briefly, during the two semesters of the fourth year, the design studio refers to different issues such as:

- The teaching approach and the methodology of the compositional process itself. Students explore basic mechanisms related to structure and investigate fundamental design concepts, principles, and elements. During the two semesters, they also explore the gradual birth of form, from early sketches to an integrated “whole”, through models, plans and details, at several scales (from 1:500 to 1:5) (fig. 2).

- Study of key problems associated with the design of a building with public character (such as libraries, museums, educational facilities, etc.) and complex functional program.

- The incorporation of the building into the urban tissue, building’s vertical evolution and structure, defining the organization and character of interior spaces in general, special interior spaces (auditoriums, exhibition spaces, etc.), basic spatial elements and details (such as stairways, ceilings, floors, etc.), the formation of outdoor public spaces, external configurations, facades, etc.

- “Osmosis” and dialectic relationship between different disciplines, such as architectural design, architectural technology and construction: defining compositional structure, supporting components e.g. linear (beams and columns) and surface (slabs and panels), appropriate materials, structural frame, details of the outer skin of the building envelope, etc.

- The need to promote basic environmental objectives in architecture from the early steps of architectural design and its relation with the compositional concept. We believe that most of the issues arising from the implementation of sustainable systems exceed time. Many of the tenets in sustainability are old ideas. Some are ancient understandings; others are developments of the last decades.

- The approach of the course focuses on - among other things - the importance of the investigation of the structural sustainable framework and the structural system as a key component of the synthetic process, while students explore the intimate connection between environmental objectives and primary synthetic principles.

As P. Hawken quotes “sustainable architecture is foremost about reimagining the relationship between human beings and living systems. The most powerful expression of this relationship is our built environment. How do we build now that there are six billion of us, now that our supply of natural capital – water, wood, energy, and land- must be far more effectively used? How do we make zero-emission houses? How do we design structures that can be reincorporated into the earth harmlessly and endlessly? ... In other words, given how many we are and how much we have to expect, how do we live?” (Earth Pledge, 2000, p. xiii).

The above question raises a significant issue: Architecture should not only be considered as art or science, but mainly as a life container, or as a “vessel of life” after the Greek architect A. Konstadinidis. Through this human-centered approach, environmental objectives, sustainability and primary compositional decisions are concepts united and combined with the “high quality” architecture from the very first steps of architectural design.
Teaching methodology

The process of design or designing as a “development” process

Among several educational aspects that coexist in our university, we believe that design is a process that is “no longer perceived as a mysterious creative act, but as a development process that can be grasped rationally, at least within certain limits” (Gänshirt, 2007, p. 65), thus can be explained and finally taught to a certain point, but at the same time without losing it’s creative mystery and complexity. Design process is linked with the gradual approach from the large to the small scale, starting with the abstract and becoming more and more concrete. As Ganshirt points out, Mies van der Rohe preferred to use the word “development” instead of “process” (or procedure, production): “We do not produce designs. We consider what could be done and we then try to develop it, and then we accept it. We always develop from a critical point of view.” (Gänshirt, 2007, p. 65) We respectively think that both terms “development” and “process” can describe the continuous and mysterious compositional operation that takes place in the design studio, as we try to investigate the interplay between seeing, thinking and doing, to identify our design tools and to comprehend and grasp the connection between perception and expression.

Context/conceptual idea/compositional structure/shape/form

During the design studio, the above “critical point of view” starts with the investigation and interpretation of all various and disparate constrains that coexist and compose the living and built environment. Its physical and non-physical aspects (e.g. social, historical, economical factors, etc.) form and configure the multifaceted nature of context (fig. 3). Additionally to these important contextual parameters, students take into account the functional requirements of the project and consider structural and technical matters. The interpretation of all complex data is a selective process, which helps students, through a “holistic” approach, to set the rules and priorities for the next stage of design, the gradually formation and development of their concept.

Prof. T. Biris, instead of the term “concept” uses the term “conceptual idea” (Biris, 1996): All the basic compositional components and notions, including primary structural and technical decisions, environmental objectives, and sustainability, may constitute and characterize the conceptual idea which is related to compositional structure and enclose from the very early steps of the development of design, the “seed” of the project, that gives coherence to the synthetic whole (fig. 4).

At the beginning of the compositional process, this “seed”, or this “conceptual abstract structural ideogram” (after T. Biris) is expressed by students mainly with narratives, gestures, sketches and “open” working models (fig. 5). Students at this stage can visualize their idea, by expressing in a three-dimensional abstract manner mainly through “open” working models, the compositional structure incorporated into its context and the relationship element-whole through the structural system joined with their idea.

The term “open” reveals the dual role of the model; on the one hand it offers the opportunity to study the space and its elements from an inside view and on the other hand it attributes to the project a quality of the semi finished i.e. of the “continuously...
developing drawing” (after the notion “development” that Mies van der Rohe introduces). Moreover, the working model is an educational tool that cannot be replaced by any other means and allows the student to activate and cultivate the relationship hand-eye-mind or else the relationship between practice, perception and cognition, while simultaneously studying in situ (learning by doing) the gradual birth of form (Demiri, Tsiraki, Athanasopoulos, 2012) (fig. 6).

The term “structural system” refers —among others— to an integrated exploration of basic spatial elements, to the definition of the supporting components through which the composition elaborates on, to the selection of the suitable materials expressing the specific structural factors, to the investigation and selection of the appropriate details of the inner structure and of the outer skin of the building envelope. Through the
Fig. 4
Sketches of the conceptual idea, working model, final model (Diploma project, Prof. Tassos Biris).

Fig. 5
Sketches and open working models during the first steps of the architectural design (Prof. Costas Caradimas and Sofia Tsiraki).
above clarification and interpretation students proceed at the articulation of the formal structure of their proposal by relating it through compositional rules, which lead them to the investigation and formation of the next compositional steps, such as the configuration of geometrical shape and the other components of form.

Several trials lead student’s work at the design studio, from abstract sketches, diagrams and working models to more and more concrete interpretations, digital drawings, plans, elevations, specific details and representation models (fig. 7).

Technology and construction

Educating students as "Architects-Engineers" means –among others issues- that during the design studio, knowledge of different cognitive areas should be related as a scientific whole.

In the second Semester of the course, more emphasis is given to the cognitive part of Architectural Technology with the final target to prepare both general construction and design detail drawings and a scaled model showing to some extend the basic principles of the construction of the composition (fig. 8).

However the main objective of the whole project is that students are finally able to identify the importance and the central role of the construction/building parameter as a key component factor of the Architectural design that cannot be separated and considered a discrete issue. Architectural Technology should be present from the very beginning of the first stage of the synthetic process and should be regarded as an operative element of the conceptual idea and not as a barren technological aspect separated from the synthetic procedure. In that sense it is clear that technological aspects participate in all stages of the design process having an equal importance in the creation of the building complex and the quality of the space.

In order to achieve it the procedure focuses on two selected targets:
• To show the intimate connection between Architectural Composition and Architectural Construction in all possible ways.

This is the main educational principle of the course. It is pointed out at every stage of the design process and is connected with all possible proposals that students are implementing. At the first stages of the design process it is emphasized that the structural framework (primary and secondary parts, load bearing & non-load bearing elements, etc.) is forming the basic corpus of the schematic design of the complex. With the evolution of the project this procedure is carried out so that there is a constant relation between the two matters - technology and composition – showing a holistic procedure from concept to application. Even at the last stages of the design process the connection is indicated, emphasized and analyzed since design detail is an equally important aspect in the creation of the architectural identity of the building participating in the quality of the space and showing the importance of the design even in small scale components of the building fabric. (Fig. 9)

• To give selected lectures on specialized building construction matters so that the students achieve enough knowledge of the various construction matters and dis-
ciplines that they are dealing with. It is considered important the students to accumulate technological expertise.

Lectures focus on the analysis of the relation between the structural framework and the form of the building, in connection to basic environmental objectives. By the presentation of examples students become aware of this constant relation and the various techniques of its expression in the design of complexes of different scale function. Lectures are also analyzing the design of non conventional building systems, the construction of contemporary building skins and claddings and the main components of the building fabric in addition to the standard building techniques that were developed in previous semesters.

Other topics that is considered important relate to Structural and Mechanical Engineering so that Architecture students start to understand how to communicate with Engineers of different expertise, to learn how to coordinate of all building designs and components and - especially for Architects that are going to live and work in Greece - to understand the impact of Earthquake in the design of structural framework regarding the elasticity or the stiffness of the skeleton of a building.

In the whole procedure of lectures and the development of the project it is clearly pointed that these specialized topics of technology should be used in a creative way supplementing and enhancing architectural composition.

As mentioned before, it is important that students have to accumulate technological expertise, and to understand the process of coordination of all building components and designs. J. M. Spector, while elaborating various integrative approaches concerning educational technology, refers to the term technology: “The word “technology” is derived from two Greek words – techne (art, craft, or skill) and logia (words, study, or body of knowledge). The etymology of “technology” suggests knowledge about making things” (Spector, 2012, p. 4). The achievement of that kind of knowledge is considered as a significant factor, as a cognitive infra-structure during the design studio. This infrastructure provides insight into the constant relation between formal design principles and construction methods.
**Human-centered Sustainable design**

The above knowledge is also complemented with *simple environmental objectives and basic sustainable principles*, and as noticed before, are inseparable components of our integrated approach.

During the design studio, several insights, approaches and methods, questions concerning on how buildings work (Allen, 2005), how buildings can reduce energy consumption and how we can achieve sustainability are considered from a wide variety of viewpoints. Factors such as, efficiency of the building’s heating and cooling devices and systems; natural ventilation and day lighting; ways to prevent solar overheating; the attainment of a good indoor climate; several recycling and renewable materials; water efficiency from the use of stored storm water or innovative wastewater treatment, etc. are explored by students.

“*Sustainable architecture* basically comes down to three purposes –first, to advance the purely selfish motive of survival by cooperation with nature; second, to build shelter in concert with ecological principles as part of this objective; and third to address the deeper philosophical conflicts surrounding the issue of whether we really deserve the luxury of this existence, given our appalling track record of environmental abuse” (Earth Pledge, 2000, p. 15).

We think that, *human-centered architectural design* should respect core environmental elements, both natural and urban, while we should understand the consequences of the introduction of the “built” into the “natural” world and the impact of design and construction on finite natural resources. During this integrative design course, interdisciplinary perspectives, environmental, sustainable and aesthetic values are combined towards a “*holistic* educational approach” with humanistic concerns.

**“Holistic” approach: Concept, construction and environmental awareness as basic synthetic components**

The compound word “*Architect*” (in Greek word “Archi-tekton”) can be translated as follows: “Archi” means “to begin, to rule” and “tekton” does not only identify the “carpenter” and “tectonics”, is also “pertaining to building or construction”. The education of this kind of “*Architect*, which is a “*holistic* interdisciplinary approach”, can be described from the comment of Ganshirt “…when these two concepts (Archi-tekton) are related to architecture and science as a whole, their meaning is extended significantly. Being an architect would then mean not just being a master builder “lording it over the carpenters”, but means acting as an artist, engineer and scientist at the same time—someone who starts to fit individual parts together to form a harmonious whole” (Gänshirt, 2007, p. 18-19). A harmonious whole consisting of aesthetic, scientific and humanistic values. Our course on the design studio attempts to examine the formation of this “harmonious whole”, through examples, principles and theories, through the interrelation of different disciplines, the common ground between art, science, technology and environmental objectives, the constant relation between technology and composition.

As the aim of the course is mainly the relationship and integration of different cognitive areas, to a scientific “*whole*”, students gradually form a broad but combined spectrum of profound knowledge, involving aesthetic, constructional, environmental,
social, political, moral values. We believe that during the process and development of composition, the above values must be identified from the early steps of architectural design. Through this human-centered educational approach, conscious social thought and action and environmental awareness are concepts and primary compositional decisions, united and combined with the “high quality” architecture. “Architects with vision have come to understand that good design must respond to aesthetic values as well as environmental concerns.” (Earth Pledge, 2000, p. 7)

During the course, much of design work is collaborative and group-oriented. The collaborative and cooperative work in the design studio, combined with open critique and discussions serves as a stimulus between students and helps them to rethink their decisions. We believe that the common working space during the design studio helps students and tutors from different departments and scientific fields, to cultivate a combinatorial, interdisciplinary collaboration, towards a “holistic” educational approach.

However, educational approaches and design processes are infinitely complicated, as the world of design contains a wide variety of trends, opinions, thoughts, observations. The perception and communication processes through which all different, controversial and complex information are perceived should be understood as open, “containing a wide variety of languages and of forms of thought and work” (Gänshirt, 2007, p. 17). During the design studio, students often have to evaluate and reconsider their principles, their concepts, their deeper motivations behind design decisions and solutions. As Ganshirt points out, “what we must avoid in all costs is to constrain design in a predefined methodology” (Gänshirt, 2007, p. 17). Therefore, our educational approach consists of certain methodology, but is also opened to criticism and revaluations by our students and us (fig. 10).

References


Note
The examples presented in this paper are a selection from different student works from the past three years of study supervised by the authors.
Invention and Subversion:
Educational Premises
and Teaching Experiences
in Ecole Nationale Supérieure
d’Architecture Paris-Malaquais
The concept of invention

Invention, which is a concept connoted for a long time in architectural theory in multiple ways, as shown by J. Guillerme, is nonetheless seen in a certain philosophy of sciences and techniques (G. Simondon) as a key concept for the understanding of the role of technology in the history of human civilizations.

Jacques Guillerme (2008) points out, from a historical point of view, the difference between invention and innovation; through historical documents, J. Guillerme argues that “invention” initially had a negative meaning in France, the term being used to denote a sort of lie or fantasy, whereas innovation has a technical/economic meaning.

With the philosophy of Gilbert Simondon, the term invention is endowed with a whole other value, it merely becomes the most significant inscription of human action in the world, or, at least, of a part of it (in fact, half a part of it, the technical realm, symmetrical to the religious realm). Indeed, according to this philosopher, invention is neither more nor less than the essence of the technical object. Invention, as the foundational action of a subject – because “it is not the individual who invents, it is the subject that does so” (Simondon 1958: 248) –, brings pure information about the relation of man to the world; it furthermore marks a rupture inside a process of evolution. It is neither abstract, nor concrete: it is being accomplished at the level of schemes, “supposing a preliminary existence and coherence of the representations that cover the technicity of the object with symbols that are part of imaginative systematics and dynamics” (Simondon 1958: 73).

Once the concept of invention is on the scene, we should also notice that invention in the sense we mentioned above – a mode of revelation – is not only what defines a relationship, but also what redefines “environment” itself. For instance, in the philosophy of techniques of Gilbert Simondon the technical object itself isn’t more important than its immediate environment; the technical object is being questioned not as an isolated object (as the key-concept of individuation in Simondon could have suggested) but as one system with the environment its function depends on (what Simondon calls “milieu associé”, and which, in Simondon, has a technical meaning in the first place).

We used on February 2013 the concept of invention to introduce a course about architecture and the technical culture in the Ecole nationale supérieure d’architecture Paris-Malaquais. More generally, the questions about architecture, technology and environment that lay in the background of these considerations are in the core of a part of the educational program of the ENSAPM, especially in the departments Digital Knowledge and Architecture, matériaux, cultures constructives.

“Invention and subversion”

“Invention and subversion” is a course of the 3rd year on architectural studies which aims to give to the students the analytical and methodological tools for the elaboration of a modest scientific research project. The result is an individual article from each student at the end of the semester. The students can chose between different specific themes, according to their personal interests and the anticipated subject of their article.

The option called “Invention and Subversion” (Ass. Professor Leda Dimitriadi) has the objective to put the theoretical basis for inscribing the study of technological and
scientific issues in a larger cultural, historical and philosophical context. This course has the ambition of considering architecture, art and the city in an open way in the light of scientific and technological developments, either in a historic perspective or in a more contemporary one.

The title given to the course, "Invention and Subversion", resumes this proposition in its most radical form, suggesting that the act of invention has not only the potential of innovation but that of most revolutionary impacts upon the "modes" of "being-in-the-world" (if we want to stay faithful to the simondonian terminology). Yet, "invention" is rather used here in an almost rhetoric way: far from focusing on the action of invention itself, we mainly and first of all have the intention to evoke with this educational proposition the capacity of signification (in other words, the capacity of currying meaning) in a domain of civilization very often reduced to its utilitarian character (for the techniques) or its opaque one (for science).

Rather than developing in the present article ontological questions about the place of environment in our educational (architectural, philosophical...) culture we prefer to put forth here a more "nominalist" approach and come back to the student’s works themselves.

We should also note that the student’s work in the “Initiation in research” course, work that is presented in the school’s program as an individual one, has undoubtedly a collective dimension too. This collective potential is reinforced by a virtual support of the course, that is a password-protected wiki website where students post regularly their work in progress. This collaborative kind of work on a wiki platform was also initiated for the graduate research seminar (Master I and II) in the ENSAPM entitled “Paysage mondial des villes” (Professor Jean Attali e.a.).

We then realize that the concept of “environment” in the context of architectural studies oriented towards the question of technology is merely an emerging one. Taking into account this immanent collective dimension, which is in fact “under construction”, we will refer here explicitly to some of the student’s articles, in an attempt to put on an (inevitably partial) synthesis of some rather heterogeneous material, trying in the same time to show how concepts of environmental problems are immanent in architectural questioning even when the theme of the research is not namely oriented towards them in the first place.

The article of Arnaud de Benoist entitled “Energy and future: towards a reasonable decreasing for the durability of ecosystems” tries to bring together a number of elements allowing to comprehend the beginning of an energy crisis in relation to existent technologies and systems of production confronted by economic models on the one the hand, and more specifically by the pyramid of energetic dependences on the other. The latter evokes directly the political question of local and territorial interdependences, and makes thus in a pertinent way an implicit intellectual bridge between the concept of autonomy and that of territorial scales. The author argues in favor of an approach based on small scale localized systems and seems to refute globalizing and centralized solutions (he argues then for local and not global technologies). With this conclusive remark his ideological position is clearly inscribed inside an important technological and political debate.

A questioning on the scale limits of human interventions treating environmental problems is also proposed in the article of Jeremy Richard in a complementary way, addressing more directly here properly architectural issues. The article entitled “The
integration of built artifacts in its environment for the durability of ecosystems”\(^4\) is presented as a synthesis of a rather large bibliography concerning biomimetic strategies in architectural design. The author points out some interesting remarks that could constitute the material for future research. One of them is the idea of a bottom up approach in the way the matter is fabricated in nature, an approach in which the structural scale distinctions are not as clear as in architectural design. We could then suggest the opening up of the conventional scale limits as known in the history of architecture. Rightly, the author proposes that recent digital developments could allow obtaining an interesting approximation of the bottom up approach as observed in nature. But, we should add, most importantly it is the opening of mentalities that could allow redefining the contours of the architectural intervention in an environmental perspective. Symmetrically, the author implicitly points out that we should transcend the limits in the opposite way also: to think of the building as a part of an ecosystem, and not as an isolated or inert technical artifact.

The latter idea is also emerging from the article of Sarah Roca-Labarre “The data-center, contemporary industrial architecture?”\(^5\). This article is particularly interesting because it puts on the scene the environmental issues in a symptomatic, almost unconscious way. In fact, the environmental question emerged during the research and became finally a central one, whilst it wasn't addressed as an objective of the research in the beginning. The analysis of data-centers seen as the contemporary industrial architecture paradigm, in comparison to industrial architectures of the past, showed that in some points in time industrial architecture condensates or exacerbates the most crucial architectural problems of this time. The author rightly then shows that one of the most important actual problems to resolve in such architectures is that of energy and environmental impacts, and that architectural design imperatively includes, if not is overtaken in importance by, the spatial management of such parameters, as is shown through the description of a datacenter of Goggle in Finland.

This brief path we tried to trace here through three student's articles (we could have mentioned even more) attempts a possible reading of individual works as a collective one, revealing different facets of a multi-level generic problem.

“Materials for eco-design, an experimental approach”

The Research seminar (4\(^{th}\) and 5\(^{th}\) year of architectural studies) offers to graduate students the educational framework for the elaboration of their master's degree dissertation. In what concerns the basic principles (methodology, scientific objectives...), the Research seminar constitutes the natural continuity of the “Initiation in research” course, detailed above, even if there are no direct links between most of the teaching groups or the themes proposed. As in the “Initiation” course, here again students have a choice between different thematic seminars. The final result of the course after three semesters is an individual dissertation on an original research subject proposed by the student.

In the option entitled “Materials for eco-design, an experimental approach” (Professor R. Leroy, Ass. Professor L. Dimitriadi)\(^6\), students are invited to proceed to practical experimentations in order to put forth innovative materials or construction procedures as an answer to energy, ecology or environmental problems. The research is highly personal and original, and, above all, practical as well. The latter is what dif-
ferentiates this specific master’s seminar from probably every other master’s research seminar in architectural schools in France. The most important and original part of student’s works isn’t the literary part (the synthesis based on a bibliography or an archive research, as in most dissertations), it isn’t in fact the text of the dissertation itself, but the material experimentations the students pursue, according to more or less rigorous scientific protocols they put up. In order to encourage innovative and original propositions, the experimental framework is quite open; however a number of objective and quantifiable results, even if they are inevitably approximate, are expected. In this way the students in architecture are also confronted by some of the premises of research in hard sciences, and by a certain demand for rigor and precision that comes with it.

In this course, as its title indicates, the environmental issue is directly addressed. Students obtain during the course some basic knowledge in this domain (for example, lifecycle analysis of materials or buildings, etc.), knowledge that each one of them enriches and develops according to his or her personal research project and protocols. The objectives of the students’ experimentations are quite diverse. It is about inventing new materials (or compositions of materials) in order to achieve structural optimization, minimization of the environmental impact, minimization of cost, improvement of industrial fabrication procedures, reduction of the time of fabrication or manufacturing, recycling of used materials and so on. Some of the students’ propositions have however also more architectural, even aesthetic objectives (materials that present new visual qualities, for example).

Invention and innovation as ultimate goals of this kind of practice are quite evidently here tied together, although we do distinguish them. What is more, students are forced to realize the distance they need to cover in order to pass from something that belongs to the order of invention (a technical/scientific singularity) towards something that belongs to the order of innovation (which has much more to do with established production systems, economic factors etc. than with pure technical functionalities). We realize during this process that the latter is far more contradictory. Students are often in contact with institutions or companies outside the school, in order to understand the complexity of this kind of problem.

It would have been difficult to refer here to specific students’ projects: as it is about original master’s dissertations, some of them being actually pursued as diploma projects or doctorate theses, we leave to the authors the right and responsibility to make them public. However an inventory of these works, with contents or summaries (under construction) and other educational material is available in the course’s website (mentioned above).

We will insist finally here again on the collective aspect of this work. The course’s website, that we intend to make as complete as possible, is the first step to reinforce this collective, and why not collaborative, dimension. As a complementary collective goal, this course aims in a second phase to proceed to the construction of a virtual “matériauthèque” on line; this database should have as a main characteristic the originality in the use of materials and the experimental approach; that means not to put forth confirmed qualities but rather potential ones. This “matériauthèque” is thus not a guide or manual for conventional construction but has mainly the ambition to constitute a tool for innovative research for eco-design in a bottom up approach. The “matériauthèque” should then be an open data base in direct relation to the students’ experimentations.
Digital technology and environmental design

With the description of these two educational approaches in the previous sections of this paper, we explained our point of view about two major and complementary facets, the theoretical and the practical one. The theoretical tries to cover a potentially large philosophical spectrum while the practical one transcends the conventional architectural scale towards the material itself on the one hand and the environment as a system on the other. As we saw above, this transition was also anticipated through some theoretical works, whilst no real link existed between the two, either chronologically or methodologically.

The third facet we should question in this context is more specifically the role of digital technologies.

A thorough thinking and work on digital technologies and computation in schools of architecture has nothing to do with another style neither with a fashion that will pass by. It isn't even a “new” thing. On the contrary, it is about an urgent and necessary actualization of the question of technological evolution in architecture, a question as old as architecture itself, inscribed in the history of construction and production, and irreducible to this of morphogenetic innovations.

If the relation between technological evolution in architecture and that of computation is nowadays more and more put forward in architectural education (although it is far from being fully accepted by the academic community), the relation between digital technology and environmental issues is far more fragile epistemologically. In a way caught up in ideological dilemmas, as characterized by “technology Vs nature”, we often seem embarrassed to put the two branches on a common basis for analysis and study, as if a fundamental incompatibility existed between the two.

We often observe a dichotomy in mentalities (dichotomy which is largely ideological), on the one side putting technology at the opposite of nature, considering it incapable, as such, of giving a coherent and durable answer to environmental problems; and on the other seeing technology as pure functionality without meaning, whose value is measured in terms of efficiency or performance.

We wish, as a conclusion, to reformulate this situation by displacing the problem. In fact, digital technology allows today for optimizations undoubtedly useful in environmental design. Many students actually work in this direction, in research seminars as well as in studio projects. Given the encouraging results of such efforts, we could plausibly lean towards an approach integrating digital technology in environmental design without technophobic hesitations. What is more, environmental design from a clearly teleological point of view could even legitimate the intense use of digital technologies.

Yet the intellectual question for architecture (and even more urgently for architectural education) is technology’s subversive capacity. In other words, what is the profoundly architectural specificity of the use of digital technology in environmental design? As technology becomes more and more pervasive (if not more and more invisible), its effects tend towards a sort of neutralization. Once we refute the digital as a new “style”, is technology reduced to pure functionality, efficient and performing for all architecture? Or are we still capable of renewing the conditions in which technology can carry a creative signification at more than one level – which is, in a way, the property of invention as defined at the beginning of this paper: something that belongs much more to the order of potentiality, or, why not, of the symbolic realm.
Notes
   id: ouarpo, pass: ouarpo-edit
   id and password as above
   id and pswd as mentioned supra
   id and pass as mentioned supra
   id and pass as mentioned supra

References
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Innovative Technologies for the Control and Reuse of Rainwater in Urban Contexts
Currently one of the most important environmental problems lie in the territorial management of the infrastructural networks that, in some cases, has produced situations of real emergency. Within a correct and sustainable urban development, the control of the flows of rainwater to the ground is particularly important. When the balance of the rainwater at a territorial level is meaningfully altered because of the ground changes, implementations of infrastructures of water collection are often necessary and they are expensive from both the economic and the environmental and landscape point of view. It is evident, therefore, the necessity to check the process of water collection at the origin replacing or placing side by side to the traditional infrastructures the so-called “green infrastructures”, as suggested by the United States Environmental Protection Agency according to the logic of the Low Impact Development (LID).

The aim of this research concerns the use of the principles of the nature as a model of management of the rainwater stimulating the hydrological potentialities not developed by the site. The final result consists in the individualization of “green” technologies both passive, only natural, and active with small engineering, allowing to carry out an urban micro-basin self-ruling the meteoric waters picked up to the ground in the area that is object of study according to the logic of “design for water conservation”.

The study based on research and teaching applications, has been applied to different types of urban basin in different geographical areas that are particularly interesting due to the fact within these contexts there are significant alterations in the natural water flows.

**The rain water reuse in urban contexts**

Within the rational water management in urbanized territories the recovery and reuse of rainwater is particularly interesting. The water is a very precious resource and it is evident, therefore, the necessity to set strategies of sustainable management through its recycle and reuse in order to contribute to the safeguard and conservation of such a resource.

In the urban context the continuous increase of impermeable surfaces has often determined great problems of erosions and flooding besides altering the hydrologic natural water cycle damaging the balance among precipitation, evaporation, groundwater recharge and surface outflow. It is evident that it is imposed, therefore, a change of attitude in the water management in urbanized territories that must follow the natural cycle.

Beyond these considerations, in addition, at the territorial scale it is very important to check its origin; the process of collecting rainwater through a controlled management that can be done by determining the contribution of rainwater and their possible recovery and reuse, infiltration in the soil and the entries in the natural water bodies.

The actions to be taken for a sustainable management, therefore, are those ones to re-waterproof the ground, allow the infiltration of rainwater as much as possible and recover them in order to reuse them.

The study of the hydrological balance at the regional scale, involves the characterization of the flows of precipitation, runoff, infiltration and evaporation. When the
balance of the rainwater at a territorial level is meaningfully altered because of the ground changes, implementations of infrastructures of water collection are often necessary and they are expensive from both the economic and the environmental and landscape point of view.

The necessity is therefore evident to check the process of water collection at the origin replacing or placing side by side to the traditional infrastructures the so-called “green infrastructures”, as suggested by the United States Environmental Protection Agency according to the logic of the Low Impact Development (LID). It is an approach to the development of the territory that uses principles tending to recreate characteristics of the natural territory in order to carry out a functional drainage of the site, so that the rainwater can be considered as a resource and not as a waste. There are many systems that can be used for adhering to these principles such as: drainage systems and permeable pavements, rain gardens and green streets. They are “green” technologies both passive, only natural, and active with small engineering, allowing to carry out an urban micro-basin self-ruling the meteoric waters picked up to the ground in the area that is object of study according to the logic of “design for water conservation”.

For implementing the LID principles, the water can be managed so that they can use the principles of the nature as a model of management of the waters, stimulating the hydrologic potentialities not developed by the site. Applied on a wide scale, the LID systems can contribute to reinstate hydrologic functions and, with particular devices, also ecological functions of the whole aquifer. The interventions of transformation of the human-made territory, in fact, must be interested, among the other aspects, also in the ecological aspect for the maintenance of the biodiversity in order to protect the natural processes that are at the basis of the ecosystems survival.

In the United States of America there are many important experiences of implementation of green infrastructure as the cases of Seattle e Olympia (Washington), Portland e Wilsonville (Oregon), Philadelphia (Pennsylvania), Emeryville, Santa Monica e San Jose’ (California), Chicago (Illinois), Alachua County (Florida), Stafford County (Virginia) e Lenexa (Kansas).

Within the sustainable water management of urbanized territories a particularly interesting case study, that can be considered as a virtuous example of “water management”, that is planning of systems that exploit rain as a resource is that one of Portland city in Oregon in the United States of America.

In 2007 this city structured and carried out an innovative project of sustainable rainwater management according to the general concept of “water management.” The rainwater disconnected from the sewerage has been collected locally, treated with natural systems and partly reused and partly subsequently reintroduced in the groundwater. It was carried out a real “diversified water collection” through systems of garden roofs, rain gardens, green streets, diffused in the whole city. Practically most of the impermeable surfaces have been replaced by permeable surfaces endowed with vegetation and able to absorb and filter water and in some cases to store it, too. The point of strength of such a project is the so-called “green streets”, that are the elements allowing collection and reuse of rainwater, but they are also more because truly they improve the liveability of the districts and they add green spaces to the city. The system consists of a net of green bands along streets and pavements endowed with pendency so that they allow the rainwater collection in established collecting areas
where natural treatments happen before their entry in the groundwater. Besides, naturalistic engineering technologies are used to check water outflows.

Such “green streets” sensibly reduce meteoric water runoff, removing also the pollutants that rain takes from the street mantle.

Moreover, the municipality of Portland tried to carry out other “green streets”, besides those ones already built, and planning new districts and carry out the rehabilitation of the existing districts in the viewpoint of a sustainable rainwater management also allocating incentives and foreseeing free technical advice to the residents who want to carry out either a garden on their own roof or a rain garden in front of their own residence. According to the data 2011 of Portland Bureau of Environmental Services, the “green streets” allowed the recovery of 140 million litres of rainwater and their expansion would allow to reach 30 million litres per year.

**Passive and active systems for rain water reuse**

The rainwater collection for their following reuse can happen either with simple collecting systems exploiting ground pendency and permeable surface (passive systems), or with more complex water collecting systems from impermeable surfaces such as roofs of buildings, paved surfaces, etc. (active systems).

In the water reuse cycle, the building represents the central element of the network: it is able, in fact, to join the resource use exigencies with the same reuse ones, in an optic of sustainable environment.

A system for recovering and re-using rainwater for buildings is set up in such a way as to allow for the collection of water from roofs, terraces and pavement gutters and to re-use it, after appropriate treatment, for various uses such as: wc flushes, car washes, washing exterior pavement areas, watering kitchen gardens, lawn and green-area irrigation, reintegration water for anti-incendiary use and even for some appliances like washing machines, appropriately fitted.

The system involves several phases, the first of which is collection. All impermeable surfaces are suitable as areas for collecting rainwater. Obviously, the greater the area for collection, the greater the amount of rainwater that can be collected for re-use.

The next phase is that of filtration. A filter is fitted that permits the removal of those elements which deteriorate the quality of the water in the water-tanks. After this, storage is required for the water in tanks.

Some of these are fitted with a system that slows and regulates input flow in order to prevent the disturbance of sediment that collects on the bottom. The tanks can be positioned below ground outside the building or in basement spaces or storage spaces inside the building. The tanks which are placed outside have the advantage of being hidden from sight and protected from accidental damage while, those placed inside have the advantage of not requiring any tampering with the external system for their positioning and therefore eliminating the risk of damage to the main system apparatus. Furthermore, it is preferable to place the latter in a vertical position so as to reduce the amount of space they occupy and to position them in parallel in order to increase capacity. The tank contains a pump, which through a control unit passes the water into the recovery plant.
Didactic experience and case studies applications

This contribution illustrates the didactic experience carried out during the course in “Design of environmental systems” (lecturer: prof. ing. Rossella Franchino - academic year 2012-13) on the degree course in Architecture at the Department of Architecture and Industrial Design of the Second University of Naples.

The aim of this didactic experiment was the study of the recovery and reuse of rainwater at the territorial scale using active and passive systems. These systems have been applied to significant urban contexts such as squares, streets and parks. For each of these urban contexts have been identified innovative and appropriate technological solutions.

The students have developed projects for which the course provided contributions with exercises and an operative workshop. The proper management and rational use of water is, in fact, currently an issue that is of particular concern in the environmental field. It seems clear, therefore, the need to develop strategies for sustainable water management in urbanized areas through the recycling and reuse of the same in order to contribute to the protection and conservation of this resource.

Below two case studies of particular importance are presented. The first case study (Figures 1 and 2) proposes an intervention for the recovery and reuse of rainwater in Piazza Vanvitelli, a square in the city of Caserta in Italy, where are the Palace Castropignano, the town hall, the sixteenth century Palazzo Acquaviva and the building of the Bank of Italy. There are also commercial activities and hotels. In the square there is a public garden with a fountain and a monument to the architect Luigi Vanvitelli. The

![Fig. 1](https://via.placeholder.com/150)

Systems for the recovery and reuse of rain water - case study of piazza Vanvitelli in Caserta.\(^1\)
vegetation is of great value, the species are similar to those present in the park of the Palace of Caserta.

The project of recovery system of rainwater in this square has proposed the implementation of green streets that in addition to providing for the recovery of rain water through the system of planters have also made green corridors which have strengthened the green already present in the square extending it to the city.

In addition, the rain water was recovered from the roof of the buildings adjacent to the square by active systems of accumulation and reuse.

Finally, the square has been further valorized by creation of a bio-pond with corners for refreshment and a large solarium.

The second case study (Figures 3 and 4) proposes an intervention for the recovery and reuse of rainwater in via Roma and corso Garibaldi, two important streets in the city of Salerno in Italy.

The project of recovery system of rainwater in these streets has proposed the implementation of green streets and permeable paving in corso Garibaldi and rain gardens in via Roma. These rain gardens collect rainwater from the roofs of buildings near to the street.

Notes
1. The tables presented in Figures 1 and 2 were elaborated by students: Di Donato Sara, Natale Assunta, Oliviero Antonella, Zaccariello Raffaela during the course entitled “Design of environmental systems” (lecturer: prof. ing. Rossella Franchino - academic year 2012-13) on the degree course in Architecture at the Department of Architecture and Industrial Design of the Second University of Naples.
Fig. 3
Systems for the recovery and reuse of rain water - case study of via Roma and corso Garibaldi in Salerno.²

Fig. 4
Rain gardens - case study of via Roma and corso Garibaldi in Salerno.
2. The tables presented in Figures 3 and 4 were elaborated by students: Picardi Sara, Piccoli Alessandra, Tessitore Stefania during the course entitled “Design of environmental systems” (lecturer: prof. ing. Rossella Franchino - academic year 2012-13) on the degree course in Architecture at the Department of Architecture and Industrial Design of the Second University of Naples.

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http://water.epa.gov/polwaste/green/
Master Course in Architecture and Environmental Technologies: A Post-Graduate Course for the Integrated Education of Architects in the Use of Environmental Strategy in the Project
Building design decisions are increasingly being taken by clients and service engineers and the whole process of separating the building from its local regional and global environment has not only diminished the importance of the architect in the building process but also resulted in poorer environmental standards of design of buildings.

The future of comfortable, healthy, low energy, low CO\textsubscript{2} buildings lies largely with architects, not engineers or developers. But one of real chances we must face in their performance and this shift of performance based design will have to be underpinned by a change of the emphasis in the teaching of designers.

There is an urgent need to improve the environmental performance of buildings in the city of the future, though great steps have been taken in the field of renewable energy use and integration of related technologies in architecture. But the integration of technologies and systems to renewable energy into buildings, requires training of architects in this field. Still today in Italy there is a paucity of architects (also engineers) who work with these objectives and dealing to these issues; so this situation lead to a failure in market penetration of techniques and systems for the exploitation of renewable energies in the architectural and urban project.

The renewable energy industry is growing rapidly amidst rising concerns about oil depletion and climate change. Renewable energy is seen by many as part of the appropriate response to these concerns and some national Governments have put programs in place to support the wider use of sustainable energy systems. This has led to a rapid increase in demand for renewable energy specialists who are able to design, and moreover install and maintain such systems. Most architects are not trained to use these renewable energy technologies and most are not aware of the principles of sustainability. There is therefore an urgent need to develop and implement new courses that prepare architects, scientists and energy planners to work with renewables to use responsible sustainable energy generation systems.

In order to give some answer to this (not exhaustive) questions, since 2002, the Interuniversity ABITA centre (a network of Italian Universities www.centroabita.unifi.it) organized a second level Master Course in Ecological Architecture and Technological Innovation for Environmental in order to create the new generation of designers who have to know of use of environmental strategy in the project (building and urban projects). Not just an architect o a technician but an enabler who manages to comprehend and activate the multitasking kind of projects.

The ABITA Centre is engaged in education, consulting and research in the field of environmental project and sustainable approach in the building construction and building-related environmental issues. Moreover is devoted to high-quality and practice oriented supplementary education on the basis of relevant academic as well as professional experience. In fact, the high level of all the professional and academic teacher group, assure an interdisciplinary training supported by an high number of research centers and national and international companies partners.

**Master Structure**

This Master Course, born - in accordance with EU directives - as a response to the high interest expressed both in the public administrations by companies and businesses to the wise management of environmental resources and planning sustainable built land. So this course if finalized to offer a specific advanced level course in order to com-
plete the proposed training courses offered by Italian high level schools in Architecture and engineering, so to give new input and instruments for environmental project in a eco-compatible perspective.

The educational goal is to define a cultural base capable of formulating and managing eco-friendly design criteria through the identification of procedures and instruments to determine methods of intervention and economic viability for both the new and existing buildings, in terms of quality, environmental and energy recovery.

The MS course program aims to provide students with state-of-the-art knowledge and expertise in some of the most important renewable energy disciplines; in detail, the environmental design carried out by teachers, is linked to the subject area of technology of architecture and is a powerful tool to stimulate student’s projects friendly solutions with sustainable matters, materials and low-impact use of territory. The peculiarity of the subject consists in its actually real connection to the ‘world-we-live-in’, even if it counts on a wide source in theory and analysis.

The MS course will run for 18 months (including the final thesis project dissertation), with a principal period characterised by theoretical lessons and a second period characterised by an applicative stage. It is based on accumulating a given number of credits (70 CFU) from a collection of obligatory courses (8 modules) a internship and a final project. Assessment is based on coursework, exams, and final dissertation with its presentation. The MS course run in autumn and terms in spring; usually the Easter term is mainly directed at the dissertation.

The MSc course comprises assessed modules, several integrated group projects and an individual final project. Students undertaking the Postgraduate Master Diploma have to complete all the provided modules, the internship period with the final project.

The MS Course program is organised in eight modules specialization areas characterised by a principal core module followed of specialist modules.

The core module are address to deeper knowledge regarding Sustainable Development and technology in the project while the areas of specialist modules are addressing to energy sustainability at different levels:

**Small-scale | Indoor Climate and Comfort**

Besides studying the design and operation of Heating, Ventilation, and Air Conditioning (HVAC) systems, this area soughs to improve competences in topics such as analysis of comfort, simulation of energy in buildings, computational analysis of fluid dynamics, or the influence of the buildings’ opaque envelope on comfort. The publication of the EU Directive EPBD (Energy Performance of Buildings Directive) has induced national laws and regulations concerning the certification of buildings and the monitoring of their consumptions. This new reality demands for an increase of the number of professionals with specialized technical education in the areas of HVAC in European countries, justifying the creation of this specialization area in the MS. Course program.

**Medium-scale | Buildings and Urban Environment**

This area builds competences for designing and analyzing urban-scale systems, both under a perspective of space organization, at the crossroads of criteria related to the
sustainable use of natural resources, functionality, and fruition, and the under a perspective of buildings as complex systems, addressing conception and operation in a context of efficiency, as well as human comfort and health.

**Macro-scale | Energy Systems and Policy**

In this area, courses are offered to allow students to master topics related with energy and environmental economics, energy markets in various forms of organization and regulation, efficient use of energy and overcoming market barriers, organization of systems for sustainability, among other topics.

During the MS course period, several technical visits are provided.

![A technical visit to a construction site.](Fig. 1)

**Modules**

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In detail the educational programs provide to:

- prepare architects as a technician enabler to manage and activate the multitasking kind of projects
- prepare students for careers in renewable energy advanced research and management;
- train the researchers and architects who will help to prepare and implement energy strategies and policies for leading manufacturers, innovative start-ups and public organizations.
Group project

The period of lectures is followed by some group projects; the group project experience is highly valued by both students and prospective employers. It provides students with the opportunity to take responsibility for a consultancy-type project, working within agreed objectives, deadlines and budgets.

![Fig. 2a](image1.jpg) Group projects.  ![Fig. 2b](image2.jpg) Group projects.

The internship

At the end of the lesson period, students have to carry out an national internship or internship abroad in professional offices or partner companies; in detail, an internship abroad is a great opportunity not only to make work experience, but also to develop other types of competences like the improvement of your language knowledge, of the culture, and of the lifestyle of the host country.

The internship allows to discover the business world and helps the participant to complete the theory and the methods that were taught during the professional career.

Many students who have participated in this master after doing an internship in Italy or abroad, have had the opportunity to stay in professional offices or in companies with success. This means that the training imparted during this course allows you to get good job prospects in the field of architecture in which increasingly requires specialization and application of systems and innovative components for building.

Individual thesis project

The individual thesis project, usually in collaboration with an external organisation, offers students the opportunity to develop their research capability, depth of understanding and ability to provide solutions to real business or industrial challenges in renewable energy technology.
Strengths

One of the most important purposes of this MS Course is related to introduce in the studio-projects the open environment (not only the urban, but also the landscape) as interface for built architecture: time has come to comprehend architecture doesn’t exist without environment!

So, a strength of this didactic experience is to teach a multidisciplinary subject explaining to architectural students how to relate their project with the reality of the settlements, the open spaces, and the wide territory.

The lecture and operational-based learning model adopted in this MS Course, is a teacher-centered practical approach in which learning is derived from the instructor, in a technical lecture setting, imparting what is known about a subject and, thus, hopefully resulting in knowledge transfer.

The point of focus in this specific learning model is on the teacher and the content being imparted. This method of teaching promotes technical learning and utilizes assessment methods that reward student reproduction of facts.

In detail:

Internationally recognized partner schools and laboratories: The program gives students the opportunity to learn about some of the most important renewable energy issues from expert researchers.

Strongly committed business partners: The research units of the businesses partnering the program make a considerable contribution, both in the classroom and in the field via student internships.

An international outlook: some lessons of the program are taught in English also, making it accessible to students from around the world.

An innovative structure: Students also benefit from cross-disciplinary courses and seminars on various technologies. The ABITA Master’s program provides targeted training in specific renewable energy disciplines and a holistic understanding of the related issues.
Expected

Students will enter the job market with the necessary skills to help leading manufacturers, innovative start-ups and public organizations define and implement their energy strategies and policies, worldwide; moreover the program also prepares students for jobs in research or teaching.

The wide array of businesses and laboratories involved in the program offers students extensive employment opportunities in the sector and, at the end of the program, students will be able to choose from a number of career options, including:

- Undertaking a PhD, at an academic or industrial laboratory.
- Becoming an expert operational project manager, in a public agency or an energy company.
- Embarking on a technical, business or sustainable development career in the energy industry.
- Embarking on a career in energy strategy development and implementation for a major manufacturer or producer.
- Contributing to the development of small businesses focused on renewable energies.

The traditional lecture-based learning model is a teacher-centered pedagogical approach in which learning is derived from the instructor, in a lecture setting, imparting what is known about a subject and, thus, hopefully resulting in knowledge transfer.

This traditional format often results in students memorizing the material for the purpose of passing an objective examination. A growing amount of research indicates that this traditional approach does not appear to be an efficient method for the learner to effectively apply and integrate knowledge in a problem-solving situation.

So the MS course applicative-based instruction appears to be not limited in developing retention of learned concepts and, more importantly, application of the knowledge in a environmental thecnical setting that requires critical thinking.

It also very interesting to explain that this new teaching methodology and techniques offered in this Course, with the pedagogy introduced and illustrate, contribute to an innovation of the work of students. A precise description of educational objectives and teaching methods, enhance the quality of the final project and respective presentation.

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The Environmental Objectives in Architectural Education
Architecture and the environment from a historical point of view

The knowledge and skills that the teachers of an architectural education pass to the students should reflect as much as possible the reality in various aspects. Among aspects linked to the architectural profession are: functional needs with their psychological, sociological and financial conditions; constantly changing technological possibilities; the impact of the built environment on the natural one. These elements of reality form a very complex net of interactions. It always existed though nowadays it is extremely developed. Taking a symbolic example of the past – Vitruvius states that the building should be “solid, useful, and beautiful” but also he emphasizes the environmental impact (appropriate site choice, it’s physical characteristics such humidity, wind directions, average and extreme temperatures). The architect of that time should and could have practiced various disciplines, being also an engineer, landscape architect, artist and craftsmen. In the past, practically until the industrial revolution, these interconnected areas could have been implemented both rationally and intuitively. Now due to very extended specialization such complex task must be executed as multidisciplinary team work.

Another aspect of the environmental elements in architecture is the way of applying of the building materials. It depended on the technical possibilities of accessibility and transportations. In the historical periods most buildings were constructed from the local materials. Only for special, expensive buildings, or for their parts, not local materials were used. Again the symbolic example would be sacred circle in Stonehenge where most elements are from local stones but for inner circle the stones with different tint were used and those were brought from far distance, the quarry in Wales. The characteristic architectural forms and appropriate town and country plan-

Fig. 1
Log-house with green roof and water insulation made of birch bark (Stockholm – Skansen, the open-air museum (fund. 1891) showing traditional rural culture displaying historical buildings from all parts of Sweden).
ning arrangements in the historical settlements were influenced by the surrounding natural environment. That caused the forced use of local materials and respect for the climatic elements. The amount of rain, snow, temperature etc. on the basis of long, practical experience of users and builders influenced forms of buildings such as scale, roof shapes and their functional elements (eaves, cornices, chimney stacks) thickness of walls, scale and localization of opening.

Since the time when the building materials production and ways of transportation were more available, the functional layouts and architectural forms depended on the conscious decisions of an architect. Architects and investors not always considered the impact of their choices on the natural environment. This was especially characteristic for long period starting with the industrial revolution of early XIX century.

New attitude to environmental aspects started with fuel crisis of seventies and visible results of greenhouse warming. This awareness is extended to wide spectrum of proecological acts leading to general idea of sustainability.

**Present issues of environmental problems in architecture**

Nowadays most of the environmental problems are precisely codified and various legal acts, technical standards and norms have to be strictly fulfilled. Generally the regulations are connected with energy saving. The main task of conserving the natural environment is realized in various ways from garbage segregation and recycling to highly developed technical equipment of “intelligent buildings”.

“Intelligent buildings” and “passive houses” represent the philosophy of controlling functional and internal environmental effects by using advanced technologies with extended automatization. Buildings of high technology, due to full control of internal physical processes must be very tight. Ventilation is controlled and supplemented with recuperation. More efficient heating equipment needs less energy. All these solu-

![Fig. 2](image_url)

Students work – concept design of the “passive house”.
tions help to achieve the leading task - a minimizing of the demand for energy needed for heating and cooling. This minimizing may cause a reduction of energy production from nonrenewable sources which in turn is important for conserving the natural environment.

The buildings’ users are generally interested in the reduction of payments for used energy, especially in the immediate financial result. But in case of the buildings equipped with highly developed technologies, the initial cost is usually high. Expensive necessary materials and technological elements causes that real profit comes after specified, sometimes long time. These necessary elements are: thicker thermal insulation, efficient windows and doors, mechanical ventilation with recuperation or efficient air conditioning, renewable energy sources such as solar collectors, photovoltaic solar panels, heat pumps, wind turbines, automatic control devises etc. Fortunately the prices of technical equipment, high at the time of introduction, steadily go down, and this equipment once exclusive becomes very popular such solar collectors and lately photovoltaic units.

The final result of energy consumption by such buildings may be very positive allowing to achieve very low demand (construction of the so called “zero energy building” is now possible) but for overall analysis of sustainability aspects, the other elements has to be taken into consideration and for appropriate calculations. This would be, for example, an amount of energy required for a production of necessary materials, such thermal insulation and specialized equipment, overall cost of transportation and application and impact of such production on the natural environment. For example the ecologists protest against the big wind turbines. One can also suspect that some sustainable ideas are used by big industry for increasing the profit.

Fig. 3
Example of everyday life environmental action – a stand for rented by the city bicycles with equipment powered with photovoltaic unit.
In opposition to that with high technological, attitude, the aim can be achieved by using passive methods which may be used separately or combined with mentioned above active solutions. This attitude is based on purposeful transformation of the building and its elements. Important is an appropriate situating the building towards the sun. Large glazed areas from south and west side allow gaining the solar energy which can be accumulated in floor and wall materials with high thermal mass. This can be intensified by adding the glazed greenhouse. The excessive solar gain can be controlled by forming special functional elements like awnings, eaves, external blinds and shutters in order not to use expensive air conditioning. Efficient use of natural ventilation may help to cool buildings in hot season. Heat escape in cold season is reduced by using low emissivity double or triples glazing and materials with good thermal insulating properties. For this purpose serves also appropriate forming of the building’s body - keeping low the ratio of surface area to volume.

The further step towards reducing costly and environmentally harmful: energy production, complicated equipment manufacturing, heavy and long distance transportation – is returning to traditional local materials or the new ones obtained from recycling process. Various raw earth technologies with basic material from the site may be used (adobe, rammed earth, straw and clay blocks). In this case the important factor is the eliminating of expensive and environmentally harmful transportation of construction materials. Straw-bale construction with high insulation value, renewable source is also effective. Most of materials used in this group of technologies can be recycled or harmlessly disposed or neutralized.

This idea of the “natural buildings”, being still marginal in comparison to big industry, steadily increases its impact on people’s consciousness.

Fig. 4
Experimental building designed and realized by the Architectural School of Warsaw Technical University with co-operation with Ecological Park of the city of Paslek. Building is constructed in various raw earth technologies (rammed earth, straw and clay blocks) has glazed winter garden to accumulate solar energy and green roof.
Environmental issues in the reality of architectural education

The complexity of nowadays architectural reality, shown above, should find its reflection in didactic programs of an architectural education. Even with the traditional basic content of the architectural schools’ curriculum students have difficulties with the general comprehension of an architectural design complexity and with the integration of divided parts of knowledge passed to students during the didactic process. In many cases this comprehension is not complete at the end of study period. Sometimes such sense of unity comes after many years of the architectural practice. At present the amount of issues demanding integration is much greater including topical environmental issues. The teaching methods should be adequately modified.

The process of unifications supposed to be realized mostly at the architectural design studios, where the students prepare designs of various types of buildings using their imagination but they should also apply the elements of knowledge acquired at specialized lectures and exercises. With the traditional systems of organization, especially in big schools, with division to didactic units specializing in specific subjects it is very difficult. In some cases the issue of sustainable architecture, as the current topic, is introduced to the curriculum but very often as separate issue either in designing or technical field. The students treat this as one more subject to pass and the adoption of this new experience for designing of other buildings is rear or fragmentary.

Postulated for many years integration between specialized subjects, especially between architectural design studio and technical areas is hampered in the school reality mostly due to mentioned organizational system. The best way would be to organise smaller multidisciplinary teams with architects and technical specialist working together at all stages of designing - sort of simulation of designing work in the

Fig. 5
Students attending the seminar at the site of the experimental building in Paslek. Scientific research took place during construction and use of the building.
real designing studios and offices. The consideration of various aspects and making basic assumptions: functional, formal but also appropriate technological solutions, at the primary concept stage, would serve as the guidelines for further development of the design. In real school practice the cooperation between the architectural studio and other specialists are carried out in the more traditional way. Students, within the design studio, try, very often intuitively, to develop the functional layout and architectural form of designed buildings. Due to lack of experience, they cannot foresee the necessary objectives coming from the restrictions of the legal regulations, from technological limitations on one hand but also from the extended modern technical possibilities on the other hand. The architectural instructors, the architects, may draw students’ attention to wider spectrum of problems at the early stage, but in most cases the technological problems are checked much later at the end of the course. It happens very often that after late additional consultations with the technical specialists the necessary substantial corrections - to structure, additions of modern service equipment, using proper construction materials – have to be introduced. This may cause the modification of the original architectural concept which done very late may bring not satisfactory final design.

The integration of various subjects is realized with difficulties but some attempts undertaken for the last decade brought already positive effects. When observing the students works especially diploma designs it is visible that some solutions connecting with environmental issues are deliberately introduced. Mainly it is awareness of climatic reality, application of proper insulation materials, avoiding the cold bridges in complicated details. Still some elements of passive concepts like external louvers, double skin walls, covering nets, are used by students as pure formal decorative elements.

Fig. 6
Detail of the student’s design showing elements connected with environmental view – proper thermal insulation including insulated fixing of balcony slab, low emissivity glazing, movable external louvers.
In architectural schools the required organizational changes should be followed by essential contents. Even if it is not possible to make multidisciplinary units, all subjects at all stages of the course should include the environmental issues presented in view of sustainable progress. Very important is the intercommunication between various units so as to know details of each other’s programs do not repeat the same information but instead may refer to them and expand the subject. Because the main task is a basic awareness of environmental issues the information should be passed in appropriate proportion from the primary basic lectures and exercises through architectural and urban designs, other supplementary courses to final diploma works. Also quite essential is to acquaint students with obligatory legal regulations, technical norms and codes connected with matter described here. Thus all these problems would not have a character of theoretical, academic exercises, but of real designing procedures. This should be very useful for students in their future work as independent, responsible designers. All environmental objectives passed to students hopefully will cause their awareness of design elements complexity and their interconnections. Especially important would be stressing the responsibility for future environmental results of taken designing decisions.

Fig. 7
Student’s work showing sensitivity towards natural environment. The multifunctional cultural centre of rural area of Kurpie District situated in the open-air skansen museum (st. K. Funk).
Fig. 8
The form of the building of Kurpie cultural centre differs from surrounding traditional buildings. It has all necessary modern equipment for proper functioning but also in used materials and details is linked to local tradition. External screen imitates characteristic wicker woven baskets.
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Environmental Education in the Context of Urban Landscape Renewal Programme in Silesia and its Impact on the Real
Location of the Faculty of Architecture of the Silesian University of Technology in Upper Silesia agglomeration - one of the oldest and largest industrial regions of nineteenth-century Europe - makes the problem of the degraded areas an important theme in the teaching practice. Possibilities for re-development and integration of the historic industrial areas with the city structure and rebuilding its relation with the region - the Upper Silesian Agglomeration of Industry - is an important issue in the teaching process of the Faculty.

Educational importance of the subject becomes more significant when the design problem leads to an understanding of the actual situation and close co-operation with local authorities is followed by a comprehension of the conditions, needs and location constraints. Such an approach to the problem gives the methodical teaching a greater meaning and raises the importance of students’ work. Equally important to the design practice education are the issues of planning, spatial context and social space. Using its location the Faculty repeatedly introduces planning workshops to the educational programme organized in cooperation with local authorities.

The present paper has the following aims:
- to present the issue of spatial restructuring of post-industrial areas in Ruda Slaska City,
- to show the effects of workshops, which took place as a result of cooperation between the City of Ruda Slaska and the Faculty of Architecture of the Silesian University of Technology (with an emphasis on the B-TEAM INTERREG workshop 1).

Workshop Organization

Area

Workshop areas were chosen by the municipalities and are reminiscent of heavy industry, mines, zinc smelter and coking plants. A significant contamination of the areas has been partly nullified in the recent years by the revalorization and forestation. Not all previous actions were generally positive. For example, visiting the area of the former mine complex Walenty Wawel, it seems that the new planners went too far in the transformation by demolishing almost all of the old industrial buildings and leaving an empty wasteland. In the place of one of the most striking images of industrial Silesia remained a true “no man’s land”.

Workshop

The workshop began with a discussion on the history and long-term industrial land use. The workshop was held in two sessions. Academic preparation was provided by the staff of the Faculty of Architecture of the Silesian University of Technology. Discussion groups were led by young academics and doctoral students from the Department of Architecture.

The goal of the first day of the workshop was to conduct a brainstorming session. Ideas, planning possibilities and “free thoughts” served as perspectives and limitations and thus as first indications for further work. Developed themes, functions and ideas were written down. On the second day of workshop the ideas formed the basis of searching for the essence of the problem and attempts to translate it into planning in
the form of sketches, notes etc. which were put on a background map. On the third day of Brownfield Days the main conclusions and proposals developed during the course of the workshops were summarized. Students worked under the guidance of the academic staff.

**Semester projects, workshop follow-up**

The ideas and proposals developed during the Brownfield Days were a point of departure for topics taken up as semester projects. The first stage of “problem identification” of the project included work with students and the focus was put on the transformation of urban areas. The theoretical aspect of the issue, enriched by experiences and achievements in the nearest spatial surroundings, provided cues to recognize the “spatial context”: spatial and historical structure of the buildings, general planning elements and the structure of green areas, logistic transport structure and other more complex plans. Studies and analysis led to the drafting of a development concept plan and to determining its regional context. Thus, a planning idea was born in relation to the development plan. Development plans drafted as a result of students’ architecture projects are summaries of the project visions which can and should become a solid basis for further discussions on the city development strategy.

**Context of the Place**

*Ruda Slaska and the industrial Upper Silesia urban area*

...These places are neither Cities, nor suburbs or villages. They have no identifying central point, nor do they have any clear periphery; ... the land surrounding them resembles something in-between: neither vast meadows or fields, nor parks or gardens, rather their remains; these are isolated green patches, destroyed, contaminated, used, chopped...

...single-family houses from outside the catalogue.... Overcrowded multi-family houses, designed carelessly, surrounded by parking lots and a collection of no man’s spaces, occasionally surrounded by thick fur of greenery, just to make it look more bearable...

Uncontrolled, dragged around urban ends and peripheries.

… and on the seas of replaceable and trivial places you would find islands, sometimes alone, sometimes scattered; .... These are old factories, monumental and symbolic, some of them dilapidated, some still operating...

Around them old housing districts, with their appearance of something uncontrollable... old settlements, living oasis, evidence of urban planning and architectural tradition...

This poetic description of the post-industrial land was presented by Kunibert Wachsten ² during VI Biennale of Architecture organized in 1996 in Venice.

From that time on many things have changed in the landscape of European urban areas of industrial origin. Mainly owing to activities aimed at promoting them and intense work and restoration programmes across the whole of Europe, including
EU structural funds. However the quoted description of the area remains relevant as it exposes one of the basic characteristics of industry: how the global transfer of its negative development features influences the spatial environment. This impact is still visible in the landscape of Upper Silesia including Ruda Śląska. Historically connected with the industrial tradition of Upper Silesian urban area, the City has been under the constant influence of similar development processes:

– industrialization which at the beginning of the 19th century transformed this agricultural area into one of significant European industrial centers
– economic change which currently, influencing the obsolete economy based on mono-structure of raw material industry, changed also the spatial landscape of the urban area.

Ruda Śląska is a City with district rights located in Southern Poland in Silesian Voivodeship, in the central part of Upper Silesian Industrial Agglomeration. Since 2007, the
City has been a member of the Metropolitan Association of Upper Silesia which encompasses 14 (out of 17) cities of the Upper Silesia region (Fig.1). The area of 78 km² is populated by 144 thousand inhabitants. The present spatial organization of Ruda Slaska is a result of combining 11 independent municipalities in one administrative unit. The districts of Ruda Slaska were established during different periods between the 13th and 17th century: the history of each of them is marked by the development of the Silesian industry, in particular of mining and metallurgy. Already in the first part of the 17th century the area of today’s city has been under the influence of urbanization resulting in the characteristic blending of housing and production areas.

The spatial landscape of Ruda Slaska represents in small scale the developmental features of the historical industrial agglomeration. Its amorphous spatial order came into being as a result of the blending of housing districts and the workplace (mine, steelworks, plant), thus creating an area with no geometrical plan, connected with excessive railway and road transport networks. Slag heaps of industrial wastes surround those quasi City-like enclaves with their traditional landmarks: towers of old plants intermingle with charming 19th-century church towers. As a rule, a city is designed according to a hierarchical structure: centre, downtown and districts. However, in the historical structure of industrial urban areas other places were of crucial importance: workplace (mines and steelworks combined with the set of facilities and accompanying services) and living areas — housing settlements. The trace of this historically preserved polycentrism is still well visible in the contemporary City structure.

Established as a result of heavy industry operation (mining, steelworks and other raw materials industries), the 19th-century European industrial urban areas bear the stigma of historical heritage longer than the actual work of the industry. Normally they also require much more revitalization effort, which is also more costly. Within the
area of the city 4 mines are still operating: KWK Pokoj, KWK Bielszowice, KWK Halemba — Wirek, KWK Wujek- Ruch Slask, as well as Pokoj Steelworks and Halemba Power Plant.

There are numerous revitalization activities suggested, the most important being the following:

- restoration of the environment degraded by many years of industry operating there; revitalization of green belts on the previously degraded areas of natural environment.
- transformation of an obsolete economy; closing down of up to one hundred years old factories and putting effort into setting up production investments with technologies posing less risk to its spatial surroundings and introduction of active protection systems of the industrial areas.
- promoting new centers of economic development; industries of the 21st century — the so called creative industries such as innovation technology, research, education and cultural centers shaping new social environment, as well as
- filling the void of unused post-industrial areas with new urban fabric useful to society, with particular effort put into filling in the lack of public space in the City and in each district.

On the basis of the experiences stemming from the transformation processes of the European industrial areas, such as so called mining centers: Ruhr and Saar districts, Nord Pas de Calais, and the areas of brown coal extraction in Lower Saxony, it could be suggested that in order to conduct revitalization successfully, restructuring of social developmental goals is required, with the full support of local communities. But the process of transformation of post-industrial landscape is long-lasting and costly. Normally, its effects can be visible only when there are various funding possibilities available: the funds come from different sectors and private-public sources. The transformation of the City or of given area would usually require defining its relationships with the surrounding areas. This is due to the fact that new investment activities most frequently take place on the in between areas, located on the border of urbanized areas. The planned directions of strategic changes for groups of Cities with a view to develop new economy include activities aimed at counteracting such risks.²

The EU structural programmes whose goal is to give European regions and cities equal economic opportunities constitute another vital element of the contemporary revitalization process, as important as strategic plans at regional or local level.

**Historical heritage**

Since the beginning of its development at the end of 18th century, industry was closely linked to the establishment and development of cities. The number of inhabitants of Upper Silesian cities and settlements grew quickly. Just like in other European Cities of similar origin, the initial number of inhabitants would usually soar. Another characteristic phenomenon was that the population of suburban settlements increased faster than the population of other cities of that time.

Industry can only operate under constant supply of raw materials, energy and workforce. Therefore, large metropolitan areas required a large number of cheap work-
ers for the processing industry, in order to increase production capacity of emerging plants. This however also brought about spontaneous development of Cities and urban areas. But it was the plants, located in the vicinity of the raw material extraction sites (coal mines), that had even better prerequisites for development due to the proximity of the main energy source. Back then, also work technology of the industry exposed the dependence of industry's development on the workforce needed to be permanent and well-trained for the job. When owners of plants, mines and steelworks planned to build an industrial plant, they would almost simultaneously plan housing areas for their new workers. Thus, the houses located in direct vicinity of plants called familoki have become an indispensable element of the Silesian landscape. Industrial areas would grow into the nineteenth century urban tissue resulting in numerous spatial conflicts. Not only would the industry cause a nuisance for the population due to its negative impact on the environment, but also through the spatial forms of processing facilities which almost always looked strange and unfamiliar. This process was exacerbated by the size of the land allocated for production, the size of industrial facilities and their connection with usually over-developed technical infrastructure.

Today, after twenty years of efforts to repair the damage caused by expansive economy of the previous decades, the post-industrial areas are still relevant to planning. The economic downturn associated with the escalation of social problems (unemployment, emigration of more creative groups) and the need to restore the damage caused to the environment all contribute to the fact that the process of city revitalization in post-industrial region is so long-lasting and costly.

Reflections

The changes taking place have created opportunities for a new focus:

- the possibility of re-development and integration of spatial and functional structure of the city,
- the perception of objects and old industry facilities as cultural heritage of technical-industrial era, thus being important elements of the place identity.

The general assumption was that post-industrial areas used to be places of production, including intensive agricultural or livestock activities, as well as post-military, railway and port areas which were initially operated but then abandoned. In the European specialist literature most of the descriptions of such areas derive from agriculture, such as “fallow brownfields” (derelict land, French: la friche industrielle, German: die Brache). In recent years, the term “urban brownfields” has been frequently used to describe post-industrial areas (www.oecd.oras/bisbrownfields.htm.). Also, the process of their redevelopment is often described as brownfields sites development in contrast to greenfields site development, the latter understood as the establishment of new investment on undeveloped “green” areas.

European examples of successful organization and financial programmes and urban actions despite various planning approaches share certain common features, such as:

- proposals are put forward by local public communities and for the project to succeed it needs an intellectual project supervisor (a person or an institution) who is emotionally committed to it and has the appropriate organizational capacity,
the investment is always financed through a number of private and public sources. Normally, public funds are used for preparation of the land for redevelopment, whereas the private funds are used mainly for the new development.

in most cases (in UK, France, Germany) there has been a separate statutory package established for the purposes of revitalization of post-industrial sites and the organization and implementing of planning and design. This is because frequently another philosophy of planning is needed than the stereotypical methods.

Concepts of Transformation – “Ruda - Great City, Ruda - Beautiful City”

Workshop general aims

The title slogan: “Ruda - great city, Ruda - beautiful city” of comical and wishful character was knowingly accompanying the introductory discussion and students’ work. Since the beginning the debate was held in terms of the transformation of the image of a small, provincial post-industrial city, which, like the rest of Europe in recent years, is subject to general world economic crisis, regardless of the degradation of the 1990s as a result of the economic transformation of the country.

The subject of the project activities were the three industrial areas (in the range between 5 and 20 ha), designated by the city of Ruda of Slaska. These areas will appear under the names: Nowara Heap, Wirek Heap, Coking Plant Orzegów. All three sites (located nearby urban development, including residential estates) are the result of many years of the activity of heavy industry harmful to the environment. The historical past is visible both in the present-day topography and the way of spatial development. These wastelands, partially covered with greenery, often require new research on their harmfulness and discussions on the possibility of their re-integration into the functional structure of the city. The problem of the protection / recovery of the natural environment, especially for the first two areas has become a primary concern to new ideas. Postindustrial area of Orzegow Coking Plant is located peripherally in relation to the major urban centers and creates a negative image of the district. This is due to the progressive degradation of the technical infrastructure and due to the high unemployment and social problems.

Workshop projects

Projects presented in the paper are divided into two groups: architecture and urban planning. Amongst these groups five projects were chosen for the purpose of the paper: Cracked Earth – Sports And Recreation Centre, Old Coke Plant. Exhibition and Education Centre and the Art Gate (architectural design); Green Recreation and Silesian Carpet (landscape design).

Architectural design

CRACKED EARTH – SPORTS AND RECREATION CENTRE (Fig. 3)

The concept is based on forms originated from lines which cross at different angles. These lines mark out walking routes, paths and access roads. Bodies of objects and spaces - squares sports grounds and recreation green areas were inserted between
an irregular network. Irregularity of forms and their apparent randomness bring to mind a desert, cracked earth which symbolizes crop failure and impoverishment and at the same time resembles lumps of coal from overexploited coat deposits in Silesia. The Sports and Recreation Centre is located on the territory of the former coke plant Orzegow in order to regenerate and activate this land. The regeneration originates in cracks — the source of a new life, where a new-sown conceptual seed sprouts.

The plot area was divided into two basic parts. In the eastern part, in the vicinity of former warehouses adapted for a museum, a conference and training centre was located. It comprises two conference rooms and an administration object. In the middle of the plot there was designed an observation tower in the form of a contemporary factory chimney. Deep in the plot, from the western side, it was proposed to locate a sports part together with a separate area intended for a hotel for players. The sports part also covers open areas for children from adjoining residential territories and a sports field.
OLD COKE PLANT. EXHIBITION AND EDUCATION CENTRE (Fig. 4)
The concept assumes an increase of importance of the area in the region after the planned regional road is built, which will provide good access to the rest of the region.

A conceptual assumption of the project is to create a “green coat” which would minimally interfere in the green land. For this purpose, the main object was raised over the area and located on huge access cores to be able to place greenery under the object. Additionally, in order to light the interior and provide the greenery with access to sunlight there were designed slits, atria in the storey’s body.

ART GATE (Fig. 5)
Art Gate is the name of the concept which promotes cultural development. The project provides for removing the contaminated substance of the mine waste dump to the depth of 55 meters and introducing a new cultural function there, which will be aimed at both inhabitants of the town and of the region. Art Gate is a symbolic passage from the everyday world to the magic world of artists.

Art Gate is an edifice situated over the stage playing the role of a cover of the theatre backroom and holding an office function. The monolithic block contrasts with the natural shaping of the land. Apart from the function of a building, Art Gate is also a bridge linking the surrounding area on the East-West axis with the amphitheater underneath it. This untypical, rough form, introduced into the landscape is a continuation of an industrial architecture of vast buildings.

Landscape design
GREEN RECREATION (Fig. 6)
The project assumes creating a service building in the area, which is characterized by landscape architecture. Relating to the Topography Trend in architecture, the authors of the concept recognize the existing lie of the land, considering it a priority. The building of the exhibition hall softly places itself into the existing surrounding. The

Fig. 5
Art Gate; source: workshop team.
designed green roof constitutes an integral part of the existing hill. On the green terraces of the roof observation points were suggested. Along the soft lines of the newly-designed buildings there are a cableway and bicycle lanes. The aim of the concept was the introduction of the slag heaps into the area of the City centre as a true park area.

SILESIAN CARPET\textsuperscript{9} (Fig. 7)
Silesian Carpet is a name of a concept project which came up to existence during a team work on the Silesian Industrial Park in Ruda Śląska. It is an extension project of the existing park witch benefits to the city and the whole region.

The design area has been drastically divided in two parts with the new N-S route. The concept is based on an idea of unifying these bits with “green carpets” stretching out over the ground. It will provide an attractive public space for the inhabitants and Silesian Industrial Park employees. Silesian Carpet is expected to be a trade mark of Ruda Śląska. It is supposed to form a center of the city, raise its prestige and increase its attractiveness for potential investors.
Summary

The industrial agglomeration region provides examples of post-industrial urban areas that require renewal processes, not only because of the global crisis but also because of still visible effects of the economic transformation of the 1990s, which took place in Eastern Europe. Ruda Slaska is a good example representing the mentioned issues.

Discussions on the problem and the effect of planning activities, carried out in cooperation of employees of the city council and the students and staff of the school of Architecture, expands the circle of possible city planning scenarios. The effects of discussions and the students’ concepts of spatial solutions can have a positive impact on:

- revival of the local labor market,
- activation of the real estate market,
- defining the limits and possibilities of brownfield redevelopment,
- presenting new attractive architectural and urban spaces.

Tadeusz Koston - city architect of Ruda Slaska summarized the workshop work in the following words:

*A human being becomes part of the space where he or she lives, therefore there is some hope that gradual changes in this space will lead to positive transformations of the post-industrial society. A huge supply of new functions which, apart from the development of degraded areas which were used to store various types of waste, gives a chance for reorganization of the urban order. Also it will hopefully define guidelines for planning documents, including mostly the study of conditions and directions of spatial development of Ruda Slaska for the years to come so as the local law will successfully encourage investment in places which used to drive away potential investors.*

References

1. Brownfield Days were the beginning of the workshop under The B-Team programme; Brownfield Policy Improvement Task under INTERREG IV C. The goal of the project is to create teams of practitioners and experts to support local authorities in developing strategies for post-industrial areas. Polish city - Ruda Slaska was amongst nine European cites joining the project.
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8. Tutor: Professor Nina Juzwa, PhD, DSc, Eng. (Arch.); students: Agnieszka Bednarek, Lidia Gombos.
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Environmental Urban Design Workshops as a Learning Tool
A case study: Erasmus IP EWWUD, Lisbon 2010 – 2012
Sustainable design became a key parameter in design practices over the last ten years. Schools of Architecture around the world have reconsidered their curricula incorporating related courses in, mostly, post graduate programs. Nevertheless, sustainability at an urban scale is not yet well integrated in the architectural educational programs, while it is widely discussed in courses of urban landscape design. As sustainable urban design is becoming a prevailing approach of urban issues, extra-curricular workshops for undergraduate students, as the one we will be addressing here, can provide students with crucial knowledge and skills to deal with urban regeneration and development.

In particular, the recent participation of the authors’ teaching team together with a number of students from Aristotle University in an Erasmus Intensive Program (IP) is discussed here as a case study of valuable learning experience. The European Workshop on Waterfront Urban Design (EWWUD), organized by the Lusofona University of Lisbon, was an opportunity to advance environmental thinking regarding the redesigning of waterfront locations, an issue widely addressed during the studio work in our main academic course in AUTh.

The methodologies, imperatives and outcomes of the IP, will be presented along with three specific projects supervised by our teaching team. The paper will try to illustrate the tools and processes for analyzing and addressing issues of waterfront areas through an environmental design approach. It will comment on the results from the exchange of knowledge and good practices between students and teachers from different backgrounds sharing common preoccupations regarding sustainable urban design. It will also try to evaluate the role of such initiatives in integrating and accentuating environmental awareness in the design process of a studio work.

**The AUTh teaching team**

As the paper will touch on the contribution and interlock of the IP workshop to the main academic process, we would like to briefly refer to the main teaching activities and engagement of the authors’ team in the environmental and urban agenda of the School of Architecture of AUTh. For the last six years, we have been teaching together a compulsory urban design studio. During the last two years, the studio has focused on the urban regeneration of the densely built historic urban core of Thessaloniki, a waterfront city. The studio adopts a holistic approach to urban design, trying to accentuate students’ environmental awareness while touching on multiple urban issues and introducing tools and resources for tackling them.

At the same time, synergetic to the main studio has been the participation of the teaching team in research projects and educational initiatives. These have enabled a more in-depth approach to specific issues such as waterfront design which is of critical importance to the school’s academic program because of its relation to the city. Such extra-curricular initiatives include the environmental urban design study for the Relocation of Thessaloniki’s International Fair near the airport, at a site by the waterfront, through an extensive interdisciplinary research program and the organization of an accompanying experimental students’ workshop with international guest professors. The team has also participated in different intensive students’ workshops encouraging students to work inside and outside Greece for broadening their experience, understanding and overview of urban space. Furthermore, the School of Architecture
at A.U.TH is preparing to launch a postgraduate program of Environmental Design in which our team and other colleagues are involved.

Erasmus IP EWWUD, Lisbon 2010 – 2012

The organization scheme

Nine architecture schools from Europe, Turkey and the U.S.A., and in particular from waterfront cities, participated in this three year project consisting of fifteen days annual workshop in Lisbon. The participating schools were:

- Lusofona University, School of Architecture, Lisbon (organizing and hosting school)
- Zachodniopomorski Uniwersytet Technologiczny Wszczecinie / Poland
- Technische Universiteit Eindhoven / Netherlands
- Hafen City University Hamburg / Germany
- Aristotele University of Thessaloniki, Faculty of Engineering, School of Architecture / Greece
- Gazi University Ankara / Turkey
- Institut de Geographie / Universite de Paris IV - La Sorbonne / France
- Politecnico di Milano Facolta di Architettura Dipartimento di Architettura e Pianificazion / Italy
- College of Environmental Design, School of Architecture, University of California, Berkeley / USA

Responsible for the program was Professor Pedro Ressano Garcia, together with a group of faculty members from Lusofona University. Pedro Ressano Garcia has worked extensively, as an architect, on Lisbon waterfront and directed research on the subject that has been published and presented in relevant exhibitions. Each school was participating with six undergraduate students and two or three faculty members. Every year there were four sites proposed by the organizing committee. Groups of eight to nine students, each one coming from a different school, under the supervision of a group of teachers coming all from one school, was working on one of the proposed sites. All sites were located along the waterfront of the greater metropolitan area and the periphery of Lisbon, presenting pressing environmental problems and rapid urban development.

The workshop organization scheme promoted an interdisciplinary approach with students and faculty members coming from different academic background, i.e. architects, planners, geographers and landscape architects, who worked together in order to formulate a methodology for handling the questions posed for the specific site of each team.

The working program

The working program of the workshop consisted of four distinct phases: 1) preliminary input, 2) getting acquainted with the site, 3) processing and evaluation of the analysis and 4) design and presentation of proposals.
Preliminary input

The environmental dimension of the contemporary city and more specifically of the urban waterfront areas was the subject of lectures presented by keynote speakers, addressing all participants of the program and providing input for preliminary discussions. Municipality representatives and high profile professionals, authors of master plans and projects of architecture of significant relevance for the regions in question, were involved in the workshop to share their perception of the theme. Students were provided with necessary urban data, examples of good practices and a series of environmental parameters, as underlying principles for formulating proposals. These parameters included:

- urban mobility
- the importance of rehabilitating and reusing the existing building stock
- the distribution, networking and redesign of urban public spaces
- the evaluation and understanding of local context (both as a natural environment and ecosystem regarding climate, vegetation, topography, water, local materials, as well as a historic, social and economic environment)

Students’ background concerning sustainable urban design was quite varied as well as their methodologies and views of planning and design. The merging together of different visions concerning different scales of the urban fabric was an intense, enriching and interacting process. Students and tutors should acquaint and start collaborating, while brainstorming to define a commonly shared vision. The opportunity of working closely together, staying and working continuously in the same place, while tutors, who were also continuously present, providing feedback and underlining environmental parameters, opted for the creation of a commonly shared theoretical basis for discussion, while promoting design proposals coherent to a sustainable approach.

For many of the students there was no knowledge concerning sustainability at an urban scale, whatsoever. So presentations and discussions within each working group in this starting phase were trying to make up and homogenize students' background.

Getting acquainted with the site

Students and teachers coming from different countries also had no knowledge of the site and its particular urban conditions. In trying to gather information, data and mapping material, students would come across the genius loci of the place, visiting and walking through the site, in order to understand its structure and nature and identify potential intervention areas. During their visits students had the opportunity to meet architects and planners working in the area, review archival material and projects prepared by the local authorities, and get some knowledge of the planning legislation involved. Sometimes not all available material was used or processed, but still students were to acquaint to a certain extend with an urban reality different from the one they were familiar with, while broadening their awareness and sensibility concerning the importance of context in any design practice.

Processing and evaluation of the analysis

In the third phase, work continued in the studios with the processing and analysis of all gathered material. Maps were prepared, representing the main elements of the ur-
urban fabric, seeking to indicate the dynamics of its potential, interpreting its present physiognomy and defining strategies and criteria for a sustainable approach of urban design interventions. Historical data and the evolution of the townscape, economic and demographic data, flows of pedestrian and cars, connectivity of the area to surrounding central districts, public infrastructure, natural and built conservation areas (potential and protected ones), centers of activities, districts and fragments of the urban fabric were traced down and evaluated. Environmental sustainable parameters were discussed in context. During the three years of the IP program, sites we had to deal with, presented common features being in the outskirts of Lisbon, with large abandoned industrial complexes and highly polluted surroundings and a pressing need for developing into residential suburban areas. Yet the way we handled analysis was quite different each time giving us the possibility to have alternative views of similar problems and arriving each time to different proposals. This depended also to the profile of students and their abilities and background so far. Sometimes planners and geographers were the majority, and one year, landscape architects. These will be discussed later on, during the presentation of the outcomes of these three years. The context analysis was concluded with a diagnosis that provided the designation of potential intervention areas.

Design and presentation of proposals

Proposals were usually referring to different levels of scale of the urban fabric. Overall urban strategies, urban repair microsurgery were sought in a perspective of triggering off urban transformations with an environmentally sustainable approach that could network projects in the actual identity of the place. A holistic approach of sustainable urban design tried to consider a wide range of aspects of urban habitats and natural ecosystems. To this end, the students' proposal sought to incorporate diverse dynamics and actors in a process of symbiotic integration of new developments to the actual urban fabric and co-existence of local and incoming populations. Design was sometimes sketchy or more detailed, depending on students' potential. The presentation of the projects were held in public with the participation of all tutors involved in the workshop along with professors from the inviting school and representatives of the local authorities. Students had to defend their proposals and answer to questions concerning their standpoint and design approach. It is important to note that three intermediate public presentations, among workshop participants, were scheduled at the end of each of the three previous phases.

The projects

The presentation of the outcomes of the three years work follows now, preceded by a brief presentation of the regional context in which we worked.

Lisbon - The regional context

Located on the natural harbor of the large estuary of river Tagus at the Atlantic Ocean, Lisbon has historically an important port city. Rethinking and redefining the relationship of the city to its waterfront owes to be a crucial part of any environmentally conscious future proposal and has been indeed the core of the EWWUD agenda. The slide of interest regarding waterfront sites, from productive and industrial activity to
leisure and culture, has opened recently a broad discussion concerning the management of such areas among urban designers.

Today the relationship of Lisbon, as in the case of many port cities, to its waterfront has been altered. Traditional sectors have seized their activities leaving undefined zones and vacant building shells, while port facilities, both for international cargo transportation and leisure, are growing. During the EWWUD workshops we worked on projects that dealt with the greater area of Lisbon. A network of historic settlements, that once served the fishing sector and later the industry, is currently growing fast. The good connectivity to the center of Lisbon, through motorways and ferries, in conjunction with the low real estate prices and the quieter lifestyle, make these settlements attractive to new inhabitants who commute on a daily basis to Lisbon for work. Lisbon has a population of six hundred inhabitants and this number rises to about three million for the metropolitan area.

Guedes (2006: 104) describing the contemporary urban situation remarks that “…the periphery has created its own centers as self-organized entities and systems. These are places that create a new possibility for the city, considering it is in their midst that new cultural expressions are being manifested, recreating themselves and becoming active. The city grows and spreads out with no specific geography as an expression of multiple processes...Its geographic borders are both plastically and temporarily expandable…”

Each year the workshop focused on different locations. No more than two teams worked at the same time on the same site.

Three case-study projects within EWWUD

Through the course of the EWWUD program the team of AUTH teachers, together with a mixed group of students worked on three sites. The projects will be presented here as case studies of the methodologies and outcomes of the workshop’s educational process.

Seixal – A sustainable approach to urban (re)design

The town of Seixal is located on a small peninsula on the south bank of Tagus. It is linked to Lisbon with a frequent ferry connection and through the national motorway network. The historic core has a well conserved dense urban fabric overlooking Lisbon. New housing quarters with a clear orthogonal grid plan have developed to the south and east of the historic nucleus and considerable public infrastructure is provided to the expanding community, which consists mainly of commuters to Lisbon. Nuclei of green open spaces include some old private farms and gardens and an area of marsh lands which is a protected natural reserve.

The character of the place has been considerably changed over the past few decades with the decline of traditional activities. Until recently, fishing was an important sector of the local economy and in the beginning of the 20th century Seixal used to be an important industrial center for cork production. Today a part of its industrial heritage has been restored, housing cultural activities. Other industrial heritage buildings include a series of abandoned watermills with distinctive architectural quality.

During the site analysis, students produced a series of multiple layers maps regarding housing, green areas, public infrastructure, activity nodes and meeting plac-
es, potential and existing conservation areas, networks and flows of pedestrians and cars, urban boundaries, sense of orientation, etc. The mapping of the urban elements and dynamics helped to identify the potential intervention areas where strategies of sustainable urban redesign where to be applied.

A series of multiple scale proposals were envisioned, focusing mainly on the repair of the fragmented qualities of the existing urban fabric. Urban mobility was reorganized with the deviation of the national road away from the waterfront and the creation of a network of green routes for pedestrians and cycling. Urban public space was redesigned all along the waterfront, introducing new planting, increasing the sense of orientation, while replacing asphalt with water permeable pavement materials using local stone.

Smaller scale interventions consisted of wooden floating platforms along the coastline, conservation and accessibility of the riverside ecosystem, while leisure and recreation activities were enhanced all along the waterfront. A new proposal for linking the urban fabric and the local market to the waterfront was designed using terraces for view and stairs creating a new urban landscape for the central communal activities.

Barreiro- Symbiotic Integration

Barreiro used to be one of the largest industrial sites of the Iberian Peninsula. Situated opposite to the city of Lisbon, across the river Tagus, it went under a significant deindustrialization phase after the 80s’. Large industrial complexes for cement, steel, chemicals and alimentation products, extend today along the docks in a derelict and underused state, while the municipality has prepared a regeneration plan for the area. The industrial activity has left the sea and land in an environmentally deteriorated condition.

Fig. 1
Students’ analysis. Urban Layers.
The residential quarters of the city, with the picturesque historic centre and the modern developments, form a continuous urban fabric of relatively low density. It is a grid plan, limited on its three sides by the waterfront and the natural reserve area of the marshes to the west. The city has an introvert character, despite the recently redeveloped waterfront to the north, while points of discontinuity and lack of orientation are common on the main waterfront itinerary from the arrival point of the ferry station to the centre.

Following the site analysis, three key areas along the waterfront were selected to be redesigned as catalysts of urban rejuvenation that would generate positive synergies and a new networked urbanity. Projects opted for the refurbishment and transformation of the massive abandoned silos, the old railway station and other parts of the industrial complex. The reuse of the redundant buildings’ reservoir contributes to multiple aspects of sustainability of the urban development, maintaining the local identity and heritage of the place while making the whole endeavor more socially, economically and environmentally viable.

At the same time, the sanitation of the marshlands area and its re-integration to the public space of Barreiro were highlighted as issues of high priority. Students proposed the creation of pedestrian and cycling green lanes through this land. A small sports center was designed to follow the natural topography of the site creating a new artificial landscape of organically shaped green roofs.

The city of Sines: Urban barrier transitions

Sines is the fastest growing port in Portugal, claiming an internationally competitive status as “Europe’s Atlantic gate”. Located about 150 km south of Lisbon, the port
holds extended road and rail links that provide direct connections to the national and international transportation network. The students’ analysis and proposals were focused on the city of Sines, a historic settlement dating back to the medieval times and its immediate natural surroundings. The development of the town was marked by catalytic events recognizable in the contemporary fragmented urban fabric as ruptures in

Fig. 3
Students’ proposal about urban mobility networks.

Fig. 4
Students’ regeneration proposal in the natural reserve area.
continuity, large urban voids and indeterminate spaces. Furthermore a series of natural or constructed barriers act as fixed limits within and around the city.

Proposals varied in scale, ranging from an overall re-evaluation of the traffic and pedestrians flows -resulting in a new master plan for the centre of the city-, to smaller scale interventions promoting a coherent and symbiotic townscape. The proposed master plan focuses on one hand on the development of a network of green lanes for pedestrians and bikes, a green belt and a series of interconnected green areas, and on

Fig. 5
Students’ analysis on urban fragmentation and different tissues.

Fig. 6
Students’ masterplan proposal.
the other hand on the revitalization of neighborhoods through the transformation of urban voids into centers of public space.

The small, urban design projects proposed, try to reassert heterogeneity of city life while creating a viable, dense and mixed-use urban fabric emphasizing repair and infill interventions with a contextual and sustainable approach.

Reviewing these three projects one has the opportunity to evaluate the potential of this type of academic team work, understand its limits and rethink practices applied during a limited but intense program. We will try and present in brief our evaluation of this workshop experience as well as its eventual use in our future academic practice.

**Evaluation and future steps**

The EWWUD workshop agenda aimed to explore a multifocal field of architectural experimentation, i.e. environmental urban design, related to a rather complex network of design parameters across multiple scales. More specifically, the workshop was oriented towards waterfront design, a popular subject with many particularities and sensitive ecological factors. The changing nature of waterfront sites, following a deindustrialization phase and a trend versus leisure activities, has given way to important urban design projects. Yet there seems to be worldwide a stereotyped approach to the design of waterfronts, which in many cases fails to adjust to the local specificities of each place. Considering the high impact of waterfront locations to the whole of cities, the workshop tried to further explore design possibilities that go beyond urban beautification and evaluate a holistic sustainable design approach.

It is evident that students faced a complex design task, demanding an integrated approach based both on broad knowledge of urban design problems and sustainability expertise. At the same it became clear that most of the students had little prior experience with environmental urban design. It is a subject that is not taught explicitly during the basic undergraduate studies of most of the participating schools. From this point of view, the workshop was a great learning tool, familiarizing students with environmental issues around an integrated approach of urban design.

Acknowledging the hybrid nature of the design task, the organizing committee had correctly opted for an interdisciplinary group of people. The fact that every design team was comprised of one student from each university made up a multidirectional group with variant educational background and expertise. This was effective in terms of bringing diverse input and opinions in the formation of the design proposal. On the other hand, given the short amount of time, it made collaboration sometimes difficult as students were not always able to communicate effectively to each other their different take on aspects of design and to finally come up with a coherent proposal.

The role of professors was thus to coordinate the teams and bridge the gap across their different knowledge and skills. It is clear that the teaching methodologies and preferences were varied regarding the prioritization of design parameters and processes. Our teaching strategy urged students to try to understand the urban context and come up with an in-depth analysis. This was essential in order to develop a critical position and propose designs that offer not just fashionable look but imaginable and viable solutions. On the other hand, the emphasis on the analysis, left students with little time to come up with elaborate solutions but rather with design concepts with potential for further development.
Yet, the value of the students’ projects was important in terms of rising community consciousness over urban and environmental issues and providing a fresh and original approach. After getting plenty of feedback regarding the urban situation from local authorities, students gave back some imaginable ideas. The enthusiasm and vision of students, away from stereotyped views, opened the way to a productive exchange between academia and local planning authorities. Local agents had the chance to attend the presentation of the projects, comment on them and exchange opinions with the students, international experts and professors.

The three-year duration of the workshop was another important factor that counted to a positive evaluation. It enabled teachers to get an in-depth understanding of the intricate local context and urban concerns. It gave them the chance to exchange in situ academic views regarding an interdisciplinary field and develop a shared approach on the waterfront design of Lisbon. It was also valuable in terms of getting familiar with different educational practices and academic backgrounds.

The workshop experience was indeed enriching for our teaching practice. We believe that the applied methodologies could be part of our semester studio of urban design, where we deal with similar design problems for Thessaloniki under a sustainable perspective. Such intensive workshops could be for example incorporated, as distinct sub-phases, within the learning process. The students’ effort and the studio work could be this way accelerated profiting from the extensive input and preliminary results that could kick start the design. This semester or year-long studio would constitute a more cohesive educational framework, to allow for an efficient exploration of the environmental urban design agenda. What is the real challenge in that is to come up with comprehensive designs with all-in-one urban, environmental and aesthetic qualities.

Acknowledgements
Lusofona University professors assisting the AUTH faculty team:
Inês Cabral, Maria João Matos, Vasco Pinheiro, Margarida Valla, Bernardo Vaz Pinto.

Students working with the AUTH faculty team:

References
Our 20-year Long Journey towards Meeting the Objectives of the European Strategy for Year 2020
The Faculty of Architecture STU didn’t take part in the 1st Conference on Environmental Education in Cyprus; therefore I would like to introduce our Department of Sustainable and Experimental Architecture showing it on the background of forty-year development of ecologically conscious architecture. The Department has been concentrating on issues of architecture and environment, ecologically conscious architecture, etc. since 1990. The final part of my paper would be devoted to a design method – a very considerate and live one which has been used in our sustainable architecture studio since 2002.

40-year development of ecologically conscious architecture

Let me start with two anniversaries. Sometimes it is difficult to date the beginnings of period-styles and trends in architecture however in the case of sustainable architecture we can lean on two considerable historical events, which entailed a significant turning point in the development of architecture in the second half of the 20th century.

The demolition of a housing complex Pruitt-Igoe (built in 1950s in St. Louis, Missouri) was the first event. The American critic and theorist Charles Jencks identified the 15th July 1972 demolition, as a moment when modern architecture died. From the present-day perspective, we already know that this claim was much exaggerated, but it was a signal for the onset of a modern architecture crisis.

The second, from a pragmatic point of view a more important event, was the Arab-Israeli conflict. In October the 6th at 14:05 local time Egyptian troops crossed the Suez Canal and this event triggered an avalanche of actions leading to the oil crises with serious consequences for the highly industrial countries economies. The oil crises forced a re-evaluation and a re-assessment of the previous energy wasting building concepts and triggered the need to seek a new and more efficient architecture.

A decade of searching and experiments

The first decade, the years between 1973 and the beginning of the 1980s (1982) can be described as the period of searching. First of all it was about finding new sources of energy, which would have been a substitute for fossil fuels, mainly oil. The ambient energy and renewable energy sources has become an alternative to fossil fuels. Solar power has become a main energy source for building performance. In the second half of the 1970s a series of experimental houses were constructed and various principles how to utilize solar energy were developed. Architects brushed up on the idea of Socrates House, which became the basis for so called passive solar houses. Engineers involved in solar-energetics focused on the conversion of sun light to heat energy through the use of technical equipments (solar collectors, solar cells). Effectiveness of the solar technologies had an essential impact on the form and expression of nascent solar architecture.

Another phenomenon indicated by the oil crisis was a high degree of dependence on civilization and technical conveniences requiring a lot of energy. The reaction of architects on the phenomenon of dependence was to design and to build a house which had been built from local material and performed by use of local energy sources, recycling principles, etc. It means to develop an autonomous house. In this
context, the term *Ecological House* appeared for the first time, too.\(^4\) The term Ecological house did not reflect a special architectural appearance but the new quality of relationship between building, its user and the surroundings. It can be understood as the first formal reference to the ecologically conscious building.

Probably the most simple and highly effective methods to reduce energy consumption were so called conservation methods, which are characterised by an ambition for a more efficient use of energy delivered to the system. The conservation methods represented energy savings by a well insulated building envelope, controlled ventilation, thermal zoning of spaces and efficient heating systems.

**From experiments to accomplished buildings**

In the second decade, which could be defined within the period from the beginning of the 1980s until 1992, the builders have moved from the experiments to improved building technologies and procedures, ranging from single family houses to larger and more sophisticated buildings. A significant progress has meant the use of solar energy, especially by passive method which means: an appropriate architectural concept, spatial order, structural and material solutions. A major qualitative change in architectural design brought a holistic approach to architectural design. It was a significant change of an approach to architecture – a building stopped to be a product situated into surroundings and became an integral part of the environment. However, a greater effort to reduce the negative environmental impact of buildings and construction activities appeared only at the end of the second decade.\(^5\) While the first decade was more or less omitted by critics and theoreticians of architecture, the first attempts to create an ecological architecture were described as the: “romantic and naive ideas of eccentric enthusiasts how to solve environmental crisis” or “… tendencies, which refuse to comply with the normal architectural standards and are looking for inspiration in fields outside architecture, in nature, human appearance under the form of a man”.\(^6\)

**From the periphery to the centre of interest**

Three major events allocate the beginning of the third decade. The United Nations Conference on Sustainable Development “Earth Summit” in Rio de Janeiro in 1992 was the first and the most important event. The second one was the European Congress of the UIA on Ecological architecture held in Stockholm and Helsinki in 1992 and the third one, perhaps the most important, for development of architecture was the World Congress of UIA held in Chicago in 1993. Participants of the Congress adopted a document the Declaration of Independence for a Sustainable Future in which sustainable architecture was officially recognized. In the beginning of 90s systems for the evaluation of environmental quality of buildings were developed,\(^7\) concepts of “sustainable architecture” or “green buildings” originated. “Deviancy” is becoming a trend in the development of modern architecture. Strategy for sustainability in the construction industry begins to be applied by various institutions, or the former clubs of enthusiasts and romantics have established or transformed into official organizations. In this decade many significant buildings and urban complexes that proudly reported that ecological orientations have been accomplished and even have been recognized by ar-
architectural critique. Edition of the publication Green Vitruvius (1999) can be perceived as a certain culmination of this decade, a launch of literature on the topic of architecture and sustainable construction, but also a challenge to create certain principles and standards on the designing of sustainable architecture and sustainable cities.

**Standardization of sustainable architecture**

While the previous three decades were characterized by designing and building ecologically conscious architecture, where more-less each building was a prototype, the fourth decade is about the declaration of the necessity to be concerned about sustainability in all spheres of human activities and the adoption of appropriate standards for the implementation of these plans. At the beginning of the 21st century, the European Union set out a long-term strategy for “A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development”. In 2004, the Architectural Council of Europe (ACE) issued a publication Architecture & Quality of Life, in which it sets out the rules for the development of a long-term policy ACE deriving from principles of sustainable development. In an initiative “Architecture and Sustainability” issued in 2009 sustainable design is becoming imperative. Leipzig Charter on sustainable European towns came out in 2007. But the European directive on the energy performance of buildings EPBD 2010 (2010/31/EU Directive on the Energy Performance of Buildings) is perhaps the most important document adopted at the European level. The Directive contains requirements to design passive or nearly zero energy buildings after year 2020 and initiative 202020. To fulfill those requirements massive employment of ambient energy, mainly solar power is necessary.

How are above mentioned tendencies to design and build energy efficient homes and sustainable architecture reflected in the education of architects at the Faculty of Architecture of the Slovak University of Technology in Bratislava (FA STU)?

**20 years of ecologically conscious architecture at the Faculty of Architecture STU**

In the fall of 1990 the Department of Experimental and Ecologically Determined Design was established. The Department focused on an environmental approach to architectural design originated from a need to respond to trends and growing interest in environmental issues and ecology. From the beginning of the 80s enthusiasts dealt with several partial topics, which later fell into “a common house” called ecologically conscious architecture. Those were who created the core of the Department. Nowadays the Department consists of two full-time professors, three associate professors and five assistant professors.

**Spontaneous enthusiasm**

Most of the results in the period 80s were formed as a “by-product” outside the official curriculum. The first attempts with environmentally oriented architecture were done in design studios. Topics for student projects emerged from the spontaneous responses to the current state of architecture and town planning at the turn of the 80s and the 90s of the last century. They were mainly responses to hostility and uniform-
ity of concrete panel housing estates built in the 60s up to 80s of the 20th century, but also on the unattractiveness and "greyness" of standardized architecture and of energy wasting constructions. Some of the students' projects were naive and unrealistic, but just such forms of exaggeration helped to raise the profile of the most glaring negative features of building results of the period. In the academic year 1991/1992 design studios were complemented by a few theoretical courses, which can be regarded as the beginning of the systematic teaching of ecologically conscious architecture on the FA STU. Studios and theoretical courses were optional, only a series of lectures given within the course Ecologically determined design in bachelors' programmes, where students were introduced to the issue of the context of architecture and ecology, was the compulsory subject/course.

![Fig. 1](image1)


**Thematic-oriented projects**

After the initial phase of spontaneous enthusiasm that characterized the emotionally-intuitive approach at the Department we have begun to articulate more exact procedures. The beginning of the 90s meant the laying foundations of research on the topic of environmentally motivated architecture. One of the first research projects was thematically oriented on principles and methods of ecologically conscious design. The aim of this project was to “take stock” of knowledge, process them according in a hierarchical sequence and to formulate a view on this-oriented architectural
design and define certain procedures. At that time, we were among the pioneers in this field. There were only a few referenced examples, but most of them were interpreted through the lens of ecologists as architects mostly. The results of the research have been used in educational activities on an ongoing basis, as well as published or presented at scientific conferences. Deeper theoretical background reverberated in topics and more complex elaboration of students’ projects. The projects were targeted on low energy architecture, the use of renewable energy sources, solar architecture. Quite successful were projects oriented on the use of alternative building materials, particularly clay, straw and wood, which have been used in Slovak vernacular architecture in the past.

As soon as the Department was created, we developed cooperation with top experts in the field of ecological building from abroad. The first visiting professor was Prof. Gernot Minke from the Gesamthochschule Kassel, a leading European expert on the use of clay as a building material. In addition to lectures on the FA STU led several summer schools of architecture focused on clay structures. During the summer schools our students erected various objects in scale 1:1 (clapper from basket-work structure, shelter built from recycled clay bricks). In 1993, a distinguished guest of our Department was Ralph Knowles professor of architecture at the University of Southern California in Los Angeles served one term as a Fulbright Professor to our faculty. The most important benefit of Prof. Knowles was the introduction of the method called “solar envelope” into our design studio. More details are given in section “Solar Envelope”.

![Fig. 2](image-url)

The formation of sustainable architecture Studio

Within years 1996-2002 a sustainable design studio in the 5th and the 6th year of study has been shaped up. After 2002 when we adopted our curriculum to the bachelor’s and master’s study programme, an elective environmentally oriented studio is within the bachelor’s programme in 4th year of study, the sustainable design studio in 2nd and 3rd semester is a part of master’s study programme (2-year study programme). Students are introduced into topics of sustainability in four theoretical courses and they utilize acquired knowledge in the integrated design studio - a coherent system of methodical manuals focused on sustainability.

The concept of design and construction of extremely energy efficient: passive buildings nearly zero energy houses, and active houses is inevitably connected with extensive use of ambient energy, especially solar energy. One of the factors which determine efficient use of solar energy is a form of buildings and the form of build-up area. This is one of the top ten environmental objectives for studio design. One of the effective methods to find the optimal shape of a building, group of buildings or build-up area is a method of solar envelope.

Fig. 3
Solar envelope

Professor Ralph Knowles, the author of the method published his method of solar envelope for the first time in his book Sun Rhythm Form in 1981. Solar envelope is defined as a “spatial definition of the maximum volume of the building on a building plot, which does not cast a shade in the neighborhood, during defined periods of time.” The size and shape of the envelope is defined by spatial data (latitude of the site, the size and shape of the land over which the envelope is being constructed, slope of land, orientation to the cardinal points) and the time datum (the time interval of solar access is resulting either from legislation or from the environmental scenario, which is determined by the characteristics of the building and its surroundings). At the beginning and end of the interval, the figures relate to the position of the Sun in the sky – azimuth and height. A prerequisite for the design of solar envelope is the knowledge of solar geometry. The building designed in the framework of this imaginary envelope respects the pre-programmed limits and in due time does not cast the shadow over the surrounding objects or terrain.

Traditionally, the evaluation of solar access, shading and the natural lighting is usually done when the project is finished, i.e. the method of the event-evaluation (posteriori). Troubleshooting is difficult and can, in principle affect the original proposal. Method of solar envelope is a method a-priori, i.e. generative method. The method provides architects a tool how to start, but also inspiration for the original, but at the same time meaningful shaping of objects.

Professor Ralph Knowles taught the method of solar envelope at our Department in 1993 and we started to use the method in our design studio to fill in the gaps between buildings in existing urban structure. The original method of Prof. Knowles has been developed and implemented in different geographical conditions (California). I edited and simplified it, so that the requirements of the technical standards are respected in Slovakia. (Foot-note #13) However, the method remains sufficiently flexible, whereas it is possible to date, for which the envelope is constructed, as well as the time interval according to the circumstances suitably modify and change. Experimental projects of how to use the method of solar envelope were worked out by students of architecture at FA STU within the master’s study programme in the sustainable design studio of Prof. Keppl and his assistant Ing. arch. Klára Macháčová, PhD, and Ing. arch. Lorant Krajcsovics, PhD. Assignments were selected in order to verify the capabilities of this method but also user demands and any problems and deficiencies in the methods. In the first stage of the experiment, we worked on a scale of the object, i.e.an individual building - plot, we strolled into a broader context, to the dimension of the group of buildings, zone or district.

A house in a gap between buildings

A street line and the surrounding building cornices are standard limits in a gap between buildings. Street line defines the plan of the house, the cornice determines the height of the object. Mechanical completion of the urban block according to these limits often deteriorates the quality of the environment especially in residential building surroundings. It can also cast a shadow on the surfaces of the objects, on which could be installed solar collectors, cells, or could be a means of passive use of solar
The application of the method of solar envelope can be a means for the shaping of spatial limits in terms of access to the Sun. This method of solar envelope utilization in the design of buildings in a gap between buildings is so far the best verified. On this subject, students have developed dozens of projects. The benefit of using this method was not only getting a set of environmentally determined spatial limits for the proposed object and an instrument which helps in finding the original shape of the building, but also a new method of creation, where the designer is progressing from the outside envelope of the building to the inside to organize an internal space of the building. In this entry, it is not to re-enforce the function which determines the shape of the building, but to shape the sculptured sun rays. Architecture shaped by the method of solar envelope can be qualified as parametric architecture, whereas the resulting form is given by intentionally chosen parameters derived from the apparent movement of the Sun across the sky.

**Cluster of buildings**

Students learn to construct the solar envelope in seminars during the course Ecological conception of architectural design. Every student constructs a solar envelope on...
the specified plot. He/she has to implement defined conditions and limits for solar access or shading of adjacent plots. The accuracy of the procedure is examined during construction of the solar envelope, the final evaluation takes place on a physical model of the whole cluster of buildings, when/where eventual mistakes are more visible.

The result is a spatial diagram, observance of limits/rules allows optimal utilization of solar radiation for individual houses, as well as for the whole set of buildings. In some cases, the students compare the control limits given by the local master plan and the control limits defined by solar envelope. The results of the analyses: 1 spatial limits within solar envelope offers larger possible building volume. The period of solar access was one hour longer than is the requirement of the building standard; 2 the volume of solar envelope changes according the orientation of a lot to cardinal points and uncovers lots with drawbacks (east-west orientation, narrow lots); 3 natural volume, height and shape accents originate in urban structure without any harmful influence on surroundings; 4 attractive shape of an urban structure with human scale is reached.

The hidden potential of the solar envelope method consists in defining limits inevitable for intensive exploitation of solar power and building passive or zero energy houses. In more details has been done a research of a smaller cluster of buildings on a change volume of a solar envelope determined by intervals 4, 6 and 8 hours direct solar radiation access.

![Fig. 6](image)

Solar envelope constructed for interval 4, 6 and 8-hour for a group of family houses. Plan view and axonometric view of an urban structure. Results from seminars led by Klára Macháčová, 2009.
An experiment at the scale of a settlement

The starting point of elaborating a master plan of a green area between two villages was a construction of a solar envelope. Consecutive steps led to fine-drawn street pattern and smaller solar envelopes. After analysing the quality of the physical environment (solar access and casting shadow/shading/shielding) students decided how to organize certain function within the territory – to create a social environment i.e. dwelling, amenities working areas, recreation, etc. Orientation of streets meant a significant impact on shaping of solar envelopes and finally on shape of urban structure.

Fig. 6
Steps led to fine-drawn street pattern and smaller solar envelopes and 3 D model of the final urban structure. Prof.Keppl studio, 2009.

Conclusion

After years of our research on experiments with the method of solar envelope it can be proved that this method could be a powerful and an efficient design tool either in design process of solar architecture (passive houses, nearly zero-energy houses, active houses) or planning a building complexes, clusters, zones and settlements with significantly low energy consumption and very low greenhouse gases emission. It could be a tool/one of tools how to design a sustainable architecture and sustainable cities.

Notes


2. Yom Kippur War


4. One issue of AD (Architectural Design) in 1976 was devoted to autonomous houses. There is an illustration of Ecological house: An archetyp – a miniature ecosystem in the country, sustained by sun, wind, rain, muck and muscle.


7. Assessment and certification of environmental and sustainability standards of buildings e.g. BREEAM, in Great Britain, 1990, LEED in USA, 1993.

8. From 2006 The Institute of Sustainable and Experimental Architecture.

9. A German architect, professor and environmentalist Margrit Kennedy.


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Integrating Ecological Objectives into the Design Studio: Being There
This paper will discuss the required skill sets for an ecologically wise design approach, and the methods needed for their acquisition through a range of projects realized in the Spring semester of 2013 within the curriculum of Istanbul Technical University School of Architecture as a first year architectural design studio assignment.

The studio assignment, which is to be analyzed and discussed is called ‘Wetlands’, and it is the last project of a group of first year students, namely ‘Otherminds’¹, within the Spring semester of 2013. The brand name ‘Otherminds’ is chosen to identify the group and its production in an effort to accentuate the need to understand other minds, such as the minds of our ancestors, the mind of the nature, the mind of the wind etc. alongside our very own minds and their internal workings as estranged phenomena. The metaphor of ‘getting into another one’s mind’ is used as a pedagogical method in various assignments throughout the year, such as the initial one-day experiments of the first semester, which involved making masks for one another, or the collaborative design-assembling task, ‘The Factory’, whereby students were encouraged to meet each other on the grounds of their designing and try to understand the other’s mind through their design. Six week long ‘Wetlands’ project, which aimed to get into the nature’s mind by merging ‘topophilic’ manners with the designing act while facing ‘real’ problems, was the last and final leg of discovering the other’s mind.

Confronting the real problems: Understanding the place as it is

More often than not, we encounter the phrase ‘in real life’ during studio conversations and critiques. This may be due to the fact that design studios in general are hermetic, or at least selectively permeable, environmentally and socially controlled spaces separated from everyday life. Hence, the oxymoronic phrase ‘real life’ is inescapable from studio jargon. The reason behind this dichotomy may be an innocent custom that accepts design students as inept to cope with complex ‘real life’ problems, so that design problems are diluted and simplified before entering the studio. We advise a full confrontation with everyday life and bring the world and all of its problems to the studio, or take the studio to the world outside.

Dividing life into ‘real life and ‘life as simulated in studio’ is problematic from the standpoint of educating an environmentally responsible designer. The gap between life as it is and life represented in the studio through design assignments creates a false assumption that all that is life can be controlled and solved through existing design methods and tools. Experience tells the otherwise. Not all design problems can be solved through known design tools. Students must have the courage to confront real problems as they are and act ambitiously to propose innovative design proposals without compromising architectural potentials. Encoding such attitude requires extensive practice in real life situations with several disappointments along the way and maybe some success in the end. That is why the studio program of ‘Otherminds’ is designed ambitiously in synch with everyday life, providing encounters with real problems, although it is extremely difficult to manage the process and obtain a good quality studio output.

In order to encounter real life situations, ‘Otherminds’ studio assignments are grounded on a place. ‘Place’ is a crucial concept in both this study and the studio, enriched and re-introduced by the work of Yi-Fu Tuan, Christian Norberg Schulz, and Heidegger. The concept of ‘place’ takes us from the mathematical and mentally con-
structured, geometric space, ‘location’ and ‘coordinates’, to the concrete ‘things’ encouraging to uncover the meanings inherent in the life-world. ‘Place’ can briefly be described as a medium where the environment manifests a character, an atmosphere. Therefore, a place is a qualitative, “total” phenomenon, which cannot be reduced to any of its properties. According to Norberg-Schulz, the ancients recognized ‘genius loci’ /the spirit of place, as “opposite” man has to come to terms with, to be able to dwell. (Norberg-Schulz, 1980) Thus, ‘place’ is intended to be addressed and represented with its multiple aspects in the studio.

A place potentially embodies all the problems related to real life situations. Design problems and relevant solutions are immanent to the place. If the place is understood as best as design and representation tools allow it, design emerges from within. As Heidegger suggests, the bridge does not define the space around it, it is defined by the very place that it sits (Heidegger, 1971). The conditions and content of the site requires a bridge, not the other way around. So a place under environmental or social threats is a good laboratory to discover and exercise design knowledge and skills with all of its complexity and pedagogically challenging uncontrollable aspects.

The second concept that interweaves through all assignments of the studio program is ‘the gaze’, which puts the body spatially within place. The gaze creates a certain vision. It connects the perception with the body. Therefore ‘the gaze’ related to being embedded in space, becoming and acting as part of the environment (Merleau-Ponty, 1964: 284). It is initially related to ‘beings’, which could be relativities of the absolute, relating themselves to the appearances in a certain space and time (Sartre, 2007).

Designing with or within places allows the designer to conjoin with the complexities of that particular place, or more metaphorically, to become one with that place. This is a very convenient approach to design environmentally sensitive projects, projects that work with and within a particular place.

To work within a place requires an understanding of that place in many respects. One must acquire the sense of place in order to have multiple mental representations of it so one can recreate that place or emulate it within the studio.

**Studio Program in Brief**

To demonstrate how ‘Otherminds’ studio program is closely linked with everyday life, a brief description is required. The spring semester program is designed around one minor and four major assignments. The program has started with the minor assignment that is called ‘the gaze’. In order to record and analyze issues related to, or affecting the gaze of a person, an excursion to a small village in northern Istanbul is planned and executed on a very rainy day. The village is selected because of its changing topography that creates various vistas including the northern exit of the Bosphorus. The representational form of the output was not described; students tackled with the problem of recording and analyzing, and created their own proposal of representation in the form of collages, superimpositions, colored graphs etc. Second assignment, ‘Places of Curiosity’, was an experiment in itself that aimed to combine the poetic and rational qualities of architecture. Students were required to design a place complete with its topography, environment and its own set of rules, starting from three pieces of scripture, which poetically defined an edge, a transition and a base. Third assignment, ‘Urban Cloud: Asking Questions to the City’ was designed specifically to intro-
roduce the problem of urban transformation in Istanbul under the pressure of neo-liberal capitalist policies into the studio, or rather to bring the studio out to the actual site, ‘Gedikpaşa’ - an old neighborhood in the historical peninsula of Istanbul - where the production of leather shoes and bags still continue in small workshops. Fourth assignment, ‘Gaze Machines’, was a design-build project based in the premises of Istanbul Technical University. Students were required to design and construct a simple machine that interacts with the place, transforming the gaze of a person. Machines sponsored and constructed by the students were installed within the central area of the campus; some of them were destroyed even before the opening, due to vandalism, gravity and weather conditions. Last and fifth assignment, ‘Wetlands’, was designed specifically to introduce environmental problems and skills to design environmentally responsible projects to the studio program.

‘Wetlands’ assignment and excursion to ‘Egirdir Lake’

‘Wetlands’ assignment is designed in conjunction with an excursion to a specific place rich with ecological beauties and problems, simultaneously. Among alternatives, wetlands provided a convenient backdrop for they constitute the weakest links in ecological systems affected easily by excessive use of water reserves and agricultural chemicals. The problems and relevant design solutions were to be discovered by students through extensive research executed rationally while engaging with the qualities and beauties of the space poetically. As often claimed, designing is not only related to solving a problem, but it is evenly related to revealing a problem (Lawson, 2006: 112). Therefore, in this assignment, letting students face a real life problem would alter their way of designing.

The idea of ‘topophilia’ can be a source of motivation. ‘Being there’ as an event can potentially open up the minds of students and they can thus become a part of the problem and solution. First thing to recognize in confronting real-life problems is that the gaze of the researcher is a part of the context. A student can become a part of the place just by looking around and doing research. ‘Being there’ and feeling the ‘thereness, thatness’ may explicitly be a method used to overcome the tension of dealing with real-life problems. One example could be the excessive tranquility of the lake, which is overtly in contrast with the students’ urban daily life. While the quiet experiences of topography would trigger the sense of place, students would be searching for environmental solutions. Therefore the tension between rational and poetic thinking and the anxiety of bringing them together can be described as another motivational quality of the studio program.

Likewise, letting the students discover design problems within everyday situations instead of describing problems via design briefs is another motivation. The goal of the studio shifts from designing a specific design to a set of problems to be able to design within a space where problem-solution pairs are dynamically interconnected. It is generally essential to redefine given problems to attain environmentally wise solutions since the conventional design problems predate environmental crisis.

Egirdir Lake was chosen as a project site for it is the largest fresh water lake of Turkey, situated in the ‘lakes region’ on the northern slopes of Taurus Mountains (Figure 1). Egirdir and neighboring lakes constitute good examples for a wetland ecosystem with such known problems as water loss, endangered species, and contamination from artificial pesticides and fertilizers. Furthermore, surrounding region of the lake
is rich with historical and modern examples of architecture and different lifestyles, which contribute to the qualities of the site.

Excursions are convenient studio tools in order to break the routine and open the minds of students up for new experiences. From the first moment of departure, their level of perception is heightened and ready to record every small event. The place of stay is also carefully chosen to enhance this effect. The hotel overlooking the lake is an award winning building. To take full advantage of the excursion’s heightened level of perception, all the minute details of it is designed to create an experience-rich environment for students.

Observing naturally occurring formations

On site research started with a seminar, where an overview of the scientific knowledge about the place is encountered. After the seminar, students from the SDU and ITU are dropped off in teams on 16 to arbitrarily chosen locations along the 40 km western shoreline of the lake and later picked up to be taken to the studios at SDU. Large-scale 16 transversal sections created by students were presented at the end of the day. On the second day, following small visits to Atabey and İslamköy, the same procedure was repeated excluding SDU students. In total, ITU students had time to be on site for more than 12 hours. On the night of the second day, specimens collected on sites were mounted in diapositive frames, enlarged and projected to a screen with the use of an old school projector. On the third day, the group returned to Istanbul.

Recognizing Cyclical Patterns

During the seminar, first steps were taken into recognizing problems inherent to the place and developing a project based on these problems. A loose brief of the project was given to the students after the seminar, which was based on the idea of designing a small group of buildings where inhabitants would be occupied with some kind of production that mends the gaps in ecological cycles caused by unwise treatment of the land.

Research reveals that ecological problems of the lake emerged following the 1950s. Egirdir has a negative water budget since the date, meaning it loses more wa-
ter than it gains although weather conditions have almost been the same. Main wa-
ter resource of the lake is at the bottom of the lake, which needs to be cleaned from
lake plants and sediments by a group of herbivorous fish. In the 1950’s a carnivorous
fish was introduced to the lake by authorities, thinking they can feed on the existing
abundance of herbivorous fish and generate extra income for local fishermen. In time,
carnivorous fish destroyed all species of the herbivorous fish. Without them, sedi-
ments in the lake-bed ended up mixing with dead lake plants to create a concrete-
like surface that clogged the water resources. Combined with manmade flood-gates
constructed on the southern edge of the lake, the natural water circulation and the
self-cleaning system of the lake has been damaged. With the absence of herbivorous
fish, which also feed on mosquito larvae, the population of mosquitoes skyrocketed
an paved way for the use of chemical poisons, leading to the hospitalization of some
of the local residents. On the other hand, using free-flowing surface irrigation system
-alternatively called wild irrigation system—caused all the artificial pesticides and ferti-
lizers rich in nitrates to flow into the lake, creating a microbiological reaction that in-
creased the population of green algae on the surface of the lake. With lower water lev-
els and algae covering the surface, the lake-bed heats up more than usual and gives
way to lake plants clogging the underwater resources more rapidly. 7

Confronting all this knowledge is a hard affair for a first year student, yet projects
started to develop even during the seminar. Learning that when you collect the algae
from the surface and dry it you can get a nitrate rich natural fertilizer— to be used in
the fields in place of artificial fertilizers- some students decided to develop a project
based on the concept of an algae farm. The importance of using scientific knowledge
as a design tool and integrating the ecologic knowledge of the place into design ideas
was experienced firsthand by the students.

Collecting the data about the place on large transversal sections; macro studies

Egirdir is a large lake - 50 km long and 5 to 15 km wide. Establishing the borders of
the project site without prior experience about the character and topography of the
shoreline was not practical. A radical approach was chosen to investigate the charac-
ter of the place by studying 16 arbitrary sites simultaneously along the 40 km long
western shoreline and comparing the differences and similarities between sections.
All information gathered during the site surveys were later compiled into thematic
groups according to their topographical, botanical and experiential data. Large trans-
versal sections 8 produced on site and studio hours were proposed as a medium to
represent feelings and experiences collected on the site. These large transversal sec-
tions were intended to combine rational and poetic impressions. Physical and quan-
titative data; such as drawing the profile and plan of the land and also documenting
the plants, the lake bank, type of trees, agricultural activities, etc. and immeasurable
data; impressions, experiences at first sight, the feelings of students were required to
be registered in the same section, using known tools such as watercolors, aquarelle,
ink wash, charcoal drawing etc., but with a personal approach.

Staying in a place for an extended time induces ‘topophilia,’ a love of place. Tuan,
uses the term as to emphasize the strong bounds of people to the places, these
bonds are related to personal experiences, social acts, cultural knowledge which are
merged together to reveal the sense of places (Tuan, 1974). Moreover, Bachelard, re-
lates the concept to bodily experiences, claiming the memories of places could only
be embedded in bodies (Bachelard, 1996). Therefore you walk in the places you like, or you remember a place you have crawled. Leaving students for hours at a place that they have not been before, inducing them to explore; walk, sit, feel cold and hungry, be amazed by the view, is related to this idea. This could be the beginning of the design process, which is abstracted from the quantitative knowledge, mostly related to internalized experiences of students about the site (Schaik, 2002: 9).

To be able to recognize features characteristic to place develops as a skill, by using or discovering observation tools. These tools can quickly be transformed into design tools themselves. The knowledge to draw a tree group on the shoreline can be transferred to draw a building group similarly scattered on the landscape. With practice experiences and feelings can be drawn and transferred to other minds to be felt and experienced approximately. Such was the goal during the production the transversal sections, collecting all the macro scale features of the site, such as the wind, the movement of the sun, rock formations, profile of the land, water level etc.

**Collecting seemingly irrelevant specimens from the site; micro studies**

During the stays, students were also asked to collect smallest things that are characteristically connected to the site. They collected seed, leaves, flakes like a botanist; eggs, bugs, small animals lie a zoologist; pieces of rocks, sand grains, soil samples lie a geologist. The assignment to collect small things shifted their attention from the human scale to micro scale, coercing them to realize and observe realms beyond human scale. The shift connects you to the place on a different level opening the possibility to understand extended consequences of human intervention to the ecosystem, repositioning human body on larger context.

To enhance the interconnectedness with the place, experimenting with surrounding features were required as an assignment. Most of the students were soaked wet up to their knees trying to record underwater, or ripples on the surface. The brief for making experiments was once again unclear, open to interpretation. All that was said was to bring some fishing equipments, or similar floating, transparent, colored objects to study the interactions and formations on the water surface or below. Experiments were introduced to students as to disturb, or play with the still water surface. These experiments were meant to help students discover the potentials of designing with the use of water; students observed sinking, moving, floating manners, how they would change the water surface, how shadows are altered on water surface, how lights are broken in the water etc.

Back in the hotel at the after hours, collected specimens from the site were installed within diapositive frames and enlarged three to four hundred times by projecting them onto a makeshift screen at the makeshift studio created in the hotel lobby (Figure 2). The results were exhilarating. Enlarging forms created in micro cosmos shifts meaning, opening new ways to interpret naturally occurring formations belonging to the place. It opens up the possibility to use found forms and natural form making processes within the design process as a form giving design tool.

**Developing an ethical and innovative stance**

After the excursion, upon returning to the studio environment, a five-week long design and development period started. First sub-assignments involved the construction
of the physical models of the sites and the development of the transversal sections. A jury with parallel sessions was organized in order to present project proposals. Sections were used successfully to communicate the complexity of the rational and poetic data about the place (Figure 3). Two more seminars were organized about permaculture and wetlands of Montenegro to raise awareness with respect to alternative approaches and sites.

Some students used micro-forms as the basis of their building section, whereas others transformed micro experiments into their program (Figure 4). Flower petals sinking into water became a architectural floating multiple platforms etc. during the design development period.

By custom, all the production of the studio is exhibited throughout the semester. The form of the exhibition, or the way in which the work will be represented are very important philosophical as well as practical problems. The problem of providing the audience with a representation of the work gets intermingled with the question of how designers represent the work in their minds. Exhibiting the work also quickens the last phase of the design process. Since environmental issues and characteristic qualities of the place were central to the wetlands project, a top down gaze at the models, or representations with a bird-eye-view were against the preliminary am-
bition of reproducing the place as it is. The gaze of the observer should be brought down from bird-eye to human-eye level in order to induce the feeling of being in the represented place. To create this effect, models were built in closed boxes with a peeping hole to have a look inside. Final exhibition reconnected the studio work with the concept, ‘the gaze’ (Figure 5).

**Conclusion; Objectives**

Spring semester program of ‘Otherminds’ studio group presented in this paper is an exemplary case for a discussion on how environmental objectives can be integrated with design studios. It should be noted that this studio deals with environmental issues on a more basic and essential level, or archaic and ontological level. It provides a field of exercise to develop the essential skills to understand a place by simply being there, engaging with and internalizing it; to be able to record its characteristic, rational, or poetic qualities; to be able to reproduce or emulate it via representations; to be able to develop an innovative approach despite the hardship of complex problems immanent to the place, overcoming the dilemma of disrupting ecological cycles by architectural intervention.

In order to understand how studio objectives work on the lower and fundamental levels of environmentally wise designing, the studio’s recurring aim to encourage stu-
udents to define a problem rather than finding a design solution to a given problem must be reconsidered. Seeking problem-solution couples within a problematic situation is an environmental or situated approach in itself, exercised in the realm of design knowledge.

The second crucial difference of the studio is that it creates an experience-rich environment where students themselves develop the skills necessary to use representational tools. To understand the place as it is, all the available tools to understand a place were employed during the excursion. It is known by experience that tools to understand rapidly transform into tools to design. If learning a skill is learning to use a tool appropriately, this skill may be transferred to use other tools and ultimately it will be used to make genuine tools to understand and eventually design ecologically.

Notes
1. The ‘Otherminds’ studio program is designed and tutored by Dr. Sait Ali Köknar, Dr. Burçin Kürtüncü, Res. Asst. Bihter Almaç and Res. Asst. Zeynep Aydemir. For logistics, group communication and archival purposes the group has created an extensive blog which can be studied at www.otekikafalar.blogspot.com.
2. The term ‘topophilia’ is introduced by Yi-Fu Tuan and Gaston Bachelard in their writings about the sense of place.
3. First assignment was closely connected with the fourth assignment, the gaze machines, so the thinking process for the concept of gaze would start from the beginning of the semester.
5. Excursion program is designed accordingly, including visits to provincial highlights such as Atabey Seljukid Ertokus Madrasah and Observatory (1224), İslamlık Democracy Museum (1994) commemorating the birthplace of the ninth president of Turkish Republic Süleyman Demirel, Gönen Village Institute (1940).
7. Based on the seminar given by Asc. Prof. Dr. Erol Kesici, lecturer in Egirdir Faculty of Fisheries.
8. All the sections can be analyzed on the excursion blog produced by the students: http://otekigezi.wordpress.com/2013/06/19/11/

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Top Ten Environmental Objectives for an Innovative Design Aiming to a Human Environment
This paper aims to contribute to the formulation of the «Top ten environmental objectives for studio design» which should constitute the basic principles for architectural and urban design and to cover all cases of interventions in the urban space. The whole text took into account the proceedings of the ENHSA Congress 2011, “Teaching a New Environmental Culture”, the considerations raised in the Oxford Conference 2008 “A revaluation of Education in Architecture” as well as a series of 7 volumes on “Cities Design and Sustainability” edited by D. Babalis.

**Method**

In a scale of *architectural design*, basic principles must cover all stages: from the initial concept up to the final elaboration of the form and the formulation of the surrounding space. These principles must refer not only to the cases of intervention realized in large, free urban or suburban areas or in the natural environment, showcasing abundant composition and construction choices, but also to the interventions inside a very dense urban fabric, not leaving much space for eco-friendly decisions.

On the urban *design level*, basic principles must cover not only the cases of new housing organization, which offer an opportunity to formulate the desired conditions in new constructions through the formulation of the urban fabric and the urban parameters defining the density, height, distance between buildings, etc, but also the cases of urban reformation in all scales, which can refer as much to buildings as to public space.

The basic principles of environmental design to be formulated for the aforementioned cases will be answering three basic issues: (a) how do I respect and protect the environment on the basis of the principles of sustainability (b) how do I utilize the environmental conditions to create quality living spaces and (c) how do the above elements contribute to society as a whole.

Combination of theoretical modules, technology courses and architectural design studio is a prerequisite for an environmental approach to architectural and urban design. New technologies reinforce an innovative thinking of the architects providing “new more efficient building materials, new more sophisticated construction methods, new smart or adaptive materials and new digital design and modeling tools”. (E. Tzekakis, 2011).

Be familiar with the latest technologies tools and techniques is important, but it is crucial that environmental issues are explored within the architectural design project and integrated into the design process “design studio is the platform in which creativity is explored and innovation is produced” (M. Voyatzaki 2011) Therefore the studio should facilitate the integration of the environmental principles outlined in the other courses to be fully realized in the design project as it has been proved difficult for students “to apply knowledge from other courses unless encouraged to do so in the design studio and by design studio tutors”. (V. Brophy, 2011)

The environmental thinking therefore needs to be brought directly into the studio as “changes in the teaching process will come more easily from engaging the imagination of design tutors and students than from crunching numbers in technical studies. The ways in which environment thinking and practice enrich rather than restrict architectural design can be demonstrated through design”. (S. Hagan, 2008)
Environmental issues should be integrated from the beginning in the design studio starting on the 1\textsuperscript{st} year and they should be combined with all the basic parameters of the architectural concept: form, function, construction, environment (physical, manmade, social). Sustainability is not limited to an environmental approach but an increasing awareness is needed for social and economic aspects of the project. Students should be familiarized to apply sustainable criteria at urban scale, building scale and detailing scale. Understanding of environmental assessments methods and key principles should drive architectural form, from an environmental perspective and new technologies should contribute to design more efficiently and to discover previously unknown forms.

**Top Ten Environmental Objectives for an Innovative Conception in Architectural and Urban Design**

1. Revise the prevailing view that sustainable buildings are designed without sense of aesthetic qualities, and demonstrate that sustainable architecture is as creative as any other form of architecture. Prove through design studio that there are many aesthetic potentials, opportunities and values in the environmental consciousness design that should create an innovative architecture through new solutions and new conceptions of forms, materials and spatial arrangements.

2. Preserve landscape qualities and site character as well as natural resources and biodiversity through landscape form and urban structure adapted to the built and natural environment and sensitive integration of buildings in the natural, social and built environment, in order to reduce the environmental impact, on the basis of the principles of sustainability. It should be taken into consideration the location, landscape, urban or rural character of the site, the cultural, social, financial, climatic context, local tradition, local technology, local architecture, local materials, the vegetation, climatic data, etc.

3. Achieve urban form and scale responding to microclimate, good solar orientation of the street patterns, sustainable typologies of urban blocks and plot sizes and sensitive orientation of buildings in order to optimize energy consumption for indoor and outdoor comfort. Searching for appropriate size and enclosure of public spaces and suitable ratio between buildings and open spaces to create attractive places with a strong identity and environmental comfort.

4. Function, Construction and Environment should be the basic conceptual issues to define the form, the volume, the spatial arrangement and the external surfaces of each building. The economical aspect should also be part of the design. Possible conflicts e.g. between a very important view and the desired orientation, or various commitments arising from the built environment, should be answered through the synthetic procedure that requires a complex mental process, selecting and combining data, testing and changing forms, volumes, and the building’s skin.

5. Aim at an energy consciousness architectural design, taking into account the local climate conditions, orientation, existing shadows, usual wind, etc, to form design strategies for solar access and solar control, natural lighting, transparency, natural ventilation, thermal, visual and acoustic comfort, sound insulation and active plant solutions, used as architectonic and urban elements in order to create qual-
ity and attractive spaces for living. Environmental quality of a building is achieved through the development of form, envelope and systems of the building.

6. *Promote strategies for energy saving and efficiency* and for reduced consumption of energy in use and in construction are necessary. They should take into account the environmental conditions and include the use of: passive heating and cooling systems, local and recyclable materials of long lasting, low maintenance and low embodied energy, dry construction systems, renewable energies, and technologies of low energy consumption, energetic methods for heating, cooling, air conditioning, air renovation, artificial lighting, renewable energy sources. Innovative technologies and materials and computer software to simulate performance and intelligent management systems. are basic tools.

7. Search for *durability* to maximize the lifespan of the buildings (S. Lee 2011) and to easily maintain them and for *flexibility* to allow the buildings to respond to changes in their initial objectives and requirements.

8. *Reduce the environmental impact of urban development and/or urban enhancement.* Enhance brownfields and eroded environments. Give identity and local identity to the city. Preserving the fabric of the existing city. Create green areas into the urban environment. Management of all natural recourses: sun, air, ground, water, physical materials. Resource saving and achieving local micro – climate benefits. Taking into account all the environmental data. Promote pedestrian and cycling movement and a public transport system in order to prevent problems of air pollution. Promote mixed uses with a good balance of houses, jobs and services and various housing typologies according to different people needs.

9. *Preserve, Conserve and Reuse* the existing buildings for saving energy, time, human action, materials, and the environment. On the other hand as many of them have an outstanding quality or they are unique because of their architectural and historic value, their preservation will help to maintain the identity of the place and the social memory.

10. *Students should be aware of the role and responsibility of the architect* in creating human and healthy society, to meet the users’ needs and contribute to the creation of human environments of a high quality, fulfilling aesthetical, functional, cultural, technical and ecological requirements. They also should be acquainted to collaborate with various disciplines dealing with environmental issues.

The above ten environmental objectives should be integrated in the design ambitions during the educational process. An intimate connection between the environment and all other issues involved in the design is necessary and the innovative ideas have to be aligned with the reality of the human situation in the post crisis world.

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“Connect the Dots”
– Instruments for Divining the Future
The aim of the paper is to tackle issues of architectural environmental concerns rising from the ubiquitous technological applications, both in terms of the built as well as the digital environment, and within the scope of depth of time and leading to an ultimately alternative future.

The discussion unfolds in relation to “Connect the dots”, a joint workshop with 5th year students from the Manchester School of Architecture March unit QED (Quod Erat Demonstrandum) as well as 3rd year design studio Arch 302 students from the University of Nicosia, Department of Architecture.

The workshop acted as a ‘parallel’ condition to both Nicosia and Manchester student projects infusing new issues, possibilities and resolutions. Students were encouraged to fall back on subjects studied in relevant design studios ranging from small scale live-work environments to large scale, long-term re-inhabiting and rehabilitating strategies. Issues stemming from both groups’ design studios were brought into play: production and consumption, ephemerality and depth of time, environmental and social sustainability, biomimesis, locatedness/remoteness and physical/digital technologies.

What distinguished the workshop from other parallel coursework such as the respective design studios of the participant students was two-fold. The timing and duration of the workshop as it was parachuted in the middle of the semester, and the format of the final output which was unlike traditional architectural communication (drawings/modelling) more like contemporary pop digital media: stop motion videos. The assumption here is that possibly by shifting the weight of student output away from traditional architectural tools, the investigation might be opened-up to new themes and unexpected resolutions. At the same time, it affords students a certain “liberating” feeling, a break from the stiffness and tyranny of architectural tools.

What was deemed as the “glue” between the two groups’ respective studios was the common preoccupation with issues of future environmental technological strategies. What was deemed “missing” from the respective studios was for Nicosia students a new sense of an urban ecosystem broader than isolated singular building issues, requiring strategies that are more network oriented, synergistic and interdependent.
For Manchester students, what was “missing” from their respective studio was the opportunity of revisiting previous learning and re-testing through a set-up of a different teaching methodology of intense “charette” type of production, as opposed to time-maturing lengthy research projects.

The paper discusses the workshop on its primary target of injecting an array of selected intensified and concentrated thematics.

**Workshop programme: beyond the physical design studio**

The students were teamed up in groups of six, containing both Manchester as well as Nicosia students. Likewise, extending into the social aspects of educational collaboration, the visiting students were hosted in the individual residences of the local students, thus promoting further interaction. The workshop meetings were three, day-long sessions. Further collaboration beyond the intensive workshop has been executed remotely, including e-publishing. This will be a continuous and accumulative process of tuning and editing using e-techniques as a process that expands architectural education beyond the physical design studio.

Shifting the tools to match contemporary digital technological applications with a “straight to publishing” strategy was one of the main premises of the workshop; the implied possible on-going digital life of the work could continue indefinitely through internet audience feedback/interventions.

The workshop started with a visit to the site, walking around its boundary to observe the surrounding areas and possible entry points. Throughout the 3-day workshop a series of tasks were completed in a production driven environment. At its culmination the six resulting videos were published online, as well as presented in an announced public presentation.
Scenario / objective of the workshop

The students were asked to envision the futuristic scenario of stitching through the Nicosia UN buffer zone. The workshop would concentrate in the immediate area around Paphos Gate as a paradigmatic section of the broader context.

The objective of the workshop was to tackle the issues of the Nicosia UN buffer zone within the inner city, while refraining from the pitfalls of decades old “political” agendas. The buffer zone was to be viewed merely as a space “left-over” in between north and south of the centre of Nicosia. The most central “plots” were to be considered regardless of political contesting, ideologies, real estate speculation, racial or religious “interests”.

The aim was to erase the singularity of existing check points (for crossing the buffer zone) by inserting a variety of alternative programmatically charged access/connecting routes and infrastructures. Anchor points would be identified on both sides (north and south) and experimentation should aim towards connecting the dots. Student groups were to propose strategies for the operative concept of their interventions (the new routes would be lined with activities/operations and functions).

The on-going project of the Nicosia Arch 302 students, located in the St Joseph’s Convent plot (which was already at the edge of the buffer zone) was to be considered as one anchor point at the Southern side.

The “dead” spaces within the buffer zone, were to be reactivated in ways that make common sense (economy of means, desires, connectivity etc.), and not necessarily architectural sense: that is exactly where the environmental aspects of the project started emerging: issues of materiality, depth of time, evolution in time, flexibility/changeability, cradle to cradle strategies, production and consumption, living/working, tactile and ethereal, all came into play.

The objective was not to recover or find data but to concentrate on how interaction with users at a public scale and personal interfaces will be facilitated by the architecture of the intervention in an apparent ‘void’ - an ecological niche offering certain affordance for a colonising organism.

Fig. 2
The Doppler Effect – psychogeography.
Students were not asked to observe the space under question as space to be planned but as space to be strategically organised. Therefore the traditional method of merely drawing lines on a plan could not facilitate this aim. Using drawing as a representation tool would imply finite and static propositions (planning), whereas video could offer more dynamic living and evolving propositions (strategies).

**Pedagogy**

The pedagogical methodology used to achieve the objectives of the workshop was one of shock and “alienation”; intensifying students’ environmental awareness by abruptly removing them from their familiar studio project environment and dropping them into another, seemingly dissimilar (different scale/use/context etc.). The aim was to afford unexpected processes and resolutions such as relaxing the tension of architectural expectation and letting pieces fall into place almost by themselves. In addition knowledge gained from previous or parallel studies could also be more liberally applied. Seeking new knowledge could at the same time be pursued by opening up the process of “risk-taking”. As a consequence the element of surprise could play a fundamental role in pointing to new directions and possibilities; thus ultimately leading to innovation, through a process fuelled by nurturing the students’ pride and authority over their own work.

The agenda of the workshop launched itself deliberately on issues that would commonly be perceived as either “childish” or “overly pop”, hence, not traditionally academic. The childish aspect of the work stems from the very premise of the act of “connecting the dots”: an act that is an abstract line connection of points, traditionally leading to just a recognizable image. But in the context of the workshop it would have to be much more: spatial and social sustainability considering both physical as well as virtual connectivity. As the architectural culture is traditionally quite familiar with the “physical” aspects of the world, the workshop shifted the emphasis on the ethereal, or the digital: hence, the “pop” aspect of the project.

These ethereal/digital aspects were to be treated as parameters of the physical spatial arrangements and operations as they could be integral in altering or enhancing perception, performance, as well as logistical deliverance into future scenarios. The popular and widespread usage of digital devices would be investigated in this capac-

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Fig. 3
The Doppler Effect – network moment.
ity. Students were asked to consider how present-day digital devices, such as tablets and smartphones, could transform the way space performs.

**Methodology**

The programme brief elements from the Nicosia Arch 302 studio project should provide the ‘infrastructure’ for the workshop theme. An abbreviated version of the studio programme would be used as a transcendental function.

The workshop would act as a ‘parallel’ condition to both Nicosia and Manchester student projects infusing new issues, possibilities and resolutions. It was expected that all students would “recycle” personal themes and projects as appropriate.

A series of intensive “charettes”, deemed very fast attempts employing an excess amount of ideology, strategizing, scratch modelling, montage, bricolage and concept research, was meant to activate an ease in the process of attempting risking, evaluating and implementing.

Recording the process of the workshop was as important as the outputs, so all teams were expected to keep a digital record of all proceedings including group work and publishing it online, almost as live streaming.

**Output specifics**

Adding a new step in the architectural proposition requirement, students were asked to present the final project in a 30-second stop-motion video. This would be in accordance to the “pop” aspect of the workshop, becoming a tool completely integratable to the new digital media: students were not only asked to present their project “live” and “streaming”, but also to publish it on a number of sites, get feedback, and reform it.

Students were not allowed to use conventional architectural representation tools such as drawings and models as a final product. They were allowed to use these modes of investigation and production, only as a process. This restriction made students aware of new means of architectural communication, as well as the new environmental issues of no singular and absolute propositions when pertaining to the topics of environmental and social sustainability.

The required output was the production of a filmic condition from points A to Z (Southern to Northern dots) and back again. This would be a 30-second stop motion video much like a flip book.

The video would be accompanied by a catalogue with directions of watching the video and strategies for critical points of reference (evolution in time, cradle to cradle, public engagement etc), while overlapping image with text and/or graphic notations/diagrams/ideograms.

The workshop teams were expected to immediately upload their work online and contact local and international media groups.

**Workshop themes**

The environmental objective of the workshop was the ecology of “things” in depth of time. The authors consider that this objective is so integral to evolution through time that may not be explicitly defined as mere goals or eventual performances.
In line with engraining an environmental culture, an exceeding surplus of ingredients and implicit suggestions about “cooking” possibilities were delivered, but no indication about the execution (“recipes” had to be invented). The various workshop themes were intentionally not exhaustively clarified and were presented as shots in the dark.

The following are possible synergetic ingredients of what the authors consider as the fundamental environmental objective that could launch the inquisitive search for a design based environmental awareness:

- **The operational**: engaging user activity/interactivity at public and personal “scales”-located and remote - accommodating the body and/or the mind –working with/ without portable digital devices (smart phones/ tablets etc).
- **Evolution in time**: speculating on the development of the intervention within a time frame (e.g. 50+ years) whilst gathering historical (evolutionary) data as well as generating environment responding to climate. Considering the possibility of a bio machine; having a future rather than just a present. Contemplating the ecology of a project in time as the priority, rather than its objective quality.
- **Autonomy**: Dealing with operative power and waste, employing a cradle to cradle strategy both materially and operationally.
- **Cradle to cradle**: considering long lasting intervention or renewable structure mutating with different iterations or a combination where some parts endure and others are replaced. Considering a 1000 year period and/or just a day.
- **Ever-changing conditions**: engaging in the exchange of a wide range of products/exchange of data/ users/ density of activity / flows. The concept of deployability could derive from responding to these data. Considering capabilities of collecting/
displaying/transmitting the data in a variety of ways – to individuals or groups in the space and elsewhere dealing with locatedness and remoteness.

- **Logistics**: considering the exchange of products, deliveries, schedules, timetables, transactions, appointments. An input/access/transmission/output instrument.

- **Performance/intend**: allowing for an “Object-ile” (the technological object assuming a place in a continuum by variation) and/or environment to fulfil parallel practical functions suited to its location but only autonomously.

- **Mobility**: Considering the possibilities of staticness, mobility and deployability.

- **Responsiveness**: considering response to climatic change such as sun, shade, wind, rain. Ability to change diurnally, seasonally etc. to reflect climate but also events/programmatic change.

- **Biomimesis and affordance as key points of departure**: considering biomimesis as a potential based on locale and trans-global digital savvy.

- **Urban drift**: considering the psychogeography of the “flaneur”, cross-fertilised with contemporary digital media dealing with space, time and human interaction in a realistic and contemporary way.

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**Selected student output**

Following is a brief discussion of selected student output from the resultant workshop projects “2 B Green”, “Bicycle Market”, “Waterevolution”, “Reaching for the Clouds”, “The Doppler Effect” and “Better Buffer”:

**Better Buffer**

Better Buffer is concerned with the process that surrounds the distribution of food. The high number of vacant plots in the buffer zone offers opportunities for programmes that are related to the production of food to be dispersed north and south of the site. The objective of the project is to increase crossings, hoping that any sense of boundaries will be erased over time.

Better Buffer is essentially a production line. However, programmes which would usually function near one another are pulled apart and placed at opposite sides of the buffer zone. Over time, interactions that evolve from these strategically placed programmes will lead to the expansion of the area, thus eradicating or blurring of the current binding lines. The proposition uses recycled shipping containers that may be fixed and/or translocatable, using all the benefits of the existing shipping infrastructure and logistics. A cycling network supports the food network. Fixed containers (an-
chored) house programmes such as service stops, cafes and preparation of food. Movable containers enable the distribution of goods within the site.

As the buffer zone expands, there will be an increase in demand for locally grown fresh produce. The constant crossing of borders will increase interaction between different types of people, thus knowledge is shared about self-sufficient living. Over time, the food production chain will expand further thus offering the wider networks of Cyprus opportunities to adapt to better buffer.

**Bicycle Market**

Vacant spaces become sites for cycle market modules and the buffer zone line creates cycle routes. The market modules act as magnets and charge in-between spaces. The cycle route therefore runs through fields of events. A wide array of programmes can be supported or appropriated such as seasonal events, camping etc. The modular structures are designed in relation to availability of local material and labour resources. Timber and metal workshops around the site provide materials for construction and ensure that the area is charged, attracting people to live and work there.

Additionally piezoelectric bikes generate energy by users. The cycle market modules become batteries to power themselves, the cycle route and in-between event spaces. In addition they are able to collect and transmit data empowering local groups to develop strategies to improve their local neighbourhoods. The gradual built-up of the archived information will be shared in public repositories linked to the bicycle market.

The market modules are constructed using recycled timber pallets in various permutations as part of a prefabrication system.

Fig. 6
Better Buffer- still image from video.
Overtime the buffer zone increases in activity and population and the cycle routes extend through and around the rest of the city in both directions.

**Reaching for the Clouds**

The concept was to create scaffolding like structures that could hold prefabricated programmable units and walkways that connect both north and south of the buffer zone.

![Fig. 7](image1)

Bicycle Market - still image from video.

![Fig. 8](image2)

Reaching for the Clouds - still image from video.

![Fig. 9](image3)

Waterevolution - still image from video.
In the centre of the proposition all programmes will merge into a market where people from both sides can buy fresh organic food. All the food will be produced inside the buffer zone by the people living there. The produce will be sold to the market thus creating a local economy. The proposition allows for people to use digital devices in order to check availability of products, time schedules, exchange needed, logistics, operation of the market and transmission of these data outside the buffer zone.

The proposal was driven by speculating about an extreme future scenario of flooding in the area and the potentialities for expansion over time. The already expanded scaffolding system provides a new elevated ground for habitable space, unaffected by potential flooding and enhanced by alternative flow systems (floating parts).

**Waterevolution**

The project relies on using as found materials form the site with the potential for recycling and re-using such as sandbags, tyres, scaffolding, bamboo, timber pallets etc.

The proposition evolved by synthesizing a modular system of operable platforms, utilizing existing and adding new water towers, an “earn-your-stay” policy, a “built-your-own” strategy combined with sensible buildability. The team utilised and expanded the water collection and supply network of the area to foresee future scenarios and propose new water-related programmes (e.g. a seasonal river and associated activities).

**The Doppler Effect**

The team identified existing and potential access points into the buffer zone, potential routes, open spaces and different strategies for connecting these, in combination with manipulating visibility towards and within the site to encourage interconnecting flows. This resulted in binding urban functions to access points as new places of interest and transit places in the city.

The team consequently developed an expandable ribbon, the “eco ribbon”, compiled from recycled frameworks, easily assembled as part of an open prefabrication system. Through the attachment of “activity units” they infused different programmes to reactivate the area, stitching each other and connecting both sides. The ribbon of spatial frames is hoped to work as a common denominator for any expansion, as a missing link in the urban system and would therefore provide a new infrastructure.

The buffer zone was arranged into three main programmatic cores in order to maximize the implementation of cradle to cradle strategies, anticipating horizontal and vertical future evolution.

**2 B Green**

The team proposed the development of a local wine production industry ranging from growing vines on existing derelict adobe buildings, to selling and consuming grape by-products.

Existing buildings are allowed to deteriorate inviting nature to take over, and assuming that a new topography/landscape will eventually emerge.
Conclusion

The “Connect the dots” workshop generated projects that demonstrated a systematic approach to the colonisation of the given urban void within the interpretation of possible future scenarios as they could relate to informed concepts for sustainable urbanism.

The environmental objective of the workshop was the ecology of “things” in depth of time, not as a stand-alone and absolute objective but as an overarching synergy of a series of ingredients, that could launch the inquisitive search for a design based environmental awareness. It is therefore important that the pedagogical tool would be one of non-descriptive nature, but one that provokes risk-tasking.

Note

The authors would like to acknowledge the contribution of Colin Pugh, Siobhan Barry and Dominic Sagar of QED March unit, Manchester School of Architecture, UK.

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Recovery of a Small Rural Building into a Renewable Energy Didactic Park
Energy recovery in the agricultural landscape
Fosca Tortorelli

The new design practices are increasingly turning to sustainable architecture, in the chosen case study, the thesis of Elizabeth Corvino held with tutor Francesca Muzzillo, develops the idea of design strategies of a rural or technological upgrading, which states an innovative and experimental vision. This project (Fig. 1) starts from the basic idea from which you try to combine the use of a natural area with the reuse of a small, rural property and to implement such synergy through the use of technologies of energy production from renewable sources.

The energy adjustment becomes an attractor for the site and to the elements that made him draw; also trying to satisfy the didactic function of the area that must be present in its new configuration, through a series of panels descriptive and explanatory performance monitoring energy. The work concerns a “Park for Renewable Energy” which finds its center in a disused farm building transformed into a prototype house Net Zero Energy. This is described through an educational path emphasized by the presence of interactive installations that use photovoltaics. The project area covers a small lot, on the edge between Lazio and Campania, on which stands a building in ruins.

In preparing the draft we have studied as models of reference types of projects related to similar experiences, such as the creation of theme parks or museums for demonstration-didactic and interactive. Some of these organizations were contacted and (if possible) visited to obtain information on their functioning, to the possible configurations of routes, integrated technologies employed. Rather than choosing radical solutions of a high impact, it has become possible to submit a comprehensive system of solutions of lower energy performance production in favor of a more harmonious agreement between Technology and Architecture.

Fig. 1
Descriptive sections of the Elisabetta Corvino’s project.
An example of carbon neutral buildings, represented by the experience of Leaf Community of Loccioni Group, was one of the reference models that were given particular attention. It is a laboratory of excellence in innovation, through the design, implementation and management of solutions for energy efficiency. According to Loccioni Group the concept of sustainability becomes a managerial approach that can generate both benefits for companies that choose to be sustainable, and a state of well-being for the whole community. The aim of the thesis was to test the design variables that connect themselves in the definition of Zero-Energy-Building integrating the technological components in the design phase, sizing the systems and evaluating their performance. The park is interpreted as a real living organism that finds nourishment from natural elements and connections through that stretch and orient themselves in a visible way distinguishing the pre-existence, point out devices of energy production.

The choices were made with particular attention to the rural world, the latter fact is also able to pass on the values of the built environment, which is one of the most important cultural elements of civilization and Mediterranean culture.

The rural landscape is part of a complex system, which combines aspects of production, cultural and environmental. It is a basic interconnection between human activity and environmental system, in which man's ability to affect the territory is expressed in different ways, which may vary in relation to different environmental conditions and different production techniques, but which in any case are based on the need to find a balance with the environment in which it operates. Thus, concurrently with the full protection of areas of natural integral preservation of the built environment, becomes a precondition for the protection of the environment and landscape, because through it, you preserve both the organizational aspects and natural and environmental resources. The rediscovery of the rural world - and with it also the rural landscape - is a necessary step towards enhancement of our culture and our history, but also the path of our civilization and our economy towards growth patterns geared to sustainable development.

Trying to interpret the potential of the system is trying to initiate virtuous processes, which can be set and achieved through:

- The planning and regulatory framework and municipal taxation of restoration;
- The check of the relationship between levels of reuse agricultural and not agricultural, according to the situation practiced by the agricultural holder;
- Analysis of the relationship between buildings and land and the necessary present and future appliances and / or appropriate, even compared to other options;
- The development of guidelines on how the renovation of the buildings including their landscape context and addresses of conversion;
- The recognition of the potentiality for reuse of building elements also compared with different functions and distinguished market options.

That being so about these concepts, the transformation of the rural construction of the project had the full respect of the existing configuration, but at the same time tried to integrate technological systems as well. The exterior image of the building has not been transformed, recovering however all the interior spaces and restoring all the
openings, so as to create internal routes such as to allow users both to use the spaces and to have a clear view of the application technology and its operation.

Intervention of major importance were the restoration of the roof (Fig. 2), which necessarily had to protect the users of the house, and the reconstruction of the floor. For the coverage has been considered a simple but functional solution. The part exposed to the south (tilted 21 degrees) was covered with photovoltaic panels. For a lower visual impact have been chosen FV panels semitransparent so as to ensure also the entrance of the light in a widespread manner. There were also placed solar tubes to bring natural light into the darkest points.

For the floor instead, it has been decided to isolate the part to the ground and to use a device radiant floor for the air conditioning indoor environments, powered by a heat pump and low-enthalpy geothermal plant (Fig. 3).

Inside the building a science center is located, media and entertainment at the forefront of research and testing of technologies, processes and virtuous actions that improve human life and reduce the impact of civil society on the planet.

Fig. 2
Configuration of the photovoltaic panels in covering in the Elisabetta Corvino’s project.

Fig. 3
Floor geothermal system in the Elisabetta Corvino's project.
Research examined the main renewable sources of energy, in order to outline the possibilities of employment in a specific geographical area. On each of the systems of production of renewable energy taken into examination a feasibility study was carried out.

The research has provided both phases of monitoring the various renewable resources of the territory and theoretical phases of processing of the acquired data.

The comparative study of different techniques of production of renewable energy and their applicability was therefore a particularly functional method to define investment priorities for the exploitation of renewable resources.

The application of the method to the investigated reality has allowed us to validate its potential in terms of benchmarking, including through the use of techniques for spatial modeling and photorealistic rendering.

With reference to the purpose to evaluate the applicability of the main forms of energy production from renewable sources in that territory, were relatively viable and sustainable solutions to some of photovoltaic systems and biomass.

The experiment should thus prove as a result the new idea of “architecture” linked to that of “nature.” This project was designed to demonstrate that it is possible to live sustainably, creating, within the study area, a real path of knowledge to understand that the use of renewable energy systems and energy efficiency can become the normality. In fact, you have to experience, understand and learn how technology should be at the service of man and not vice versa.

**Formative strategies**

*Francesca Muzzillo*

What can we deduce from the above experience? Which principle underlies the project with reference to formative strategies?

As already explained, the project is aimed at reclaiming a rural area and, at the same time, at creating a didactic park for renewable energies, in order to improve a general responsible attitude for sustainable technology skills. However, the most relevant coming out focus is that the best choices are not the most relevant ones under the point of view of energetic performances, but the ones that found a balance with respect to the perceptive rules.

Then the main aim is to encourage young people, especially architectural students, first of all to reconsider the design methodologies from a different perspective. In fact, while taking into account a general system of components into correlation with a list of codified requirements, it is possible to value the choices following a sort of design inference between banner energetic performances and landscape environment. The process should go from an intuitive observation to a following chosen array of performances with a set of progressive little improvements which are made onto the plane of the intuitive perceptive.

But experience teaches us that, without taking into account each specific environmental situation and its own particular constraint, there is no homogeneous disposition for sustainable recovery of rural architecture. For example its envelope is ideal for shading and for natural ventilation; but there are sometimes inherent limitations for
daylighting and balanced solar heat gain unless changes are made to the exterior architectural features. Even if most existing roofs can easily collect water, rainwater harvesting systems may not be universally apt to every type of rural environment. While passive cooling is easily achieved through high mass performances, a lack of flexibility into massive masonry structural system does not always allow introducing new fountains and basins as evaporative cooling strategies. Most of all, some technologies of sustainable design such as solar hot water heating, photovoltaic and even small wind turbines difficultly operate without any interference on landscape.

An appropriate relationship between the façade and its exterior environment is difficult to define even in a specific site (Fig. 4). It could only be verified by elaborate simulations and virtual schemes. On this basis students could try to determine common denominators of different typological combinations and compare them with comparative design strategies. Of course this preventive work should be very systematic, with relation to traditional materials into different combinations and with respect to natural elements. It is in fact useful to preview performances with natural elements, considering their flexibility and the capabilities of having different behaviors. Anyway, perceptive rules may not be found in a simple way.

Notwithstanding the inherent difficulties, there are latent opportunities in a didactic process with an attitude towards adaptability and a composition of personal experiments in a united mosaic. So, speaking of energy technologies which are available nowadays, it is useful to provide an approach in order to help students to make choices which reveal to be the best ones only if they are considered inside a specific context.

A useful method is to provide hypothetical conditions for energy performance relating them to a framework of variable conformation of the building that has to be

Fig. 4
General concepts of Elisabetta Corvino’s project
recovered. So it is possible to evaluate energy-efficient technologies though a rigorous research, that moves towards a more conscientious result into the decision-makers progression. In this process, behind every project, there is the resolution of the often contradicted relationship between individual choices of students and choices which are congruent to a common didactic approach. And it is at the limit between the personal and the collective that infantile creativity emerges, when the children, in “relating to the uniform”, begin to find a solution to problems and to build their own place in life. Never more explicit than in the game, the dynamic between social space and individual space is continually full of movement, while individual creativity continually enters into conflict, and is continually solved, with its acceptance to a system generally agreed on. This is not such an elementary dynamics. There is the single and there is the group. And, between one and the other, the action never makes a definitive choice.

The first reference, in order to have a unique integration between every new technological solution and the image integrity of preexisting architecture and landscape areas, is a perceptive progressive analysis. The intent is to let students be concerned with how to make a choice at the intersection of perceptive acquiesces and environment objective choices, in a way between the theoretical formulation and the practical application.

This concept is very important in teaching, as, in fact, students’ attitude is at the same time professional and still intuitive.

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Urban Lab in Parametric Vision
Environmental Iper-Design
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Over the years, Environmental Design Labs have increased their focus on energy and environmental issues, operating on different scales of intervention and identifying a specific interest for the technology control of buildings and social spaces, at urban level too. A natural evolution of this approach is the pursuit of new stimuli to offer different operating modes on the built environment (compact and diffusing cities), in order to train young architects who can help solve climate change problems in urban areas (the so-called urban heat island) by adopting more efficient methods, and the control of formal results and the quality of urban spaces.

In many countries, the post-industrial crisis has been causing large production and commercial urban areas to be discontinued, and this not just on a large scale and in big cities. Even in small centres, the production and commercial system – organized in networks and districts made up of small and medium enterprises – shows a progressive dissipation of the economic system whose tissue, which is not completely compact in itself, is founded on capillarity.

Based on today’s extensive literature on the urban sprawl and the boost to economy coming from good practices supported by Europe, the policies implemented by public administrations are focusing on finding urban spaces and single buildings to be offered to investors, in order to create economic alternatives and a new growth within the built and urbanized territory. In the Marche region, PORUs (Piano Operativo di Riqualificazione Urbana, Urban Renovation Operating Plans) are, for instance, a new important method adopted to redefine urban settings according to a fundamental principle: it is no more possible to build beyond the settled urban limit.
What are the tools used to implement this new political and administrative approach? What are the professionals to be involved who can effectively operate in specific situations without neglecting any complexities, being able to organize the different measures to take according to the various size scales: from the whole urban system to the single buildings?

It is clear that the success of urban planning cannot be based on the definition of new functions for spaces and building only: the term ‘quality,’ the main strategic objective of design activities, has to include all the aspects related to the environmental wellbeing, understood as an improvement of its perception by its users.

Quality can be perceived in an endless series of perception nuances and can be measured based on functional, formal, energy and climate performances using adequate design tools and different size scales. It is therefore necessary to define the parameters that will allow to get this varying ‘quality.’ This is no more based on a single ‘correct’ choice, but on balancing different ‘correct qualities’ which need to be matched in that specific place, time and space.

The Environmental Design course of the ‘Eduardo Vittoria’ Architecture and Design School is focused on this. It is aimed at not managing complexities through a choice of set and limited minimal requirements and, even worse, through the definition of objectives that cannot be changed.

In the course, the complexity of the issues involved is clear in the lab itself, allowing students to face and interact with many aspects at the same time. Despite in architecture schools design activities are aimed at defining and measuring the qualities of the environment in spaces, they must be able to carry out formal and landscape activities based on environmental requirements, also considering the relationships that the creation of an urban small space or a small building can create with the nearby context and with the environment at large.

The course is based on two parallel methods meeting at a specific point chosen by the student, where the ‘environmental’ results come from a careful and in depth design.

Fig. 3
Sketch by Federica Ottone.
The project domain is identified by the student within two paths that explore theories and methods of design and, at the same time, verification tools of immediate “environmental” output.
The first cognitive and methodological method allows an open approach towards the complex issues to be faced. Its main aim is to help student-designers to be aware of their role in space and time, learning how to manage any activities according to the environmental conditions and their individual choice.

The second operative and instrumental method offers the tools (see the following paragraphs) needed to get new chances of defining urban areas and buildings. In the design phase this can be achieved by melting the different parameters (shape, function, climate performances, visual perception, comfort, etc.) in a dynamic balance based on relationships rather than on self-reference.

Therefore, the training of skilled professionals seems to offer public administrations a chance to communicate with designers able to fully understand the need for a sustainable transformation of cities, and who are aware of the (measurable) consequences that even small actions can have on the design.

Control of the microclimatic interactions at different scales
Roberta Cocci Grifoni

Teaching environmental applied physics to students of architecture requires addressing a wide range of strategies, systems, and technologies typically associated with various aspects of sustainable design to achieve energy saving or carbon-neutrality.

Such a need responds to the growing interest of the built environment professionals in achieving a more sustainable and environmentally conscious built environment. On this premise the course is focused on “sustainability” and deals with the topics of the energy efficiency and the use of renewable energy sources at the building as well as at the urban level.

In fact, integrating sustainability considerations in the early stages of the design is recognized to be particularly important because of the high impact that design decisions taken in these stages have over the subsequent performance of the building or community especially when aiming for carbon-neutral designs.

By analysing the interactions between the climate and the building envelope, and considering the most advanced building and system technologies for the control of the internal and external thermal comfort, the tools for an energy conscious design and the criteria for the first sizing of the systems are provided. From the building to the region scale, the energy efficiency and the availability of renewable energy are discussed, with a special attention to solar energy, natural ventilation, passive devices and diffuse power generation.

The landscape scale, the urban scale and the building scale are the main formative fields that have been assessed during the applied physics course. This is an important aspect because students have to be capable of a “crosswise” analysis of the urban dysfunctions both towards completion and clearing planning based on the technological innovation (i.e., the micro-climatic control of the open spaces through greenery and plants and the re-use of the urban out-skirts) and towards reinterpretation and rehabilitation of the urban metabolic system through the strategic reuse of water and green (green corridors, urban parks, regional parks, district parks, cycle paths, etc).

Aim of this process is to provide theoretical, methodological and operative tools, at different scales, for exploring the architectural space, taking into account its building, technological, energetic and environmental dimension. In this way the environ-
mental project bring the eco-building vision into reality and shows how green design and sustainable construction can achieve massive energy and environmental savings (up to produce energy) without forgetting the importance of architecture and aesthetics.

Achieving this goal requires the utilization of both passive design strategies and state-of-the-art energy efficient technologies to design buildings and residential quarters that use much less energy than current practice, and then to incorporate renewable energy generation systems into the fabric of the architecture to cover the remaining demand.

There are some significant issues addressing the course and characterizing the environmental design:

1. Site analysis: it is important to identify the potentials and limitations of a specific site with regard to the availability of natural resources and the impact of adjacent building and/or natural elements.
2. Climate analysis: it is necessary to identify the optimum passive design strategy or group of strategies for a certain local climate.
3. Solar access and solar control: it is based on the principles of solar geometry and how to take advantage of the sun in colder climates (solar access) and to avoid it in hotter climates (solar control/shading).
4. Passive and active heating and cooling design strategies: it is required to use the principles of climatic design and the main strategies for heating and cooling in each of the major climate regions.
5. On-site energy production: it is fundamental to employ the principle of on-site power generation and some simple methods of sizing some of these systems.
6. Life cycle analysis of building materials: it is important to use available tools in identifying and comparing the life cycle assessment of buildings materials and systems (including embodied energy and other environmental impacts).

The following pictures (Fig.4 and 5) show, as example, previous analysis steps.

Fig. 4
Climate Analysis.
At the same time, the course uses several performance analysis and simulation software, each aiming at performing a specific analysis task. Simulation of whole-building energy use has been utilized to fully simulate the annual energy use of a building, and analyze the results to identify major energy consumption end-uses and how to reduce them. The purpose of these analyses is to support retrofit design strategies the climate of the urban outside space influences the energy consumption of a city and the processes which create these climates are very complex. Therefore, the most precise way to calculate or assess the impact of changes is through numerical methods, although there already are several models, that can deal with the complexity of urban structures and even take into account human thermal comfort.

This approach seeks to optimize building and street proportions, street shading, open space, air movement and building materials relative to thermal comfort and Urban Heat Island mitigation.

To give an example, ENVI-met (M. Bruse, 1999) is an efficient tool which analyzes micro-scale thermal interactions in urban environments. It is a user friendly tool that aims at reproducing the major processes in the atmosphere that affect the microclimate on a well-founded physical basis (i.e. the fundamental laws of fluid dynamics and thermodynamics). In addition, COMFA+ model (a comfort evaluation tool) can be used for calibration purpose, because it has been assessed in an Italian urban area (Dessì, 2007) in order to simulate thermal comfort conditions in outdoor spaces.

It is a comfort evaluation tool based on the energy balance of a person in a given outdoor space. It is one of the simplest models of outdoor comfort evaluation, but also sensitive enough to the physical variations to mitigate microclimatic conditions.

In order to evaluate the effectiveness of different design choices, during the course, several prognostic techniques have been applied and compared. Specifically, the ENVI-met model and the COMFA+ method have been examined and a new tool has been developed, named ENVI-COM+ (Latini et al, 2010), aiming to both automate the calculation process in a steady approach such as the COMFA and to improve the simulation coherence.

The ENVI-COM+ tool has been used to automatically investigate the effects of the proposed variations on the basis of the environmental parameters. Simulations show how different paving materials affect local comfort, and greener solutions seem to be even more performing than expected. Furthermore, designing of green surfaces seems to be insufficient to achieve an acceptable comfort sensation without further
protection from solar radiation. The introduction of shading devices such as pergolas or trees determines a strong enhancement of local comfort also for existing commercial and residential buildings.

**Parametric tools for environmental design**

*Bonvini Anna*

The activities suggested to the students at the Environmental Design Lab relate to a set city, the attribution of new functionalities in areas that are no more connected to their own context and that are no more suited to host the functions they were originally developed for. The aim is creating projects that can suggest new quantifiable scenarios, and defining measurable relations between the built environment and landscape elements in view of achieving innovative formal and technical results improving the quality of cities.

The search for new scenarios sets a general concept through the definition of active processes involving urban outdoor spaces, buildings, the environment, economic activities, and social and cultural dynamics through energy and environmental controls.

The general concept is the basis for the methodological and design process, it defines the objectives, it sets the design framework, and it indicates the tools to use, the analysis to carry out and the performances to obtain. The concept indicates the different phases and the relations between the different parts.

The whole design process is a network where it is possible to find the connections and to assign them parametric functions describing them and defining their nature. The parametric approach to design makes it possible to change the parameters and functions of the concept without modifying it, and to control any changes taking place in the system.

The parameters used can be directly obtained from tables, derived through spreadsheets or software like ENVI-met and Autodesk Ecotect Analysis, and they can be input again in other environment design or simulation support softwares as ENVI-met and COMFA+, allowing additions or later audits (as explained in the previous paragraph).

The two software tools are both used as analysis and audit tools for the project as they simulate the suggested scenarios. They also graphically contribute to the depiction of the concept through the formalization of output files.

One of the methodological solutions found by the students aims at optimizing the formal, energy and environmental features of the design by controlling the buildings composition, improving the exposition, screening sun rays, managing internal and external ventilation, and applying passive and active systems for heating and cooling.

The same focus is devoted to the design of outdoor spaces. The local microclimate depends on the city morphology, the physical characteristics of existing buildings, the physical and mechanical properties of surfaces, facades and floorings. In order to achieve an outdoor comfort level, especially at our latitude, it is essential to have shading systems and green areas, control ventilation and choose the right type of materials.

These elements have to be analyzed and included in a system based on the borders set by the concept. This has to be achieved by constantly comparing the formal
and the technological choices, and the microclimatic interactions. It is essential to continuously check the data obtained.

The environmental data are processed with analysis tools that can translate design elements into simple models. They define relations between climate and environment general factors, such as external and internal ventilation related to the building facades. The outer shape, the building’s volume and the recess systems are planned maximizing performances. Through qualitative and quantitative analysis of air flows on facades it’s possible to assess their benefits and estimate the thermal comfort at ground level.

The ENVI-met software allows for microclimatic analysis of the design areas. It is a 3D simulator reproducing the main processes in the atmosphere affecting the microclimate. It offers simulations on micro scale. It is an efficient tool for the analysis at urban level. The local microclimate characteristics are simulated and taken into account in the design, that can be changed when the performances obtained are not acceptable.

The meteorological data extracted are compared with the data obtained with COMFA+.
COMFA+ is a tool used to assess comfort. It is based on the energetic balance of people in outdoor spaces. It is a tool able to evaluate physical perceptions following changes in microclimatic conditions.

The data obtained with ENVI-met, Autodesk Ecotect Analysis and COMFA+ are interfaced and actively included in a system within the project through the introduction
of a generative modelling software allowing to define direct connections between the different tools and parameters used.

Specifically, it was suggested to use Grasshopper software, a Rhino plug-in that allows to obtain digital models, where information are translated into shapes and the change of the input parameters enables to control the environmental mechanics of the design. Thanks to this process, students can formalize and optimize data in a wider path, where the different project sections are internally mutually connected.

The individual and the whole are connected, and while elaborating the concept it's possible to get back to specific elements and change them according to later analysis or to different data obtained during the planning phases.

The various parts are not assembled but mutually integrated based on an inclusive model. It's a dynamic evolution process where, after establishing any relations and laws governing the concept, it's possible to act on different units without disrupting the whole. It is always possible to keep track of any intermediate phases and change them.

This method allows to work according to multidisciplinary blocks. The networked organization of the concept, developed through parametric controls, makes it possible to contemporarily work on different sections of the design, verifying each time the interactions of one part with the other.

This methodological approach was developed to manage complex processes through concepts coming from the scale of whole urban areas, and it also offers the chance to directly develop works in detail, a solution useful for the serial production with 3D printers and numerical control machines.
New parameters for smart cities and building adaptation
Khalifa Mostafa Rabea Abdelbaset

Dealing with smart cities and building adaptation, getting each possible information about all design parameters is fundamental to start any kind of Architectural or urban design projects; information should cover all kind of scales in architecture and urban planning fields; from huge scale such as earth land surfing, to big scale such as perceptual city Spaces 3D maps, to intermediate scale such as neighborhoods and communities, to headquarters data, until reaching buildings information and users data in small scale. It is needed to cover not only physical or geographical city contents, but also to cover intangible contents such as people activities, social actions, and relations context. Urban and architectural developers use data integration between tangible and intangible information to start the project phases; from conceptual stage to final design stage. “The term “city” comprises not only a geographical area characterized by a dense accumulation of people or buildings in the context of pervasive urban sensing. More, it is a multi-layered construct containing multiple Dimensions of social, technological and physical interconnections.” (B. Resch, R. Britter, and C. Ratti -2011) In urban scale, data are no longer readable in images or maps, but in codes. In urban codes program in SeaneableCity lab in MIT, data are generated at an unprecedented rate. In 2010, Eric Schmidt, Google CEO, said that “the data amount that collected since the dawn of humanity until 2003 is equivalent to the amount we now produce every two days”. These huge quantities of data, produced as a result of the proliferation of digital technologies can illuminate how cities function, and can show the interaction between people and the environments in real time.

In sequences, all that amount of real time data can help to uncover some new parameters of the hidden complexities of the city. Urban change activities are assessed...
based on analytical models capable of simulating and reproducing the micro-climatic and physical behavior of urban areas. These models analyze the interactions between buildings, surfaces, plant cover, air and energy flows in urban sections subject to climate conditions, and the relation between the different objects and to the people living in those spaces. The design process is, therefore, based on various parameters and complex design factors. The process complexity is not due to the sum of the different factors, but to the understanding of logical relationships among them within generative modeling process and differentiation laws.

“Process is more important than outcome. When the outcome drives the process we will only ever go to where we’ve already been. If process drives outcome we may not know where we’re going, but we will know we want to be there.” (Bruce Mau, 1998)

Integrated Relation of parameters in design process leads to have a new phenomenon strategy of project design through parametric modeling environments in both architectural and urban scales. The environment of parametric design assigns new characteristics to project design process; it gives flexibility to analyze, modify, and change regards to information updates. It provides the ability to respect regulations, the easiness to control parameters, and to give feedback to different project sectors. As digital information based environment, all tools have good connectivity with each other in which sharing data, giving feedback, and transforming data in readable way among of them is available. These characteristics increase teamwork collaborations and optimize design process operations in all projects phases. Specially within the environmental design process, the mono parameter and mega-data parameters are continuously settled in relation with each other, they should interact, both in analog and digital way. Therefore, the project gets to the objective point where it is possible to manage any change or data updating during the entire design process so that the consistency of the whole is maintained. The project is rooted on a model able to evolve free form constraints, moving towards different directions and analyzing elements at different scales. There is a constant focus change from bottom to top and
vice-versa and from the detail to the general overview. Thus, the teaching methodology suggests the integration of the design process with those tools. The result of this summary is an overall and extensive understanding of the project framework.

Notes
1. See the interesting diagram in Chiara Palumbo’s article ‘Il patrimonio archeologico in Italia e la riconversione delle aree industriali dismesse: meccanismi di riuso e valorizzazione’ in: D. Musiano, G. Salini (edited by) L’attività di ricerca nel dottorato - Atti Codat 2009, Alinea, Firenze 2009, p. 257, where they highlight the extensiveness of this phenomenon in Europe and particularly in Germany, where it is much more dramatic than anywhere else.
2. These are the objectives of this law (REGIONAL LAW November 23, 2011, no. 22, Art.1)
   a) promote urban change quality, reducing the land take;
   b) create high quality public spaces;
   c) modernize infrastructure networks and improve energy efficiency;
   d) streamline complex urban transformation procedures aimed at upgrading large sections of the urban system;
   e) define integrated strategies to improve urban slums, also offering services and infrastructures;
   f) increase safety levels and reduce hydrogeological risks;
   g) decrease the effects of climate changes;
   h) contribute to the implementation of ecologic-environmental networks.

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Teaching Enhanced and Intelligent Materiality: Developing Innovation and Performance
Materials are more than matter – they are properties, they are small worlds with their own rules, connections, “relationships”, and “fields”. They are microcosms with features that are similar with their macroscopic ‘cousins’ but what dwells in them is energy and molecules are the ‘landscapes’. As in normal scale, according to the landscape, the energy can pass through, stay for a long time, leave something behind, or take something with it. They exhibit so many ‘behaviors’ that we, humans, can experience them as phenomena, such as thermal mass, light absorption, or shape change, but without ‘seeing’ how that phenomenon occurs.

Contemporary science has unraveled quite a lot from these microcosms, enough to understand the way they can affect energy and the mechanism to control or benefit from these processes. It is serendipity that this is happening as humanity strives to gain better control over the energy management issue, to regulate how energy is used efficiently and avoid many ominous predictions, all of them a direct result of wasteful energy management practices. In less than two centuries humanity managed to tilt the balance and threaten the equilibrium of the environment that sustain the ecosystem. This adversity can be dealt, in a certain degree by the development and the application of innovative and high-performance materials.

There lies the critical contribution of the education of future architects, being fundamental applicators of materiality in the built environment. These new developments draw interest from the practice of architecture but as a whole architects remain largely ignorant. Materiality is employed mostly with the visual outcome in mind. The multidisciplinarity emerging in the field of construction leads other scientists, who show more interest such as physicists, chemists, and environmental engineers, to converge to “humanity’s common goal” and affect the practice. Their work is not harmonically tied with architecture yet, but it is of the outmost importance to be. While there is a common goal for constructing ecofriendly buildings, as 40% of the energy expenditure goes to buildings, it is not addressed in a cooperative, synergic manner. In order this to happen, architects must be adequately educated to understand the possibilities and the underlying science as to be able to establish the required synergies.

As architects evolve, they must be educated regarding what materiality is beyond the looks, what materiality is in its ‘heart’. Controlling more aspects of materiality, architects can affect more comprehensively the ‘output’ of a building and its role in the environmental balance. This balance, and in general the trade-offs of what materials provide is the chassis of the described course. The educational program is based on classes and overall potential rather than specific material. In this way the focus is located on the general characteristics and the potential lying in them. The potential is revealed through applications, actual or projected, that use these characteristics as a distinctive advantage. There is basic classification to facilitate the best possible understanding, and an auxiliary one.

The basic classification is based on characteristics and especially on the way materials deal with energy, either as inherent ability or as a structure. The second classification is based on the effect occurred in the architectural impression, meaning the impact on the morphology of a building according to what scale level the application is perceivable. In general all materials are examined from the view they affect energy. Materials that regulate energy are by default the most efficient doing it with no outside cost and no maintenance. It is difficult to imagine a better solution to solve many
issues of efficiency. The ability to address issues by mere application and no maintenance provide a unique advantage. There are even materials that take heat and turn it back to power – going contrary to entropy. A well designed solution employing complementing materials/behaviors could even achieve processes similar to the negentropy. Such an outcome would provide an amazing benefit for producing zero-energy buildings, even turning a positive balance.

**Classification - according to energy management**

There are three ways in which the materials are being examined, according to their properties and behavior, in order to present the contemporary potential of their use in Environmental Design:

Class 1: Using materiality to transform energy to a form that can be used directly or store it for alternative uses:
- Thermoelectrics – they provide a unique advantage for addressing heating/cooling and as a byproduct gain even energy!
- Photovoltaics – the most common contemporary technique of using the sunlight for power.
- Piezoelectric – applied to exploit people movement and wind pressure.
- Photoluminiscent – use the sunlight to produce no-energy lighting.
- Dye Solar Cells – a novel way to use sunlight avoiding the rigidness of photovoltaic assemblies.

Class 2: Using materiality to affect the energy transmission and regulate its dissipation and radiation:
- Phase changing materials – heat regulating materials affecting significantly the thermal load building elements can handle.
- Thermochromic/Thermotropic – changing color or light transmission change the absorption levels of energy from solar radiation.
- Suspended particles – change the opacity of glass panes.
- Titanium Dioxide – capturing air pollutants and keeping a surface clean and reflective to sunlight.

Class 3: Using materiality to automatically change form/geometry/texture, applying responsive ad-hoc design techniques to affect the way the environmental conditions impact a building:
- Shape changing materials
  - Shape Memory Alloys – changing form through heat, thus reacting automatically to the temperature of an environment.
  - Shape memory Polymers – the same as above but with polymers that have a lower efficiency rate but they are significantly cheaper.
  - Thermo-Bimetals – an ingenious actuator to provide simple shape changes through thermal conditions.
- Wood – the differences of hydro absorption per wood type make it act as the thermo-bimetals but moisture acts as the regulator.
- Shape changing gels – absorbing moisture changes shape by exchanging matter
- Electroactive – change surface characteristics affecting light deflection, acoustics, and aerodynamic features.
- Volume changing materials
  - Mineral Ad-/Absorbents – they regulate moisture and ventilation.
  - Super Absorbent Polymers – the same as the mineral type but they present most promising future development

Through applications, experimentations and scientific projections this educational direction aims to establish a solid foundation and a creative instinct in exploring and exploiting the unlimited potential given by forward thinkers in the fields of material science, environmental engineering, and architecture.

Some other techniques that hold much promise for the future of efficient materials are meta-materials and bio-materials. Meta-materials can divert microwave radiation, turning something “invisible”, and so help surround an envelope to reduce radiation absorbed and thus greatly affecting the heating of any building. Heating radiation belongs to the microwave type, meaning that assemblies of small size can divert the radiation.

Organic or bio-materials that cover a building envelope can also act in this direction. Plant life uses the solar radiation for photosynthesis, becoming a natural solar barrier or filter. It also helps regulate the amount and velocity of the wind on a building’s surface facilitating the processes to maintain the temperature around the building stable.

**Classification - according to phenomenology**

While energy imprint was always a very important aspect in constructing and maintaining buildings, the visual outcome was always of the outmost importance for architecture. So it would be negligible to abstain by creating a classification regarding exactly that aspect. How materials affect the morphology of a design. From software perspective, sophisticated simulations of the materiality effect on buildings, even in real-time, are already available. This has a direct effect in educating the required generative processes apply materials to given conditions and enable easy, parametric, dynamic form-finding and form-behaving.

As architects ‘see’ things phenomenologically, meaning they perceive features in the macro scale, they have to understand better the mechanisms that affect these features and, more importantly, the fact that the mechanics of it are located on the smallest scale. The geometry and the attributes of a material’s surface and consistency are the key to how it looks and performs. The ways to intervene with precision to these characteristics are two, either through molecular manipulation or through organic processes. With molecular manipulation one can already create high performance materials, like carbon nanotubes or the much-promised graphene, as well as smart materials that can lead to lighter, stronger, responsive elements just through their molecular arrangement and its dynamics. The bioprocesses, on the other hand, are either performed through enzymes, like Nexia Biotechnologies’ BioSteel, or through biofabrication.
Bio-fabrication, being currently in its infancy, is a method where living organisms, such as bacteria and viruses are employed to produce a framework for macro-structural fabrication for architecture, as a pure bottom-up process. This research is the current epitome on parametricism, algorithmic processes and multi-disciplinarity. The work of Flynn, Lee, Peele and Belcher on viral fabrication employs viruses to produce ‘building blocks’, such as collagen, that can be assembled to construct larger elements. The technique can be employed, when fully developed in the future, to produce a variety of materials that will exhibit any designed effect and behavior. Furthermore, if necessary, it will have the ability to mutate to a different variant of the material. Finally, it will self-repair itself continually and even fine-tune its performance. The ‘tool’ for that is a genetically engineered retrovirus that can perform all the aforementioned tasks as a minuscule worker. This role is played by the acetobacter xylinus bacteria on the work of Araya, Zolotovsky and Gidekel. The A.Xylinus produces cellulose by consuming sugar, found in many industrial disposals. By controlling genetic characteristics and physiological parameters, the team, with the help of genetic engineers and biologists, achieved to control the creation of structural elements in different scales, even for architectural use. They finally conceived and created a crude “Biological 3d Printer” based on the organic nature of the ‘material’, which leads to distinct responses according to stimuli that either act as attractors or repulsors, allowing for different densities and forms.

Following there are the three main classes that the material application affect – macro, meso and micro scale. These three approaches present different ways in which materiality can contribute, according to scale, surface, volume and depth and their phenomenological value that plays a critical role in the way architecture communicates with people. There is also one class more, the nano scale, which is presented to suggest some possibilities of the distant future.

Fig. 1
The macro scale

At macro scale the effect involves material application techniques that have an impact on the whole building and its behavior affect on the overall morphology. This the prominent working scale for architects and usually their priority in designing, especially in public buildings. In contemporary design, the computational power facilitates diverse from-generative techniques that may include the behavior of materiality, in both looks and efficiency. There is also the ability to produce mass-customization, a feature that allows many different variations that suit better individual users or conditions while maintaining a sense of a whole. The key feature of this process is the analysis of the important attributes of the materials and the building components used in projects as well as their classification to wider groups that share similar characteristics. The requirement for most precise evaluation of the final outcome should come by procuring more extended datasets of these characteristics that advanced materials and fabrication techniques possess. In this way various aesthetics can be estimated upfront and then produced by specifically controlling the complexity of any design, as aesthetics originates in the variety of the assembled ‘discrete’ elements. By connecting together a large number of pieces with small visual complexity, one can create assemblies with increased phenomenological complexity, reducing somewhat the sense of ‘complex simplicity’. Energy management can work quite effectively when the regulating factors work as a team, while multiple elements reduce risks of general failure.

The materials categories that are the most effective at this scale are:

- Shape Changing Materials, which affect the geometry of various structural elements affecting the form and thus the way environmental factors come in contact with a building, and

Fig. 2
• Property Changing Materials, especially the ones that affect color and light. The visual effect of materials that regulates the amount of radiation, comes through their filtering and can produce radical changes in how buildings look as a whole.

The meso scale

The meso effect could be described as the personal view/space. It refers to a scale where a person can not perceive the whole but a part of it. Regarding materiality it affects building components or elements that maintain a certain individuality in relation to the overall form of a building. At this scale the environmental benefits are simultaneously aimed both at focused and ambient phenomena. In general the way of approaching this scale follows the same itinerary as with the macro, regarding overall design, simulation, evaluation and fabrication techniques. The main difference from the macro scale is the level of detail that can be attained, giving more care for the focused spatial performance. In this way customized environments can be achieved addressing specific type of activities.

The design and materiality in this scale can affect directly the quality of life. The potential presented from the ability to create precise environmental conditions and spatial adaptations allows a designer to meet exactly the user needs. The materials categories that are the most effecting in this scale are:

• Shape Changing Materials, which affect the geometry of various structural elements affecting the form and thus the way environmental factors come in contact with a building and how humans perceive and interact with specific elements, and
• Property Changing Materials of all types affect this scale. The effects regulate specific factors of how humans perceive and interact with specific elements. They are

Fig. 3
Glaister, Mehin and Rosen: Chronos Chromos Concrete (2008).
the most common application in creating “animated” environments. The smaller scale means that are employed on many detached objects that can be rearranged allowing further customization.

• The application of certain formal assemblies can also affect the way energy waves come in contact with the building. While this technique must be applied in macro scale, their structure is noticeable only from up-close affecting visually the meso scale.

The micro scale

The micro scale is considered today the usual field for the application of smart materials, especially the ones that regulate thermal load but they are not limited there. In this scale the material are incorporated in the elements and they are not visible. They act in three possible ways – regulate heat, transform energy, and increase efficiency (to reduce required materials). Applications include materials but also micromachines, such as MEMS (Micro-Electro-Mechanical Systems). There is a lot of research running mostly because it promises radical results and the application is easy as the materials are integrated in conventional building material. The advantages at this scale are practical as phenomenologically they affect partially the way a building is built, albeit hard to tell the difference. Practical matters though are affected significantly since the materials work on molecular level and they are seamless between the parts. This reduces the main drawbacks in maintenance and complexity, a problem that affects critically the cost of application.

Fig. 4
A spider mite on top of a MEM’s device surface.
The materials categories that are the most effective at this scale are:

- PCM (Phase Changing Materials) present the extraordinary ability of regulating the absorption and dissipation of heat through a calculated process of phase changing of the applied material, usually paraffin-based small spheres. This ability allows normal built walls to act as having a substantially bigger thermal mass.

- Piezoelectric material can transform mechanical energy to electricity, thus exploiting the normal everyday pressure, and other mechanical stresses, human activity applies on the environment. Especially in public buildings the benefit can be substantial for generating electricity and reduce the environmental impact.

- Thermoelectric materials are small assemblies that can regulate heat while producing electricity. When the one side of a thermoelectric panel is heated the other one gets cooled, while electric current is generated. The assembly can work in the opposite direction also by using electricity to create phenomena with greater impact. The inherent ability to act as a countermeasure to exterior temperature conditions make thermoelectrics a promising technology but it have to be produced in larger scale.

- Electroactive materials and systems can also transform mechanical stresses to electricity but they are used mostly as sensors or preventing systems technology. Their main application reduces the need of material for structural systems leading directly to resource and maintenance economy.

**The nano scale**

Evidently, this is the more intriguing and the most futuristic approach while, most likely, it will take a lot of time for it to be widely applied. Its basic characteristic is that the manipulation of matter is taking place in the material’s core, allowing not only for better programming but also for fabrication within the core of it all. The first steps are taking place in the form of creating molecular materials or through the engineering of living organisms to act as small assembly factories that produce matter bit by bit. The abilities extend in the creation of small bio-mechanical hybrids that can act as the smallest autonomous machines combining sensing, actuating and computing functions acting as tiny energy regulators. Furthermore, sophisticated construction at this level allows for structural perfection, leading to lighter and sturdier structures that use less material and have the ability of self-repair, eliminating maintenance requirements. It is evident that the potential of this direction leads to structures with significantly smaller environmental imprint.

**Conclusions**

The education of the role of materiality in architecture, as it is extended as a critical factor of regulating the energy management and affecting the size of a building’s environmental imprint seems mandatory in the present circumstances. The multifaceted role is difficult to be covered completely as it is heavily depended on other disciplines with a total different mindset of transmitting the knowledge. As a solution, two types of classification are introduced, one regarding properties and the other regarding the visual outcome, in order for young architects to create the ‘medium’ to transfer this type of data to their mindset.
In order for the understanding of the method to search, choose and apply in architectural context to be verified, the students have to present an application and explain how they achieved their goals, regarding both energy management and aesthetics, using certain materials. The materials chosen are presented through a blog (Comafat.blogspot.com), creating an ever expanding dataset that students can continue using in the future to remain updated for new materials and new possible ways of application.

**Notes**

Building Blocks for Social Sustainability: A Four-Day Design Workshop
This BBSS workshop is classified by the University of Nicosia curriculum as a catalyst workshop because it occurs for a limited amount of days, and it aims to hone in on particular and unique skills, not usually encountered in the curriculum. Catalyst workshops take place twice a year, in the middle of the Fall and Spring semester respectively. At this time, students take time away from their scheduled classes and concentrate on a four- or five-day thematic workshop of their choice. Catalyst workshops are pre-approved by the department and maybe offered by any member of permanent faculty, adjunct faculty or design professional. The benefit of this educational scheme is three-fold: students are encouraged to acquire non-conventional skills that will enrich their architectural pallets. Secondly, students are compelled to complete a project in significantly shorter timeframe and thirdly, students have the opportunity to come into contact with specialists and instructors outside the department’s faculty.

The participants were required to gather in groups of three or four, each group exploring a particular thematic topic. The final output required was two panels (A1 size) in portrait orientation, produced with any available media. The first panel should exhibit the group’s site analysis findings and the second the design proposal. The format of the final output had to be maintained to facilitate future publications.

**Philosophical Premise**

The initial impetus for this workshop was the desire on behalf of the team of instructors to explore the much-elusive concept of social sustainability and to synthesize the diverse findings resulting from the different perspective of the four instructors. The interests and research areas of the instructors vary from participatory design, urban sustainability, industrial adaptive reuse, solar architecture and gendered spaces. A distinct overlap in the team’s research areas is sustainability.

The amalgamation of the team’s interests and sincere observations of some general trends among the student body yielded the framework for the workshop. Subsequently, two axes were laid down to set the direction for the workshop’s targets:

- Address the concept of sustainability from a social perspective.
- Reposition the role of the architect.

Ultimately, the aim of the workshop is to encourage the creation of better places. In fact, one succinct definition of social sustainability is the craft of combining design of the physical realm with design of the social world for creating successful places that promote wellbeing by understanding what people need from the places they love and work.

**Sustainability from a Social Perspective**

It had been observed that architecture students who have completed the first year or two of study and are in the process of developing their own private architect’s psyche, are often intimidated by tales of sustainability. Misconceptions are frequently added to the pot, creating even less favourable positions. Perhaps the greatest misreading sustainability needs to defend itself from is its presumed direct correlation to the natural environment. Students operate under the impression that if ecological dysfunction is addressed and tackled, happy communities will ensue. It was the intention
of the instructing team to impart to participating students that sustainability is very much a social issue and is deeply connected to community consciousness.

The workshop aimed at providing an amenable introduction of sustainability in all its broad implications, and thus to demystify it by breaking down certain stereotypical connection such as linking sustainability to photovoltaics or recycled concrete.

Repositioning the Role of the Architect

Another observation shared among the instructing team - two members of which have graduated from their studies within the last five years - is the architecture student's preoccupation with the grandiose architectural product. The culture of the architect as the genius, the hero, the master builder, is easily contracted by young, impressionable minds. This condition quite frequently acts as an obstacle towards producing meaningful spaces that are sustainable in their longevity, their contribution towards social interaction and their synergy with the natural environment.

It must be noted that currently, many architecture schools have shifted towards cross- and multi-disciplinary teaching methods that encourage students to acquire a more global perspective that allows them to position themselves in a healthier stance with respect to global circumstances and to their peers. Nevertheless, defining the successful architect as the one who produces high profile, high-budget projects is still quite prominent among professional and academic strata.

The workshop aimed at introducing the notion of the architect as the facilitator or coordinator, rather than the all-knowing expert. The facilitator is keen to help community members express their own ideas and desire about their living spaces (both public and private), rather than educate them on the better ideas. The facilitator will then collect these ideas, and by utilizing his or her academic expertise, will produce a design, and ultimately a built project, that will satisfy the community’s needs for better living.

Two particular elements of the workshop allowed for the participants to practice the role of the facilitator: one was its brevity and the other was the fact that the participants were to work in groups, rather than on their own. The short time allowed for the workshop – four days in total – made it less conducive for long exercises in form finding, that sometimes lead the well-intentioned architect astray from the real issues and the complexities of the project program. Group work also lends itself toward the skills of facilitating and coordinating. Not only is there a better possibility of constant flow of creativity, there is the inherent condition where the team members need to be well coordinated and respectful of each other in order to for the team to reach optimum results.

Teaching Methodology

After initial introductions, the participants were informed to the workshop aims in a format and language that was simple and straightforward in order to make them comprehendible and easy to recall.

- We will learn how to take on an area of historical interest and multiethic profile and devise ways to make all inhabitants (temporary and long-term) gain a sense of spatial and physical inclusion.
- We will invent and/or choreograph structures, systems, actions and/or narratives whose purpose will be to energize city hotspots.
- We will aim to accentuate cultural differences and similarities while enhancing mutual respect between communities of cultural diversity.

**The Site**

It was decided early on in the preparation of the workshop brief, that the students would be provided with a site. The prerequisites for the site selection were that it be urbanistically diverse so that all participants would have the opportunity to explore a group's particular interests. Also, it was important that the chosen site offer the challenge of multiple layers of history and human ecosystems.

The area chosen is the inner city of Nicosia that lies within the Venetian walls. Following a military incursion from Turkey in 1974, the city has been divided in two parts approximately equal in area, with a United Nations administered buffer zone in the middle, running from east to west. It is a site rich in commercial and residential activity, with a large number of craft shops and small-scale industries such as carpentries, car-repair workshops etc. The area remains active for approximately twelve hours daily, on weekdays and on weekends. The residential units accommodate low to middle income and house mostly immigrant workers. Several buildings are listed and new construction is highly regulated. As a result of its multicultural and long history, the walled city of Nicosia, is well known for its romanticized atmosphere and attracts a large number of tourists on a regular basis.

**Workshop Process**

Part of the workshop’s success is owed to the fact that schedules were promptly kept on behalf of the participants and the instruction team. The total number of participating students was 27. The ratio of student to instructor was 1:7 and it proved quite conducive to a productive studio culture.

The workshop’s schedule ran as follows: the first half of the first day, students were required to follow two introductory lectures and watch Garry Hustwit’s film *Urbanised*. During the second half of the day participants were to settle into groups of three or four and visit the site. On the second day students presented their project concentration and design proposal and spent the day working on site analysis. On the third day, participants were expected to work on their design intervention and the fourth day was dedicated to panel preparation. At the end of the fourth day, all projects were presented to peers, faculty and guests.

**Day One**

The first half of the first day was spent addressing the theoretical premise of the workshop. At the University of Nicosia, issues of sustainable design are first introduced to the academic curriculum in the fourth year of architectural studies. Since most participants in the BBSS workshop were in their third year of studies, compressing a comprehensive introduction to sustainability and then branching off to matters of social sustainability was a significant challenge.
First Lecture: Introduction to Subject

The first of the two lectures aimed to explain the key concept of social sustainability, while at the same time, position it in the broader spectrum of sustainability. Firstly, definitions were set forth, and an attempt was made at distinguishing between the terms green, ecological and sustainable. It was then crucial to link these terms to issues of architecture, urbanism and regional design. Sustainability was then linked to the components of economy, community and environment, pointing out that sustainability needs to employ all three in equal measure.

Following this general introduction, the term social sustainability was discussed at some length. Participants were encouraged to consider examples from their own residential environment. Overall, matters of social isolation and spatial exclusion were discussed more enthusiastically than other topics.

Other issues discussed were:
- Sense of community identity and belonging
- Tolerance and respect
- Engagement with people from different cultures, background and beliefs
- Friendly, co-operative behaviour in neighbourhoods
- Opportunities for cultural, leisure, community, sport and other activities
- Low levels of crime and anti-social behaviour with visible, effective, community-friendly policing.

Each group was advised to choose one of four themes to tackle. Since social sustainability is such a wide-ranging issue, the four themes were introduced as a more tangible vehicle for participants to express their intentions. The topics, inspired from the publication Design for Social Sustainability, A Framework for Creating Thriving New Communities (Woodcraft et al, 2011), are purposefully wide and overlapping so that they do not limit or compartmentalise creativity.

I. Amenities and social infrastructure

This theme involved issues such as safety and well-lit open spaces. Jane Jacobs’ notion of “eyes on the street” was discussed at length. Participants discussed the potential of community assets such as shops, food production, gardens and buildings as well as good transportation systems and communication connections. In this theme the subject of maintenance in public spaces was explored.

Case studies presented for this theme included a project in a Brazilian favela where a group of architecture students designed a “public space canopy kit” that the community can assemble in less than four hours to create shaded spaces.

II. Social and cultural life

In the context of the second theme, community groups, neighborhood networks (e.g. babysitting circles, lift share schemes) and matters of local identity (e.g. street parties, distinctive architecture) were discussed. The case study presented was the “Walk [Your City]” project, where urban designer Matt Tomasulo instigated the posting of low-budget signs informing citizens walking distance between city landmarks (formal and informal ones).
III. Voice and influence

During the presentation of this theme, issues of creative community engagement and participatory decision-making were discussed. The case study shown, which addressed the issue of community engagement, was a project in Brighton, UK, where a simple scheme was employed by the community to monitor daily energy use. The average monthly electricity use of Tidy Street was documented graphically by a local artist on the middle of the asphalt, along the entire length of the street. Every week, the residents’ power consumption was recorded and documented on the asphalt graph. These made the residents actively aware of their consumption and prompted them to make changes in their lifestyle in order to effectively minimize their daily electricity consumption. At the end of the month, a considerable decrease in electricity consumption was achieved (and graphed on the asphalt). This project exemplified the positive impact a visible target can have in a community.

IV. Space to grow

The fourth theme was intended to stir ideas on flexible infrastructure and planning. In spite of the fact that the built environment seems ostensibly static, the community that inhabits it needs to maintain a dynamic potential to grow and adapt. An important parameter to consider is the interstitial spaces, described in class as ‘meanwhile spaces,’ exist between the formal public spaces and the decidedly private ones. These spaces, sometimes overlooked by the real estate market, present a unique opportunity for creativity because the rules and surveillance either do not apply to them or they are distinctly different to conventional public spaces. Another factor in allowing a community space to grow is a systematic approach to dispensing news and other information relevant to the on-goings of the community. Neighbourhood websites, a network of locations for community boards, frequent newsletters are three examples of such approaches.

The case study shown was related to the notion of meanwhile spaces. It is an annual project called PARK(ing) Day, which originated in California and has gradually become a global event. On the third Saturday of each September, citizens, artists and activists collaborate to temporarily transform metered parking places and offering them for public use. The intention of this project is to call attention to the need for more open spaces and to improve the quality of living spaces.

Second Lecture: Introduction to Site

The second lecture delivered by a member of the instructing team, presented a comprehensive introduction to the physical, infrastructural, cultural and historical characteristics of the walled city of Nicosia. The presentation was visually powerful as well as informative and it provided the participants, some of which from other cities and other countries, a rich visual library and a wealth of material to draw inspiration from. Images included land use maps, infrastructural patterns, mapping of temporal uses and events of cultural significance, demographics, open spaces and green spaces, etc. Some of the information imparted was also through interpretive sketching on urban design principles. Development of the area was shown through progressive mappings that covered a range of around one hundred years.
**Day Two**

The majority of the day was spent in discussion of relevant issues in small groups and on a one-to-one basis, which proved beneficial in allowing participants to internalise theoretical perspectives. Subsequently, participants were encouraged to personalise the concept of sustainability and invent their own definitions and design direction. Groups presented their site analysis findings to the instructing team and discussed reasons for choosing a particular theme. Group projects included topics such as issues of street safety and lighting design (Fig. 1), digital broadcasts (Fig. 2), mediating spatial isolation (Fig. 3), multi-ethnic food markets, environmental awareness and others.

In terms of production, groups were advised to spend the day on formatting their site analysis findings and arranging them in a legible and constructive manner. At the end of the day, each group was expected to print a draft copy of their first panel to be presented the following day.

**Day Three**

The day began by a pin-up presentation of all draft panels on site analysis. The instructing team and the participants offered constructive comments on the context of the site analysis, its applicability to the design proposal and on the legibility of the panel. The rest of the day was spent on designing interventions. Time was set aside to make necessary amendments to the site analysis panel.
Fig. 2

Fig. 3
Day Four

Participants continued working on their design proposal, concentrating on the layout of the second panel. Since the Catalyst Presentation was scheduled for 7pm in the evening, there was no room for extensions and participants were compelled to work with remarkable efficiency. Projects were to be concluded at 4pm, so as to allow two hours for printing and preparing for the Presentation event.

In order to facilitate the final output process, one of the instructors undertook the task of printing all panels. This was helpful in avoiding plotter congestion and malfunction, which is a frequent occurrence among architecture students. The same instructor was also responsible for preparing all panels in electronic order so that they may be projected during the Presentation event. Another instructor was in charge of preparing each group’s verbal presentation. Groups were required to choose a group speaker and each speaker was required to prepare a description of their project that consisted of only two sentences. This was not an easy task to complete. Another instructor took over organising the participants while they pinned up their final printed panels.

The Catalyst Presentation event commenced on time, and after a brief introduction by one of the instructors, the participants presented their projects eloquently and proficiently. All projects were well received and the workshop was concluded with a few hours of relaxed celebrations.

Lessons Learnt

Although the workshop outcome was regarded as a success both in the quality of the final product and in the dedication exhibited by the participants, several elements can afford to be revised and improved, should the opportunity to repeat the workshop present itself.

One element worth improving is the diversity of media used during the design investigation. Most participants used software means, few used sketching and hardly any used model-making or other media. A reason for this is a prominent misconception among the architecture students at the University of Nicosia that models need to be pristine in order to exhibit the finished product. Working models, although popular among some students, tend to be avoided by most when there is tight schedule to be observed. In future workshops time will be set aside at the start of the second day of the workshop for some conceptual model-making. Materials can be collected by the participants after their site visit on the first day and they will be required to create models in the span of maximum two hours. This will allow the project to be considered as a three-dimensional, tactile proposal that will inform and enrich the final product.

Another improvement is the encouragement of innovation in the strategies employed by the participants in their solutions. It was observed among the instructing team that the outcome of solutions was at times, more or less, formulaic. A consideration would be to introduce a stronger theoretical premise, with more emphasis on more involved methods of uncovering the spatial issues of the users.

Conclusion

The diversity of interests and administrative strengths among the instructing team proved to be valuable in the efficiency of the workshop and should be a serious
consideration when a workshop of similar parameters is being planned. Instructors played to their strengths in matters of strategizing, organizing, technical support. On a theoretical level, the participants benefitted from the contribution of a researcher in urban sustainability, human comfort, industrial heritage, solar architecture and development of interstitial spaces. The participants also benefitted from the local knowledge of the instructors of the walled city of Nicosia and experience with regulations regarding the built environment.

The greatest challenge of the workshop was for participants and instructors to negotiate the issues of a broad theoretical premise and tackle matters of scale in the span of four days. The selection of theoretical axes imparted to the participants as well as key associations proved to be crucial. One example of a decisive association is that sustainability is associated with social welfare as much as it is with environmental ethics. Another association is that a sustainable building has to be ‘green’ but a ‘green’ building is not necessarily sustainable.

At the conclusion of the workshop, the participants were infused with a significant dosage of ideas on sustainability, which they were able to apply through efficient time management and constrictive group work. In the participants’ following year of study, they will have to follow a semester-long course on history and theory of sustainable architecture, a course on sustainable building practices and the choice of a year-ling studio in sustainable design: this catalyst workshop aims to prepare ground.

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Environmental Design in the Courses of the School of Architecture at the Technical University of Crete
The School of Architectural Engineering at the Technical University of Crete (TUC) (www.arch.tuc.gr/department_en.html) is the youngest of the six Schools of Architectural Studies in Greece. This year (2013), it has completed nine (9) years of operation (it was established in 2004 in Chania, Crete) and, already, in the last academic year (2012-13) the number of students enrolled on its courses has reached a total of 580.

The School’s curriculum covers all the typical subjects provided by courses of architectural studies: architectural design, architectural technology, theory and history of architecture, urban design, art lessons etc (Papamanolis, 2011). These courses are staggered over a period of ten semesters and are taught by sixteen appointed professors of the School, plus a small number of professors from other schools at the University, who cover the needs of special courses (mathematics, statics, reinforced concrete, electromechanical installations, social sciences etc), as well as a small number of contract teachers employed to cover teaching needs that cannot be met by the existing teaching staff.

Environmental design holds an important place in the School’s curriculum. The subject is taught through a number of different courses with components that are directly related to the environmental and energy behaviour of buildings and the built environment in general. It is also taught through lectures and student projects in other courses of the curriculum, particularly in the area of architectural design. Issues concerning environmental design are also the focus of student research and thesis projects.

The paper presents the courses in the curriculum of the School of Architectural Engineering at the TUC that teach different aspects of environmental design.

**Environmental design in the curriculum of the School**

The main course dealing with environmental design in the curriculum of the School of Architectural Engineering at the TUC is that of “Bioclimatic Architecture” (www.eclass.tuc.gr/courses/ARCH172/). The course is mandatory and is taught in the 6th semester of the School’s undergraduate programme.

The aim of this course is to consolidate knowledge of the basic concepts of bioclimatic design and energy savings in the built environment. Students learn about the basic tools for energy control and how renewable energy sources can be integrated into the architectural design of buildings. Through the course, students acquire the skills that are necessary to evaluate building design from the point of view of energy efficiency and to alter designs in order to achieve maximum environmental benefits.

The course includes components on basic bioclimatic building’s geometries, passive and active solar systems, techniques of natural ventilation and passive cooling, shading, daylighting and environmentally friendly materials which are presented through lectures. Additional, special lectures present examples of successful applications of the principles of bioclimatic design in buildings. The course also includes a module on the ECOTECT building energy design software, presented through two workshops.

As part of the course, students are required, in groups of three, to complete two projects:

- The first project requires them to choose one from a specific list of fifteen different topics forming basic environmental design strategies and are distributed in three
main categories: passive systems, materials and active systems. Each group has to study and analyse its selected topic and then make a class presentation about halfway through the semester (Fig. 1).

Fig. 1
Studies involving shading from projectors as part of student work on the bioclimatic architecture course.

Fig. 2
Daylight analysis of the proposed design as part of student work on the bioclimatic architecture course.
The second project requires them to prepare and propose interventions that will improve, in terms of energy and environmental behaviour, an exhibition pavilion that they designed in the previous year of their studies, on the architectural design course. These interventions relate mainly to two topic areas from the proposed list, one of which must be the topic studied in the first part. Students are asked to environmentally compare their old and new proposed design of the exhibition pavilion using physical models and specialized computer applications (Fig. 2).

For these two projects supervision is provided in workshops throughout the semester. In these supervisory sessions teachers collaborate with the members of each group, discussing and jointly exploring different options and solutions for each project, providing clarification and solving queries.

The second course in the curriculum of the School of Architectural Engineering with a component directly related to environmental design is the course entitled “Building Physics and Principles of Environmental Design” (www.eclass.tuc.gr/courses/ARCH101/). It is an optional course in the 7th semester of the undergraduate programme. It discusses issues relating to the integration of buildings into the environment (natural and anthropogenic). It examines the interactions between buildings and their environmental parameters (solar radiation, temperature, wind, humidity, noise, pollution etc.) and elaborates proposals for the optimisation of their environmental and energy behaviour. The course is based on lectures on theoretical topics relating to building physics and environmental design, and also on presentations of individual buildings where, in the context of their architectural designs, relevant parameters have been taken into account. The course contents include: an introductory section; energy and building; thermal protection; sun control; lighting; moisture protection; architectural acoustics; ventilation; wind protection and indoor air quality. As part of their course, students are required to complete a project in which they select a design project from a previous semester and suggest ways in which the design can be improved in terms of environmental and energy behaviour. For this project supervision is provided in the workshops throughout the semester.

Parameters relating to the favourable integration of buildings into their environments (natural and anthropogenic) feature, of course, in all the School’s architectural design courses, even in courses like district and urban planning, landscape planning etc. An example of this is the construction course in the second year of studies and, more specifically, in the 4th semester (www.eclass.tuc.gr/courses/ARCH100/), where, in the lessons on insulation, extensive reference is made to the interactions between buildings and their environments and the role of the insulation of the shell in improving the energy and environmental behaviour of buildings. Environmental design has so far been the subject of several undergraduate research projects and theses. Examples of research topics include solar systems, lighting, sun protection, passive systems and passive cooling. One research project worth mentioning is a recent project that studied the problem of excessive indoor heating in a primary school building in the city of Rethymno and resulted in the formulation of specific proposals to deal with it (Fig. 3) (Spiridaki, 2013). A diploma thesis on the subject of sun protection in a building on the campus of the TUC is currently in preparation, while the choice of building materials with environmental criteria has played an important role in several other projects and theses.
Some findings from the teaching of courses relating to environmental design

Experience to date has shown that environmental design has had a significant impact on students of architectural engineering at the TUC. Students perceive and understand the importance of environmental design in the courses they study, as well as the important role it will play in their future work as professional architectural engineers.

Among the courses that include environmental design as a major component, there seems to be a special preference for the bioclimatic architecture course, in which both student participation and interest is high. A likely reason for this preference is the fact that in recent years wide publicity has been given to energy studies and the energy inspections that are now mandatory in all buildings in Greece and already represent an important part of the professional work of Greek engineers (Papamanolis and Mandalaki, 2011). Interest in the Building Physics and Principles of Environmental Design course appears to be weaker. This is perhaps due to the fact that the course has a high theoretical content, which students of architecture do not generally like. Nevertheless, despite the fact that the course is optional, it is chosen by almost all the students in the school.

As regards the environmental components in other courses of the undergraduate programme, student response to them appears to be quite satisfactory. Student research projects and theses on subjects directly related to environmental design have also produced positive impressions (and grades).
One of the problems that the School faces in implementing its curriculum is the shortage of staff (teaching, administrative and technical). For example, the bioclimatic architecture course is run by two lecturers teaching classes of approx. 100 students, while the building physics course is run by one lecturer teaching classes of approx. 70 students every year. Another problem is that of the order in which the courses are offered: to be specific, the bioclimatic architecture course is taught first and then the building physics course. This sequence is not very successful since the Building Physics and Principles of Environmental Design course contains material which serves as an introduction to the subject of environmental design (as the name of the course suggests). The right thing would be for this course to precede the bioclimatic architecture course in the curriculum.

Conclusions

In terms of the provision of relevant knowledge and skills, the subject of environmental design is covered quite satisfactorily by the courses offered at the School of Architectural Engineering at the TUC. The two courses in the School’s curriculum which are directly related to the subject – Bioclimatic Architecture and Building Physics and Principles of Environmental Design –, together with the components of other courses dealing with the energy and environmental behaviour of the built environment, appear to provide a sufficient grounding in the subject – at least at undergraduate level – for students’ future professional needs.

The teaching of environmental design in the School’s curriculum could be improved by bringing in a number of experienced tutors to assist the lecturers already teaching relevant courses. There is a need of relating the two courses directly with the Architectural design studios and generally connecting the design studios with environmental principles. In addition, it would be a logical move to reverse the order in which the two main courses relating to environmental design are taught, i.e. the Building Physics and Principles of Environmental Design course should be taught first and then the course in Bioclimatic Architecture. Significant improvement would also bring change in the course of building physics from optional to mandatory.

References


Environmentally Sensitive Architectural Projects: High Quality, Low Cost, Energy Efficient Social Housing in Different Italian Climate Zones
The educational structure of the Design Studio in Architectural Construction - characterised by the centrality of the class in “Technological Design Studio” and the parallel teaching of “Environmental Control Systems” - provides students with the theoretical, methodological and operative tools required to design architectural space in its spatial-formal, technological-constructive and energy-environmental dimensions.

Second year students are encouraged to consider in their projects the relationships between architecture and construction, technological solutions and aesthetic results, structural elements and energy-environmental control systems, building materials and environmental comfort, high energy performance and low-cost, innovation and resources saving, inhabitants needs and carbon footprint in a complex educational process whose final objective is an environmentally sensitive architectural project.

In a contemporary world characterized by economic crisis, growing consumption of non-renewable resources and lack of housing for low-income people, the challenge of the Design Studio in Architectural Construction in the academic year 2012-2013 was to design “high quality, low cost, energy efficient social housing in different Italian climate zones”. Whereas “high quality” means not only spatial quality, but also energy efficiency and climate sensitivity.

From an educational point of view, this theme is particularly efficient because, in addition to imposing the students an architectural problem, it encourages them to tackle social, environmental and economic issues.

In order to facilitate the relationship and the interchange of knowledge between teachers and students in the design process, second year students are divided into three parallel classes of Design Studio in Architectural Construction that have worked out the same program and the same design exercise. Each of these classes was accompanied by two teachers (one of Technological Design Studio and one Environmental Control Systems) one young tutor and attended by approximately 60 students.

**Educational objectives**

Environmental educational objectives of the Design Studio in Architectural Construction can be summarized in the following top-ten.

1) *Ethical approach* to the project. From the “how to do” to “why to do”.
2) *Sustainable approach*, including social and economic sustainability.
3) *Awareness in planning*. Each project determines modifications of the environment. Designers (in this case architecture students, who will be the designers of the future) should foresee these modifications and be able to “control” their consequences.
4) Analysis of the socio-cultural, technological-constructive and climatic-environmental specific conditions as basis of an “appropriate environmental project”. The same architectural project is not necessarily sustainable in different contexts and climate zones.
5) Design project as recursive design process characterized by a systemic approach.
6) *Quality* (in its larger concept) as “results” of the architectural project.
7) **Reduction of energy demand in all the phases** - designing, building, managing and demolition – as a result of appropriate design choices, applied technologies, used materials and also inhabitants’ life style.

8) **Passive systems of energy saving and supply combined to active systems.** Passive and active systems have to be formally and functionally integrated with the architectural project.

9) **Attention to the inhabitants’ needs** to improve their live quality also when needs are changing during the use of the buildings.

10) **“Off the shelf”, low cost designing.** Use of dry assembly, removability and maintainability of parts and components, with consequent economical and environmental resource savings.

**Teaching methodology**

The design experience that students gain in the design studio is a holistic non-linear recursive design process in which all the design choices during the various design phases and at the different scales are finalized to develop a high environmental quality design project and to “master” (or at least to consider) the complexity of relations, the multiplicity of techniques, know-how and skills and the consequences for the environment, that converge within the process of designing, manufacturing and building contemporary architecture.

To achieve this goal a methodology, characterized by a systemic approach, has been developed. This teaching/designing methodology works at three different designing scales: district, building and constructive, with three different designing levels: spatial-formal, technological-constructive and energy-environmental. Students are encouraged to design at the three different scales, taking into account (for each of these scales) the issues related to the three mentioned levels and the interactions between different designing levels and designing scales.

Therefore in the 15 design studio weeks students are supported by theoretical lessons, seminars, presentation of case studies as best practice examples, contact with public administration and building component manufacturing companies as well as project reviews. All these activities are intended to involve students in a comprehensive planning process that simulates the entire creative, design and constructive process in which the building organism is “broken down” into its parts and it is “reassembled” in the design project.

Objective of this process is to achieve a manifold quality: spatial quality, formal quality, technological quality, constructive quality, environmental quality, indoor and outdoor comfort quality; in quick the life quality of the inhabitants. Quality not as a sum of many partial-qualities, but as the result of a comprehensive approach towards the environmental design project.

**Designing social housing: different user needs that change over time**

Social housing can be defined as “housing for households whose needs are not met by the open market and where there are rules for allocating housing to benefiting households” (definition of social housing, Cecodhas, 2006). In particular an official definition
of social housing in Italy is “dwellings rented on a permanent basis; also to be considered as social housing are dwellings built or rehabilitated through public and private contribution or the use of public funding, rented for at least eight years and also sold at affordable prices, with the goal of achieving a social mix”.

With the intention to obtain the above mentioned social mix and to improve the social life of the disadvantaged families that will live in this social housing, each students’ design proposal must include:

• at least three different types of housing units, characterized by different sizes (from 28 to 100 square meters) and different users (for example: singles, young couples, single parents, families, couples with 1 to 4 children, older people with limited mobility, families with disabilities, out of town students, temporary foreign workers with distant families, newly arrived immigrants, home-workers etc.);

• indoor common spaces (for example: meeting room, laundry room, bicycle storage room, children’s playroom, gym, etc.);

• indoor common and meeting spaces (for example: squares, covered squares, pedestrian and cycle paths, children’s playground, etc.).

Another feature of social housing is that the dwellings are not property dwellings, but they are rented to low income families. So it is possible that not only the inhabitants’ needs change over the time, but also that the inhabitants change every couple of years and that therefore the space requirements will be totally different. Accordingly the dwellings - designed by students in the Design Studio in Architectural Construction - have to be able to be easily and cheaply modified, repeatedly over time. To achieve this goal it is necessary to use appropriate technologies and devices and to plan in advance many possible configurations of the dwellings.

Fig. 1
Plan of the “virtual site” located in three Italian cities: Milan, Rome and Catania.
Designing with the climate: three different climate zones

Another important issue, addressed in this design studio is the relationship of design projects with the context in which this will be engaged. Indeed does an architecture in order to be truly environmentally compatible need to interact not only with the urban and social context, but also with the climate and environmental context.

The site for the design exercise was a “virtual site” (characterized by buildings and green spaces) located in three Italian cities: Milan, Rome and Catania (Figure 1).

Designing in three different cities - characterized by different climate conditions – helps students to understand that the same architectural project is not necessarily sustainable in different contexts. So students were divided into three big groups (one for each location). Each one started the design work with the climate analyzes of its location. From the second week of classes, these large groups were further divided into small working groups (two students, in rare cases three), to develop a design proposal.

The idea of using the same site and locate it in different climatic zones, has the didactic purpose to make projects in different climate zones easily comparable (Figure 2). Indeed in this way it is possible to see how the same site (with the same orienta-

Fig. 2
Three different projects in the three different cities. Models – scale 1:500. Students: Alessia Celani and Chiara Corradetti (Milan), Christian Falistocco and Davide Fusca (Rome), Lorenzo Marani and Arianna Marinelli (Catania), professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
tion, the same pre-existing buildings, the same streets, the same green areas, etc.) and only changing the climatic characteristics, very different projects are obtained.

For example projects located in Milan are characterized by compact buildings that seek to reduce heat loss and protect the indoor and the outdoor spaces from the cold winds, particularly in the winter time. For buildings located in Rome, students have developed both summer and winter strategies. In contrast, in projects located in Catania students have focused their work on preventing overheating in the summer months using appropriate natural ventilation, solar shading elements and water cooling systems.

**Presentation modality of the design proposal**

At the end of the semester student groups are invited to give a public oral presentation of their projects supported by appropriate drawings and models at different scales.

Drawings are organized in 5 separate tables corresponding to 5 “strategies”: **concept, urban, building, living and constructive** (Figures 3 to 8). For each strategy the drawing highlights the contributions of the two parts that characterize the Design Studio in Architectural Construction: Technological Design Studio and Environmental Control Systems.

- **Table 1 - Concept strategy.** In this drawing the vision of the project is presented, highlighting the main design choices from a spatial-functional, energy-environmental and technological-constructive point of view and indicating the main objectives in relation to the quality of life of the inhabitants and to the “climate sensitivity” of the architectural project. With this first drawing students try to “sell” their design proposal and identify the types of users who will live in their social housing.

- **Table 2 - Urban strategy.** This drawing incorporates climate analysis of the site (temperatures, humidity, prevalent winds etc.), two master plans (scale 1:500) of the ground level and of the roof level, where the position on the site is shown (the orientation and the shape of the buildings are motivated by a careful urban and climate analysis), at least two sections of the site (skylines) and three-dimensional studies of the shadows on the site on different days of the year. This last study aims to show how the building or the building complex have been positioned to maximize (or minimize) the solar exposure of the façades and of the outdoor spaces according to the climate zone. Also the design of the common outdoor spaces (relationship with the existing buildings, streets and parks, walking and cycling routes, green areas, children’s areas, bicycle storage, parking etc.) are an important part of the design project at the urban scale.

- **Table 3 - Building strategy.** This strategy is presented with plants, elevations and sections (scale 1:200) of the building or buildings, diagrams which show the relationship between “service spaces” (stairs, elements of horizontal distribution like gallery or corridors) and “served spaces” (residential units and indoor common spaces) at the building scale. The plants of the buildings show also the different typologies of residential units. This table contains also climatic/energy sections of the housing complex, including the identification of the active and passive environmental control devices under various environmental conditions (summer/
winter, night/day). This drawings are based on the results of using a quick energy modelling software or energy simulations, with the help of which the students selected and dimensioned the used equipment.

• **Table 4 - Living strategy.** In this drawing two or three types of dwellings are presented with plans with furniture, sections and elevations in scale 1:50. Diagrams show the relationship between “service spaces” (kitchen, bathroom, closet etc.) and “served spaces” (living room, bedroom etc.) at the scale of the dwelling. Furthermore, this table highlights the flexibility of the apartments and the possibility to modify and to use these in the future in a different way or by different users. The size of the rooms are in accordance with Italian legislation for social housing. They are therefore quite small.

• **Table 5 - Constructive strategy part 1.** This drawing includes one or more details elevation and vertical and horizontal sections, (scale 1:20 with details scale 1:10), that aim at defining the function and “value of the position” of each technical element and developing the critical connections between building components. An important part of this design is the legend that lists all materials, the layers, the thickness and the related manufacturing companies. Each element (like external walls, roof etc.) has also to be checked with respect to its energy performance (thermal transmittance U, superficial mass Ms, thermal time shift φ, decrement factor Fa and periodic thermal transmittance Ymn).

• **Table 5 - Constructive strategy part 2.** In this table technological and constructive aspects of the design proposal are presented with an exploded axonometric of the architectural organism, which permits the clear identification of the building system, “exploded” into its component parts (structure, external envelope, roof, internal partitions, etc.). Students have to use in each design real products, systems and components, that that can actually be purchased on normal market.

Each group of students is also invited to present their project proposal with the support of two models.

The first one, in scale 1: 500, includes not only the considered site, but also the adjacent lots and is a “three dimensional view” of the Table 2 - Urban strategy. Indeed this model shows the design choices at the urban scale: the spatial organization of the site, the shape of the building complex, the outdoor spaces, pedestrian and cycle paths, access to the lot and the relationship with the existing buildings, roads and parks.

The second one is a model of a structural bay (scale 1:50) in which it is possible to distinguish the constructive system from the “cover elements” (exterior walls, roof, etc.) that generally are movable and in which it is possible to see the layering of the building elements (Figure 9).

**Results of the design exercise: innovation of the students’ work**

As in any Design Studio, the results of the students’ work have been very different from each other and characterized by heterogeneous levels of quality.

However, it is possible to summarize that the most part of students’ design proposals focus on the search for innovative solutions and experimentation, in terms of quality of the spaces, used technology and environmental approach.
Fig. 3
Example of concept strategy, urban strategy and building strategy. Students: Christian Falistocco and Davide Fusca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
Fig. 4
Example of *living strategy, constructive strategy and model*. Students: Christian Falistocco and Davide Fusca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
Fig. 5
Example of concept strategy, urban strategy and building strategy. Students: Alessandra Di Cerbo, Maria Francesca Iuresca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
Fig. 6
Example of living strategy, constructive strategy and model. Students: Alessandra Di Cerbo, Maria Francesca Iuresca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
Fig. 7

Example of concept strategy, urban strategy and building strategy. Students: Flavio Nughes, Francesco Paolo Russo and Andrea Ulisse, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
Fig. 8
Example of *living strategy, constructive strategy and model*. Students: Flavio Nughes, Francesco Paolo Russo and Andrea Ulisse, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.
The main innovations of the students’ work, regarding low cost – high quality housing are:

a) Conception of innovative environmental projects in which the reduction of energy consumption and the maximization of the indoor and outdoor thermal comfort are obtained not only with the application of passive, active and hybrid environmental control systems, reactive building envelopes, natural ventilation and day lighting systems, solar shading devices, Trombe walls, green houses etc.; but also with appropriate design choices like building orientation, location of the different functions in the building and with parameters not directly connected with the architectural project, that again can be influenced by the architectural project like inhabitants’ life style or use of public transport.

b) Development of flexible housing systems adaptable to modifications of exigencies. Indeed most of the working groups have not conceived the project as a finished solution, but as an ongoing project that changes and transforms over time. This innovative space conception, while safeguarding qualities of privacy, proposes new forms of spatial organisation in relation to the requests made by a progressively
less conventional and more fragmented group of users (that do not necessarily be-
long to the same family), application of systems characterised by the transforma-
bility and adaptability of spaces according to the modification of needs by existing
residents or needs of new users.
c) Use of prefabricated building systems, lightweight components and technologies
and “off the shelf” materials and products (not really commonly used in Italy), pref-
erably assembled using “dry” connection techniques. Development of simple mod-
ular structures comprised of small sized elements; technical-functional devices fo-
cused on the optimisation and rationalisation of spatial-functional performance.

Conclusion

The very demanding design experience proposed in the Design Studio in Architec-
tural Construction 2012-2013 at SAD-UNICAM was much appreciated by the second

Fig. 10
Students and models on the day of the presentation of the design proposals.
year students that - in the 15 weeks of the course - participated actively in the many proposed activities and worked hard and passionately on their design proposal.

The design theme “high quality, low cost, energy efficient social housing in different Italian climate zones” has been an interesting opportunity for the personal development of the students, whose work has achieved more than satisfactory results.

Actually the biggest result was not the project itself, but how students approached a new design methodology and a responsible and environmental approach towards the architectural project and the fact that - for the first time in their short college career - they have set themselves questions concerning the social, economic, ethical and environmental issues of architecture.

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Environmental Aspect in Architectural Education in XX and XXI Century - Change of Perspective
Faculty of Architecture was established in 1915 as a department of the newly created Warsaw University of Technology (WUT). Members of the Organisational Committee - the creators of the curriculum - derived from various European schools, polytechnics and academies of fine arts. They had different scientific experiences and aesthetic inspirations.

The school was founded as a synthesis of heterogeneous aesthetic and educational principles. Objectives of the curriculum accepted at the beginning, still remain the basis for defining the directions of the teaching methods evolution. Modifications to the learning system referred to the development of architectural thought in Europe and the world. They were related to the influence of individuals functioning within the school and were not free from ideological leverage.

Basic education foundations formulated in 1915 created a framework for the establishment of interdisciplinary studies, combining artistic and technical elements:

"Today, we are striving to create a new institution, which will unite our potential and continue to develop it (...) The curriculum, which we outline here, aims to educate architects of the highest and widest range - a broad artistic culture and serious expertise, are our guiding threads, through the overall studies program and individual subjects performed."³

At the beginning of the twentieth century, in the heart of Europe we can observe the development of philosophical thought and new artistic trends which had their source in the rapid transformation in many areas of life. The massive usage of new construction materials: iron and concrete, as well as the increasing demand for architecture strictly subordinated to function (industrial, technological, typified buildings) were changing approach to the construction creativity. New possibilities appeared - to erect buildings of previously unattainable height and to create free floor plans - resulting from the structural capability to overlap the bigger spans.

The nature of European architecture around the year 1915 was still characterised by the affection to historicism, particularly with regard to the average production. The representatives of a younger generation of progressive architects departed from traditional thinking about form tending to a rational architecture, using new materials and technologies, architecture which met the expectations of the age of technology.

A key role in the new school curriculum played the design courses. In the first period architectural design classes were conducted by representatives of chairs responsible for rural design, city buildings and monumental design. Profiles of teaching units were often determined by professional interests of leading professors. ¹⁰

Environmental issues appeared in design tasks at the beginning mainly in relation to the character of location, the rational resolution of function and optimisation of material solutions. Primarily, they were related to rural projects, designs for buildings situated in the green areas, as well as residential complexes. A new approach to the problem of housing design was based on a rational thought directed to improving the standards of living and the functional logic of the interior composition.

Interest in developing new housing solutions was related, inter alia, to the growing, unmet needs of residents of the cities.
In 1929, the status and availability of average standard apartments was defined as the housing disaster:

“City building in the post-war period, somewhat satisfied the needs of upper class, while living conditions of hand-workers and less salaried white-collars are steadily declining: a very small increase of flats available for these classes is not able to fulfil requirements generated by both population growth and housing losses resulted from destruction of old buildings.”

In 1929, an initiative was established to launch reserves of Social Insurance Institution (SII) with the aim to organise the campaign of the construction of small flats housing.

SII action was implemented in years 1930-1934 [9]. At the beginning of 1930, SII Design Office was established in Warsaw. The office was responsible for: the preparation of types of flats for all types of location, land use sketches, designs, cost estimates and final drawings.

Professor Rudolf Świerczyński was assigned to organise the architectural office. At this time he was associated with the Chair of Rural Design at Faculty of Architecture WUT, where he taught students and shared with them the penchant for ascetic approach to design.

In the same period (1927) Military Cantonment Fund (MCF) was launched. Its purpose was to provide an adequate number of apartments for married officers and NCOs through the construction of residential buildings and their administration.

MCF has developed several projects, repeated there, where local conditions allowed. The Fund also announced - in 1928 - public architectural competition for the sketchy design of typical houses for officers and NCOs. Under the terms of the competition, organisers required standardised types of dwelling units and building elements as well as economical material solutions ready to rational implementation. Competitions were announced also for specific locations (Lviv, Kraków, Bielsko). The high level of works enabled to develop new types of flats, successfully used in residential building.

Projects for MCF were performed by the best architects of that time - such as Professor Czesław Przybylski - Head of the Chair of the Monumental Architecture at the Faculty of Architecture WUT. His teaching activity was entirely consistent with the creative thought. He introduced innovative methods to teaching design, he was enthusiastic about the new trends and architectural solutions so he encouraged students to creative pursuits.

Institutional activities, such as IIS and MCF building campaigns has brought many solutions rationalising the function and architecture of residential buildings.

MCF has set specific standards for the designed buildings and dwellings, such as for the NCOs:

- functional structure comprising: two rooms with a kitchen, an alcove and additional rooms, with a total area (on average) 55 m²;
- apartments located in four-storey blocks, heated by stoves;
- each apartment with the associated basement and a separate attic for drying laundry;
- flats arranged in a way ensuring easy supervision by the hostess and with minimum distance runs;
- daily life concentrated in the largest room - forming a kind of habitable kitchen with niches: for the kitchen stove and bath;
- parents bedroom connected to the living room by the three-wings glazed doors;
- regular alcove bedroom - detached from the kitchen and separated as an isolated small room with an area of about 7 m²;
- installations - one vertical sewage drain and one for the water supply for two dwellings;
- garbage shoot for each apartment;
- manual elevator for coal - located by the staircase;

The Building and Housing Association of IIS was also using guidelines for standards and types of housing. Since the aim of the Association was the mass delivery of housing, the question of types of housing and the related standardisation elements of their construction was one of the key issues.

Establishment by the Association coincided with the moment of publication the outcomes of the International Congress on Architectural (CIRPAC: Comité international pour la résolution des problèmes de l’architecture contemporaine (International Committee for the Resolution of Problems in Contemporary Architecture) - elected executive body of CIAM: Congrès internationaux d’architecture moderne, International Congresses of Modern Architecture) in Frankfurt am Main. The main object of interest of the Congress was exactly a small apartment. Results of Congresses work was publicised in the form of exhibition of typical housing plans: “the smallest apartment”. Exhibition included designs coming from almost all European countries and it reached Poland at the beginning of 1930.

All the materials presented at the exhibition can be seen as an image summarising certain period of the housing history in Europe and the quintessence of views on a rational solution to living space.

In this context, the Association decided to avoid all purely experimental attempts, shifting the focus to the use of actual solutions and adapt them to local conditions.

Types of housing established and implemented by the Association did not differ substantially from the standard solutions.

The starting point for the development of housing types was a matter of the size of usable space and maintenance costs for the smallest apartment. As a smallest unit of housing was considered a chamber with an area of 24 m². The highest standard acquired a three-room apartment with an area of 85 m².

In establishing the types of apartments essential were the following assumptions, for each flat:

1) it was used by a single family, or a single person;
2) it was separated by a closed space (hall) from the general transportation areas (stairs, galleries, general hallway);
3) it had a separate kitchen stove, sink and lavatory inside the apartment;
4) it had a separated storeroom.

Thus, each apartment constituted a separate unit for habitation and household management. Only the laundry was moved outside the apartment and centralised in general laundries.
Separation of special room for washing and bathing was dependent on the size of the apartment.

Rationalism in thinking about habitation and architecture in general was reflected also in the works of one of the greatest Polish architects of that era - Juliusz Żórawski.  

In 1919 he began studies at the Faculty of Architecture in Warsaw, from which he graduated in 1927 and immediately became an assistant in the Department of Monumental Design under Professor Czesław Przybylski, then - to 1928 - at the Department of Rural Design under Professor Karol Jankowski.

Żórawski successfully implemented Le Corbusier's five principles of modern architecture. In his buildings we can see a fascination with the aesthetics related closely to the technology and function. He used a modern materials combinations and progressive structures to optimise the construction and facilitate the exploitation.

As an example we can present a residential building at Puławska 28 Street, built in the semi-frame construction of a special type used for the first time in Poland.

Żórawski had a rich output of theoretical works, still actual, which may be used in teaching architecture. In his deliberations, he drew attention to the role and nature of the architectural activity, perception of space and the role of architecture in its formation. The term "landscape" he defined as: "visually perceptible whole of an area with its nature and all the works of human hands". He claimed that “the architectural continuation must be consistent with the manifestations of life forms” and a landscape is made up of a combination of form-parts belonging to both the nature and the architecture. This attitude was reflected both in theoretical thought and in Żórawski’s works - through creative integration the architecture with the context.

In the urban scale thinking about the environment was implemented, inter alia, in the form of the garden cities idea. Among the Polish examples inspired by this concept, in whole or in parts are: suburban towns Konstancin Jeziorna, Podkowa Leśna, Milanówek, Komorów, Ząbki and parts of the districts of Warsaw: Sadyba, fragments of old Żoliborz, outside Warsaw: Karłowice in Wrocław, Giszowiec in Katowice.

At the initiative of Władysław Dobrzyński, president of the Warsaw Society of Hygiene, the first exhibition of Garden Cities was organised in Warsaw in 1910. Krakow held another exhibition: “Architecture and Interior Design in the Garden Neighbourhood”, which has hosted Ebenezer Howard.

Tadeusz Tołwiński - one of the founders and Professor of Faculty of Architecture in Warsaw WUT - won in 1911 the competition for parcelling property of Count Ronikier in Ząbki near Warsaw, where he designed a housing estate implementing all the features of the Howard’s Garden City. Tołwiński strove to create “model Polish settlement” with unique functional and aesthetic values. Exemplary was the architecture of the buildings, transportation system, municipal greenery. The new estate gained the character of the green city. The project embraced system of public places and the proposal for optimal structure of streets and parcels. Ząbki had good transportation connections with the city of Warsaw. The additional advantage was the proximity of a large forest complex. Parcelling of land and construction of houses was stopped by the outbreak of World War I and finally desisted after World War II. The preserved fragments of the original urban structure are still an excellent example of the Garden City idea implementation.
In 1925, to realize the slogan “live in the countryside - work in the city” the concept of a modern suburban settlement was created. Podkowa Leśna areas were found to comply with all the requirements of the garden city idea, both in terms of health and environment. The project was developed by the Warsaw architect Antoni Jawornicki, an assistant and lecturer at the Faculty of Architecture. In the plan proposal, he used the terrain topography, roads and waterways. He integrated existing land-forms with the new planning concept. The forests he adapted as a park and green belts. He surrounded streams with parks using the existing walking paths. New streets followed the lines of existing roads. In the centre of the village streets are arranged in a horseshoe shape. They intersected radially extending from the midpoint of avenues. In the south-western part of the city streets were concentrated around the two squares forming the geometric arrangement. Unique wide tree-lined avenues were situated in the central part of the plan.

An interesting example of modern urban planning thought, integrating issues of rational management in the environment is the concept of Functional Warsaw, presented by Jan Chmielewski and Szymon Syrkus in 1934.

The authors began from analysing the location of Warsaw in Europe - at the crossroads of the Baltic - Black Sea routes and the transcontinental track. Through the study of physiographic conditions of the city and surrounding areas, research of the settlement network, they designated major functional areas for urban development. The authors stated: “Enlisting them into the orbit of influence of Maximal Warsaw, we give the centres the logical development and we justify their raison d’être by the allocation of functions, which, under a comprehensive analysis of the situation, needs and perspectives, will be designated by the planned economy.”

In this way, for the first time on such a scale, the program of spatial organisation of the “urbanised region” was formulated.

The concept of Functional Warsaw showed the internal layout of the city, districts of different functions with the separation of green and recreational areas as well as the entire region divided into industrial zones, agriculture and forestry.

At the level of curriculum, the awareness of the environmental context was implemented, inter alia, by involving issues of “health” in rural and urban design classes. For example, in the program of studies for the academic year 1921-1922 [7], the subject of city building design included: “general principles of health, economic, social, aesthetic bases for houses design”. In urban design problems (subject: town building) modern city appeared as an organism, including “transportation technology, health, social issues and housing, needs of commerce and industry”. An important element of the curriculum was designing gardens - taught as a theoretical introduction to the subsequent design classes.

The environment problems became increasingly important when the subject: landscape architecture appeared in the program. In the academic year 1933-1934 the classes in semester 3 and 4 embraced: “Landscape and its elements as a base and background for architecture. Organising the architectonics of the landscape. Setting the architectural forms in a specific space and cosmographic and natural living plants factors. Artistic features of the building areas and their functional development.”
Horizontal building structures and transport, the concept of placement and architectural-landscape shape of building. The compound of architecture works and plant forms. Outlines, selection and plant spaces arrangements. Using the plant and landscaping threads in architecture. Vegetation in residential settlements in general. Material and aesthetic order in surrounding green areas - as the air reserves for cities. The formation of the modern landscape. Green neighbourhoods and cities. Streets and squares tree planting and lawn areas. Public parks and people meeting places. Stadiums. Cemeteries. Parks of the future."

Cited examples show that environmental problems were present both in architectural practice and education from the beginning of the Faculty of Architecture in Warsaw. Architecture and environmental compounds were analysed in terms of rational relations and development. The motivation was to improve living conditions, from the interior scale, through the situation and surroundings of the building up to the city or region level.
Current curriculum of the School reflects the environmental issues on many different layers. Starting from the analysis and definition of the role of architecture in the natural environment and cultural heritage, through technologies serving ecological solutions to progressive ideas which go beyond the present-time standards.

Contemporary training program involves and develops the environmental issues in many different forms. Starting from the analysis and definition of the role of architecture in the natural environment and cultural heritage, through learning technologies serving ecological solutions to progressive ideas which go beyond the contemporary standards.
References to the relationship of architecture and the environment appear in the design tasks from the first year of study. The project activities - both in the open space and urban tissue - are related to the environment. The first architectural task is a project of space for one person (second semester). The object is located in a place chosen individually by the student and should be harmoniously associated with the nature. In the academic year 2012/2013 the students in one of the groups carried out a project entitled: “on the road”. The starting point was to correlate the function and character of the designed object with its surroundings. A variety of projects manifested in functional premises (the place for hikers, cyclists, motocross riders, kayakers, anglers, climbers, airplanes travellers et al) and location selection (open space, in the trees, by the water or on the water, hilly terrain, inside architecture).

The problem of the relationship between architecture and the environment appears in the curriculum in the following design exercises, like in the second year of studies - project of public building in the landscape and a detached one family house in a green context.

Current professional design trends are naturally reflected in the project topics during the studies.

Issues of technology and energy savings are realised in a particular design tasks for subsequent semesters. Their influence is evident in the topics of theses defended in recent years at Faculty of Architecture.

Today - at the beginning of the XXI century we seem to face a new approach to environmental problems in architecture. After experiments, visions and utopias started in sixties we’ve reached a juncture which can be described as a technological attitude. Nowadays, technology and budget often determine the direction of development.

Sustainability - is it now more about the man or more about the global economy of architectural applications (through strict energy consumption control, use of renewable sources etc.)?
Consequently - should the architecture education closely reflect these practical trends, or should it rather strive to create natural harmony with the environment, using both traditional solutions and new technologies?

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Architectural Ecotonics
and the Metacrustic Harmony
**Anacrusis**

**Definitions**

In a statistics study, Preece (1987) used the term “anacrusis” as a prolegomenon, before the Introduction.

In classical prosody, anacrusis is, according to Encyclopaedia Britannica (online), “the up (or weak) beat, one or more syllables at the beginning of a line of poetry that are not regarded as a part of the metrical pattern of that line”. An important aspect is that anacrusic formulas are self-standing, more or less complex, insulated events (“... not a part of the metrical pattern of that line”). When replicated in *podia*, these can form the iambic (two syllables, one *breve* and one *longa*, U __) (Giuleanu, 1986: 594) or anapestic rhythm (three syllables, two *breves* and one *longa*, U U __) (Giuleanu, 1986: 598).

In music, several sources define the anacrusis as “one or more notes or tones preceding the first downbeat of a musical phrase” (Merriam-Webster Dictionary, online). Giuleanu (1986: 658) offers a complete perspective on the subject in the 7th section, “Rhythmic Crusis and Anacrusis”, from the Chapter VII, “Classical Procedures of Rhythm Forms Development”, part A, “Exclusively Rhythmical Procedures”. A musical phrase or theme can begin by a crustic (with the downbeat, the main accentuated value, the crusis) or anacrusic rhythmical formula (with an upbeat or with several rhythmical values, even complex musical passages, the *anacrusis*, preparing the main accentuated value, the downbeat, the crusis). In both cases, after the downbeat articulation, the crusis (from the Greek term *krousis* meaning hit, beat, accent) (Alexandre, 1850: 818), follows a part representing the distension, the resolution of the accentuated event, the *metacrusis*.

**The approach**

An important aspect emphasized by Giuleanu (1986: 660) is that in an extended anacrusic formula, the rhythmical and melodical design is a kind of curve, a parabola with a center prepared, focused and expressed in a musical paragraph with an extensively developed resolution structure, a complex metacrusis. This is a concept that we shall extend in architecture by the means of an analogic system similar to the one that Cezar (2003) proposes, using the porosity of the architectural and musical domains definitions, the connections between these areas and the comparative methodologies in the intent of modeling the inner self of the architecture as a complex metacrusic structure. Therefore, we are proposing a comparative, metadisciplinary approach of the architectural creation, redefining the terms and context, returning on the roots of the concepts and words and tracing again the limits, since architecture itself is a discipline of limits and topologies.

**Domains limits and porosity**

**Metadisciplinary perspective**

Defining architecture, like defining any knowledge area, is tracing its limits, but the limit concept is marked by the peratological complex system comprising, among oth-
ers, the peras and poros Greek roots (Alexandre, C., 1850; Boisacq, E., 1916; Chantraine, P., 1968; Liiceanu, G., 2004). Porosity is a quality, a dimension and a characteristic of the limit and this is how disciplines are defined in this new, open perspective. Through this porosity, the concepts, principles and methods of a discipline can escape and interconnect on a higher level of generality, in the area beyond the discipline limits, where several disciplines can meet and their principles can operate not being marked by the character, sometimes too narrow, of a certain study perspective that can focus on a problem, loosing the wood for the trees.

Fig. 1
Disciplines, peridisciplinarity, interdisciplinarity, metadisciplinarity.
Discipline produces its own and specific principles and methods that can freely invade the interdisciplinary space, the disciplines mesotopy, through the open pores of the discipline’s limit and find synaptic connections with other disciplines. This model goes beyond the border sciences concept, the peridisciplinary area and the interdisciplinary connection systems, allowing principles and methods from various cultural domains to freely interconnect in a metadisciplinary space, using the limits’ pores and a general system of analogies. Instead of focusing on an always narrower domain, disciplines extrovert and open valences. The porosity is the quality of the limit that allows and sets the fundamentals of the comparative sciences.

Crusis and Crisis in Architecture

The actual crisis in architecture is mainly a restricted segment and an effect of the general development crisis and the architectural shift towards Sustainable Development was generated by this multicriterial crisis that asked and finally imposed an ecological patch, but, at least in the form it is commonly applied, this seems hardly to line up a solution. This was the moment when architectural discipline needed a reconsideration, a new definition, since it went so deep into its own scientific consolidation that it lost contact with the context, therefore the new definition had to broaden the horizons and expand the connections. Even knowing general ecology developed earlier as a science, human ecology is, surprisingly, a very young discipline (Acot, P., 1988).

“Architecture occurs as a sharp blade cutting the contours that separate the human built environment from the larger, natural context.” (Vidrascu, 2008: 259) The keen edges of the architectural works were deeply connected to the abrupt limits of the architectural domain, both marked by a crustic character that disconnected them from the context, bringing them to a turnpoint: architectural works had to open towards the environment and architecture had to open to other disciplines.

Metacrustic Architectural Harmony

Different eras of historical evolution synthesized, at the cultural level, specific structures and styles that have found expression in various forms of artistic phenomena, including in music and architecture, but not limited to these two areas. The study of the principles’ common fundamentals governing the composition in the two areas of culture offers a different perspective on them, not so new, but rich in meaning.

Synchronic and diachronic elements of architectural composition and perception can be independently studied, but, within the proposed working methodology, we study the musical correspondences in architecture through synchronic elements of composition and perception in the harmony, timbre and composition forms, on the one hand, and on the other hand, through diachronic elements, primarily in the melody (monodic or polyphonic) and in the rhythm, but also in the dynamics (the variations in intensity) and the agogic (the rhythmic variation).

The anacrustic spaces that can transform the interior architecture according to the complex metacrustic structures concept are the transition spaces, the architectural ecozones that we will further define. We found these architectural structures in ancient and vernacular architecture and we can illustrate it in a parallel analysis on two related structures inspired by Romanian vernacular architecture, a crustic and an anacrustic solution.
The real enhancement of the metacrustic solutions intrinsically depends on the used anacrustic formulas, focusing the full compositional potential of the accentuated values of the musical or architectural structures. Therefore, we believe that the metacrus-
tic compositions completes their valences spectrum and truly find expression only in anacrustically-prepared formulas.

While crustic architectural spaces are defined by firm closures, sharp boundaries and nongraduated transitions between the interior and exterior, anacrustic-metacrustic embodiments are characterized by the presence of transitional spaces that have an important role both in providing the comfort inside without special, energy-consuming and polluting technical efforts, but also in the enhancement of interior spaces by enriching them with aesthetic valences and by their connection with the environment.

Such transitional spaces, specific to the green architecture both in the general composition and in the complex structure of the buildings boundaries, can be identified in vernacular architecture and can be linked with preparatory, transitional rhythmic formulas, specific to the traditional popular music. Ethnomusicology and comparative musicology studies offer the perspective of a new interpretation of architectural composition.

Houses with verandah and porch are very common in the Romanian vernacular architecture and these are models of transitional spaces integration in the overall architecture of buildings.

A distinct morphological typology is the sacnasiu houses of Oriental influence. The sacnasiu, a Turkish origin term, is a small room at the upper level of the princes and boyars houses, protruding from the front of the building and closed with windows and shutters.

Fig. 4
Fig. 4
Metacrustic structures.
Comparative Musicology Perspective on the Architectural Ecotonics

The border sciences studies, the comparative cultural theory and the interdisciplinarity already offers a precious support to the synchronical and diachronical Architectural Ecotonics, but the perspective proposed here is one of a metadisciplinarity, another area that is in the process of redefining its identity. The basis of this approach are made in Antiquity, being known that, ever since then and the Middle Ages, the music theory was associated with arithmetic, geometry and astronomy in their capacity to correlate natural phenomena with numbers and numerical relationships (Lochhead, J., 2011; Cezar, C., 2003).

The relations we can emphasize, in this particular context, between architecture and music, cover the general areas of the harmony, melody and rhythm, with a particular study of the metacrustic architectural topologies.

Environmental objectives for studio design

While principles on higher levels of generality usually impose and explain by themselves, the more specific and deeper, in detail concepts or peridisciplinary to metadisciplinary perspectives need further argumentation, therefore we should concentrate on a wider synthesis of the last principle in this short list we are proposing for the objectives a design studio should consider for an environmentally-conscious approach and briefly present the arguments for the others.

Sustainable Development fundamental principles assimilation

This objective is too self-explanatory, so we will simply mark its first position in the list. Sustainable Development has to be taught as basic alphabet and ground discipline, and this, not only in architectural schools.

Environmental performance, economic prosperity, social equity and cultural foundations

We witnessed a development paradigm shift when social equity was added as a main criterion, then when the environmental integration became the third pillar of the Sustainable Development.

The fragility of the contemporary development balance issue becomes, however, more sensitive, as not one, but all the pillars are now put in question, and this, not just in their redefinition perspective, but also in that of the contribution to the overall development sustainability. The flagship seems to be, on the one hand, the economic crisis that turns us back to the relocation, not at all ironic, of the development’s primary equations by reconsidering the “first bottom line“ from an ensemble that we seemed to understood how to manage after a long journey. On the other hand, beyond the sometimes artificial “greening“ development, the cultural pillar of sustainable development is just gaining substance in the difficult context of globalization.

This complex crisis not only that is not over yet, but it is not yet fully defined and understood in its implications and reflections in the urban development, this is why
we need to refine the crisis concept in terms of density and intensity, tension, (dis-)continuity, limit assumption and, starting from here, as a broader cultural concept that we can migrate from Comparative Musicology into the Architectural Poietics.

Since the environment protection became an important cause, we gradually seem to forget the other axes of development, but we should not conceive any environmental performance without economic prosperity, social equity and cultural foundations.

**Integrated, not agglutinated technologies**

The technologies used to complementary improve the performance of the building have to be integrated in the architecture, part of the concept and only a higher

**Well-configured spaces, not highly-engineered “repairs”**

The ability of an architect consist in conceiving a self-regulating building that can live by its own, due to its concept, without calling specialised engineers to apply local appendical solutions.

**Inverse-Kinematics**

Knowing the objectives is a key for developing any project, therefore we should start with the results we are expecting and model the project backwards, step by step. A usefull hint is to use the objectives sets and the Green Architecture rating and certification systems, starting with “Leadership in Energy and Environmental Design” (LEED) and “Building Research Establishment’s Environmental Assessment Method” (BREEAM) as a complementary source for the Project Brief.

**Synchronic and diachronic approach**

We have to define the structures along with the processes in every project. Ecotones are also defined in a structural approach as well as in an evolutive perspective and Architectural Ecotonics reflect that principle.

**Respect the closed cycles**

Architects have to learn how to work within the closed cycles of nature, conceiving their projects in a life-long perspective, carefully considering the water, waste, constructions and demolition materials cycles and all the evolution of the built environment.

**Conceive a cultural environment within, not against nature**

The antropic environment was for too long conceived independently, with poor connections to the natural context. Culture is often trapped between the legibility of the Sustainable Development’s fourth pillar and the almost anti-cultural approaches attempting to restore the natural order (Cezar, 2003).
Master the limits

An architect should generally be able to work within the conditions imposed for a project. The Ancient Greeks did not believe in going beyond the limits, there was no objective there. In fact, there was nothing there. The source and the spirit of the Greek tragedy was not in the impossibility to transcend the limit, but in the difficulty to reach it, not in the limit denial, but in the respect of the limit. In fact, transgressing the limits had nothing in common with the eroic connotations today we are used to, but on the contrary. (Liiceanu, 2004: 170-173). One category of limits we have to consider in the Sustainable Development perspective, for instance, is the resources limits. The equilibrium is, finally, about mastering the limits with creativity, not going beyond them.

Architectural Ecotonics

We started to develop this metadisciplinary perspective on the Sustainable Urban Development with a first study on the Architectural Ecotonics (Vidrascu, 2008) and the well-tempered transition spaces principle is further gathering other generous and inspiring perspectives for the architectural education that we propose.

We defined the Ecotonics as “a field of study within the ecology concerned generally with the transition ecosystems between adjacent ecosystems and particularly with the structures of these systems and the specific processes at this level” (Vidrascu, 2008: 260). Furthermore, the “Architectural Ecotonics apply this field of study to those urban and architectural structures, at different scales, that define the transition mainly between these structures and the natural environment, but also between various such urban and architectural structures”.

The changes brought by the Information Technology and Communications progress are deeply marking the contemporary society, both in the relations between individuals and at the macrosystems scale of the whole society’s development. These processes’ restructuring does not reverse, however, the fundamental values and principles underlying the composition of these systems and found both in the architectural creation process, as well as in the formation and information of future architects, a complex process where ecotonics also apply at the methodological level (Pendleton-Jullian, A., 2009).

Boundary-spaces, exchange-spaces highlighted especially in the urban structures conceived as ecosystems or living organisms, where exchange-spaces are the domain of the metabolic processes manifestation, are those bearing a rich load of meanings and (in)formative potential. We focus on these topologies, starting with the semantically and functionally enriched – along the society evolution – archetypal values, plus the new Information Technology and Communications serving the culturally grounded concepts, without substituting them, providing relevant, efficient architectural and didactics solutions.

Conclusions

Architectural Ecotonics, a comparative eco-architecture concept set on the same foundations with the Limits Bath(m)ology theory (Vidrascu, 2008: 261), can contribute to a
new Sustainable Architectural Development perspective, especially when irrigated by inspired connections and symbiosis with other disciplines of which comparative musicology is only one, but seductive, spring.

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Eco-Smart Home: Eco-design Technologies for Living
The Concept Design

“From a thousand years, Sher, a little Tibetan village, remains stubbornly clinging to his life, despite his unhappy position, perched as it is on a narrow ledge flat situated on the rapid slope of a mountain. This place, on the arid plateau of Tibet, receives only eighty millimetres of precipitation a year, but every drop is collected in an ancient irrigation system. The average annual temperature is around zero, and from December to February, the mercury can fall between -20°C and -30°C. ... The little village of Sher depends on three forces: the sun, the rain and the wisdom to use well the resources of nature. … Modern life leads to a decrease of this kind of ability and this wisdom”

According to this approach emphasizing rationalist duality of synergies established between the human being and his living natural environment, the Laboratory of Indoor Sustainable Technologies of the Degree’s Course of Architecture at the Second University of Naples (academic year 2012-2013, lecturers: Lab A - prof. Antonella Violano) carried out a challenging didactic experience.

The construction industry is currently in a time of great change, due to the economic crisis. The green building has become an opportunity for efficiency and, at the same time, eco-sustainability.

A responsible use of resources and materials lead rethinking the design process. Therefore, the Quality Design becomes an attribute formal and practical at the same time, made of appropriate technical solutions and design choices wise and adaptable to the environmental conditions.

In addition, the architect shall be responsible for interpreting the relationship between not only environment and building, but also potential offer of building systems and direct users’ demand, according to a rationality motivated by the comfort’s needs. In that case where the intersection of demand and offer is not in balance with traditional construction systems, it is necessary to design measures improving the performance of the building system with innovative materials, components or even technological units capable of achieving the objectives of “Possible Quality”. However, these targets cannot be deducted unconsciously; they derive from a complex re-thought design thought, which skilfully combines composition and constructive knowledge.

The Technological choices are not only based on the resources available and the needs expressed, but also the eco-compatibility of the proposed transformations and efficiency, achieved in asset rating for new buildings and in operational rating for rehabilitation of existing building.

Designing and innovating mean “Choose wisely” and the mechanisms of complex development of design ideas must be able to answer a question, which in the meantime has evolved / renewed towards ever-higher standards of performance.

So, the design as the reference point of balance between ends and means, has the envelope as a true writer of his script. It is the border between the internal and the external environment through which control and monitor the in and out passage of matter and energy. Therefore, renewing the concept of envelope means to place it as product of joint approaches: design, technology, plant engineering, ... because at the
same time must meet the requirements of composition and structural, technological and energy, plant and functional.

**Methodology**

The construction industry is increasingly oriented towards eco-friendly behaviour and high performance energy technology. Continually architects and engineers strive to design choices that can efficiently manage all the resources. These conditions have got a strong tendency to innovation, in which the impact factor of knowledge has a high benefit: added value!

If we consider that design and innovation require “knowing how to choose”, the complex mechanisms of development of project ideas have to respond to a question in the meantime evolved / renewed towards ever higher standards of performance.

New models of design production redefine the powers of the technology industry for innovation. There are necessary in some cases, creativity and courage, in other cases, awareness and sensitivity, but in both cases there cannot be technological innovation without innovation of mind: this is a renewed approach to interdisciplinary project with a range of conceptual lines on which basing methodology and practice.

Therefore, this course aimed to teach the theoretical principles and methodological tools of technological eco-design. The theme of the course is designing an ECO-SMART HOME of 60 m² for a couple of intellectuals, located in a place near the Mediterranean Sea, atop a cliff oriented to South characterized by a rock, hill, five trees and a spectacular landscape to the south.

The concept design must be based on "Environmentally Friendly Behaviour", fit for the future in according to the 2010/31/UE Directive. The specific topics of the laboratory are:

- Charrette: understand the needs of the direct users (a couple of intellectuals).
- Green building concepts, including sustainable site selection, water efficiency, energy efficiency, sustainable materials and resources, and indoor environmental quality.
- Building materials with low environmental impact.
- Sustainable technologies for designing light and opaque envelope: windows, walls, floors, panelling and finishes.
- Domotics: how to transform the input requirements of the system in technological solution.
- Integration of innovative sustainable and energy-efficient technologies.

Each group of students prepare a graphic and descriptive work, divided into three steps.

The first step is THE META DESIGN, very important in order to determine the needs of the couple of intellectuals (with the Charrette tool) and to define design and technological solutions according to law requirements.
In this phase, students analyse the relationship between the building and the assigned external environmental components: sunshine, ventilation, shading in order to find needs, requirements and performance for a residential building, which can be called eco-smart.

The design must be integrated in a place overlooking the sea (climate zone C), where there are some physical constraints: an emerging rock and five trees, which can not be cut down. In addition, the ground is sloped and it is forbidden to design retaining walls greater than 60 cm. The prevailing winter wind is from northeast (Grecale) and the prevailing summer wind is from south-west (Libeccio).

The second step is THE DESIGN: Defining building characteristics: spatial conformation, technological, functional and environmental-energy performances.

The third step is the technological quality of design, which is the study of innovative technology - building automation - applicable to the design of interior space, according to the conceptual approach of “Possible Quality”.

Every design must meet eight Golden Rules of the eco-design for living:

1. **Designing response to specific needs of direct beneficiaries**
   The architectural design is not a product but a service because it has to meet needs such as welfare, usability, aspect, management, environmental preservation. All technological design solutions must be appropriate to these needs.

2. **Evaluating the Primary Energy Need**
   Once determining specific needs, all technological solutions adopted for envelope and plants systems must minimize the Primary Energy Need for heating, cooling, production of domestic hot water, lighting and ventilation (Cannaviello and Violano, 2012).

3. **Designing considering the life cycle**
   Each human transformation determines impacts on the environment in two moments: when resources are taken and when the results processing of those resources (emissions, liquid and solid waste) are re-injected into environment like waste. A truly sustainable transformation, which is as close as possible to zero impact, takes account of these two types of impact, and it is implemented keeping in account the implications over the entire life cycle: from cradle to grave. (Crawford, 2011).

4. **Climatic factors are elements of the architectural design**
   The building organism lives in synergy with its surroundings and the environment through the envelope exchanges matter and energy with it. For this reason, sunlight, wind, rain must become materials of the architectural design and the design must integrate technologies using them (Pinto de Faria, Verde and Violano, 2013).

5. **Choosing natural and local materials**
   Eco-compatible materials and components have a low environmental impact during operation and are not toxic. If they are local, they are well integrated with the environment, the workers know how to work them and reduce the economic and environmental costs for transportation (Roaf, Fuentes and Thomas-Rees, 2007).

6. **Using recycled and/or recyclable materials**
   Choose recycled materials helps to increase the demand for this kind of materials on the market; but this is not enough. The building construction industry must make recyclable materials once disused building (Foster, Stelmack, and Hindman, 2007).
7. Assessing the maintainability of materials and components
   Materials and components must be technically durable, replaceable and easily maintainable (Chew Yit Lin, 2010).

8. Experimenting with innovative technologies
   Understanding in detail performance and benefits of innovative technologies and experimenting them in the design is highly instructive. Knowledge, creativity and experimentation produce real changes. Innovative ideas and tools can help the environment and give rise to new forms of design.

Final Results

The cognitive process carried out by the students in order to draw a house energetically efficient, functional from the point of view of distribution and environmentally smart, has produced three different and interesting types of design:

1. traditional use of space and materials
2. traditional spatial distribution and innovative materials
3. innovative materials and spatial distribution.

The formal and material characteristics of these designs differ greatly, but the energy and environmental performances are all respectful of the minimum legal requirements:

- Transmittance less than 0.40 W/m²K for the climate zone C
- Attenuation of the thermal flow equal to about 0.15
- Phase Shift of the thermal flow more than 12 hours
- Architectural bioclimatic integration
- Eco-friendly materials.

However, it is not sufficient to make the architectural design; it is important to verify their own choices and be able to assess the possible need changing solutions, too.

The use of specific software helps the student in this evaluation and they make easy the verification of technological choices.

Therefore, during the course, the performances of the opaque envelope are evaluated with the free software J-tempest, which calculates the values of Transmittance, Attenuation and Phase Shift of the thermal wave and it compares them with the existing parameters of the law being in force.

The free software Pilkington Glass checks compliance with the regulatory requirements of the transparent envelope.

The evaluation of some important parameters is been taught:

- transmitted light through the glass (in percentage in comparison with the incident light);
- heat Transmitted through the glass (in percentage in comparison with the incident radiation);
- transmittance (in KWh/m²K)
- solar factor $g$ (a percentage that value ranges between 0 and 1), in fact it indicates the ratio between the thermal energy globally transmitted through the glass and the incident one.

It’s important that students make their own choice considering the heat component is not the only variable: conditions of light comfort and fruition of the confined space need a different quantity of natural light in relationship with both the intended use, and exposition and characteristics of the environmental surroundings (presence of obstructions close to the glass front and their shadows).

Below four examples are illustrated.

Two examples of eco-smart home characterized by traditional use of space and materials

The design process of all students’ works began by taking under consideration a series of fixed parameter such as natural restrictions (emerging rock and trees), orientation in order to optimize passive energetic performance, panoramic viewing towards the sea and the territory, and the use of traditional construction materials.

Every technological design solution is finalized to establish an organic relation between house’s positioning, geometry of the design and the local natural resources. This choice assumes a double function on a conceptual-geometric basis. The priority problems concern space distribution, energy saving and minimum environmental impact.

The choice of local tradition’s materials suggest surfaces in exposed tufa stone and south opened towards the panoramic view of the sea facades, with appropriate solar shadings systems.

In addition, passive systems such as the overhanging of the roof and solar shading will provide to keep out solar direct radiation during critical times in summer.

Some other projects have used deciduous green as shielding for the western and eastern fronts.

During winter, the lowest elevation of the sun above the horizon favours the entry of solar radiation, while the deciduous green will be leafless, providing total sun exposure through the glass wall.

In order to guarantee indoor comfort during summer and winter, cooling and heating are generally guaranteed by a radiant floor, which would permit, through circulation of water hot in summer and cold in winter, an efficient indoor comfort.
Fig. 2
Design: characteristics of envelope of the “Wall-cone home”.¹
Fig. 3
Design: envelope's characteristics of the “Natural Inception home”.

3
Fig. 4
The technological quality of design: eco-solutions and building automation systems of the “Natural Inception home”.
**The thatched house**

This design has a clear architectural bioclimatic matrix and the specific technological choices are the use of straw and bio-brick. The use of straw in the construction industry is ancient, but today it takes on the character of innovative material. The straw is a humble material but rich in quality.

The thatched house was designed as an organism, in analogy with the human body. It is equipped with a lung, the tower of the wind that breathes thanks to the natural air currents present on the headland. Its skin, the envelope, perspires through the walls made of bio-bricks and covered with lime plaster. It protects the south window from the sun, just with a geometric design solution: it is inclined sixty degrees so that in summer the direct solar radiation at 12 is tangent and not incident.

The house has a circulatory system made of radiant panels and a digestive system provided with a system of constructed wetlands. Photovoltaic tiles are placed on the ground south of the roof, sloping of twenty-three degrees for maximum performance. It meets 50% of its electricity need and its brain is a home automation system can handle efficiently the different scenarios.

Fig. 5
Scale model of the thatched house.
Fig. 6
Meta-design: concept design and environmental integration. 4
Fig. 7
Design: characteristics of envelope.
“To dare: the price of progress”

The architectural sign of this project has an organic matrix and it comes from the desire of integration with the environment, but this is only an integration of lines. The formal result is an intense visual power.

However, the project meets all energy and environmental requirements, using innovative technologies and materials. The opaque envelope is made of Perlideck, which is an expanded perlite with a comprised between 0.15 and 1 mm grain size for the realization of insulating lightened concrete. The entire production process is characterized by the absence of VOC emissions of fibers, radon, toxic gases or dangerous particles: the expanded perlite is a product oriented for the development of green building and it is environmentally friendly. It is also characterized by a porous structure microcellular, which gives excellent performance as a thermal insulator.

Electrochromic windows form the transparent envelope. These are entered in the construction market for a few months. These devices have the advantage compared to the liquid crystals of having to be fed electrically only to start the change of state. In fact, the device maintains its molecular condition long, once modified with a minimum electrical pulse. Each panel has its own potentiometer control of electric intensity that can be connected to a centralized system and computerized.

About lights, the house has an optimal ratio of glazing that ensures adequate natural lighting during the day. At night, indoor and outdoor spotlight are power led, which ensure economy, efficiency and quality.

The performance of heating and cooling are guaranteed by a radiant floor: a single system for heating in the cold seasons and cooling in those hot. In summer season the system sends cold water through a net of pipes in the floor. The floor cools downs gently, with no air movement. Clearly, for the winter season the system will send hot water to heat the floor and so the rooms.

These processes are controlled by a CPU unit called Velta Genius Evo, that are individual room controllers so you can customize the temperature room by room at any time of the year for the maximum comfort and energy saving.

Conclusions

The design of a building structure with efficient functionality requires creative interpretation of integrated architectural spatial potential, flows of matter and energy often denied or granted too generously, an expert search of balance between technological innovation and quality. Therefore, performant envelopes, efficient plants systems and functional spaces can meet the needs of the real protagonist of architecture: the direct user. In this didactic experimentation, the energy saving and the use of eco-friendly technologies, from requirements become opportunities.

My invitation is always the same: let’s change the design method!

References

Fig. 8
Meta-design: concept design and environmental integration.\textsuperscript{3}
Fig. 9
Design: characteristics of envelope.
Fig. 10
The technological quality of design: eco-solutions and building automation system.


Goleman, D 2009, Ecological Intelligence, Broadway Books.


Notes
2. The students that carried out this work are Mario Capasso, Clelia Paolella, Carmela Tavano.
3. The students that carried out this work are Francesco Pio Arcella and Carmela Marrazzo.
4. The students that carried out this work are Luigi De Simone, Vincenzo Dell’Aversana and Domenico Cantone.
5. The students that carried out this work are Valerio Palmieri and Andrea D’Alessio.
Polyphony and Pluralism in Environmental Design Pedagogy: Five Responses to the same Question
Value systems: society-architecture-architectural education

Would architecture be exclusively about providing shelter to protect from the elements, practising architecture should suffice to be about learning the technicalities that entail the optimal performance of the artefact, the building. However, as architecture came to transcribe the values of a given value system and ethics in time, practising architecture is more of a political and philosophical stance that expresses values and conveys messages of a society that are embedded in the artefact.

In order for architectural education, to prepare individuals to carry out this complex task, that is to raise thinkers that through design can create the shelter as a value reflector, a meaning carrier, a technological advancement, an optimally performative artefact, it needs to follow and encompass the values of the given system in time.

The impact of value systems on architecture and architectural education

The prevailing power of dissecting a problem into smaller parts to render it more tangible, hence manageable brought architecture in modern times closer to the sciences and distanced it from the humanities. Architectural education, in its attempt to follow this approach, taught these fragments in isolation leaving the synthesis to incidentally and occasionally occur in the minds of the gifted.

In this reality the education of the environment to architects, given its heavy scientific bias and body of knowledge, has been caught up. For decades educating architects to encounter the impact of their designs on the environment and vice versa is an afterthought taught in isolation in the form of a peripheral body of knowledge to inhabit students’ conscience and to be capitalised when necessary. Although the criticism on this isolation and fragmentation is harsh, it is quite common for school curricula to offer the relevant body of knowledge in the form of theoretical courses in a non-studio context on building physics, material properties, construction detailing or software possibilities for simulation. The synthesis, or integration and articulation of this knowledge with design have been, for decades, rare. Students, as a consequence, find it impossible to handle it within the broader complexity that design entails by its very nature.

Moreover the power of media and the marketing that accompanies the star system has a strong impact on students. Their role models are mostly rewarded for the boldness of their formal propositions and less for their sustainable nature.

It is quite common, therefore, for strong students in design to consciously neglect the environmental aspect in their design proposition. Similarly, it is quite common for students, conscious of the environmental impact of their designs to produce less innovative and exciting formal design propositions as in their effort to acquire the necessary and basic knowledge drift away from the other aspects that render a design proposition both exciting and complete.

In the last two decades, and in a less fragmented approach to understand the universe architecture and architectural education as a consequence, operate on the basis of connectivity, integration, articulations and associations among different things. This way of operating lies on a contemporary way of thinking and encountering a problem systemically. The power of interactivity and emergence are predominant when phenomena are studied and processes are at work.
The design studio can act as a catalytic platform and as the fertile soil to eradicate the problem of fragmentation and isolation while offering new possibilities for associations and connections to be made and for integration to be achieved. Teaching environmental design in the studio is gradually gaining ground in contemporary school curricula. Implicit increase of awareness and acquisition of knowledge in the design studio can be an interesting pedagogic manipulation and manoeuvre in teaching environmental design to future architects. Two key characteristics are considered vital: the one is to learn from recent or past history and another to learn on the job, that is while designing.

**Sustainable building skins at AUTH**

The above observation has constituted the premise and departure point of setting up an elective studio course that runs on a vertical structure for third and fourth year students for 12 weeks. The aim of the course is to stimulate students to deal with both issues at a time. For this to be achieved, the following characteristics are introduced to the course through:

- ‘reading’ architecture, good or bad, through an environmental matrix, finding the ‘lenses that can ‘see’ this aspect of a building,
- relating the content and use of the building with the environment itself, being it the climate, the place or its immediate or broader physical, cultural and notional context,
- keeping the brief rather simple so that students do not have to engage with programmatic complexity,
- choosing a site that intrinsically introduces issues of global sustainability, forces the unconscious learning process through history, and by offering design freedom.

More specifically, the students are asked to design a small-scale pavilion to raise environmental consciousness in the local community. The site is the main square of the city of Thessaloniki where the local community holds public events from performances to political manifestations and gatherings. The urban grain is dense and the physiognomy of the context highly historic and rich.

The students are introduced to the brief from the first day and while they anticipate design they are given a presentation on a good practice and one on a less competent example, demonstrating on the former the synergy between design decisions and environmental consciousness and the contrary on the latter.

In order to start exploring ideas regarding their projects, the students are asked to analyse the climate aspects of the site. In this way, they become familiar with the basic elements of a climate analysis and are encouraged to use sources and appreciate their implication on design. By gathering information on temperature, relative humidity and prevailing winds they are asked to relate these data to issues such as the priority of heating or cooling, as well as the importance of ventilation. An important part of this analysis is to understand solar geometry. Students are encouraged to explore the sun availability on the site by providing seasonal diagrams using either simple sun
path diagrams or software such as Ecotect. Within this exercise acknowledging issues regarding the micro-climate is equally significant. The students are asked to evaluate the use of materials within the urban context. In this way they learn to appreciate the implications of the extensive use of hardscapes (high surface temperatures for example) and are encouraged to incorporate the immediate landscape when designing their building.

Since the focus is on the environmental aspect of the building, basic knowledge of building physics is required for the course. In addition to that, knowledge of passive solar design, natural ventilation, daylighting, renewable energy in buildings and innovative materials constitutes great input towards achieving the aim of the course. In this context, students are asked to choose a building from a list prepared by the teaching staff and present its basic features relating to the areas mentioned above. The buildings are selected based on the incorporation of certain features that have contributed to their energy efficiency in several ways. The students are asked to use a matrix with the following criteria: a) energy / environmental strategies applied (natural ventilation, shading, wind towers, solar chimneys, use of thermal mass etc) b) renewable energy systems applied (ground source heat pumps, building integrated photovoltaics, solar panels, micro wind turbines) c) materials and building elements (specific glazing properties, hollow core slabs, insulation). Through the precedent study, students enrich their mental stock, they are familiarized with strategies that they are likely to use in their own projects and learn through examples while examining building in its entirety, rather than studying separate examples of specific features-fragments on different buildings.

Following the climate analysis and precedent presentations, tutorials on their design follow. Half way through the module, students are given specific tutorials on software tools that will enable them to test their projects with regard to solar radiation. Ecotect software is selected, due to its user-friendly environment and ability to inter-operate with other 3d visualisation and form-generation programs students are fascinated by. Students learn to evaluate orientation and issues of availability of solar radiation. They are encouraged to explore the design implications of the solar geometry on the design of their building and more specifically on the fenestration using a simple 3D model and evaluating the solar radiation in terms of sun availability and shading. Apart from openings, depending on the project, students can use similar techniques to demonstrate strategies such as the incorporation of solar collectors or PVs.

In addition to the software tools, students are asked to produce diagrams that describe the basic environmental or energy related features of their project. These diagrams are usually architectural sections, enriched with all the necessary information to describe how the students have incorporated issues related to the environment in the design of their building. Typically, they produce sections that correspond to winter and summer. It is worth mentioning that they are not accustomed to produce these types of diagrams in other studio courses of the syllabus and consequently find it rather difficult to demonstrate their decisions on these drawings. However, it has been proven to be a particularly important exercise, as this gives them the opportunity to evaluate their design decisions. Ideally, this enables them to use it as feedback and to go back and alter when necessary in order to improve their design, with regard to the environmental aspects.
The freedom to design with no explicit constraints has yielded quite interesting approaches in the years the course has been running. The present paper will present five entirely different approaches to the same brief alongside their pros and cons in order to critically overview the pedagogy implemented. These cases come from different years the project has been running in the syllabus and constitute five generic types of responses to the same year, observed in time.

**Case 1**

*The logic of ‘superuse’*

The project

The design of the pavilion emerges, based on the logic of “superuse”. “Superuse” as a design concept focuses on the search of existing and recyclable materials, which are available in proximity with the construction site. The project is a simple form and builds out its skin with unexpected objects used as construction materials (Fig. 1, 2).

The positive aspects of the approach

At first, it seemed as if the students were abstaining from design. The process of re-discovering the sustainable potential of everyday objects demands hands-on experience and physical, speculative visits to scrape yards in the vicinity. Their creativity was exploited in exercising their lateral ‘thinking, outside the box’. It was a very mature approach for the students to not be seduced to create exciting designs, but to focus on rediscovering the potentiality of existing and recyclable objects. Their imagination concentrated on extracting the potential from every day, non-building objects and inventing ways to convert them so that they could act as building components. By these means a successful project with a strong concept based on sustainability ethics was created. Furthermore, this approach drew attention to the concept of life cycle assessment of the materials used, underlining the importance of the availability of materials and their proximity to the construction site, as well as their applicability to alternative ways of use, introducing an alternative aspect of recycling.

The negative aspects of the approach

In the course of the module, the process was slow and the use of the object a preoccupation, an end in itself. Difficulties of answering how to assemble different non-constructual material, limited the opportunity to investigate different building forms in regards with environmental performance. The profound interest in using existing and recyclable objects shifted the focus away from choosing the construction materials based on energy performance criteria. As a result, the final energy performance analysis and assessment of the proposed scheme were inaccurate and were based only on assumptions. As for students, given their educational level (4th year), it was almost impossible to simulate with accuracy the energy performance of the building. To certify this performance and to precisely and rigorously control the indoor conditions would be an impossible exercise. In retrospective, a combination of using formal-conventional building components and recycled ones would have been an interesting trajectory.
Fig. 1
Superuse: A. Apostolinas, L. Margariti.
Interactive-adaptive

The project

The students worked on the idea of a building skin that would adapt and interact with the sun paths in order to gain energy or to be protected depending on the time of the year. The posture of the building on site emerged from an interplay of its transformations and the sun paths (Fig. 3).

The positive aspects of the approach

It was an interesting endeavour as, despite the physical movement of the building, the students had to develop a very good grasp of the impact of the sun and the building. Following the concept of transformation, the students showed good understanding of the context and climatic data of the given site, challenging the idea of adaptable building skins in order to respond to the changing climatic conditions of the Mediterranean climate.

The negative aspects of the approach

A rather long period of time, disproportionate to the overall time dedicated to the project, was spent on resolving the technical aspects of the interactive skin. The animated representation, albeit interesting, seduced the respective students to self-indulge and neglect the indoor spatial qualities of their building. An important delin-
Fig. 3
Interactive - Responsive: P. Lazaridis, V. Kontaki, A. Marandidou.
quency of the environmental analysis of the project was the lack of testing the energy equilibrium between the energy gained from the idea of building adaptivity versus the energy needed to customize and construct such a building skin, as well as the operational energy, missing an interesting challenge for the selected design concept.

**Top-down, form deterministic sustainability**

The project

The students worked primarily on the formal aspect of their design in context only taking into account the footprint and posture of the building in context and in relation to sun paths.

The design inquisition prevailed and for a great part of the tutorials there was fear that the process and its outcome could have responded to any brief irrespective of the commitment and agenda of the module. As a consequence, the proposal, while very exciting, became almost irresolvable when materiality was at stake (Fig. 4-6).

![Image](image_url)
The positive aspects of the approach

The freedom the students chose to work with allowed them to experiment and enjoy the process. The building proposed was rather exciting. The strength of the students in design and their overall performance in the school drove their perseverance to resolve the constructability of the skin, working on non-standard detailing customising most of the building components.
The negative aspects of the approach

The bottom-up formal determinism of the process followed, inevitably rendered environmental consciousness an afterthought. Detailing and the anticipation of materiality were complicated and essential compromise on the formal proposition was necessary. As the project was eventually extremely competent, it is likely that the students will continue to operate similarly in their life as practitioners until costing their building will be necessary. The high cost of customisation is and will be a drawback for non-signature buildings for sometime, especially in times of financial and other crises.
**Bottom up and parametrics**

The project

The respective students known for the strength of their design propositions decided to work on a bottom-up logic where the building volume would be determined by its relation and positioning to the orientation and effectively to the sun paths. Using morphogenetic software the proposed volume tilted, grew, turned, shrank or expanded accordingly (Fig. 7, 8).
Fig. 8
Bottom-up Emergence: S. Krommydakis, A. Prinionaki.
The positive aspects of the approach

The use of a morphogenetic software as a form manipulator in regards with the changing climatic conditions was a challenge in itself and a useful educational process, introducing to the class a new research area in architecture, where the abilities and limitations of the interoperability of morphogenetic and environmental analysis tools and methods are examined. The changeable ‘pixelisation’ and perforation of the building skin and the variability of its materiality fully exploited the very aim of the module; of using the building skin as an adaptive, changeable interface that with its form, versatility and flexibility as well as its variable materiality can best control the relationship between the indoor and outdoor space.

The negative aspects of the approach

During the first stage of the design, where morphogenetic software “was fed” with climatic and context data in order to create a series of primitive forms, the lack of deep understanding of the data used, led to scientifically inaccurate compromise and easy assumptions, questioning the consistency of the design methodology adopted. Preoccupation and difficulty in dealing with the formal aspects of the proposition as well as the resolution of the materiality of the skin, weakened simulation that could offer sufficient feedback for the reconsideration of the posture of the form and the permeability of its skin.

_modest, sensible and mature_

The project

In the four years of the life of the module, this is the only one project that suggests an absolutely underground building. Despite their teachers’ encouragement, the students fought with themselves coming to terms with having no formal proposition in context (Fig. 9).

The positive aspects of the approach

Most likely it would take a talented architect who cares about the planet and the overall ecosystemic nature of environmental design to make such proposal. The dense, historic urban grain of the city could only welcome what eventually became a bold idea. The subtlety of the design can only reveal a mature and serene attitude, rarely found in fourth-year students. Students have shown great understanding of the issues created by their decision to go underground, regarding the indoor quality of daylight and air, proposing design solutions.

The negative aspects of the approach

A great part of the time on the project was consumed on persuading the students to bury the building entirely. A sense of loss and wrongdoing generated an apprehensive attitude of not serving architecture and a great deal of tutorial time was dedicated to discussions otherwise very intriguing for the entire group. Would part of
Fig. 9
Modesty and Sensibility: L. Kontozoglou, P. Stergiopoulou.
this time have been spent on researching and designing those building components, which reinstate the exchange of air and daylight with the outdoors, innovation could have replaced the conventionality of the selected solutions.

Overview

Although the operational value of the precedent study is evident, we learned that the most crucial part of this teaching method is to contextualise examples. Often, high-end technological devices towards environmentally conscious buildings are morphologically seductive, a very good reason for students to overuse. A great part of the analysis of good or bad practice examples should be dedicated to the appropriateness and adequacy of the particular strategies in the given context. It is interesting to note that good practice examples that primarily appear in cold climates are inappropriate examples to copy in the Greek climate. Cooling, sun protection and natural ventilation were deemed to be the top priorities of a designer in the Greek context.

Moreover, to make it more attractive this part of the module focused on contemporary examples. No doubt, the award-winning precedents are the obvious buildings worth-studying. However, learning from history being it vernacular architecture, exemplars of low-key architecture that does not boast about its environmental consciousness with implicit environmental consciousness are great cases in point to be studied. On top, albeit provocative, it is often the case that award-winning buildings do not necessarily make a global and a truly sustainable impact on the planet if their sustainability is not global. High running costs, continuous maintenance, need for private transport and long distance from residential areas to commercial buildings, need for long and costly transport of the occupant to the building, and employment of costly customised components are some of the issues to be considered when a building is examined for its environmental impact. All the above constituted intriguing in-class discussions.

What we also felt was that in our effort to simulate real life scenarios, we would have to include other disciplines in our teaching team. It was only in the last semester that a mechanical engineer has joined the staff.

Furthermore, it was noted that students, having a fragmented and superficial knowledge of building physics mainly on a theoretical level, encountered great difficulty in incorporating sustainability ethics in their design as a concept from the early design stage. They were not able to contextualise the design question and many of their decisions in design process were based on preoccupations and assumptions, due to lack of environmental analytic skills as a part of a unified way of questioning building design.

Architectural education is confronted with a very challenging task to encompass and manifest environmental design in school curricula. It has to develop interfacing strategies by ranking and prioritising the various necessary levels and emphases of this very broad subject. It is certain that there is no point in relegating the teaching of the specifics to non-studio teaching. Teaching the basics of building physics is vital, but it will never become the embedded knowledge necessary if it is left isolated and beyond any implication on and implementation in a design question.

All the above, can only act as a small step in the right direction. Different scales, different context and different degrees of complexity have to be explored for a more
global approach to environmental teaching in a school curriculum. Would that be accomplished, a school can raise competent designers with technical knowledge. What will still be missing, however, is the appreciation of the role of environmental design as a minor contribution to a broader highly political and philosophical discussion on the globality and systemic nature of sustainability. Teaching environmental sensitivity has to occur across the board of education from primary school onwards, as a political and ethical stance, a position, an attitude, a responsibility for the future of the generations to come. Any perfectly shaped teaching method is highly irrelevant or a drop in the ocean given the magnitude and importance of the issue.

References
3. It is interesting to note that in the last ten years, for example, only three in ten architects that were awarded the Pritzker Prize –the most prestigious in the domain- have been also awarded prizes for their sustainable designs.
6. ibid
Reality: Education for a Credible Social and Political Future

The profound changes in past years in society’s attitude towards environmental issues have had a strong impact on the principles that underpin environmental teaching.

This theme asks how the present economic crisis and the structural changes underway in the world politically and economically might affect society’s future expectations of environmental design, and how this should influence its teaching.
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Holisticity:
Regenerative Ecosystems
and Political Ecology
in Architectural Education
In the mixture of discursive processes of urban studies, ecology holds a distinct position. Regarding the city, the problems posed by globalization, of mobility of the capital and of hard demands such as infrastructures, public transportation, human resources’ development and profitable industries remain the investments’ attractor and the urban transformations’ catalyst in a highly connected world economy. Simultaneously, the contemporary discourse on creative, virtual and symbolic economy (i.e. R. Barbrook and Sh. Zukin), not only underline the necessity for a spectacular image of the metropolis, its global character, but also describe the cultural forces constituting what will be hereby expressed as urban imaginary, its self-realization. Post - modern thinking of the city (i.e. J. Jacobs, D. Harvey, Chr. Boyer) has proposed a series of contexts that coincide in that they are critical to the homogenizing prospects of modern visions and multifarious strategies of accumulated power regimes, and in an ontological shift towards multiplicity of interpretations.

So, the abundance of approaches, agendas and archetypes towards the meaning of ecology, or the teaching thereof, derives not only from the omnipotence of its content, but also from the contextual elasticity of contemporary, cross-disciplinary and hybrid episteme: from soil biology and water harvesting to apocalyptic discourses of post-industrial scarcity, from “natural” goods turning into commodities to patents of ancient genetic material, and from the hope-marketing of “green” development to meaningful bonds forged under the communal care of the immediate environment. Within this broad spectrum, this paper will try to approach ecology as architecture, which attains - or longs for - a complementary theory and practice. Here, the bipartite proposition of political ecology and regenerative ecosystems’ design corresponds precisely to that.

Sustainability and the design of environments efficiently supportive to the body seem to have given architecture a new “raison d’être”, only to remind us that the perspective of the natural body cannot be obsolete or uninteresting but rather is timeless and “constitutive of conscience at a founding level” (Delanda 1999). From that point on, sustainability as a systemic attribute is understood by Hemenway (2010) as the mid-point between things that are degenerative and regenerative. Regenerative ecosystems induce a certain notion of “ecofunctionalism”, as, more often than not, the regulation of the fauna and flora on the basis of reciprocal connections between ecosystem functions and the vigorous circulation of biomass are concepts that sprout from agroproductive exigencies2.

As many ecological studies like to point out, in the next few years more than half the world population will be living in cities. This, amongst other things, is likely to disrupt the distinction between urban and rural areas, as polycentric, resilient food webs that provide fresh products are becoming of strategic importance. So, in the last decade, landscape architects, urban developers and life scientists have developed new concepts that must enable food production to take its place in the networked metropolis of the 21st century. Metropolitan agriculture consists of complex network of agroproduction, processing, trade and logistics that has been developing in and
around the nodes of the global network since 1970. In fact, as long as urbanization and agriculture are absolutely intertwined, population growth needs rise in agricultural productivity on the one hand and regulation of urban habitat on the other. From there, it leads to a revision of habits and imaginary constructions of urban and ecological becoming: Being a part of an ecosystem comes together with being part of a community—with both terms resounding utopian, neglected and discontinuous.

**Regenerative Ecosystems**

Regenerative cities (Girardet 2011) stand for a *restorative relationship* between cities, their local hinterland and the world beyond, thoroughly linked to new opportunities in financial, technology, policy and business practice. “We need to re-enrich the landscapes on which cities depend. (...) This text argues that the established horizon of urban ecology should be expanded to include all the territories involved in sustaining urban systems. Urban regeneration thus takes on the meaning of eco-regeneration, (...) to learn from nature and shift from a linear to circular urban metabolism”(Girardet 2011). Apart from the symbolic economy (Zukin 2005) of nature, which Girardet irrevocably evokes, the above proposition is, for this paper, a persistent link to the discourses of urbanism and architecture and a resilient reference that intertwines the urban and the rural.

Delanda goes far into exploring the origins of the agroproduction paradigm and its relation to his (and Braudel’s) distinction between markets and anti-markets 3: “(...) the splitting open of the nutrient cycles had important consequences. Every input to food production which came from outside the farm (not only fertilizers but also insecticides and herbicides) was one more point of entry for antimarkets, and hence, it implied a further loss of control by the food producers. While a century and a half ago farms produced most of what they needed (and hence ran on tight nutrient cycles), today American farms receive up to seventy percent of their inputs (including seed) from the outside. Worse yet, the advent of direct genetic manipulation has allowed large corporations to intensify this dependency”(Delanda 1999).

On the antipode, the term holistic often appears to sustainability/regeneration contextualizations, implying a certain integration of ecological technologies, as opposed to the reductionistic approach to that imbued technological ecologies, especially during and after the agrarian revolutions of the 1970s. Permaculture, one such system, is about design highly productive ecosystems, principally forest gardens, that require low input and maintenance once established, by mimicking natural ecosystems in terms of complexity, resilience and stability (Mollison, 1981). Permaculture spread out of two Australian farmers who observed how aboriginal farming practiced horticulture and habitat, and, combining this traditional and cosmological knowledge with the Western mentality of organization, constituted them into a systematic ecosystem design deontology and a card file of techniques. They expanded this deontology into a socio-ethical proposal, that also addressed - at a certain degree - the man-made causes of environmental degeneration and the socio-political involvement that the actualization of these systems presuppose on a broader scale. Permaculture increasingly gains the attention of Western ecological imaginary, as it proposed, from an early time, concepts like LCA (life cycle assessment), closing material loops and nutrient cycles, polyculture, farming, building and terraforming with an integrative ap-
proach - under the multifarious definition of “human settlement”. Their guiding principles include diversity, kinship, symbiosis, reciprocity, and community. Also, urban Permaculture is concerned with the application of growing crops, closing material loops and retrofitting habitats within cities.

There is a debate, however, whether such low scale, low impact, integrated, alternative agro-production could “feed the planet”. One answer is: probably not, yet what about the other systems of agro-production? But, in this thesis, we wish firstly to frame such questions as getting back to the “resourcification” of nature (Luke 2000) such methodologies try to overcome. Secondly, to accentuate the potential of application of these methods in an urban context as primarily symbolic, educative and politically meaningful - however, their symbolic magnitude draws its potential from the very fact that their practices and results are primarily actual. If, as these systems suggest, provide the chance to self-regulate the immediate environment in a reciprocal way, they contribute to both an economic and a collective autonomy. They provide the design tools for establishing reciprocal connections between ecosystem functions - but, more than that, they provide one of the many voices that intertwine these practices with the imaginary re-institution of ecology - a re-institution that involves psychological, artistic and political processes. Whereas this point will be addressed later on, what we will accentuate here is the notion of resilience and the profound impact that it can have on architectural education.

Developed within systems ecology in the 1970s, ‘resilience’ as a science of complex adaptive systems and as an operational strategy of risk management has flourished, progressively asserting itself as a dominant discourse in natural resource management (Millennium Ecosystem Assessment, 2006). The concept of resilience has in the recent past rapidly infiltrated vast areas of the social sciences, becoming a regular, if under-theorized, term of art in discussions of international finance and economic policy, in corporate risk analysis, the psychology of trauma, development policy, urban planning, public health and national security. (Walker and Cooper, 2011)

According to Fred Kirschenmann (2012), the classic definition of resilience is “the capacity of a system to absorb disturbances and still retain the basic functions and structures”. In his context, an agro-ecosystem is resilient to the degree that it maintains its productive capacity without crossing a threshold to different kind of function (i.e. less productivity or collapse) - and if it does succumb to a new, less desired state, that it alone provides the resources and redundancy so that it can continue to produce the goods and services under these new circumstances.

While the concept of resilience is appropriated in numerous discourses, resilience in ecosystems and communities is more or less absent in environmentalism as a globalized consumerism, or as a way to do a “little less bad”. Nevertheless, what differentiates the aesthetic-ethic congregations of these methods from “eco-managerialism” (Luke 2000) is the social imaginary of self-sufficiency, which also extends to low, or at least controlled, heteronomous financial interdependencies. If maximum efficient production for short term economic return, using specialization, simplification and economies of scale and resilient, diverse food webs supportive to resilient and diverse cultures are mutually exclusive and conflicting, what is the purpose and validity of environmental design for innovation? This remains an open question. From there, the dive into a more philosophical approximation is mentioned: are “faux paradis” politically invalid? The question if and how are these conflicts, between the cases
of political engagement in a wide and anonymous urban condition and the cases of insular shelters of applied, yet molecular change, correspond to the different scales of the public realm: transpersonal and hyperpersonal.

**Political Ecology**

Ecological administration is hereby defined as a way to reconfigure the material arrangements and energy flows, according to the particular functionality of ecosystems - the life species involved in a particular system. This rationale may address a multitude of disciplines, most notably engineering and the life sciences. In a similar way, ecological design minimizes environmentally destructive impacts by integrating itself with living processes. Through these fairly straightforward aspects, we will approach the ontologically ambiguous discourse of urban ecology, symmetrical to the ambiguous functionalities of the human species.

Thus, to holistically address ecology, as interrelationship of organisms and their environments, as interrelationship of subjects within relational space, and as economical and political power relations, allows to regard urbanization as processes of metabolic changes – processes that are never socially or ecologically neutral. Thus, the discourse on nature is the means of researching and establishing theoretical frameworks for addressing the political and social aspects of ecology, and to re-signify a corroded terminology. *The word “nature” is used here to encompass two somewhat different clusters of ideas: a menagerie of concrete forms ranging from the human body to parks, gardens or complete ecosystems and an ideological and metaphorical schema for the interpretation of reality* (Heynen et al. 2006).

Both ecological administration, hardly a mere architectural feat, and the constitution of collective subjectivities, hardly resulting (linearly) from a gesture of any urban planner, are crucial for both the cities as symbolic entities and actual habitats, as well as candidates for a meta-class narrative of power and advocates of a use-value based economy. That “there is nothing a priori unnatural about New York City” (Harvey in Heynen et al. 2006) is a way of saying: we shouldn’t frame nature into (actual or virtual) tropical forests, we should be suspicious when discerning between nature and culture - the ecological problem is a political problem. And indeed, there is nothing a priori “unnatural” about anything, since the very notion of ecology permits almost any kind of stretching of terms like “flows”, “systems” and numerous eco- prefixes, the validity of which is left depending only on their contextualization and actual contents. However, one of the challenges of their theoretical approximation is to express the relative character of nature, which is culturally appropriated as a discourse that operates and unfolds on the basis of language and social imaginaries, and to abolish the relativism that some multifarious definitions of nature promote, obscuring their political aptitude under an unconditional inevitability of “emergent” technologies and markets. Or, from a different angle, “to expand the problematique of ecology and to assert that alternative technologies are an issue of limited range does not mean we overlook its importance as a particular struggle. In other words, we oppose those who, in name of a “revolutionary” strategy, question the validity of the ecological project” (Castoriadis 1981).

If ecology raises political questions in ecosystems and regions far away from the sight and dwelling of the many, in cities, it is nothing more than a parameter of geopolitics itself. The city as node in a highly connected world constitute a sum of so-
cio-environmental processes, in which nature and culture produce a hybrid ecology of diachronic material elements (air, water, earth, fire etc.) with contemporary class, gender, ethnic, civil and communal social relations. “Urbanizing nature, though generally portrayed as a technological problem is, in fact, as much part of the politics of life as any other social process” (Heynen et al. 2006). Popular discourses of “ecological urbanism” put the emphasis on functional dynamics of metabolic pathways or the promotion of new forms of bio-diversity as a corollary of social and cultural complexity, though perhaps only an ecologically enriched public realm can new kinds of urban environmental discourses may emerge” (Heynen et al. 2006).

New kinds of environmental discourses, one could argue, are not a subject of ecological administration, but of critical theory. Indeed, it is within the current “ecological imaginary” that nature is mediated, conceptualized and virtualized - often reduced to a “green” product. On the other hand, regenerative administrations are implemented disproportionately less than they are discussed - and in less essential ways than the environmental studies, albeit politically dubious, point out. Regarding that issue, Luke, proposing an analysis of power – knowledge formation in the epistemological constitution of “the environment”, acutely claims that the “resoursification” of nature is first conducted in the relative and relational spaces (Harvey 1992): “Before scientific disciplines and industrial technologies turn its’ matter and energy into products, nature must be transformed by discursive processes into natural resources. Once nature is rendered intelligible through such practices, it is used to legitimate many political projects” (Luke 2002).

The demands for ecology, creativity and territorialization, regarded as primarily political demands, all too often collide with state-market-spectacle mediations and with widely established socio-historical perspectives. At the same time, the regime of urgency and “crisis” as heteronomy intensifies but does not change the issues that they address: the self-institution of urban subjectivities as autonomous, regenerative actants. Moreover, autonomous communities, as a distinct part of Western utopian thinking, adhere to established semantic links of new age stereotypes and individual “salvation” - revisited with the amalgam of eco-high-tech Californian Ideology, “both hip and rich” (Barbrook and Cameron 1995). However, the current conjuncture of well-educated “virtual” workers with precarious labor might provide a new framework for urbanites to deal with alternatives that are technologically feasible, ecologically sound and politically comprehensive. They are hereby used to express the potentiality of applying an example of “disruptive eco-tec” on a basis of networked communities and to visualize scenarios of their operations in a metropolitan continuum, that no longer discusses rural and urban as spatial attributes but as cultural incentives.

Conclusions: Holisticity

The introduction of organic elements and their interactions into architecture proposes a deontology of design that deals with them as structural elements and focuses not only on their mechanical, climatic or otherwise crude physical properties (like shade, evapotranspiration or the capture of aerosols) but also on their ecosystem functions, like energy transactions, biomass circulation and edibility. Similarly, the interaction of animal and human habitat, seen in that way, is neither one of a pet nor one of livestock but one of synergy. Needless to say, this issue has a range of consequences in
the level of socio-ecological imaginary, as it evokes a reevaluation of more or less every psychological and aesthetic attribute regarding the habitat, like spatial patterns, hygiene, movement and accessibility hierarchies, daily functions etc. A passing from a technophilic modernity to a biophilic post-modernity seems more than promising – and in that passing, architectural education can have a significant role. Nevertheless, elucidations of the political realm cannot be expected to be as positive: *Man is no longer man enclosed, but man in debt* (Deleuze 1992). Similarly, the teachings of political ecology go far into questioning the benign stereotypes of nature, and its mediation, thematization and visualization as a “state of being natural” and an ecological myth made part of a virtual commodities mainstream.

The “reality of the ideal” seems to leave the project of ecology, within the architectural discourse, practice and education, loud and meaningless – despite, or rather, due to the current trends of sustainable development, in which the accentuation seems to be the continuation of development, with minor differences. Nevertheless, if ecology is a “strong candidate” as the key point of a major shift in human’s perception and interaction with the world about – a shift with as many dimensions as this perception: epistemological, political, social etc. - then the same is true for technology. And for both, “utopia is always just around the corner, but we never get there” (Barbrook 2006).

More than just fleeting dreams, these narratives of salvation are widely implementable to facilitate exploitative agendas - as environmentalism in design studies facilitate the constitution of nature as object of management with an up-dated role. Under this scope, the very notion of regeneration, whether it stands for the ongoing trends of “urban regeneration” or for “regenerative ecosystem design”, carries a message of betterment, which is neither considered obvious as such, nor politically neutral; it is then crucial to identify not only the practical contents of such a term, but also the theoretical context under whose evaluation is this betterment meaningful, as well as for whom and in what ways. By the same token, what would “post-crisis” mean, if not that crisis are over? Isn’t crisis imminent in capitalist economies? Or is the post-crisis world yet another hope-marketing extravaganza, an affinity to post-discursive syntax, a fugal urge?

This paper attempted to sketch out the concept of holistics as pedagogical deontology, proposing two conceptual tools to approach the object of ecology from an educational design perspective: regenerative ecosystems and political ecology. One could argue that the introduction of agro-ecosystem analysis / synthesis in architecture, even with a holistic methodology and a critical perspective, can be considered slightly “out of the subject”. What it does bring forth is ecological and systemic complexities, in a radically different way than standard environmental design curricula, like bioclimatic features and energy efficiency. Standing in contrast to reductionistic, simplifying and plug-and-play eco-innovations, it proposes to view systems in the whole scheme of scales and time frames, making it, at the very least, an exercise in systems’ thinking and ecological sensibilities. But also, apart from fairly straightforward overlaps with established architectural research bodies like landscape urbanism, urban agriculture and eco-tec fantasies, “there is a dialectic, very much alive, between capitalism on the one hand, and its antithesis, the non-capitalism of the lower level on the other...” (Delanda 1997). It is on the notion of autonomy, that regenerative ecosystems design and political ecology are thought to coincide. But these anti-structures, as in the notion of anthropologist Victor Turner (Faubion 2008), are not a vaguely defined public
entity, the hyper-personal, civilian interest - they are personal and transpersonal subjectivities, that also adjust their practices to the metropolitan exigencies and the crises conjuncture. In that, architectural education can merely try to highlight parameters in the processes of their “subjectifications” and “territorialities” (Deleuze and Guattari 1972) – maybe not to be taught, but, at least mentioned.

Notes

1. To elaborate on this brief statement: Many students, especially those who are poor, intuitively know what the schools do for them. They school them to confuse process and substance. Once these become blurred, a new logic is assumed: the more treatment there is, the better are the results; or, escalation leads to success. The pupil is thereby “schooled” to confuse teaching with learning, grade advancement with education, a diploma with competence, and fluency with the ability to say something new. (Illich 1971)

2. Form is, at best, their material expressivity (Delanda 1999), one of the many dimensions within complex feedback loops. However, the term landscape brings forth the conceptual complexities which can be said to emerge from the evaluation of the place by the projection of cultural values (Kotsakis 2006). In turn, contemporary architectural discursive notions like environments, atmospheres or territories integrate cultural complexities into what is to be appealing to the spirit – so, within the practices of biomimicry, “biomorphism” is an example of the visual order.

3. In short, markets are eslf regulating meshwork market systems where as antimarkets are hierarchical command oligopolies. Delanda argues that “small markets, that is, local markets without too many middlemen, allow the assemblage of human beings by interlocking complementary demands. These markets are indeed, self-organized, decentralized structures: they arise spontaneously without the need for central planning.” (Delanda 1999) “A bottom-up approach to economic modeling should represent institutions as varying mixtures of command and market components, perhaps in the form of combinations of negative feedback loops, which are homogenizing, and positive feedback, which generates heterogeneity.” He adds: “More importantly, one should not romantically identify meshworks with that which is “desirable” or “revolutionary”, since there are situations when they increase the power of hierarchies.” (16)

4. Because in many ways the political question, “Who is the enemy of the environment, and who’s the friend of the environment?” asks you to say, “Well what would a friend of the environment be and what would an enemy of the environment be?” and what it would quickly lead you to probably conclude is the enemy of the environment is us. The people who live pretty high on the global food chain (Luke 2000).

5. Regarding these new exigencies, he mentions the end of cheap energy (currently, 10 kcal of energy for 1 kcal of food), fresh water scarcity, loss of biological health of the soil that cannot absorb and retain water due to external inputs, loss of biodiversity and genetic diversity that are resources for the local adaptation of species, loss of human capital, that is, young farmers and the shift from annual crops to perennial crops.

6. For example, “with the post-911 revolution in “homeland security”, resilience has become a byword among agencies charged with co-ordinating security responses to climate change, critical infrastructure protection, natural disasters, pandemics and terrorism, reorienting these once distinct policy arenas toward a horizon of critical future events which (we are told) we cannot predict or prevent, but merely adapt to by “building resilience” (Walker and Cooper 2012).
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Barge Board, Glassphalt, Bicycle
Phones and “Lover Nature”
"It is a magical, bewitched and inverted world in which Mister Capital and Mistress Earth - social beings and things simultaneously - dance their spectral dance."

Karl Marx, Das Kapital

In the early 19th century the houses in New Orleans were built from barge board. This wood came from dismantled vessels that had floated down the Missouri, the Ohio and the Mississippi to unload their bounty at the mouth of the great river at what was then the nation’s third largest city. The forests of the northern Midwest, themselves a renewable resource, became the vehicle that in turn carried the produce, renewable also, on the available free energy of the rivers. The barge, which had no power of its own and thus could not make the wasteful trip back north, then became houses and the produce was shipped through the port or consumed by the people of Louisiana who themselves, in terms of labor and human ecology, were likewise renewable.

It was the beginning of the 1970s, long before recycling, green and sustainability acquired their current enervated semantics and before they became household words and occasional household practices, and long before they became fashionable clichés, William Donald Schaefer, the ambitious mayor of Baltimore, a city in severe decline, referred to regularly as “The Armpit of the Eastcoast,” instituted a program of “glassphalting.” He also gave the decaying 19th-century industrial town the ridiculous name “Charm City,” a name that has persisted given the well-documented sarcastic humor of the citizens (see John Waters, H.L. Mencken, Frank Zappa, David Byrne, Gertrude Stein and an endless array of lesser, but equally sardonic, notables to be found in the taverns and on the street corners of this crusty metropolis). “Charm City” has caused eyes to roll for 40 years. On the other hand glassphalting was no joke. It involved the use of cullet, the crushed byproduct of local glass companies, donated particularly by the Maryland Glass Corp. (of the blue Bromo Seltzer bottle) and Carr-Lowery Glass Co. The streets were paved in asphalt impregnated with cullet. It was magic. The sad avenues of the fading downtown sparkled at night in the headlights. By day, locating the many colors of glass, particularly the blue Bromo bits in the pavement, was an absurdly ludic distraction from the effort of crossing the hard grid of streets especially in the heavy
humid heat of summer. And it was safer. Headlights reflected in the streets and delineated all that was passing over them. It was economic as well, with a savings of 30 to 40 cents a pound. And it is still there, like “Charm City,” 40 years later - more than twice the life-expectancy of regular asphalt. The irony is that the ‘80s craze for recycling glass, the first material to achieve ecological star status, made the practice of glassphalting untenable, for the producers could sell their cullet for prices with which the municipality of an even more dilapidated Baltimore could no longer compete.²

In a recent discussion with students, the Baltimore architect Jamie Snead spoke of labor relations within a medium-sized office whose exquisite work has raised the local standard appreciably. Discussion centered on the encouragement of a stable-office staff, on an awareness not only of the simple dynamics of a healthy and empathetic workplace but also of one where the skills and imagination of the staff are engaged and thus, reciprocally, where material, facture, and critical response are encouraged. Production, labor, construction, surface, time; the political economy of work thus may resonate with intentional methodologies that address the aesthetic and the technical to produce the exceptional.

In 1851 Joseph Paxton virtually automated the process of constructing the Crystal Palace, itself a gargantuan reification of replicative process and of wise conservation of effort and maximization of materials. The wooden fence that had surrounded the building site and was the first element constructed in the park, was eventually dismantled and became the floor of the vast greenhouse. In the Parco Sant’Elena in Venice, when one of the grove of trees dies, its stump is cut into the rough shape of a chair, thus remembering the plant’s majesty, providing solitary furniture and reducing the cost of the plant’s demise by not having to engage in the costly practice of stump removal on this island where all is done from boats. In the new techno-dynamic India, in 2001 for 1000 citizens there were only 22 conventional telephones, three personal computers and one cellphone! The engineer-activist group GRASSO (Grameen Sanchar Seva Organization) provides bicycle-mounted telephones. The bike generates its own electricity as it moves from village to hamlet. Its operator carries news, gossip and agit-propaganda as well.³
“Environmentalism and even the words ‘environment’ or ‘ecology’ are often associated with a kind of piety about the conservation and protection of animals and plants as well as a holistic understanding of ecological terms. America’s endangered beauty is a kind of palliative, inspiring spiritual reverie and aesthetic appreciation of landscape scenery.”

Keller Easterling, “Terrestrial Networks”

Despite similar examples, systems of infinite sensibility and actual sustainability in an often low-tech interpretation are now regularly overlooked. To garner prestige or serve markets, “high performance,” ostentatious, and more lucrative solutions find favor. Writing nearly 15 years ago, Easterling already noted the degree to which the environment had become a cliché, readily available for appropriation or branding and taught as such in many schools of architecture. The question needs to be asked - is sustainability another consumerist totem, following the automobile, television and devices of advanced information transfer? Like freedom or terrorism, sustainability is a word that has become nearly meaningless given its repetition and the ease with which it legitimizes without challenging the substance of that legitimized. In the academies, but now also in real-estate development, it murmurs of verisimilitude. Even archconservatives, the usual enemies of ecology due to its potential for curtailing the most aggressive strategies of big business, are now embracing the concept. The Heritage Foundation, the think-tank that Ronald Reagan badly needed to help him formulate the asinine concepts that underwrote “evil empire” and supply-side trickle-down economics, published A Guide to Smart Growth. Albeit, the booklet spends most of its effort debunking environmentalism and encouraging “smart,” as in profit-friendly, development. Nevertheless the fact that such a reactionary organization would pay lip-service to these ideas, especially at a moment when neo-conservatism was ascendant following the 2000 faux-election, was a back-handed recognition of the necessity of some sort of balance in any equation that juggles aggressive exploitation and survival.

University departments of architecture now commit themselves to sustainability as a first priority while often not teaching contemporary methods or engaging the
critical issues that must ensue in any such practical/doctrinaire pedagogy. The University of Maryland, where I recently taught, offered two new full-time positions on its architecture faculty, both specializing in sustainability. Fortunately, this search that certainly could be perceived as weirdly myopic given the vectors that press on architectural education, was instead so diluted by the mis- and reinterpretations of this exhausted term that almost any candidate could be perceived as appropriate, thus inviting an essential heterogeneity. Even if it’s the nature of tenured and comfortable faculty not to keep up, in this case protocols are engaged that demand a sense of temporal sequence and thrive on immediacy combined with a profound grasp of history, acknowledging the fact that symbiosis was an essential element of pre-Enlightenment survival.

In the Gulf Emirates, a region with the world’s largest carbon footprint, future super-luxury communities are marketed as “100% sustainable” in a climate, nearly uninhabitable and notoriously exploitive of labor, where that claim is clearly absurd. There it is simple eyewash, another label like Rolex, Louis Vuitton, Hummer, meant to generate status and endorse privilege; like the ever-present Swarovski-studded architectural pantheon - Zaha Hadid, Jean Nouvel, Norman Foster, Ivana Trump (no kidding! – she is titular author of a luxury highrise in Beirut – quote “I really enjoyed designing it!”). In Beirut new towers hosting 5000-plus-square-foot condos drape louvers indiscriminately across their facades disregarding direction but totally aware of the look of progress borrowed from projects a decade old in slick Western design magazines.

Simply, triple skins and photovoltaics intensify the cost and corporate involvement in building. Other than profits, any positive return, in terms of economy and ecology, seems remote especially in a climate like that of Northern Europe where solar-related increases in production time and material complexity promise minimal rewards - except where profits fall abundant and fertile like the coins of Danaë. It is ironic that that region has marketed its meager exposure to the sun whereas the Mediterranean, where such alternative energy would be highly efficient, lags behind in its implementation and in the semantic enthusiasm with which solar energy is met in the north where buildings looking green constitutes the greater part of desirability. That’s the point. It is literally the color. Green is safer than the fading red of the welfare state and more palatable for the economic/political oligarchs who call the shots now more than ever. In a grey and somber climate the color is revitalizing and the concepts it reifies mollifying; politics of advantage for social democracies who suffer from severe loss of leftist nerve in a parsimonious economic climate that seems to have now become permanent. This cycle is well known, much discussed and yet still remains a practical given, presumably because its value lies elsewhere, far from the physical environment, in the pockets of builders and speculators.

Frantic technological development and its transformation into consumer jetsam are endemic side products of Enlightenment thought coupled with concomitant increases in invention/production. The problem that sustainability is trying to address, no matter how theatrically, is only as old materially as the Industrial Revolution, along with modern capitalism and all the technologically empowered advantages and horrors that twine around contemporary life – war, medicine, mobility, comfort, alienation, etc., all of them egregiously destabilizing ecology. Before human systems had to be more or less self-reliant within auto-limiting contexts. In other words the planet had to be casually ecological before 1750, if rather grim for other reasons like feudal-
ism, oppressive religion and disease. It is indeed ironic that many sustainable proposals seem to encourage those very expensive and market-driven solutions that are a major cause of the problem in the first place. Yet we still reach out to industry, and to the economic machinations that underwrite it, for solutions to the problems for which technology and capital are largely responsible. Convoluted construction methods and extravagant resources are anything but ecological. Maintenance demands highly skilled applications and labor. All contribute to the profits of internationally situated corporations while inviting failure and greater costs spiraling in a double helix of means and ends without closure. Any glitch in the smooth and precisely orchestrated green mechanism can bring the process to a halt and requires remedial procedures that again require advanced and esoteric materials and expertise.6

Not so obvious and thus not so financially attractive despite their much greater effect are labor practices, low-tech and local materials and the fair treatment of local unskilled workers, legislative innovations and new techniques that may not involve major industrial dominance of processes. After all, who important sees local employees with jobs, or simple and recycled materials well used, production procedures re-assessed, the workplace relocated - small revolutions in a truly anachronistic building profession? These are much closer to the spirit of “sustainability” but are less ostentatious and produce less revenue for corporations, real estate, designers and politicians.

“…every operation can be directed and performed by men who have been unable to earn living wages in sewer and pavement work, in railroad and house-building work; who have broken down from incompetency in the hat-making and in the painting and glazing lines; and the services of whose sons and grandsons in carrying torch-lights, and stock ing the pri-

marys, must in some way be suitably acknowledged. The whole story is not told in the explanation; but, if it is considered how a constant gravitation in a general direction finally operates through many thousand channels of influence, it will be found to tell a good part of it.”


Poverty and provision of a modicum of comforts in pursuit of decency were major, if not the major, concerns of moderate and leftist administrations in the periods that bracketed World War II. Basic housing or farming were essential topics. The discussion is absolutely essential; how to subsist – to survive, to not so deplete the planet that it becomes unlivable, to coexist and not just with our species. Yet, with alarming repercussions the emphasis has now shifted from “subsistence” to “sustainability” among the dwindling numbers of Americans who still hope to “do good” in relation to a society whose civility is dwindling proportionally. This is a shift with diverse implications. Rhetorical emphasis has switched away from decent living conditions toward iconic rather than systemic issues such as the sun, or recycling, or costly industry-friendly technologies. This polyccephalic discipline encourages such isolated action. All are fundamentally worthy topics but in isolation they can easily be hijacked or devolve into mediatized fetish. Such concerns can underwrite the neoliberal impulse to disengage from the uncomfortable aura of poverty-relieving entitlements in an era when gen-
erosity is declared to be untenable and the rich focus on consolidating their increasingly disproportionate gains, on abandoning the ghettos to what are self-servingly perceived as their own destructive impulses.

Sustainability has now largely taken over as a primary focus in academic, governmental and business ventures that address the civil. Given lucrative green practices and the aforementioned privileged segments of society they primarily address such hermeneutics are predictable. Sustainability’s protagonists have moved up in class and its direction is from the top. Constituting another form of spurious “trickle down” in the U.S., sustainability gestures almost exclusively toward those in a position to afford its costly and time-consuming practices. It must eventually benefit everyone to some extent but its target is more exclusive, its price tag usually prohibitive. The environment often becomes a neo-Pastoral excuse for bypassing indigenous, low-income workers, low-tech high-yield practices, local materials and labor forces and regional initiatives. Furthermore it can be used to marginalize the poor, physically as in parks separating races, or conceptually in the sense that the poor themselves can be thus viewed as a form of pollution, to be suppressed, quarantined or deleted in an act that “sustains” healthy society. The ghetto thus becomes a mortal brownfield to be re-landscaped. Avoidance of the concerns that made subsistence obligatory is a subtext that responds to pressure from American political/economy to ignore the lucrative danse macabre that now shapes culture. Such choreography moves, by definition, toward the right. Although sustainability’s activists would presumably argue the opposite and give good examples, the overall texture tends toward the socially exclusive and fiscally prohibitive. This is a glaring example of the evidently unconscious cloaking of commercial interest, conventional civic structure and covert forms of discrimination under the cover of apparently benevolent causes.

Sustainability is often a pretext not only for spending big-business money on costly solutions but also for importing “experts” of all kinds who are uncannily like the usual high-paid consultants offering placebos that bleed the economy without substantial contribution. In addition, the formal pyrotechnics that are often coupled with sustainability when it encounters design are both extremely expensive and demand specialty applications that further serve the market and the neo-liberal politics that thrive on things super-consumerist cheap or super-exclusive expensive marketed to a society increasingly divided along similar lines. Finding a middle ground or another ground between or outside these two motives is perhaps the role that sustainability could manifest but rarely does due to the comfort that not doing so provides within professional and academic venues that are innately conservative.

From profits to prophets, contemporary polemics support spending as the solution. Indeed it is inevitable that change will occur over time and urbanism will bear the beauty marks and scars of that process, will be pummeled by revolution and tainted by the conventional. Yet change is composed more of means than spirit. While the devices and methods with which societies confront the contemporary and anticipate the future may transform, basic cultural issues remain numbingly static. A cathedral in 1300 or its equivalent, a train station in 1900, projected quite similar desires through transcendental space. Passions at the level of the collective persist while the medium of their expression modernizes. Nevertheless ecstasy and providence thrust again to the forefront in the proclamations of an amnesia-ridden critical community cranked up on disengaged zeal, again avoiding the rude issues that accompany engagement.
Onward with an eager and consumer-product-promoting fervor that avoids the facts of urban production and economy! The death of theory and particularly history lends itself to such grandstanding, extolling a future that looks anything but promising to those who still care to notice.

“What exactly those pleasures are is difficult to put into worlds. They include enjoyment, the stimulation of the senses, beauty; durability and an unobtrusive usefulness…The coincidence of sensual maximalism and spatial and systemic minimalism make sustainable design an oxymoron of intriguing potential.”

Matthias Sauerbruch,
“Sustainability and the Pleasure of Architecture”

Sauerbruch’s mention of the impossible cohabitation of certain cardinal principles again recognizes the latent energy of modern contradiction, a theme that reappears persistently when dealing with culture and its products. In this case the glaring inconsistency can easily become the key for its actual effective implementation. A good example for such endeavors is ecofeminism making the apt comparison of women and the environment as subjugated entities with complex relations to both power and making. For this discussion the relative structures of sexuality and land within an ongoing cultural context thereby uniting political and geographical ecologies find direct causal and methodological conditions. They initiate a dialogue in which sustainability may find real traction. The discourse on access and control of resources, whether it pertains to material or gender, and the interaction with class and ethnicity, provide a model that can then return to the environmental disciplines from which ecofeminism came. Radical realignment can be seen as a symbiosis with both the existing and the imagined. This seems to offer an intriguing response to some tough questions. But it has nothing to do with the residual Pastoralism that links ecology to simplistic notions of the “natural.”

Annie Sprinkle and Elizabeth Stevens’ eco-sexology moves from Mother Nature, or Marx’s “Mistress Earth” for that matter, to “Lover Nature.” While laced with a healthy dose of humor, they do seriously offer a critical assessment of the relation to the human conceit that is “nature.” A mother is dominant, imperious and invites rebelliousness in her brood. Sprinkle points out that this attitude, in relation to the environment, leads to the arrogant disregard of an adolescent both manifested in the “whatever” attitude of business and the disregard of often desperate populations. The mistress is marginal and subservient, at least economically. The lover meanwhile demands the formulas of passion; respect, negotiation, compromise, affection, appetite, sustenance. Perhaps even the rhythms of the erotic can have metaphoric implications.

In any case, one doesn’t have to embrace the “raw and cooked” to say that ancient and “primitive” societies have always had to have a local view of sustainability. History illuminates in this case. And ecology has been superficially defined by its association to hippies and back-to-nature types. As typified by current Northern European enthusiasms that rely on complex and costly streamlining of ineffecutal energy consumption or by the neo-Arcadian gestures of American eco-architecture, the projecting of “green” solutions can tend to contribute finally to the tunnel-vision and self-righteous-
ness that any ecological viewpoint must repudiate to be effective, given that these are symptoms of terminal imbalance. This intricate ecological phenomenon depends on the acknowledgment of the interdependence of systems within a transforming structure, if it is social/psychological as in ecofeminism, or environmental as in the classical origin of the term. Actually the two are just sides of the same coin. It is the recognition and equilibrium of interdependencies that tends to define an ecology - a set of relations, a collective symbiosis. Despite design’s compulsion to reduce all ideology to simple form, ecology cannot be manifested as a material (i.e. wood, rammed earth), a shape (i.e. biomorph, non-orthogonal), a slogan (i.e. green, sustainable) or a sanctimony. These offer a buzz without assessment of the implications of one choice in reciprocal relation to others, and this is the point of ecology. For instance, are insulation, solar energy utilization or “green material” selection enough standing alone? Do they even achieve much without the context of a comprehensive strategy or a reassessment of labor relations and production practices? Are they preeminent over the political economy of transport or reinvestment in and training of indigent workforces or the reevaluation of the archaic practice of building on-site as opposed to the renovation of redundant industrial space for the production of modular building elements? But, again, such practices are not profitable for those in power! Their cheapness and practicality require suppression. Is energy really something that comes exclusively from the sun, or fossils, or generators or is it as much that hoary old problem of work and management, of biological political/economy, of geography? Isn’t energy a dynamic, not a thing? It involves material, labor relations, expectations and the imminence of a future that may not happen.

Actual sustainability could reflect low initial cost through original practices, generate a small footprint by subversive means, rely on renewable and recycled materials, speed production through local action and employ an amenable indigenous low-skill workforce with solutions that are simple to implement. While offering undeniable value from a humanist position on a basic level, the concept tends to devolve under the pressure of late-capital and dogma. Its immediate value seems to be mostly propagandistic or simply stylish. And, like all incantations, it can nurture avoidance. For it to work on the level of architectural production or urban design, sustainability must be scrutinized more deeply than flamboyant, often ludicrously ineffectual, solutions. Instead of focusing entirely on a “natural” environment that can only exist by implementing a romantic and outmoded belief in “the separation of man and nature”, why not focus on work’s site-specific protocols, or its relation to capital, or methods that are simple, sensible, cheap, humane and use community resources – in an ecologically balanced production cycle? Furthermore this could become a critical area in which design theory could seem much less irrelevant and be much more erudite, rather than continuing to desperately search for new shapes to subject to what Manfredo Tafuri condemns as “operative criticism.”

A form of eco-urbanism seems a viable response to some of these questions. A symbiotic city recognizes class interdependencies as manifested in urban form and as a form of ecology themselves; acknowledging the reciprocity of public and private space, infrastructure and fabric, ordinances and interpretations, all these infinitely complex communions that form cities. One system of occupation and survival is very like another. NOTE: none is more or less “natural” than the other since all are products of animals and climate. Settlements and cities are more akin than they seem since
they acknowledge, by their very existence, the interdependencies of human actions, structures and circulation with workforces, capital and desire. Cities are ecologies that often malfunction and sometimes die... like bird's nests or ant's hills. Isn't the urban by nature an issue of sustainability given that in some way it must be social to function? Cities are smooth or rough ecologies, efficient and symbiotic or dysfunctional and cannibalistic, fair or exploitive, but they reflect the inevitable rhythms and exchanges that their inhabitants must assume to survive. Planning has, at times, verged on such models in its morphological/economic descriptions and this may be one of the reasons that geography has become an umbrella discipline. It identifies the most viable elements of a systematic civility, sows the ripe field of eco-urbanism. In fact ecological readings of the city subliminally guide many urban contemporary design proposals. These offer a range of dependent responses, proposing interactions rather than precise forms, thus mirroring the inevitable synergies that have always characterized the development of communities. Glassphalt, barge board, humane and experimental office practice, a recycled fence, stump chairs, bicycle phones; all propose models that can be implemented at metropolitan scales... or at the most intimate.

Notes
6. In 1947 the Soviets released what has become the most successful (prolific, popular, iconic, lethal) weapon of the second half of the Industrial Revolution, the AK47 or Kalashnikov assault rifle. (Avtomat Kalashnikova [Russian: Автомат Калашникова]). It was adapted from the German StG 44 (Sturmgewehr 44) designed in 1942, a refined and precise gun that could have changed the balance of conflict had Nazi production levels of this first assault rifle reached desired levels. On the other hand the Soviet success with this weapon was in its lack of meticulousness. It’s tolerances are large, it’s materials rough and easy to replicate or adjust. In other words it is a crude mechanism that was therefore extraordinarily durable, rough, a common-sense object designed to take and thus deliver punishment. This strategy pertained as well to more sophisticated Soviet weapons such as tanks and planes, all of which were simple, inexpensive and thus could be prolifically manufactured at fractions of the costs of those produced by the Russian’s capitalist adversaries. The assault rifle also served Soviet battlefield tactics which depended on frontal assault with great losses to both sides where automatic weapons became preeminent over more accurate aimed fire. The U.S. finally released its light assault rifle nearly 15 years after. The M16 is a delicate weapon, it was first used in Vietnam and had problems with jamming that required refined maintenance. Many U.S. soldiers took AK’s from the enemy and used them as a preferred weapon. Many others paid with their lives for the greed of the weapons industry. The M16’s cost is about three times that of the AK. This sophisticated and
intentionally expensive weapon certainly produced extraordinary revenue for the Colt Firearms Corporation but was much less dependable than the globally popular AK. This is merely a well documented example of such systems that generate great success and wealth within limited boundaries but whose precision is inappropriate to the rougher applications of everyday life.


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A Sustainable Method for a Social Living
The inescapable energy resources crisis scenario, together with the massive challenges brought by climate changes, represent the motives which give rise to the cultural debates on the role of architecture as an instrument to control ecological mechanisms related to urban and environmental contexts. This premise brings forward the necessity to amalgamate the project design related to environmental sustainability, along with its economical and social aspects, transforming the architectural subject-matter in the discipline with the ability to unite multiple points of views and more theories. Such a discipline must give concrete answers, in order to frame baselines on which to formulate hypotheses and declinations as answers to the requirements expressed and in order to be significantly incisive on the global economy of a given city. If on one hand the debate on architectural sustainability has brought an enormous development on the research regarding themes on buildings, on the other hand, it shows a late attention towards project attention on an urban scale, which however possesses ample spaces for innovation on a social, political and programming scale of this theme.

Over the last decade, the wellbeing of inhabitable spaces has never been the fruit of a sane planning scheme capable of taking advantage of local climatic conditions, but the tendency has been that of reproducing identical manufactured goods within the various climatic zones. Internal comfort has always been delegated to technological systems and machinery rather than qualitative planning. In fact today we inherit buildings which consume on average 160kWh per mq, a value equal to over 100kg of CO₂, figure equal to that amount emitted in the ecosystem each year. Different realized projects, such as the Solar City example in Linz, or the Bit Park in Mallorca, have adopted, in the last few years, planning strategies sensitive to the context and to the climatic conditions, promoting new lines of research which are still innovative; but despite the high planning quality, the sustainable districts and interventions aimed at suitable building energy consumption on large scale, cannot yet define a replicable method yet, and so remains an isolated case, as in the aforementioned Spanish project. As Alberto Clementi states, within the preface of Ester Zazzeri’s text (2010:9), it now seems obvious that there is a substantial delay in planning discipline with regards to the sustainable theme in its holistic meaning on an urban scale; if in fact in the modern ‘through urban planning and architecture, we have invented the theme of hygiene’ (the Ville Radieuse is the most notable example), today, on this subject, technological, comparative and scientific approaches seem more prominent with regards to composite and planning approaches.

Consequences of such a delay are evident in the coordination errors within each sector, which often render such proposals technologically ineffective, always more present in northern Europe. This rises the necessity of systematically defining, an architectural approach to urban planning of housing: a method where composite, functional and sustainable approaches are closely tied together in their several global definitions. The omen is a summary of concept of urban sustainable composition in which the environmental quality is judged firstly within the choices about settle, within the problem of relative management of the measure congruent with unoccupied and built place, within responsibility of services closely related with regulatory framework and finally within technological solutions of individual buildings. The logic is to adopt, as Casini says in Costruire l’Ambiente (2009:42), ‘in construction industry a holistic approach to planning that follows the Life Cycle Thinking collective principle aimed at
reckoning with environmental social and economic relapses within planning choices about the whole life cycle of building from locating place to building, to management, to disposals and recycling material as from cradle to cradle. But the inflexibility of the sustainable planning for urban scale comes from a political complex and platy background composed not only by principles and aims but also by European administrative directives (for example the Toledo Declaration (2010) or the more recent Project 20-20-20. According to this last European directive by 2020 it will be necessary to save 20% of the present energy consumption thanks to adoption of more meticulous standards on new buildings (for example the new sustainable quarters) or to those that are subjects of important retrofit interventions (into building recycling of urban concentration). In particular, Project 20-20-20 considers, as Casini writes (2009:32), ‘energy saving of 60-80 Mtep/year by 2020, corresponding to 5-6% of energy final consumption within the UE in 2020. A reduction of CO of 160/210 Mtep/year by the same year, corresponding to 4-4% of the total emission of CO ad the possibility to create from 280.000 to 450.000 new workplaces by 2020 especially into construction sector, of certification, of energy audit and of heating plant and air conditioning inspection. So this initiative helps not only to guarantee a strong effect on energy saving and environmental respect, but also to create work in a stagnant sector (until now).

The employment growth would be stimulated by the necessity to make new technological systems and components suitable for more efficient buildings. Unavoidable rules, that can help every aspect of economic, social and environmental sustainability. Architecture schools will have to learn to answer to these rules not only for a legal compliance of products, but above all to give an instrument useful to community aimed to guarantee the wellness of urban ecosystem. This legislation aims to create rules and lines that should be followed for the development of a compact city where new quarters can find gain, by sustainability, the relation with the context, build according to biodiversity respect, identifying the method able to integrate architectonic composition with eco-friendly projects. The purpose of the research is therefore to reach a definition of the concept of Sustainable Urban Composition in this complex and necessary scenery. In an attempt to make sense of the problem, it’s possible to identify more different ways in the contextual relations, defined in terms of the relationship with the place and in the implementation of innovative technological solution.

A purely technological way in which solutions come from arguments made on building envelopes, available on solar thermal plant settlement and good ventilation of open spaces, is represented by the already mentioned case of Linz, the Solar City designed by T. Herzog, R. Rogers and N. Foster in Austria. In this kind of urban project the biological and technological knowledge are combined in favor of urbanism. Solar City, however, presenting a limit design, dictated by the absence of characters in context. While this project represents an excellent example for the neighborhood’s environmental quality of the excessive experimentation of the technological innovation defines a serial model, which can be repeated in every city belonging to the same hemisphere. Solar City does not actually succeed in forming relationships with the city of incisive membership, contrary to the case of Montecorvo Eco-Ciudad, (Logrono, Spain); a project designed by the group MVRDV. The project is characterized by a careful approach to the context: the great landmark is built close to the headland (adjacent to the town center), it opens himself to the exterminated solar fields of the Spanish landscape, according to the topography of the area. The design choice is to
densify the required quantities in a single building, favoring the permeability of the soil. The area available is thus destined to park for more than 70%. The line-built is cut close to the difference in height, dictated by the orography of the land, so it can create a *mirador*, an artificial terrace overlooking the valley and opened to a roof garden placed along the roof/ground floor as the expedient of Vaccaro in Ponte Mammolo for the INA-CASA, a method described by Carfagna (2012). A social place that cultivates urban orchard, meeting, living... The alienation that a single serial long building could generate is excluded from the treatment of the skin of the building itself, which is constantly changing, reinventing (an inescapable reference to the historic Castilian and more generally in Europe). In this case the importance of open and meeting space (the valley and the mirador) and the construction of sociality of the neighborhood is precedence over technological choices. But could an hybrid way between these two approaches be identified? The one marked by the technological innovation and the second aimed at building social spaces? *Est modus in rebus*? The opportunity useful to test an integrated approach between the two ways identified, was the contest *PASS: Progetto per Abitazioni Sociali Sostenibili* (project for social and sustainable

![Fig. 1](image_url)

The project of the contextual masterplan provides for the redesign of the open spaces through the intervention supported between public and private entities. Recovery and redesign of abandoned spaces allows the construction of new places aimed for socializing in the neighborhood. Rendering by the Author.
The competition announcement, promoted by ATER and won by Espegel Alonso on 2010, wants to recover the degraded area of *S. Maria del Soccorso* through 4 principal themes: quarter reshaping, increase of 120 popular houses (stationed in porch floor and in the roofs of building), integration of new services and retrofit of present product. The competition announcement, released by regional governmental authority, is an example of the answer to political legislation and to the natural need to recovering degraded area of cities. The PASS was contended with the aim to define an approach between energy, planning and social sustainability during the different moments of the intervention. Proposal’s quality has been certified through *protocol ITACA*, adopting intervention’s spheres of the protocol from the project to guarantee the project’s effectiveness about environmental sustainability by legal planning. Design proposition, thanks to interdisciplinary contribution and virtual environmental test (by Ecotect, Vasari and ENVI-met software) aims to define instruments for saving urban areas, considering economical, social and environmental sustainability. Solutions adapt creativity to local identity, by valuing ex-agricultural and permeable areas' resources, making empty urban areas dense and making mobility sustainable. The feasibility of the project can be guaranteed by an implementation schedule, achievable if there’s collaboration between public and private companies.

The aim is to change private areas to ones characterized by a new sense of collectivity, using again social experiences of neighborhoods houses of INA-CASA by reshap- ing open spaces according to the landscape project. Open spaces are regenerated, through an efficient waste material management the arrangement of water collection, and also the introduction of urban vegetable gardens and agricultural and food park, in order to stimulate the citizens’s creativity and promote sociality in the area. It is an attempt to bring people closer to the district, hoping for a plan of action focused on the encounter between people and public authorities, encouraging self management of the district as well, in order to build a politic sociality. The abandoned green areas are converted into vegetable gardens and urban orchards, with a double aim: helping the economic development of the district and, at the same time, teaching the inhabitants of Tiburtino a healthy and ‘sustainable’ diet, thanks to the social aggregation brought by the urban vegetable gardens. Green areas gain, therefore, an extraordinary value, through the appreciation of the agricultural resource offered by the *ex-agro romano* ground, and giving back the area a vegetable harvest as the time of the *borgata*. Exactly in that year, the orchard cultivated on the menders of the Aniene river (the Victory Orchard), that were characteristic of that agricultural landscape, provided for the scarce economic development of that area. But the substantial feature of the contemporary urban orchard, compared with their first diffusion as small allotments used for family sustenance, is to be found in the social status change. Even if there are experiments of vegetable gardens interpreted as sheer economic integration, the occurrence causes a wide interest due to the high social value. The economic crisis, in fact, has converted the tendency to urbanization, promoting the development of the agricultural gardening as a recovery device of the abandoned areas or promoting agriculture as improving means for the quality of the urban life through integrated programmes (such as the *Paunsdorf Siedlung* of Lipsia or *IBA projects* of Amburgo). Disregarding therefore the different explanations, it becomes easy to register the sensitive growth of the demand to cultivate vegetables inside the cities, perceived by each social class, so it is
The characterization of the courts, mediating the insertion of new services, managed by the neighborhood units, allows the recovery of degraded areas and the construction of a meeting places.

Measuring the quality of the environment, the architectural value of new residences is defined by the opened spaces. Patios and terraces become flexible spaces designed to solarium or urban orchard, depending on the needs of the inhabitants. In the background solar chimneys define the new image of the city. Rendering by the author.

more evident the importance of this theme is highlighted regarding the coordination between the social integration and the political management of the Smart City. But the final aim of the project is to define a system, with easily recognizable characters and language, able to give sense to the complexity of the area and to guarantee integrated processes of participation and composition, realization and management.
It is implemented the thesis promoted by Dierna and Orlandi, in *Buone Pratiche per il Quartiere Ecologico* (2007), according to which “the transformation of the territory must have a suitable feature regarding the natural dynamics, and try to replicate, if possible, high grades of naturality and biological nets”. Working therefore on the quality of the open spaces, the ex hamlet is completely redesigned: the different functions and the new services thematize the space between the houses and remodelate the hierarchy (attraction places in the courts and neighboring unity suitable places in the internal squares). The new cycle path becomes a central point of the life in the district, offering skating, sport and resting areas. Along Via Mozart, the stairs are converted in a solar chimney, guaranteeing the ventilation of the houses and qualifying the street front as the new totem of the contemporary city.

The arcade floors are rescued, introducing commercial areas and new sustainable houses. The *no-place* is therefore filled by terraced houses, that, together with the new detached houses disposed in the coverings of the already existing manufactures, offer a varied typological complexity to the district, letting also to reshape the fifth facade of the buildings; a complex formal competition, especially in the comparison between the solid of the terraced house and the void of the courtyard. Moreover, every single house has been designed in respect to the architectonic scale, in order to guarantee a proper use of the already existing skylight passages and to avoid demolitions, reusing the existing masonries. A projectual event, that of the PASS, whose experimental value is highlighted thanks to a recent housing tendency, according to which its main aim is a high social and environmental quality of the housing unity and a low cost of construction and production. Even if the housing theme is a projectual topos since the beginning of the history of the Architecture, the three-sided dimension of sustainability (economic-social-environmental) makes it extremely unique and necessary.

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The *new machine à habiter* proposed recovery plan coverage. On the left the current state of the buildings, on the right a view of the interior of a unit-housing type. In the background, the urban gardens on the private patio. Rendering by the author.
According to this, the European housing experiences try to respond to those features, registering the social change, the change in the modus vivendi of the contemporary man, of his economic and affective instability, supporting the flexibility and transformation of spaces, the functional mixtè and the social dimension of the project, in order to give a more varied housing offer. The architectonic landscape shows, as a matter of facts, new machine à habiter, transformed in true technological tools, where research offers new models, depending on the habitability, flexibility, differentiation of use and fruition; but also different variations on the installation side, such as solar capitation, refreshing and warming, rescue and reuse of the rain-water, waste material management et cetera... For the roofing, kerlite 20 kWp photovoltaic modules have been installed as well as solar thermal modules capable of covering 60% of the annual need for ACS. Climatic glass-houses, capable of ensuring 3W/m² passive internal throughputs, have been installed in south-oriented balconies of buildings. Furthermore, the existing heating system will be replaced with a high-performance air/water hydronic heat pump. The flexibility of energy supply, the use of a mix of renewable energies, the new degree of thermal isolation, and the expected passive gain that have been foreseen will result in minimum thermal needs. The economic feasibility of the intervention is guaranteed by the funds made available by the call for tenders and by the incentives foreseen by the Development Decree 2012 DL 22/06/12 No 83, on top of the rewarding tariffs established by the Energy Account with the consequent reduction of the investment pay-back. The economic dimension of the investment becomes particularly relevant in the light of the market surveys carried out in the sector of construction, which anticipate a 15% increase of market values of ecologic buildings (an appreciation similar to the one registered half a century ago for the availability of electricity and potable water).
The aim is the definition of designing processes that can have an objective value and therefore be certifiable, so as to yield an architectural quality promoted by a politically coordinated management. In the specific case of PASS, construction quality endeavors to comply with the definition given by the UNI norm 10838:1999 according to which construction quality can be summarized as ‘the ensemble of properties and features of the built organism, or parts of it, that enable it to satisfy, through its performance, explicit or implicit needs’ and, at the same time, to provide a response to the technicalities of the 20-20-20 Project. The global outcome of the intervention has in fact been estimated at 30% lower consumption compared to the current buildings. In this perspective the management, the planning and therefore the policy inherent to the intervention become the fourth dimension of urban sustainability, the fundamental step that can constitute the basis of the inter-sectorial coordination necessary to start the recovery of parts of cities. As already mentioned, the regional company ATER has played the main start-up role in the proposed example, but the geographic and economic limit does not allow the call to turn the Tiburtino III into an opportunity to have a significant impact on the global economy of the city. Therefore the need arises for further coordination between the different administrations at regional, province and municipality level, to operate jointly with the relevant private entities. In the absence of political coordination, the triple social dimension (social, economic, and environmental) of urban sustainability might remain isolated with the pilot case, without evolving into a method: a method that would be useful not only to perform energy savings with building patrimony, but also to the achievement of a new citizens awareness of belonging to a place that they have perceived as filthy and abandoned so far. In this logic, policy must define a planning able to identify the choice of the different interventions and their respective degrees of priority on the grounds of the real estate and financial resources and of the correlation between energy and social needs.

Fig. 6
Compared to the legal framework mentioned, it is natural thinking of the political governance as a fourth dimension of the sustainability. Without it, integrated experiences such as the PASS, aimed at the recovery and reconstruction of the sense of belonging of the inhabitants, could hardly exist.
It has in fact to be underlined that the proposed urban project does not have to be understood as an ultimate contribution to the sustainable development of the city; the goal of a sustainable city cannot be achieved through few and limited recovery activities, as pointed out by the above-mentioned Zazzero (2010:185) in its research: ‘These topics highlight the need to evaluate in-depth the current degree of sustainability in the city, and the variation of this degree owing to punctual actions’. Signals from the administrations\textsuperscript{19} side, be they national, regional or municipal, remain contradictory, due to the lack of integrated projects beyond single episodes. However, the EU positions allow for hoping in a possible coordination between the ministry of infrastructures, regional and municipal entities, and private actors, so as to inaugurate, in a future not too far away, a new method of inter-institutional partnership that has been so far lacking in our approach to territorial management\textsuperscript{20}. An additional element of evidence that political coordination constitutes the fourth and most important dimension of urban sustainability.

Notes

1. The strategies for proper orientation of buildings and the technological innovations used in the project are well explained in Hastings, R & Wall, M 2009, \textit{Sustainable Solar Housing: Strategies And Solutions}, Volume 1, Sterling, VA : Earthscan

2. Quotation translated by the author.

3. The global definition of sustainability, in the economic, environmental and social mean, is dictated by the many trends emerged in contemporary publications and call conference. This kind of trend and his definition is well explained in Grondzik, WT & Kwok, A G 2011, \textit{The Green Studio Handbook - Enviromental Strategies for Schematic Design}, USA: Architectural Press

4. Quotation translated by the author.


6. Quotation translated by the author.

7. For the basic principle of the system settlement, the proper orientation of buildings, in this regard see Herzog, T 2008, \textit{Solar charter}, Cesky Tesin: Prest publishing

8. The text makes reference to international pilot experience about the sustainability districts. For more details, see Zazzero, C 2010, \textit{Progettare Green City}, Trento: List Lab

9. The results of the competition were collected and published within Annese, M & Del Brocco, B 2012, \textit{PASS: Progetto per Abitazioni Sociali e Sostenibili. Tiburtino III}, Roma: Gangemi Editore


11. Building a new context masterplan, tried to involve the municipal and private entities subject inside of the project recovery. Through this device, it was possible to expand the themes of the com-petition at the PdZ 15bis, otherwise related to the ATER’s property area. The political governance ensures the feasibility of the re-design of the built environment.

12. On the importance of the urban orchard, useful for the construction of place’s sociality, see about \textit{Lotus} n° 149 (2012)

13. Concerning the experimental project, there have been taken into consideration not only the biophysical aspects and the technological factors as evaluation tools, but also the flexibility and diffusion aspects, from the proper management of the housing system and its measure, its
energetic analysis, in order to define the features to be used to project the thermo-hygrometric elements of control of the urban public areas

14. Quotation translated by the author.

15. The social character of the courts, the hierarchy of the open spaces between the houses and the design of meeting’s place in the social district are a leit-move of the INA-CASA experiences. The social construction of the living places is a topos that attversa the of the contemporary history of the nation. For more details, see Carfagna, D 2012, L’architettura tra le case - abitare lo spazio aperto nei quartieri ina-casa, Città di Castello (pg): Alinea edizioni

16. The typological variety proposal is a direct expression of the new trends of the international scene for living. The evolution of houses unit and choice of settlement of the urban project, refer to the texts Arpa, J, Fernandez Per, A & Mozas J 2011, Density is home, Vitoria-Gasteiz, Spain: A+t Architecture Publisher and Fernandez Per, A, Mozas, J & Ollero A S 2013, 10 Stories of collective house, Vitoria-Gasteiz, Spain: A+t Architecture Publisher

17. The reference is the complete works of Le Corbusier for the development that has given to the issue of residence. In particular, see about Le Corbusier, 1961, L’Urbanistica dei Tre Insediamenti Umani, Milano: Edizioni Comunità

18. Quotation translated by the author.

19. Quotation translated by the author.

20. Quotation translated by the author.

References


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From Polybius to Dadaab: Traumatic Urbanization in Age of Man-Made Climate Change
The 2007 *Fourth Assessment Report* published by the Intergovernmental Panel on Climate Change (IPCC) estimates that 145 million people will be permanently displaced from their homes in the next 90 years due to man-made climate change (IPCC, 2007). This number is more than three times the number of people displaced today by wars, famine and natural disasters and is expected to rise when the 2013 IPCC report is issued (NYT, 2013). The global economic, social and political disruption that will result from enormous population shifts is incalculable. And yet little is being done within the humanitarian aid regime to create strategies for feeding and sheltering this destabilizing human tidal wave.

Perhaps it is the sheer scale of this immanent humanitarian crisis that limits our ability to conceive of more appropriate responses. After all, how can one imagine constructing the shelter, water, food, sanitation, energy, education, security and healthcare infrastructures needed to support a displaced population equal to the population of London? Imagining the scale of this undertaking becomes even more daunting when one realizes that this imagined new city is on the far side of the globe and that the equivalent of eighteen Londons will be needed (Potter, 2013).

Another constraint on our ability to conceive of the scale of this crisis stems from the common misconception that impacts will be slow and incremental. We in the Global North discuss the impact of climate change in terms of gradually rising seas or slowly infiltrating deserts; we do not see the immediacy of the crisis. We allow ourselves to think that people will have time to consider their options and make intentional moves out of harm’s way. We hopefully resign the responsibility of reversing climate change to advances in science and engineering. The reality, of course, is that catastrophic climate events displace countless thousands overnight. Rather than find-

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Fig. 1
Aerial photograph of traumatic urbanization development in Port au Prince, Haiti following the 12 January 2010 earthquake (Photo by author).
ing solace and security in the homes of extended families living in urban centers— the preferred and naive approach to sheltering the displaced in the humanitarian aid regime— huge populations will find themselves struggling to survive in areas destroyed by cyclones, fires or flooding.

For the last hundred years or so, the most visible humanitarian response to mass migration in the aftermath of catastrophes has been the establishment of “refugee camps.” Characterized by long rows of tents, this strategy has its origins the Roman Republican Army’s desire to systematically organize its legions on the battlefield (Polybius, 1923). Machiavelli’s use of The Histories by Polybius in the 16th C. led to the continued use of gridded army camps in Europe through the end of the 19th C and beyond (Machiavelli, 2003). By the beginning of World War I, abandoned military camps (left behind as battlefronts moved) were co-opted by humanitarian relief organizations to shelter families displaced by the war (Schmidt, 2003: 2.1). As the humanitarian relief regime expanded its mandate to address shelter needs in non-military relief situations the military camp model was uncritically adopted to organize displace people throughout the world. Not only does the grid form of a military camp create a panopticon-like opportunity to control occupants, the organization itself is alienating. Already destabilized, civilians face significant psychosocial challenges in the face of their new living arrangements (Williams, 1990).

Fig. 2
Typical post-Machiavelli diagram showing a Roman Military Camp Plan as described by Polybius. This image is from Lipsius, Justus, 1547-1606, De militia romana, libre quinque; commentarios ad Polybivm, printed in 1614 (Library of Congress Special Collections. Photograph by author).
The adoption of a military organizational model has resulted in a range of additional issues for those living in the camps including a devaluation of basic human rights (Agier, 2008), dramatic increase in violence (especially against women and children) (Lischer, 2005), increased levels of disease (Sinha, 2012), disruptions in childhood education (Crisp, et al., 2001), as well as dramatic environmental damage (UNHCR, 2001).

Fig. 3
Displacement camp built on near level field near Port au Prince, Haiti. This is the area where the first cases of cholera in Haiti were reported following the 2010 earthquake (Photograph by author).

Fig. 4
Syrian refugee camp under construction 30 km East of Kilis, Turkey, March 2013. Prefabricated shelters with running water, sanitation and electricity surrounded by a 4m high concrete wall (Photograph by author).
In addition to the rows of tents, contemporary refugee camps theoretically share the Roman preference for flat and open land. However, without the resources to level strategic locations, today many refugee camps are built using the military grid, but without consideration of the most obvious of topographies which leads to further erosion and sanitation concerns. Despite the astounding number of people currently housed in Refugee Camps (more than 5.8 million by some estimates (Schmidt, 2003: 1.0), and the inevitable and dramatic increase in that number due to man-made climate change, little is being done today to improve the global response to traumatic urbanization, even though most experts now agree that these provisional military cities are a poor response for housing civilians in light of universal human rights.

Recent events in Syria, for example, illustrate that even when a massive financial commitment to sheltering refugees is made, the urban design solutions underscore the military metaphysic of contemporary humanitarian aid efforts (Mills, 2000). Cities for thousands of refugees, complete with water, sanitation and power infrastructures, are being constructed in Turkey, but their conception is more akin to a prison fortress designed to hold potentially dangerous foreigners than it is a place designed to humanely support a traumatized community fleeing unthinkable horror.

One reason that refugee camps continue to be built is that they are conceived as a “temporary solution.” Conventional wisdom dictates that host nations, loathe to permanently welcome an influx of ‘foreigners’, make available only the least valuable land with the fewest resources. Their hope, it is said, is to encourage people to return home by making the refugees’ stay uncomfortable. National governments, with the support of the international community, work to reconstruct their citizen's homes after a natural disaster, but of course some internally displaced people are functionally refugees fleeing internal strife. The reality is, however, that no matter what the theoretical deterrents are to staying in a refugee camp, places like Dadaab in Kenya continue to grow. Created 20 years ago to shelter 90,000 refugees fleeing Somalia, today it hosts more than 380,000 refugees and IDPs from all over the Horn of Africa (Essa, 2011; Horst, 2006). The humanitarian aid regime, shielded by the realpolitik of international diplomacy and national sovereignty, is able to focus on stop-gap solutions despite on-the-ground realities including interminable tenures and incalculable expenses as seen in Dadaab and elsewhere.

Of course, without any assistance, displaced people usually suffer a worse fate. Following the 2010 earthquake in Haiti, many houses were badly damaged and were unsafe to live in but residents were unwilling to abandon their homes because they still contained personal belongings and because the residents did not have secure land tenure and feared that if they left they might not be able to return. In the Carrefour neighborhood of Port au Prince, a large, private estate was annexed by the very poor local community following the earthquake. Although the location allowed them to return to their homes during the day to secure their personal possessions (and sometimes cook meals), no one felt safe staying in the homes for any extended time. Their adjacent ad hoc encampment was erected on a steep, muddy slope. Small footpaths allowed people to move between the crude shelters none of which was larger than the sheet or shower curtain from which it was made. There was neither water nor sanitation.
Further complicating the idea that a refugee camp can be a “temporary solution” is that mass migration by itself is a significant environmental problem (UNHCR, 2001). Every time a population must flee a hazardous environment, they invariably create stress on the environment they move through and to and this in turn amplifies man-made climate change; climate induced mass-migration perpetuates climate change (Morgan, 2010: 15-16).

Given the lasting environmental damage caused perpetual displacement and the inevitability of temporary, militarized civilian camps becoming permanent as land and material resources disappear due to man-made climate change, we in the Environmental Design community must begin to address this social and political reality of our planet’s future. Environmental Design curricula have tended of late to focus on either Smart Growth or New Urbanist solutions, emphasizing top-down formal planning developments that attempt to resolve complex and competing social and environmen-
tal concerns, or to focus on bottom-up organic planning developments that celebrate inclusionary strategies that empower multiple stakeholders. As seen above, for the last century, when thinking of traumatic urbanization, the top-down approach has resulted in militarized city plans characterized by grids of streets and built in disregard to the existing environment. Likewise, although traumatically displaced populations share a great deal in common with other ‘bottom of the pyramid’ populations in terms of overall need and human rights concerns, evidence suggests that Human Centered Design, or other inclusive design practices remain mostly ineffective even in relatively stable communities (IDEO, 2010; Pal, 2006; Belsky, 2013).

Regardless, the need for immediate responses in an emergency eliminates most opportunities for either comprehensive planning or significant community engagement. The complex environmental, social and political realities of climate change displacement, not to mention the scale and urgency of our climate crises and the fact that climate change displacement will disproportionately affect the world’s poorest people, underscore the need for a new and integrated approach to traumatic urbanization. Emerging within the international development community is an idea that a “strong state planning” approach combined with a “market-enabling framework” could overcome some recent challenges in poor communities. This so-called “muscular planning” concept suggests clear approaches for creating inclusive and sustainable urban development such as more inclusive infrastructure planning, a more comprehensive national, urban and regional plan, a more “proactive” view of growth and change, and “would produce explicit spatial plans for metropolitan areas” (Belsky, 2013; p45).

Although many displacement camps are located in remote or undesirable locations, the “muscular planning” framework may prove adaptable when considering new approaches to traumatic urbanization. For example, rather than allowing sector specific non-governmental contractors (such as WASH or Shelter NGOs) to work independently, governing agencies could foster greater cooperation among humanitarian aid actors. Given a mandate to cooperate, NGOs and contractors could work with community representatives to begin to innovate approaches to camp design that break from today’s ubiquitous militarized compound. Similarly, a “muscular planning” framework would empower local and regional planning agencies to create explicit spacial plans in anticipation of inevitable regional climate change displacement. Finally, with long-range national and regional plans designed to promote inclusive and sustainable development goals in place, “backcasting” in the event of an emergency will ensure that the first steps taken following a crisis are in support of planned future development instead of avoiding long-term environmental, social and economic responsibility.

While specific changes in our approach to traumatic urbanization must be context based, clearly there are general universal human rights issues that, if addressed, would dramatically alter the topology of traumatic urbanization. Among the most obvious are water and food security, sustainable water and waste distribution, personal safety (especially for women and children), education, energy and micro-enterprise. Were any one of these issues (or virtually any other of the rights assured by the Universal Declaration) established as the motivating thesis of the design for displaced people, a true shift in the quality of life and long-term outlook for displaced people would be assured.
While this paper has focussed on the need to reconsider the planning strategies employed in crisis situations, it must be noted that man-made climate change will effect other design and development issues as well. Among the most pressing issues are the regional disruption of traditional organic building materials (e.g.: deforestation caused by desertification), and the obscene problem of creating so-called “temporary shelters” that address the standards of appropriate humanitarian aid. Environmental designers consistently propose outlandish shelters, completely disregarding the SPHERE standards (SPHERE, 2011), appropriate technologies, and adaptability to uneven terrain. Most significantly, we must work with communities to develop flexible approaches that accommodate various social and cultural ideas of family and home and that provide opportunities for displaced people to engage in the economic opportunities found in constructing shelters and growing food.

Humane and durable strategies for sheltering at least some of the 200 million people that will be displaced in the age of man-made climate change should be (re)considered in light of the historical record of past solutions. Future developments must begin to anticipate adaptive strategies for food and water security, durable shelter, sanitation, energy, safety and education at a minimum and all of these concerns are hobbled when made to conform to the limits of decontextualized Roman military camps.

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“Ecosophic” Game-Design: Towards a Cryptic BioTopical Architecture
On Gameology

The terms “Game” and “Play” have been continuously designated throughout the past few years as central concepts or even as main methodological tools for many distinguished subjects of basic and applied research, within a wide range of cognitive fields, relative to Technological and “Positive” Sciences as well as to the so-called “Human Studies”. Arguably, this phenomenon is related to the dizzy growth of Electronic Game Industry (EGI). Having overcome in relative financial terms the cinema industry, playing a key-role to the exponential development in digital entertainment and info-communication technologies, EGI has reached out to give impulse even for the formation of new academic branches (Game Design Studies).

Of course, this kind of cultural evolution could not leave the fields of architectural and urban design unaffected. It is indicative that at least during the last 15 years, there’s a rapid increase in publications of studies and discussions that focus on the relations of games with space and design issues, although their content ranges from enthusiastic declarations (liberating manifestos) to strong criticism (mainly on socio-political and psychological impacts).

Basic approaches regarding Play and Games

Before focusing on topics mostly related to the field of architecture, an attempt is made to map the often confusing cognitive spectrum that makes use of the concepts of game and play or of a similar terminology. Our main intention aims to highlight both the breadth of the subject and the importance of dealing with it, but also to give some basic notional clarifications necessary for its deeper understanding and further development. So far, the research has led to a distinction among five general orientations, which are briefly described below. Selected phrases recognised as ‘conceptual keys’ are adopted as conventional titles of these categories, while additional information regarding the content and the particular perspective of each approach is included.
Homo Ludens

One of the most prevalent among these types of approach departs from a predominantly anthropological - socio-historical perspective (closest to the so-called “continental” philosophical tradition) with the key reports to be drawn from the works of Johan Huizinga “Playing Man” (“Homo Ludens”) and Roger Caillois “Man, Play and Games” (“Les Jeux et Les Hommes”) 1. Both in these works, the emphasis is given in highlighting the decisive and enduring importance of various game and play forms for the understanding of the evolutionary generation of Culture as a whole. Let us say these approaches set off in opposition to traditional views that tended to interpret games disparagingly, either in a functionalistic way (as means to conquer capacities), either as substitutes of higher cultural establishments (namely political institutionalizations and religious rituals) 2.

Play Theory

Another related approach, which is used to be associated with some major branches of psychology (developmental, evolutionary, neuropsychology, cognitive science etc.) focuses on the importance of “playfulness” for the formation of the temperament of the human “subject”. By emphasizing on bio-psychological procedures of child development in its social context, this approach highlights the key role of certain game types and play forms in the configuration, maintenance and enhancement of all perceptual, learning and creative abilities of the individual. Play is here recognized as a particularly expedient activity of individual or collective self-education (Game-Based Learning) 3.

Game Theory

From a quite different perspective (closer to the Anglo-Saxon analytic philosophical tradition), the well-known “Game Theory”, which is typically classified as a branch of applied mathematics and economics, focuses on the systematic study of various game-types, as a method of analysis for issues related to individual or collective decision-making in conditions of conflict or cooperation, in an attempt to understand the different types of human behavior 4. Let us note that, in addition to its inner-disciplinary success, that game theory has contributed significantly, through the provision of adequate theoretical loans, to the development of various disciplines -from economics and sociology to anthropology and evolutionary biology- in ways directly extendable to philosophy; starting from the realm of epistemology, the notional components of the discipline slip into matters of ontological status, moral formation, aesthetic perception, political affiliation etc.

World-Play

A less common approach, which could be included in the idiosyncratic theoretical field of “post-philosophical’ thought, draws the above title from the homonymous work of the Greek-French philosopher Kostas Axelos (“Le Jeu du Monde”), that poses as its main representative. Very briefly, this prospect claims that the world as a “natural state”, bearing cultural meanings, ethics and re-significations, is possible to be
read as immanent in the playful condition, as an extended “meta-game” (game of games) or as “the set of sets of the games we play” (K. Axelos). In other words, play is recognized as a universal (all-encompassing) concept and as a general existential condition. This category might also include the work of other philosophers (such as F. Nietzsche, J. Derrida, G. Deleuze, J. Baudrilliard) who have made extensive use of the terms “game” and “play”, considering them as key notional tools in the prospect of forming a vision and interpretation of the world and human culture free of “essentialistic” or “meta-physical” perceptual schemata. Needless to say that this philosophical approach works as a framework integrating the wider worldview from which our research sets forth.

**Game Design**

Finally, a character of a separate category can be attributed to approaches that treat game as an object of design (Interactive Arts). At that point, emerges the key-factor of the game-plot; a multifarious and highly synthetic product, which requires a creative process of interdisciplinary collaboration. Game is here interpreted both as a means of entertainment and as a field of artistic expression - oftenly bearing special educational value. Basic references are the works of Jesse Schell ("The art of Game Design", 2008), Katie Salen & Eric Zimmerman ("Rules of Play: Game Design Fundamentals", 2003) and Friedrich von Borries, Stephen P. Walz, Matthias Böttger, ("Space Time Play. Computer Games, Architecture and Urbanism"), among many others. It is estimated that this latter category can better integrate the subject of the whole proposal, mostly because it highlights the relations of games and play to the wider issues of architectural design and urban planning. Of course, that does not mean that the other approaches should be bypassed as “off topic”. Instead, as expressed by the title, it is exactly the vision of an “Eco-Sophic Game-Design” that seems best to enable a synthetic composition of all the above, under a joint interdisciplinary approach, that can serve both as an appropriate new method for innovative environmental design and as a pedagogical tool for a broadened architectural education.

**Play, Game and Space**

Far from the potentiality of a final definition of “play” and “game”, it is a rather common assumption that these terms, apart from being subjects of theoretical treatment (eg, as special regulatory typologies, as intertemporal cultural phenomenons with special functional and symbolic significance or even as “universal” philosophical concepts), are at the first place referring to specific -individual or collective- activities. These activities are not just conditions of interaction, in the broad sense of a bidirectional sensory relation between people and their environment, but an interactive relationship par excellence engaging and “influential”, insofar it derives special “meaning” through specific systems of rules, targets and symbolic representations. In that sense, gaming, whether related to direct material footprints or not, is introduced as a significant additional tool for interventions in space, both as an object and as a means of an interscale design process that is able to bring special opportunities for a meaningful interactive entertainment and (self-)education, enabling dynamic fields of public expression and socialization.
The Vision of a “Playful Landscape”

Since the one-way message transmission and the dominance of the dipole production-consumption in the cultural sphere, to the era of globalized market and internet, we can identify a paradigm shift in the way the city itself and primarily its public space are rendered thinkable. From the late 90’s until today, the essence of “playful interactivity” (PI) appears again, although in different socio-historical contexts, as a central conceptual reference with critical influence over issues related to urban planning in a “meta-modern” metropolitan reality. Through a rhetoric that praises the qualities of wandering, of changing platforms, of adaptive environments, of open-source networks etc. PI appears as an additional tool to attain direct-democratic policies in space, satisfying the increased request for a broad social participation at all levels. This trend becomes more evident nowadays, where more “futuristic” approaches refer to “Smart Cities”, which will utilize the rapidly evolving digital technologies, so as to resolve “playfully” their complexed functional and socio-environmental problems. On that basis, we could go further from urban space to wider regions and talk about “Smart Landscapes”, respectively enhancing the “Vision of a Playful Landscape”.

An additional argument in favour of the former “vision” is based on the fact that the inclusion of playful interactive elements and relationships in public space arises as an extension or completion of the traditional ways of incorporating artwork or monuments in this area; perhaps even in partial contradiction to them, to the extent that the latter do not tend to promote wider relational spatial performances but rather lead to a “passive” intake, forming almost exclusively visual relationships that often result in a disinterest on behalf of the user. Mainly, however, the enactment of such a dimension to the basic design criteria is identified as carrying an increased ability to mobilize urban activities largely independent of financial and commodity exchange relations. Therefore, it is estimated as a counterweight to the rapid growth of consumer patterns of functional activation of public spaces, which, because of their intense class-distinctive character, are interpreted as one of the main causes leading to the obsolescence, abandonment and often to the will for destruction on behalf of population groups experiencing publicity in conditions of social exclusion.

Nevertheless, one should not consider “playful interactivity” as a kind of panacea that will automatically solve all the problems between people and their environments. This is because a genuine application of these design principles in architecture poses several difficulties, as it requires an exceptionally multivariate and stratified composition processing, which is not easily compatible with the demands for “quickness” and “efficiency” that dominate the wider social landscape. The issue becomes more complex, as it is dependent on broader social-class hyper-structures, often of increased political-economic power, the complete makeover of which is neither shown to be easily reachable, nor depends solely on architectural ideas set in terms of research objectives. Instead, what is required here is a much more generalized involvement of the people. On the other hand, it is exactly this kind “playfulness” that could best serve as a tool for the motivation and training of the whole population, to the prospect of such an involvement.
“Augmented Reality” Smart Gamification

On that basis, ESD embraces the idea of Smart Gamification, a kind of “scripting” process which aims to engage space-time elements-factors of all types, scales and functions (architectural, environmental etc.), into some sort of a desirable game plot. To that direction, the newly-acquired category of “Augmented Reality Games” (ARGs) has begun to gain attention. The notion is used so as to describe a “hybrid” kind of game, constituted as a mixture of digital and non-digital gameplay elements. Following, to some extent, the motto of “Back to Materiality”, ARGs take place mainly in the “Real” public space-time, thus turning it into a Gameboard or a PlayScape.

Apart from their special space-time nature, ARGs tend to look up to some well-known (non-violent) game genres, mostly “Strategy”, “Role-Playing” and “Adventure” Games. Speaking on the last, we clarify our main reference to games whose plot is based on a variety of mental and physical challenges, such as Quest-Inquiry and Problem-Solving activities, carried out mostly through “cryptic” elements (namely enigmas, riddles, puzzles), which are nominated for their highly entertaining and self-educational value.

The broad cultural significance of the Cryptic

From ancient philosophical questions to current scientific problems, from the Great Sphinx and her famous enigmas to the contemporary psychoanalytic approach (that envisages human subconscious as a complexed self-referential riddle-puzzle of uncertain solvability), it is arguable that the “Cryptic” in general has played a most significant role throughout the history of human culture. It is also clear that the concept of Cryptic is governed by an extensive polysemy, so that is somehow cryptic itself. For convenience, we outset to clarify that in this text, we adopt a concept of cryptic expanded enough, so that it may include anything that is able to induce a kind of mental challenge, in ways that could generate certain encryption/decryption processes. We must stress that this concept of cryptic does not refer exclusively to a linear process that leads to a predetermined final solution, but it can be incorporated in open structures, able to allow various relationships between different components. Additionally, these structures can be responsive to multiple contents, so that their design can use, with creative intelligence, ideas and information drawn from a wide range of possible influences, enabling correlations among various scientific, philosophical or artistic fields.

Such a multiple, non-deterministic/ non-finite, “demystified” nature of the cryptic is attempted to be described by the concept of “meta-Cryptic”. It can be said that, as referring to a dynamic problem-solving procedure, this concept approximates the very essence of creative design. Therefore, by engaging its qualities into the ESD principles, we come up with fertile ground, not only for the cultivation and the methodological justification of a most-requisite interdisciplinary approach in theory, but also for interlayer multifunctional interventions in real space, in ways that are limited only by human imagination.

Performing the meta-Cryptic

Beyond the field of conceptualization, we can now focus on the very performative function of the meta-Cryptics. After accentuating the fact that the spatial dimension...
of the game plot often plays a central role for its whole content, reasonably our emphasis is given on meta-cryptics into which the space-perceptive factor occurs intense. Classic examples are games based on challenges of orientation. Others engage combinational Riddles/Puzzles/Enigmas that deal with logical, arithmetic, geometric or topological relations, aiming for the understanding of complex mechanisms and interconnections through personal inquiry and interference. To the same direction, it becomes clear that we speak about meta-cryptics which do not refer exclusively to mental exercises, but require the involvement of the entire body into physical challenges, within a wide range of necessary qualities, from muscular strength, fleetness and endurance to suppleness and delicate movement.

In any case, the content of the plot should be able to allow transitions between different perceptual fields, enforcing the development of reflexes, in relation to visual, audio, tactile, olfactory, taste stimuli, so that eventually could cultivate a treaty “sensory interchange” (mainly associative) similar to “synesthesia”. For example, this could be achieved by matching light and sound frequencies or other sensory data, along with the participation of parameters with a broader conceptual and symbolic content. In that sense, “synesthesia” is interpreted as “enlarged perceptiveness” and is evaluated as perfectly suited to be an objective for a public activity, while also being a prerequisite for an even more enlarged - and more necessary – ability of socio-environmental “empathy”.

To specify a bit more, we believe that a game-plot based on meta-cryptics should be structured according to the three following criteria:
- Three-level Progression (gradual increase of complexity/difficulty), from single cryptics, combined to tree-like structures, interconnected to open networks
- Multiplicity of players (and content), that will enable cooperation among their different desires and qualifications
- Self-Mutability, through the potentiality of interventions on behalf of each player

Summarising, we note that meta-Cryptics (dynamic forms of “inter-sensory” combinational Riddle-Puzzles), as carriers of additional meaning that enhances the mental-cognitive aspect of game, combined with the psychic stimulation - and the emotional reward - that usually accompanies the effort to resolve them, come to help in producing a variety of sensory stimuli that aims for the mobilization of the desire for exploration, the deepening of observation, the challenge of innovative ingenuity, the enhancement of combinatorial capability and synthetic thinking. We estimate that such playful activities, in addition to being able to deliver a “sublime” and memorable aesthetic satisfaction, can bring along a particular pedagogical value, as on the basis of this multidisciplinary – at the same time individual and collective, mental and physical, interactive and “synesthetic” - dimension of meta-Cryptics, it is possible to develop more attractive, less forced, so in a sense, more appropriate pedagogical methods, which may exceed the traditional educational standards that promote hierarchical relationships and unfair competitiveness and be addressed potentially to the whole range of ages and social layers, cultivating forms of unmediated and more cooperative social interaction. In that sense, our proposal gains a clear ideological sign, as a political project for collective self-education, which is considered as better able to effectively respond to the demands of the “ecosophic” trinity, reaching beyond the joy-of-discovery, to the fulfillment of (self-)understanding, creativity and ultimately life itself.
Meta-Cryptics and Architectural Education: Gamifying EcoSophic Design

If we have to specify on new forms of architectural education, in more legitimate terms that necessitate the role of a university, the first thing to propose would be the expansion of the study schedule by new lessons that will encounter the broad interdisciplinary demands of Game-Design. Apart from the traditional “lesson-watching” and reading methods, as case-studies, students would have to play certain (digital) games and make descriptions and critical comments on their design and plot characteristics. After that, individual or teamwork projects should give special focus on the design of meta-cryptics (along with the submission of papers that explain and justify their content). We can then imagine a different system of appraisal, through a “bottom-up” procedure for an “overall” critical account, where each team would have to play and evaluate the games of all the others.

Finally, the ideal for a classroom would be to unify these projects into a dynamic plot for an AR Ecosophic Meta-Game, able to be activated in the landscape of the future Cities. To that direction, meta-cryptics can be embedded as hidden messages throughout the urban “porosity” or “materialized” by low-scale constructions, where, complementary to the main architectural parameters (functional, structural, bioclimatic, aesthetic, symbolic etc.), additional synthetic factors that relate to the content of a riddle-puzzle should be imported. The last could be “derived” from innovative design proposals for Ecosophic Attractors. By that, we are referring to specific multi-functional interactive devices that can generate pedagogical interfaces about ESD principles (fig. 2).

Fig. 2
Example of an Ecosophic Attractor. Apart from being a particular placemark, carrying a multitude of symbolic references (“meta-Totem”) and a multi-sensor info-post about dynamic environmental and urban factors/ functions, that generate an ongoing digital cartography, the device constitutes a multi-functional instrument, that can produce coloured light, musical sound and electric power (through solar, wind, water, geothermal and human body energy), while serving as a key-point (or as a clue distributor) for the solution-decryption of certain urban meta-cryptics.
Fig. 3-5
Diagram of an AR Ecosophic Meta-Game for the city of Athens. Ecosophic Attractors are to be strategically interspersed in vital points along the public space network, as main nodes whose interconnections could create a "playful ecosystem".
Exit

In conclusion, returning to the introductory phrase of Felix Guattari, we believe that Ecosophic Design, as described in this text, along with a process of “Smart Gamification” of its principles, has the potentials to achieve this very dynamic “articulation” of the Three Ecologies and contribute to the formation of a self-sustainable condition for the future cities. Nowadays, where complex cultural problems (ecological, economic, socio-political, psychological etc.) are interpreted by the dominant terminology of “crisis”, such a design and educational method could lead to a kind of adaptive “self-consciousness”, as a prerequisite for the evolution of forms of innovative “urban intelligence”, therefore for the development of a “critical status” in its positive sense, that overcomes the negative still implied, referring not to a general cultural reduction, but to a heightened collective environ-mental ability. Thus, “inquiring playfulness” aims to a radical redefinition of urban landscape; one that could provide to all bearers of urbanity a –not only exciting– but also highly educative medium of living, enjoying, collectively managing and creatively reinhabiting the Commons of a Sustainable City that wants to play a significant role in the “playscape” of a post-crisis global society.
Notes

1. Key component in that perspective is Callois' notional distinctions, from the broad play categories of “Paedia” and “Ludus” (which outlines respectively the “fun” or “training” character of playful entertainment) to the more specified game “species” of “Agon” (competition), “Alea” (gambling), “Mimicry” (role playing) and “Ilinx” (vertigo).

2. It is worth mentioning Callois' vision for a sociology based on games, which embraces the idea that games can serve as “symbolic accumulators” of the “inner nature” of any culture, reflecting social relationships, political structures, ethical beliefs, individual or collective desires etc. This mode of thinking seeks for a sociological analysis of various cultural facets based on the systematic examination and interpretation of the dominant game-types and play-forms, in extension to a sociology of games which focuses on the social dimensions of specific games.
It is also worth noting that this whole perspective has served as a key reference for the promulgation of comments, criticism and often subversive intentions and claims directly related to the issue of producing and experiencing the urban area, such as those of Henri Lefebvre and members of the Situationist International.

3. Benchmarks of this wide approach are the works of J. Piaget (namely his book “Play, Dreams and Imitation in Childhood”, 1945) and M. Csikszentmihalyi (who introduces the notion of “flow”, highlighting its importance for the achievement of the “optional experience” of creativity and innovation, e.g. in his book “Beyond boredom and Anxiety: Experiencing Flow in Work and Play”, 1975), D. Winnicot’s “Playing and Reality” (1979) and several more recent studies, such as Patricia Anne Masters’ “Play Theory, Playing, and Culture” (2008).

4. Key-role methodological distinctions of certain game typologies (such as Single/ Multi-player, Competitive/ Associative, Partial/ Total Ignorance, Zero-sum/ Non-zero-sum, HyperGames, MetaGames etc.) are here made mainly according to the particular regulatory context of each game.

5. The term attempts to describe a concept of “no opposite”, an infinite interiority, where nothing can escape its descriptive power.


7. As part of this shift, the references to the vision of “Playful City”, as expressed during the 50’s and 60’s by H. Lefebvre, the Situationists, by Constant’s “New Babylon”, by Y. Friedmann, Archigram and Superstudio, are frequent in a grade of banality.

8. A classic example of such a game is the well-known “Treasure Hunt”. One of the best – in our opinion – electronic games of that type is CYAN’s “Riven: the sequel to Myst”.

9. In other words, any single observation, labeling, information, trace element, knowledge or concept can be utilized for the design and construction, but also for the solution of many kinds of Combinational Riddles/Puzzles/Enigmas.

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**in Greek**

**Lectures**
The Effect of Design Education on the Students’ Perception of their Professional Role: The Perspective of Architecture Students in EMU
The process of education builds a variety of perceptions and pre conceptions about the students’ future career and their roles in the society (Eyikan, 1998). Based on some researches which have studied the design education, it is possible to say that there exist different strategies to create these self-conceptions during the educating process (Gutman, 1988; Blau, 1988 in Eyikan, 1998).

Today, the architecture profession is facing challenges as a result of the existing fragmentation between the architects, the society and other professionals (Eyikan, 1998). Although the education system seems to be aware of this problem, (the social role of an architect, his career and professional life is mentioned in the objectives of almost all the universities which are studied by the authors), this problem still remains unsolved and students are still facing challenges when they begin their professional career.

In recent years, green architecture and designing according to the needs of cities, nature and landscapes are becoming essential (Hewitt, 1984). Lack of the required information in this field has negative and sometimes destructive effects on the constructed buildings. (Watson, 1984) In order to avoid fragmentation between the environmental knowledge that students gain in the architecture schools and its importance on their career, environmental subjects in the curriculum must be beyond introductory courses (Faker, 2000) and this field needs to enter both in the theoretical courses and the studio projects (Wright, 2003).

In order to study the students’ perceptions of their professional role, the architecture department of Eastern Mediterranean University is selected as a case to study. This university is a member of MIAK accreditation. As social awareness, social role and professional career is also mentioned in the objectives of MIAK accreditation, this article focuses on the changes of the students’ perceptions of their professional career, comparing with the objectives of MIAK. The main purpose of this article is to find out how do the students’ perceptions about their professional role changes during four years of design education. In order to find answer for this question, first of all the following questions are investigated:

1. How do the students’ perceptions about their professional role change during four years of design education?
2. How do the architecture schools prepare students for their professional lives by improving their environmental and social awareness?
3. Is there a gap between how planners attempted to change this perception and what really happens in design studios?
4. Is the challenge, which students face after beginning their career, related to this gap or not?

Although some researches are done to study the profession of architecture and the social role of an architect (Esherick, 1984; Resenberg, 1961; Grand, 1949; Hamilton, 1949), a few of them studied the students’ perceptions about this issue (Eyikan, 1998), and none of them compared the changes of students’ perception in each year of their education. This gap currently exists among the existing literatures.

The rest of the article is structured as follows: For the first step, literatures on the objectives of MIAK accreditation are studied. Second, the social awareness of the students, their ideas about the architecture profession and the environmental and professional values are reviewed. Third, the collected data from the students are analyzed.
and discussed and finally, the existing situation is compared with what is written in the literatures as the objectives of design education.

**Main objectives of design education**

The courses in the architecture curriculum are divided into these main categories:

- Basic knowledge about architecture
- Construction courses
- Environmental courses
- Preparing students for the design projects
- Complementary courses (Orbasli, 1998).

**Objectives of EMU**

The field study which is used in this research is the architecture faculty of Eastern Mediterranean University in Turkish Republic of North Cyprus. The faculty of architecture is an international association, which has more than 600 under-graduate students from many different countries. Faculty of architecture in this university is established in 1990. In the 11th of July 2011 the evaluation of new application which has made by the EMU department of architecture has been finalized by the Turkish council of accreditation for architecture (MIAK). The EMU program has the 4th accredited program between all the architecture programs in Turkey and North Cyprus which are over than 60 (MIAK 2011).

**MIAK Accreditation**

The MIAK community in its program claims that there exist different and creative alternative careers in the profession of architecture. Thus, it has different programs to prepare students for these careers. Improving the students’ research skills, training students based on new technologies and methods and giving scholarships to the talented students are done in the program.

MIAK accreditation is aware of existing environmental problems. According to the aims of MIAK, students should learn the social and environmental issues and make decisions accordingly. In order to achieve this aim the community focuses on the following items:

- The way that students are prepared to explore the various dynamics that shape the physical environment
- And the way that architecture schools transfer the required information to the students in order to reduce the environmental problems.

Although MIAK program prepares architectural students to have different careers, the most important role of an architect in a design group according to this program is being a leader.

In this article some of the skills that students learn during their education process are investigated. The council expects that the graduated students have below skills as professional architects:
1. Speaking and writing skills: effective writing, reading, listening and speaking abilities are part of the important knowledge that students gain in this education system. These abilities help them to defend their professional design. Moreover, communicating with the customers and other designers or professionals is another positive effect of these abilities on the students’ future career.

2. Graphical presentation: to make appropriate presentation, students should be able to present their professional projects with hands and computer software.

3. Research skills: research is one part of the design process. An architect should be able to obtain the required information.

4. Designing skills: students should learn the basic principles in architecture, urban and landscape design.

5. Teamwork skills: the MIAK educating process enhances students’ individual capabilities to take different roles in their future career, however; as a member of the design group, students have to be able to work in a team. Coping with different ideas in a team is the effect of this skill on the students’ career.

6. Site conditions: the ability to take into account the settlements of the lands and nature.

7. Environmental systems: to emphasize on the importance of lighting, acoustics, air conditioning and understanding the basic principles of energy use. (MIAK, 2006).

Social roles of the students

The main objective of architecture is to answer the needs of the society. The changes in the society should also become apparent in the architecture. Each architecture product is not only aesthetically beautiful but also answers the needs of the community. Each school trains students in a way that they have enough knowledge from present and past in order to handle the problems of the future. Hamilton also argues that each student must have enough knowledge about economy, engineering and also on social issues. In addition, from environmental point of view he explains that landscape architecture is important for all the design students. Students have to realize their responsibilities about the community. What education gives to them is a narrow training compare to what it should. To become more conscious about the community, more elective courses must be in the curricula with other departments, including courses on sociology, political issues and science. Today the architectural courses make students isolated that they forget that “Architecture belongs to the community not to the favored few!” Students should be aware that they are not only active members of the society but also leaders in the process of design (Hamilton, 1949).

Definition of the profession

“Every profession has both a set of claims and intentions- what it prefers to do- and some organizational structure or mode of operation called the profession. Professions are defined by these claims, intentions and presumed competencies: they are also defined, in some cases, by what they do not do.” (Escherick, 1984)
Today the architecture profession is not an agreed agenda. In the recent 50 years it took different forms and is significantly changed. Esherick (1984) in a study mentions what The National Council of Architectural Registration Boards explained as what an architect has to learn during his education. In the prepared list of the required knowledge, a great part of them are allocated to social sciences including “sociology, social statistics, social structure, and socio-economics.” (NCARB, 1981 in Esherick, 1984).

**Professional values**

**Environmental design**

The new understanding of design according to the environment began after the contemporary critiques of the design policies and procedures. The time for designing buildings like isolated sculptures had finished long ago (Neperud, 1978). Environmental Design is an overlap of environmental science and its utilization in the designing process (Moore et al., 1985).

“The field continues to be a hybrid of environmental psychology, environmental and urban sociology, social and urban geography, and urban and applied anthropology from the social sciences; as well as the socio-cultural research parts of architecture, human factors engineering, interior design, landscape architecture, and urban planning from the environmental professions.” (Moore et al., 1985)

The existing environmental problems root in the lack of environmental awareness in the previous practices and what we have to do now is to consider environmental issues which were ignored for a long time (Spargaren and Mol, n.d. in Guy and Farmer, 2001). In the educating process, an opportunity exists, with encouraging the students to design considering environmental problems (Guy and Farmer, 2001)

Hewitt (1984) believes that, although some theoretical courses are entered in the curriculum to improve the awareness of the students for environmental issues, still the design products seem to be isolated from the surrounding environment. Environmental issues and landscape design are introduced to the students in theoretical courses and apart from the studio projects thus they are not integrated with the designing process.

Professionals have different views about the importance of emphasizing on the environmental courses in the educating process. Some instructors believe that architectural design is a difficult task by itself and limiting students with environmental issues makes the process too complex and difficult. Some others claim that environmental science is not necessary for the architects and specialists are responsible for this aspect of the design process, however; professionals believe that students should gain fundamental knowledge about the environment, technology and structure; otherwise, they can not apply environmental aspects in their projects properly (Watson, 1984).

“Architecture learning is, by its nature integrative. It connects knowledge and imagination through exploration of form and articulation of issues, informed by the means of construction within a cultural and environmental context. The ultimate measure of a curriculum is how this knowledge and imagination are brought together.” (Watson, 1984)
**Research in design education**

Research can be defined as an organized search to find the required knowledge for a specific subject. Research in different subjects is needed for an architecture student (from accessing a view over the position of universities, to scientific part of design education and the architects’ dual role in the society, as an artist or a scientist). This broad view can be accessed only by a wide research and the architect will be highly aware of new materials, techniques and rules (Taylor, 1947). The importance of research is explained by Hamilton in a way that: students have to become self-educated. Their interest has to be motivated for research and discovery. All these should happen in a free environment which leads students to research and to find answers themselves (Hamilton, 1949).

**Presentation and education**

The final presentation is referred to a visual language of the final graphical present, which is in most cases far from the design process. Sometimes this factor becomes so important in evaluating the students’ projects that inevitably some of the focuses move from the design into the presentation. As a result, aesthetical and graphical aspects become more important than the design itself even the social values and theory of design become less important. Most of the students believe that each element in the final presentation is important for their career; however, perspectives and rendered drawings are mentioned to be slightly more important than the others in the existing literatures (Gurel and Basa, 2004).

**Team work and design education**

The ability to do the projects collaboratively has become significantly important recently. In order to have innovation, creativity and to become successful in the competitive industry, employees have to work as team members (Gardner and Korth, 1998 in Pfaff and Huddleston, 2003). Researches have demonstrated that students learn more when they are working as team members. This ability has to be developed by working with others during the education process (Freeman, 1996; Johnson and Johnson, 1984-85 in Pfaff and Huddleston, 2003). In the first step students have to learn how to work in a group in their classes and then this ability can be expanded into working with other classes and working in a professional team after starting their career (Feichtner and Davis, 1984 in Pfaff and Huddleston, 2003). A Lot of benefits are addressed with working in a team. For example, students will become more social, their ability to translate information and knowledge will improve, they can work on more difficult projects, will become more interested about the projects and persistent in bad conditions (Pfaff and Huddleston, 2003).

Beside all the benefits which are mentioned before, some disadvantages are also addressed with working in a team. The tasks are divided between the group members so that each student can only work on his/her part (McCorkle et al., 1999 in Pfaff & Huddleston, 2003). This fact limits their learning process for the general project. This problem can be solved by changing the team membership (Joyce, 999 in Pfaff and Huddleston, 2003).
The other problem is that some students do not work and disrupt others; thus, they affect the work of other members. The way that instructors evaluate the final project of an individual work or a team work can also cause problems. Sometimes not evaluating fairly can adversely affect the students’ perceptions about working in a team (Feichtner and Davis, 1984 in Pfaff and Huddleston, 2003). A great number of students prefer not to work in a team as a result of the mentioned problems (Pfaff and Huddleston, 2003).

Data collection methods

A survey research is done among 48 students of the architecture department of Eastern Mediterranean University in North Cyprus. These students are selected according to their grades in the mid-term jury. Two below average, two average and two good students are chose from each design studio, from the first year to the fourth year. The method for data collection in this research are questionnaire and literature review. A qualitative and quantitative method is used to evaluate the questions in the questionnaire. The questionnaire included three main parts, in the first section role of architect is asked from the students. In second part the questions investigated the students’ skills which they gain during their education. The close ended questions are evaluated by SPSS.

The questions in the questionnaire are selected according to the factors which are mentioned in the MIAK’s objectives. This part of the objectives is allocated to the social role of an architect.

Data analysis and results

The role of an architect in the design group is asked from 48 students of design education. The results are shown in Fig. 1.

A general look to the figure demonstrates that most of the students consider their role as leaders in a design group. This fact does not change noticeably during their education. Decision making is the second role which is mostly chosen by the students and few of them consider themselves as a simple member of the group. It shows the fact...

Fig. 1
Role of an architect in the design group from the students’ perspectives.
that architectural education is preparing the students to become leaders and masters (decision makers).

In the next stage some of the students’ skills are examined to find whether today’s education really prepares them for their future career or not.

For achieving this aim the first question was related to the environmental awareness in the design studios and in professional life (Fig. 2).

Most of the students in the third year believed that environmental subjects had a significant role in their studio. This awareness increases in the first three years of education, however; in the fourth year the environmental courses had less effect on the students’ projects. The figure also shows the students perception of the importance of environmental courses on their professional career. This factor increases during four years of design education.

Secondly, the students’ ability for graphical presentation is asked. The results are shown in Fig. 3.

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![Fig. 2](image_url)

Students’ perception about the importance of environmental issues.

![Fig. 3](image_url)

Students’ perception about the importance of presentation.
The diagram demonstrated that the emphasis on this subject slightly increases in the design studios, however; students' perception on the importance of this skill is improving significantly. It shows that education had prepared students properly in this aspect.

Then, the importance of being constructible for the studios' design projects is evaluated. The results are illustrated in Fig. 4. The focus on this subject increases. Moreover, more students in the higher studios are aware of its importance in their future career.

The evaluation of “Talk skills” is shown in Fig. 5, it obvious that students' ability for talking is decreasing. Although this skill is important for their professional life, the education seems to have diverse effect on this ability. “Team work” is considered as one of the required abilities for the students' future profession (Fig. 6). Although it is expected that the students become more aware and improve this ability year by year, the diagram shows that students prefer to work independently, despite the fact that they are getting more and more aware of its importance for their future career.

Finally, research skills are investigated. Fig. 7 shows that this ability is developing in a right way during four years education.
Conclusion

The students’ perception of the career that they will choose and their role in the society is highly affected by the strategies which educators select. This fact leads us to the question that: does the current education system create a correct perspective about the professional roles for the students? The reviewed literatures argued that the design education system makes students so isolated that they face challenges in communicating with other professionals and even the clients. By reviewing the existing literatures and objectives of MIAK, this paper explained the importance of social role and the students’ profession for the architecture education.

Returning to the question posed in the beginning, it is now possible to state that design education has a significant effect on the students’ perceptions. The results showed that this influence sometimes matches with the written objectives; however, there exists some points that it become completely against what the educators have planned. As an example, the role of an architect in the design group can be mentioned here. Results demonstrated that students consider themselves as leaders and it does not change noticeably after their education. The objectives of MIAK also mentioned that architects are educated to become leaders. Some skills which are valuable for the students’ career are also evaluated. Although the MIAK’s objectives emphasized on the students’ ability for environmental design, students seem to forget about
what they have learned in the previous studios. The students’ project in the fourth year focuses on the constructability and structure and they do not consider the environmental effect of the products of their designs. However; most of them believe that environmental subjects have an important role in their careers.

MIAK also emphasizes on graphical presentation and how it affects the students’ career. The studies in the EMU, architecture department, also prove this fact. Although team work is also significantly important for the planners, researches showed that education has an adverse influence on the students’ perceptions about this issue.

This article can serve as a base for further researches to suggest some solutions in order to solve the existing adversarial effects of education on the students’ perceptions of their role in the society.

Acknowledgements
This article is prepared in Eastern Mediterranean University, department of Architecture. I would like to express my appreciation to Asst. Prof. Dr. Guita Farivarsadri for her assistance and advice for this study.

References
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Conservative Environmental Strategies based on Contemporary Design Solutions

Two Alternative Eco-Friendly Models, Developed in Master Diploma Researches
Eco-design refers to both, the improvement of the industrial processes and changing human behavior. The former demands a reaction against CO₂ emissions leading to global warming, the development of passive and active energy saving systems, promotion of new energy sources, changes in energy consuming devices, etc. Achieving the latter requires education. We need to build awareness – how to use space in a way that does not lead to its degradation. As the pace of change depends on social acceptance, new models of behavior cannot be a nuisance. Designers of futuristic environment must aim to achieve the effect, not only ecological, but also acceptable to users, attractive, fashionable.

The application of environmental solutions in the field of architecture is an interdisciplinary activity. However, it is quite easy to rank problems usually considered. This applies both to scientific discourse, practice and educational activities. We see an increasing number of students’ projects, which include components of energy efficiency (wind turbines, photovoltaic panels, passive systems, etc.). Studies focus on recycling buildings, shaping urban structure dependent on new types of vehicles and communication systems. The optimization and streamlining applies to individual buildings and entire spatial systems. It has been said that information revolution brings Archigram concepts back to life [Cook, 1999].

This paper presents two masters theses, based on environmental objectives. Both do not apply to cities. The first examines the possibility of alternative, futuristic food production and spatial effects consequent to introduction of new technology. The second - considers the problem of green energy and its impact on the environment. Brought ideas help to reflect on the scope of the environmental activities of architecture and architectural education.

The invention of Gilbert Ellis Bailey [2011] is nearly a hundred years old. But in its current architectural sense, it was revived thanks to the contribution of Ken Yeang and Dickson Despommier [2010]. Self-sufficient skyscrapers composed of residential, office and crop-growing areas, debuted on exhibitions of architecture. Hydroponic layers on suspended platforms and containers replaced real soil not only in futuristic visions, but also on the construction site. Mixed tissue of (constant) city is expected to take over functions traditionally deployed in the region.

RoboFARM project, submitted as a master thesis on Warsaw Faculty of Architecture, involves a different scenario. Study on the technology of eco-agricultural production led the author not to the city, but to the country. Not to inventions based on efficient fertilization, but to appreciation of the forces of nature. The idea respects the significance of traditional sequence of crops, natural mixing genes, synergy of components of natural farm ecosystem and finally - the importance of human interaction with the environment in the natural site of agricultural production.

The technology used to reinforce the crop is totally futuristic. It is based on the application of versatile robots that can interact in a swarm. ROBO-individuals are equipped with quadrocopter propellers as well as four-bug’s-legs transportation system. Expected bearing capacity is about 250 grams. Experiments on prototypes led us to the findings, the main constrain is battery life and charging. Since the thesis goal is not application but algorithmic concept, technical limitation was skipped. The author assumed the progress of mobile power sources will allow to overtake it in future.
Fig. 1
Landscape patterns of RoboFARM.

Fig. 2
Robo-harvester flying unit.
Inside RoboFARM, production becomes a parametric process that can be programmed. Automatic control of nutrition elements in the soil, irrigation, natural and climatic conditions, depends on sensors transported by robots. On the base of measurements, types of crops are selected for the appropriate land modules. With the growing, conditions change as well as resulting species. The initial procedure implemented to control the crop bases on cellular automata. Certain rules are applied to determine neighborhood, succession and area of crop cells. Secondary rules are derived from monitoring of development (physical, climatic, effectiveness parameters).

Resolving landscape differs from the standard. Functional module no longer corresponds to the scale of the combine harvester, but the micro-robot. Functional dependencies and botanical patterns initiate a new generation of field’s aesthetics.

What are the consequences of changing farming methods in architectural space? The presented concept approaches the problem in a sustainable, but a visionary way. The tradition of living in the countryside is analyzed by using algorithmic methods (shape grammar). The rules are applied to the process and execution is again dedicated to robots.

Owner’s house concept is based on the principle to reconcile specificity of living in the country and human needs of the present. Design scheme follows distinct polish-manor system, providing contact with the surrounding nature. At the same time offers individualized aesthetic solutions. The interaction of designer, user, and robotic performers formed detail of the exterior and interior.

Final effect of RoboFARM comprises of: changing landscape of field patterns, introducing new forms of houses and their surroundings, redefining building features and open space functions. Everything – expressed in a new language, but adapted to the local context and human preferences.

The polish energy sector is dominated by the use of fossil fuels. Large reserves of coal, mining tradition, concerns about accident risk in the nuclear power plant, led to a state in which CO₂ emission is one of the main barriers of growth.

In areas of dispersed building structure, such as Masuria, problem is even more serious, because local heating systems do not provide adequate control of emissions. Individual farms are a major polluter of the environment. The reaction in the form of wind farms brings environmental effect, but causes side effects. Over-scale objects disturb hilly, varied landscape, unique in Europe. Similarly, solar cells and collectors bother distinctive, historic architectural substance.

Under these conditions, diploma project brings the concept of industrial building that integrates the environmental functions. It originates from the character of the place, takes into account the needs of the community and creates a form adapted to the place. A small hydroelectric power station on the river Pisa renews local tradition. Water steps were used for centuries in the region for the construction of mills and sawmills. Local power stations, even before World War II provided 50% of energy needed.
Fig. 3
Flowchart representing rules managing RoboFARM and scheme of pattern growth.

Fig. 4
House of the owner and house of robots (The hive).
Fig. 5
Educational path of the station – themes and schedule.

Fig. 6
Landscape-friendly architectural form and detail.
Diploma concept reacts on Masuria needs and specificity. In order to adapt the concept to contemporary needs, author tried to create landscape-friendly object, taking into account the life processes of aquatic ecosystem. Above all - built a complex, which in addition to the basic technological functions, distributes ecological information. Power station provides significant amount of the energy needs of the neighborhood. The process of generating energy becomes a prominent feature. Water turbines, power transmission, its consumption in the facility, constitute the exhibition. Power plant is open for visitors as exploratorium. Sailing harbor, hotel, cafeteria attract users. During ordinary tourist activities the object provides information on the environmental impact of the plant.

The outer form harmonizes with the idea of a modesty and functionality. The building was covered with soil from the north and east - becoming thermally efficient. Large windows provide an attractive view and are equipped with active shutters supporting the management of heat.

The small power plant project is an example of ecological approach to design. However, it is something more. It’s not just about technology, which we believe to be right. The purpose of the investment is primarily to promote and educate. With regard to local circumstances, community needs, integrated commercial services the project is likely to be accepted. In addition to green energy it also produces green awareness.

Carefully recollecting achievements of the past centuries show that environmental design is not a modern invention. In harmony with nature, designed the ancients. Ebenezer Howard and his successors openly declared eco-postulates. Natural context inspired architectural solutions on the level of structure, form and detail [Frampton, 1995]

Contemporary eco-design depends on dominant technological genes. The IT workshop provided tools for the description of complex processes. As a result - it has enabled the creation of multidisciplinary solutions, efficiency and impact of which can be accurately assessed and measured. It is worth considering, whether while focusing on the obvious achievements at present, we do not lose sight of the deepest meaning of eco-design. If yes – how should architectural education emphasize the importance of human needs and human existence in an ecosystem?

Notes
1. RoboFARM, master thesis, Faculty of Architecture Warsaw University of Technology 2013; author Lukasz Iwan, supervisor Jan Slyk
2. Small Power plant in Masuria, master thesis, Faculty of Architecture Warsaw University of Technology 2013; author Marta Goralska, supervisor Jan Slyk

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Parametric Rococo;
or a Short, and the Long,
History of Landscape Urbanism
“Avant le déluge, it is logical that one fits out a number of Noah’s Arks: and the attributes of the Ark are, as is well known, a pregnant symbolism and a proud estrangement from that which is on the verge of being submerged by the purifying wave.”

Manfredo Tafuri, “The Ashes of Jefferson” 1

At a recent lecture in Baltimore, Chris Reed, the principle of STOSS Landscape Urbanism “impressively honored” 2 for innovative projects and teacher at Harvard, presented his craft as little short of revolutionary. Rhetorically, a blurry set of Futurist/Green superlatives implied that STOSS’ was a new way of approaching the planet’s surface, that the work was “thick” and “hybridized” propelling the most advanced and melded readings of the urban and the ecological. Disregarding at least the last two centuries of urban innovation, it was further proclaimed to be “the first theory to truly challenge New Urbanism.” The lecture reiterated an omnipresent problem; an absolute disregard for history, even recent history, its effect upon current design and the exhausting need to proclaim novelty concerning forms that cannot escape history’s omnipresent gaze. What followed was a rhetorically inflated description of several relatively predictable landscape projects: a waterfront with illuminated benches; a paved campus plaza with “deployed” benches; a promenade with bleachered benches along a brownfield river edge. Except for the expressionist articulation of these ubiquitous seating elements, the admission that Reed doesn’t like flowers, the description of conditions like flooding as “welcoming in the porous river bank” and the implication of spontaneous activities as if such activities are not as normal and
predictable as apple pie… or benches; these STOSS projects are typical civic and recreation grounds, small to medium-sized parks and squares handled in conventional manner with plantings, even flowers, and a few accessories that formally endowed them with a luxurious and safely contemporary look. Reed’s talk was portentous and, at times, pretentious while the facts were neither especially innovative nor did they contest the protocols that have historically produced the best and worst of those metropolitan and rural spaces that are consciously touched by design. Much ado about something, but something with a long and rich track record that would have been better served by other, more realistic, tropes. From this one exposure it would seem that landscape urbanism is simply landscape architecture in search of lebensraum, much like post-theory’s position regarding critical studies. Hooked up with even more imperial verbiage than is usual in discours architectural and plugged into the terrifyingly facile shape-making enabled by information technology and parametrics, we again find the clothes to be new only as far as rhetoric can carry them. On the other hand, given the expensive materials and unique morphologies “deployed,” neoliberal economy is well served by this new/old discipline, as is the custom with much of contemporary design’s most recherché forms and discourse. In Reed’s talk, urbanism, a topic that is indeed assaulted voraciously by the New Urbanists, was not substantially engaged in any way other than by employing the normative relation that open spaces and their customarily applied accessories have maintained with other civic structures throughout the long history of the development of cities. In any case, the declared war between New and Landscape Urbanism appears to be largely a sales tactic for both. Their work seems almost irrelevant in a context of civil design while it is readily available to the strategies of capital marketing.

“Luxury in the eighteenth century took advantage of the various forms (modified a little) in which authority had previously been voiced; but these forms now signified no hinge beyond themselves; they no longer corresponded to their original context – and the artist could play with them capriciously for the sake of pleasure and variety…The disappearance of the symbolic element caused a corresponding profusion of lines and pattern, and with the absence of meaningful content the observer was left with superfluous decoration whose gratuitousness he might find either enthralling or scandalous…it crackles and flickers and scintillates, making the mythological images of authority childlike… the affectation of a nursery-like ingenuousness was an essential accompaniment of the Rococo mind.”

Jean Starobinski, “The Rococo Style”

The discipline of Landscape Urbanism is taken very seriously in quite sober institutions, from MIT to the Architectural Association. In what seems a hopeless or cynical endeavor, Notre Dame University in Lebanon offers it as a graduate major in a ravaged and negligent country where abuse of the land matches the damage to the urban brought by decades of wars and rampant corruption crossed with real-estate exploitation. Lebanon’s cities and countryside are examples of what societal abuse can generate and are certainly in dire need of attention. But, as with the weightless ancien régime extravagances of the Rococo itself, the sorts of formal extravaganzas that Landscape Urbanism produces seem profoundly beside the point, thus serving perfectly to maintain
the status-quo for Lebanese elites who are the primary source of a desperate nation’s problems and whose children attend the nation’s exclusive private universities like Notre Dame. As seems to be inevitable in the modern era when novelty has become an almost compulsive goal, the Landscape Urbanists have invented again a discipline that has a venerable history dating back to Virgil and Pliny the Younger at least, if not the ancient Greeks or Egyptians placing their buildings in respect to mountain and field. Back to Abbé Laugier and Francesco Milizia, back to a host of 19th-century proponents of the picturesque from Alexander Jackson Davis and Andrew Jackson Downing to Frederick Law Olmsted, the Prairie School and Ebenezer Howard, to Benton MacKaye and probably Kevin Lynch (whose wonderful diagrams are worth the price of admission and then some) and certainly to J.B. Jackson. And wasn’t urbanism inevitably linked to the ecological before the Industrial Revolution? We know André Le Nôtre was a Landscape Urbanist at least by default, reproducing Papal Rome as garden, and Baron Haussmann his dutiful disciple returning the formal logic to Imperial Paris. Wasn’t Thomas Jefferson one too, if an urbanist at all? Wasn’t his grid an extraordinary act that integrated land and polis? Isn’t the suburb, or Atlanta, the Pastoral’s great designed revenge; enmeshed with the most ferocious acts of capital speculation?

“...since the UVA round table (1931) on regionalism MacKaye had begun to characterize his particular approach as ‘liquid planning.’ Unlike solid planning the components of liquid planning were active... a field of crops, as a rotational organization, was an example of liquid planning. Highways,
railroads, and ports were also examples... since their shape or position was less important than the flow of goods among them. MacKaye described the ‘iron web’ of civilization as a circulatory system, the strands of which were ‘hollow’ and like ‘veins’ carried the ‘vital liquid element,...”

Keller Easterling, “Partition: Watershed and Wayside”

Biomimesis is as old as the often tragic state that we, with misguided hubris, call civilization. If not on the inscribed rocks of Africa or in the painted caves of Lescaux, certainly during the Greco-Roman era, in Islamic decoration and Renaissance naturalism, the imitation of a contrived “nature” has served as a counterpoint to an ever more organized, technologized and urban existence. This vacillates between the philosophical and the visual, embodied, for instance, in Pastoral poetry and the Corinthian Order. After all, our invention “nature” is the imitative basis of mimesis itself. The concept is just that, a concept generated by, and reacting to, increasing degrees of civilization and its discontents, reified as cities. Following the Enlightenment, the reaction to mechanization and social reshuffling that accompanied the Industrial Revolution was extreme. Augustus Pugin, William Morris, Owen Jones and Christopher Dresser, Arts and Crafts and more explicitly Art Nouveau, the more “organic” manifestations of Expressionism and Surrealism, Benton MacKaye and his socialist “Hell Raisers” eventually enfranchised as the Regional Planning Association of America, Italian hill town obsessives, Scandinavian “crafted” materialists and the phenomenology-lite embraced by those hungry for the tactile, Bernard Rudofsky, Japanese Metabolists, Christopher Alexander, enthusiasts of the biomorphic, smooth and striated, in the ‘90s, and now the Landscape Urbanists, and furthermore the increasing interest in and marketing of ecology; all these looked to biology for inspiration but all but a few, like MacKaye, stopped at that look and adopted morphological variations of “natural” imitation. Usually, image was enough. But, given that the city is the primary sign of civilization and that it is designed by intention or pragmatics... or both, then the more integral, less visual, lessons of the “natural” should have greatest didactic significance. This is obvious, not just from the partial list of passions mentioned above, but also in the language by which cities are described - artery, node, nucleus, membrane, heart, constriction, flow, etc. All refer to biological conditions.

Francesco Dal Co and Keller Easterling explicity chart the development of a terrain-driven civic practice in North America to a history fueled by both physiocracy and greed. The integrated compositions of Olmsted and Vaux approached the city in terms of countryside and vice versa. As Kenneth Frampton points out, they were influenced by the designer of the Crystal Palace, Joseph Paxton’s, infrastructure-aware work at Birkenhead Park near Liverpool. In their projects for New York’s Central Park and Prospect Park in Brooklyn, traffic, land value, foliage, typology, geology and axial/picturesque composition cohabitated. As foregrounded by Easterling, in 1925 Benton MacKaye referred to the flow of energy and transport as a “surface web.” The analogy of fluvial flux became a leitmotif. In his “terra incognita,” production and bodies flowed while intertwined. In The New Exploration: A Philosophy of Regional Planning of 1928 MacKaye identified, “an ‘outflow’ of early settlement and exploration... a ‘reflow’ of railway settlement and industrialization, the ‘inflow’ to urban areas, and ‘backflow’ to the suburbs...” MacKaye’s visceral model for metropolitan interpretation combined the sensual dynamism of the wild with the cultural release that followed the end of The
Great War and of the societal certainties that did not return from the trenches – in other words, the grand convulsion of the 20th Century.

While beguiling forms pour forth yet again, this time from Landscape Urbanism’s digital springs, it is hard to see substantial conceptual advances after the work of the Regional Planning Association of America in the 1920s. This extraordinary collaboration should not to be confused with the “exquisite marginality”9 of the city-beautiful group that gathered to produce The Regional Plan of New York, a cornucopia of brilliant follies whose authors included Raymond Hood, Harvey Wiley Corbett and Hugh Ferriss. The Regional Plan was the Neanderthal of metropolitan development but simultaneously, as is often the case with evolutionary dead-ends, the generator of fabulous caprice and fanciful extrapolations like Hood’s megastructural towers and Corbett’s Venetian thoroughfares framed in Ferriss’ patented sublime. A compelling folly itself, ineffectual as concrete proposal but wildly inspirational for future generations of metropolitan ecstasies, particularly for Rem Koolhaas “culture of congestion,” the fantastic Regional Plan appeared in the same period as the much more viable and effective Regional Planning Association. The RPAA group included MacKaye, Clarence Stein and Lewis Mumford, who may now embarrass due to their obvious leftist bias then but whose contribution to city thought and form is irrefutable. Their synthetic/metaphoric amalgam of geographic, geophysical and civic systems has remained uniquely applicable in reference to civic development especially when seen in the context of the long genesis of Landscape Urbanism.

With rare and notable exceptions “contemporary theory” is largely transformation couched in terms of radical innovation. Recognizing this, a benign illusion like absolute originality is indeed productive in the sense that it frees the next generation from the tyranny of influence by means of Harold Bloom’s misprision.10 A Freudian split, a reversal, overturning, a hermenutic glitch allows the apprentice to reject the influence of master while in fact entering into a process of transfiguration. Thus Giorgione or Titian, both working in the atelier of Giovanni Bellini, could appear to totally reverse the master’s still splendor, modeling and miraculous color while actually extending and enlivening them. Art transforms far more often that it invents and therefore must cheat rapaciously. This is its power – to deceive magnificently. Metamorphosis succeeds the demiurge incessantly while the latter’s protestations of virgin insight are bought cheap by the cult of novelty.

“If the author, for instance, of a travel guide is free to propose new comments on the land he has chosen to present, he is certainly not free to change its most common name since the easiest signpost is the best…”

Bruno Latour, “Reassembling the Social”11

Despite claims of audacious novelty, the terminology and discourse of Landscape Urbanism are quite predictable when seen in a diachronic context and, when seen in a synchronic one, routinely multidisciplinary without the vitality that such frothage can produce. Here high-bling recycling becomes preeminent. Flashy low-cal phrases are as serpentine as the graphics they accompany, digitally laid across troubled domains. Despite the obvious fact that methodology should stand preeminent in such an iterative discourse, their graphic sprawl emphasizes flat elegance, beguiling forms - biomorphs, digital glaciers, algorithmic smears and wipes, insistent visual seduction.
“The dangerous voyage into the labyrinth or into the underground is here replaced by an overdetermination of form; but that form is only an enlarged fragment, equally hermetic by excess of eloquence.”


Giambattista Piranesi’s Campo Marzio marked a high watermark of reified 18th-century angst. This was generated by the profusion of knowledge that gestated as the Enlightenment and a breakdown of traditional values that is loosely defined as Natural Law. In the etching an entomological assortment of creatures slithers across the Tiber basin. From a campo, a field, visually beguiling pattern emerges like crops, claiming to be urbanism while approaching a deafening degree of formal white noise. This “active decomposition” takes shape as an orgiastic proliferation of classical architectural forms liberated by the Baroque and Rococo producing a graphic cityscape of nearly complete representational exhaustion. Fascinating profusion thus arrives at almost intentional meaninglessness. Piranesi’s Carceri also seem to actively search for the same sort of senseless imagistic promiscuity, radiating a heady mixture of dismay, confusion and the eroticism of the labyrinth.
The basic element that is novel in the anachronistic pastoral discipline of Landscape Urbanism is the look of these drawings that reflect the debatable advances in representation inherent in new software, advances that shift the act of “creation” to “abstract mechanism” and thus wallow in the economic/demiurgic problems inherent in the terms *abstract* and *mechanism*. Furthermore they present an illusion of the automatic or aleatory while in fact they remain as subjectively determined as all depiction. An eye still edits and a hand still halts the machine. When these typical representations are factored against the same precedents that all of the biomorphic and expressionist work of the last decades must be, they too more than hint at formal revivalism of early Modernist Expressionism, of Kurt Schwitters’ Merzbau, Frederick Kiesler, Hans Scharoun, Giovanni Michelucci; all gone horizontal. They also mostly
concern visual results rather than the critically recherché discourse they claim to attend. The beguiling possibilities that the perforated, contorted and biomorphic inherently hail in what used to be called “organic” paradigms can then be applied to development strategies with some impression of environmental sensitivity. It’s soft, smooth and green-looking after all. The development of high-end utopian/futurist parametric forms in general, and thus the interest in discovering urban morphologies in “natural” topographies, seems another symptom of the ongoing desire on the part of architecture’s critical community (despite its own self-declared demise) to disengage from typologies or methods that might engage some sort of messy political discourse. By making smooth flowing messes, read as abstract, civil mess is thus avoided.

A history, in this case a vibrant one, needs to be assessed and utilized in order to be fruitful rather than simply serve to endorse the current market and repeat the market’s baroque, anemic and obfuscatory rhetoric squarely aimed at avoiding risky social engagement and augmenting profits. As with the fabricated term “nature” - an ideological contrivance linked to agriculture and comfort - historically it has been inherently assumed that “the land” would generate urban form that would flow naturally into the hinterlands thus making suburbs. The grid was therefore its vehicle and frame, a rationalist one that melded form and ideology seamlessly. Seen from above isn’t the magnificent pattern it provokes in the hinterlands already more beguiling than anything digital? Set in enigmatic relation to the flows of agriculture, the paisley ladders of suburbia accent given topographies. Perhaps it is the beguilingly graphic, “smooth” or “striated,” “fragmented” and “melded” qualities of the actual land, portrayed as “organic,” that appeal to Landscape Urbanism. But, despite the non-orthog- onal smears and zoomorphs that the organic is seen to imply, the actual organisms generated by contemporary urbanism are anything but haphazard in their growth.

The same is true of cities or gardens of course. Or perhaps the exhausted if beguiling contrast of the grid and the blob, or the automatic and obligatory associations that can then be made to the current enthusiasm for sustainability and ecology; these may encourage readings of the land that should be interrogated before tacit acceptance. In any case, parametric pastoralism produces exotica that are fuzzy, complex looking and in the end recapitulate the conventional agendas of planning and urban design without the concomitant uncomfortable political/leftist or hegemonic/rationalist odors that waft from those weary disciplines. Another variant urges the utilization of in-between city space and terrain vague in an update of garden-city motives, of the romance of ruins, of Piranesi and Hubert Robert. This was already radically investigated in Barcelona before Landscape Urbanism’s reinvention, in a city where terrain vague became a cardinal issue.

Terrain and its relations to human production offer vibrant positions from which theory, prose and poetry can engage the physical. The point is well made by the example of John Dixon Hunt, whose move from instruction in literature to garden theory to heading a faculty of landscape architecture is a perfectly “natural” one. Unlike the extravagant practicality and prohibitive expense associated with architecture, landscape design’s metaphoric linking of the land to philosophical principles, physiocratic economy and optimistic endeavor offers a discipline where ideas can finally supersede fiscal and technical constraints and formal autonomy, or better still, can enter into productive coexistence with them. “Dirt is cheap,” as a former architectural employer used to say, and therefore debate over its significance and relations to the arts
and literature can be, and have been, exceptionally rich. Yet landscape architecture is generally a discipline overwhelmed by horticultural matters, eschewing theory, or it wanders in the fields of an “eternal return” to “nature” that must be heavily reassessed to be other than a vestige of romanticism framed within a questionable pastoral whose history, since Fascism gave it a really bad name, verges on the diabolical. And now Landscape Urbanism apparently also meanders away into an amnesiac’s idyll of shape and image retrieved from its own rich history yet mostly avoiding the engaged critical models made available by that history.

In its analogies, much of the high-bling low-cal rhetoric of Landscape Urbanism runs parallel to that of a New Urbanism it claims to “truly challenge”. To disengage urban work from political analysis is indeed a challenge given that a distinction between the two is so fine. Yet this is the point, for the latter would no doubt provoke toxic questions about the former given inherent inconsistencies in “such politically ambiguous notions as mobility and network as the fundamental diagram of the city and at the same time the appropriation of such socially regressive models as the neighborhood, the village and the community as idealized and falsified representations of the city.” It is true that it is convenient not to confront the socioeconomic leviathan. Glib urbanism of all sorts encourages formal disengaged patterning backed up by equally uncritical rhetoric. It thus achieves the same sterile ends as those it claims to challenge, if by cooler means. Furthermore the suburbs do beguile – at a distance – may even inspire a reassessment of the urban from in friction with the land. Paisley, swirling, biomorphic, colliding, striated, discontinuous, punctuated by vast abstract figures, Arshile Gorky and Agnes Martin meet the parametric - they do look great from the airplane window passing over the Great Plains and that enchanting grid, on the way to yet another conference, another battle of the faux-Titans in the grand histrionic tradition of professional wrestling - New Urbanism vs. Landscape Urbanism. “Let’s get ready to rummmmmble!” While both flail rhetorically, the contrived conflict they nurture seems to be largely a propagandistic collaboration for mutual benefit, like that between power elites in every discipline. As was already pointed out, the leaders

Fig. 5
Godzilla.
of apparent military enemies naturally conspire and are mutually served by war. Together these two forms of neoliberal “urbanism” take the show on the road promoting by default, recalling the scorched-earth attitude of Robert Moses or a grade-B movie where a blundering Godzilla fights an equally clumsy Rodan (or perhaps, in this case, Aedicula vs. the Blob) while they absentmindedly trample Japanese cities.

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2. All quotes are either from the pamphlet that accompanied the lecture, 2013 AIA Baltimore Lecture Series – SHIFT (STOSS would appear to be their author) or from Reed’s talk. “Impressively honored” is from the pamphlet.
9. This phrase was used by Francesco Garofalo in conversation, describing to the work of Carlo Scarpa, Rome 1991.
15. See Hunt, J D 1976, The Figure in the Landscape: Poetry, Painting, and Gardening during the Eighteenth Century, (Baltimore and London: The Johns Hopkins University Press); or Garden

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Environmental Interior Design:
Adaptive reuse of a Former Post Office
Environmental interior design

As demolition and construction are by far the largest producers of waste - in the UK, twenty-four percent of the total waste material (Clark, 2008) - reducing waste is vital for creating environmentally responsible interiors. In Context + Environment, Brooker and Stone (2008) present reusing existing buildings as an act that is intrinsically respectful towards the environment because the amount of resources needed for reuse is far less than those needed for new constructions. Moreover, they state that when the existing building is historically or architecturally significant, it provides a link to our cultural and collective memory. As adaptive reuse is considered highly sustainable - environmentally and socially - a first step towards environmental interior design is re-using an abandoned historic building.

Moreover, interior architecture and design is often looked at as being temporary as it anticipates current fashion and personal taste. Indeed, many interiors have a very short lifespan, ranging from a few days for scenic installations to a few years for retail, to one or two decades for domestic interiors (Douglas, 2006). In The Philosophy of Sustainable Design, McLennan (2004) says: “A lot of buildings and building products get designated green or sustainable because they contain a few features that lower their environmental impact to some degree. Sustainable design is not about features … Sustainable Design is a design philosophy that seeks to maximize the quality of the built environment, while minimizing or eliminating negative impact in the natural environment.” (McLennan, 2004: 2-3). He argues that, as the word sustainable means “to be maintained,” it does not necessarily imply the need to change the way we relate to the natural world. He believes that instead of “sustainable design,” “restorative design” would better cover its meaning. Furthermore, as explained by Alan Durning (1999), the only efficient measure in creating a more environmentally friendly world would be a shift towards what he calls ‘post-consumer lifestyle’ – where we have enough material comforts but we make them last longer. As such, a second step in environmental interior design is focussing on durability, and therefore high quality and timelessness design.

Adaptive reuse as a method for social and political engaged interior architectural education

Working with existing buildings, repairing and restoring them for continued use has become increasingly important in the architectural practise since the 1970’s. According to Brooker and Stone adaptive reuse includes that “the function is the most obvious change, but other alterations may be made to the building itself such as the circulation route, the orientation, the relationships between spaces; additions may be built and other areas may be demolished” (Brooker and Stone, 2004: 11). Our interior architecture program at Hasselt University (previously at PHL University College) has always given important attention to adaptation and reuse of historic buildings. Particularly in the design studio, exercises have been made on transforming former industrial sites, castles, large farmhouses, or religious buildings. In order to prepare the students to the social, political, economical, urban and practical reality, which they will be confronted with in their future career, we always start from actual problem statements: existing buildings, in a specific urban context, which are misused, underused or abandoned.
In the past, these exercises were only limitedly supported by research. As such, the design task was often abstracted from the actual and realistic context of the given building. Since a few years, however, increasing attention has been given to research in design education; initiated by the Bologna declaration of 1999, the architecture and interior architecture programs in Belgium – formerly belonging to a polytechnic or beaux-arts tradition – were integrated into academia. As a consequence, these programs did not only need to train students in design skills, but also in research skills. Where design and research are thought as rather separate skills in the bachelor program, in the master program students have to combine both in their ‘Master Project’. The Master Project consists of two parts: the ‘Master Thesis’ and the ‘Master Design Project’ whereby the central idea is that the results of the thesis help to inform and guide the design project (Petermans et al., 2013). In the unit ‘adaptive reuse’, students usually work each on one specific building that is abandoned or underused. Traditionally, the research is build up as follows:

- History of the building and/or site
- The site in its urban context
- The architecture of the building (qualities and weaknesses)
- Opportunities for adaptation and reuse
- Master plan

Next, a design for the building is made taking into account the research outcomes. The extent of the various aspects, however, strongly depends on the specific situation of the building or site. The increase of research in education has led to design outcomes that are more rooted in reality and as such gain social and political implications. In what follows we describe one specific master project dealing with the transformation and reuse of a former neo-gothic post office in Brussels (Theys, 2012).

**Case study: adaptive reuse of a neo-gothic post office**

**Context and design brief**

The post office is located on the site ‘Tour & Taxis’, a 37 ha large site in the north of Brussels along the Willebroek canal. Since the early twentieth century the site was a depository from where goods were transported by train or boat. The different buildings on the site served as depots, shipping offices and offices for administration (Vanderhulst, 2010). Since the 1980s, when national borders were opened for European trading, the site has lost its initial function.

After two decades of vacancy and neglect, ‘Project T&T’ is set up in 2001 to work out a new development for the site. Project T&T includes several phases. The first phase was the restoration and reuse of the Royal Depot, the most prominent building on the site. Respect for the historic architecture was a key concern for the owners and the architects involved. The building houses: offices on the upper floors, retail and hospitality on the ground floor and, a wellness centre and an exhibition space on the underground level. In a second phase, the Sheds, a large industrial hall of 17 000 m², was renovated into a space for organising events and fairs. An underground passage-way connects the Royal Depot and the Sheds. Currently, Tour & Taxis receives about
700 000 visitors a year and can as such be considered as a successful reconversion of an urban site (Debièvre, 2011).

However, two buildings on the site still wait for a new use: Gare Maritime, a former railway hall, and Hôtel d’Administration, a former post office. The reuse and transformation of these buildings formed the topic of a master project in interior architecture; four specific requirements had to be taken into account:

1. The new use has to fit the overall concept and master plan of Tour & Taxis and add a new dynamic to the site.

Fig. 1

Fig. 2
2. The new use has to fit the master plan for the neighbourhood, which will be transformed into a new district for high-quality living, working, leisure and retail.
3. Although both buildings are not legally protected as a monument, respect for the historic architecture has to be fundamental to the project.
4. The project has to be cost-effective.

Research and value-assessment

In order to define a new use and an architectural approach for the adaptive reuse of Gare Maritime and Hôtel d’Administration, an analysis of the buildings was made based on literature study, archival research, interviews with people involved in Project T&T and several site visits, especially the two vacant buildings.

Gare Maritime and Hôtel d’Administration were both constructed in the period 1902-1910, by order of the national railway company (NMBS) following a design by the engineers Bruneel en Zone working for the NMBS and architects Constant Bosmans (1851-1936) and Henri Vandeveld (1851-1929). Both buildings are exemplary cases of early twentieth century architecture and craftsmanship through the use of ironwork, natural stone and the control of incidence of natural light (Vanderhulst, 2010). However, both buildings clearly differ in character; Gare Maritime is an example of industrial architecture but Hôtel d’Administration is a public building and as such its façades and public interior rooms are more richly decorated. The style of both buildings is neo-gothic, although characteristics of art nouveau can be recognized such as large windows and cupola’s to allow incidence of daylight and the use of plant motives in the decoration.

Fig. 3
Nara grid of Hotel d’ Administration.
Based on the analysis of the buildings, a value-assessment tool, the Nara grid, was applied in order to identify their most important values. The Nara grid is developed at the Raymond Lemaire International Centre for Conservation (KU Leuven) and is based on the Nara Document on Authenticity. Initially, the grid was developed in relation to restoration of masonry but later, it has been applied in relation to other themes in conservation such as 3D documentation techniques, evaluation of eclectic architecture, restoration of historic interiors and for designing a master plan for the conservation of specific heritage sites (Lemmens et al., 2006; Van Balen, 2008; Jaenen, 2008). Contrary to other existing heritage-evaluation tools (Mason, 2002), the Nara grid enables assessment of both tangible and intangible aspects. Figure 3 presents the Nara grid for the Hotel d’Administration, figure 4 the Nara grid for the Gare Maritime. The issues written in bold are considered more important in relation to the building than the other issues. For both buildings, three common key values were defined based on the Nara grid outcomes: craftsmanship, quality and exclusivity. These three key-values were taken as a basis to define a new function of the buildings, but also the architectural approach towards the historic architecture; ‘craftsmanship, quality and exclusivity’ in this project connects the historic architecture, the design and the function.

The functional concept

Both buildings will house in the first place retail functions. Hôtel d’Administration will be transformed into several smaller shops that can be rented by selected retailers who offer exclusive, luxurious and qualitative products from all over the world. The central hall will be transformed into a public space for exhibitions or events. Moreover, a bar and restaurant will be located in the building.

Gare Maritime will be transformed into a covered market where fresh, artisanal products are sold. But there will also be the possibility of tasting the products in one of the trattorias. Although this covered marked is not intended to have the same luxu-
rious character as the shops and restaurant in Hotel d'Administration, the same pursuit for quality of the products will distinguish the project.

**The architectural concept**

Following the value-assessment that has led to the identification of the three key values for the site - craftsmanship, quality and exclusivity – these values were studied more in-depth through the buildings’ architectural characteristics, i.e. the neo-gothic style. Two important adherences and theorists of the neo-gothic style, Eugène Emmanuel Viollet-le-Duc (1814-1879) and Louis Cloquet (1849-1920), were studied in order to gain better insight in the original architectural and functional concept of the buildings.

According to Cloquet, ‘*la convenance*’ – the experience of pleasure - can only be reached by designing the building specifically for its intended function; a building can only obtain beauty when it fulfils the needs of its use. As such, Cloquet continues, contemporary architects need to be engineers (Cloquet, 1901: 38). In the five volumes of *Traité d’Architecture* (1898-1901) he gives an extensive description of the neo-gothic style, which he organises according to the buildings function, e.g. abattoirs, post offices, railway stations, private dwellings. Looking at the chapter on post offices, the characteristics described by Cloquet can be clearly recognized in the design of Hôtel d’Administration, both in its special organisation – the plan and section – as in its decoration. As illustrated by figures 5 to 8, it is even possible that the architects while designing based on Cloquet’s description of the typology.

The theories and practise of Eugène Emmanuel Viollet-le-Duc gave even further insight in the architectural approach towards restoration, renovation and reuse of Ho-

Fig. 5
Ironwork decoration, Source: Cloquet, 1898-1901.
Fig. 6
Ironwork decoration Hotel d’Administration, original plan by Bruneel, Source: archive Project T&T.

Fig. 7
Ironwork column, Source: Cloquet, 1898-1901.
tel d’Administration and Gare Maritime. Within his position as architect and first chief inspector of this ‘Commission des monument historiques’ in France, Viollet-le-Duc was involved in many restoration works of mostly Gothic buildings, among which the Notre Dame in Paris, the castle of Pierrefonds and the citadel of Carcassonne. His interventions were often far-reaching, as he added for instance completely new parts to the building ‘in the style of the original’ (Vaccaro, 1996).

This ‘stylistic’ approach was rooted in the nationalist zeitgeist in which historic buildings were conceived as national monuments, and were restored in the most appropriate style to illustrate the achievements of the nation. Nevertheless, the influence of the restoration movement, of which Viollet-le-Duc was the originator, was not limited to France. Instead, influential architects such as George Gilbert Scott (1811–78) in England and Pierre Cuypers (1827–1921) in The Netherlands were followers of the restoration movement. But the work of Viollet-le-Duc was also criticized by his contemporaries and descendants. John Ruskin for example describes this kind of stylistic restoration as ‘a destruction accompanied with false description of the thing destroyed’ (Ruskin, 1849: 148). But nevertheless, both Viollet-le-Duc’s work and writings are particularly relevant to the contemporary practise of adaptive reuse, as he clearly aspires a continued use. Concerning reuse of historic buildings, he claims:

... the best of all ways of preserving a building is to find a use for it, and then to satisfy so well the needs dictated by that use that there will never be any further need to make any further changes in the building. ... In such circumstances, the best thing to do is to try to put oneself in the place of the original architect and try to imagine what he would do if he returned to earth and was handed the same kind of programs as have been given to us. Now, this sort of proceeding requires that the restorer be in possession of all the same resources as the original master – and that he proceeds as the original master did.

(Viollet-le-Duc, 1990 [1854]: 222-223).
Inspired by Viollet-le-Duc’s ideas, the ‘stylistic’ approach is applied to the restoration and adaptation of Hotel d’Administration in the context of this master project. Firstly, Viollet-le-Duc’s methodology to first study the buildings’ history and architecture in full detail is applied here: the original plans of the building were consulted in the archives and were compared in detail to the actual state of the building. This survey showed that several adaptations were made to the building in the course of time; however, it was not always clear when and why these interventions were made. Moreover, as for some parts of the building only the plans and sections drawn by the engineers were kept in the archive, it is possible that these drawings do not show the buildings’ full detail and decoration but focused on construction instead. Secondly, as to the restoration and the re-design of the building, Viollet-le-Duc’s approach to ‘try to put oneself in the place of the original architect’ is applied, although not in a historized way. Instead, the values that were at the core of the original architectural concept of the building - craftsmanship, quality and exclusivity –, are translated into a contemporary design language.

For the Gare Maritime, the same architectural approach could have been valid, however, due to the limitations of the master project, the re-design of the Gare Maritime was not worked out as part of the project; instead, the design part of the master project focused solely on Hotel d’Administration.

Design

In general, the retail design practise is rapidly evolving and retail buildings and interiors are often refurbished more frequently than other type of buildings and interiors (Mesher, 2010). This has often let to trendy and fashionable designs. But for Hotel d’Administration, a building with high historical and architectural significance, a timeless design is more suitable. To deal with the tension between the monumental and timeless character of the host building and the trendy and temporary character of its new use, a specific concept for the reuse of the Hotel d’Administration is worked out. On the one hand, all interventions which are not directly related to the retail function but which make the building suitable for contemporary use are done in a ‘permanent’ way. These interventions include for example all installations, and horizontal and vertical circulation. On the other hand, interventions directly relation to the retail function are made reversible, such as for example shopping windows and the interiors of the individual shops.

Moreover the new interventions do not contrast with the host building but are made in synergy with the original neo-gothic building, in accordance with the restoration theories of Viollet-le-Duc. An important element in the contemporary design is a new staircase that is added in the former counter hall. The staircase is made in contemporary materials but clearly inspired by a classical, monumental staircase, intend for giving a good view over the large, central space of the building.

Conclusion

This case study showed that an in-depth study of the original building – its history, urban context, original design concept, current state – may be an added value in finding a new use for an abandoned historic building or site, but also in generating a design
solution that respects and enhances its historic and architectural value. Tools developed through (academic) research, such as the Nara grid, may also help in analysing the site and defining a new use for it as well as a design solution.

In general, the architectural approach towards adaptive reuse of a building or site has often been one of ‘contrast’ between the old and the new. The interior architectural approach however, may be one of ‘synergy’ between the old and the new so that the intangible values, or ‘soft values’ of the building may be preserved or even may revive in the new design concept of the building. How to conserve and re-establish the original values of a monument has also been the key issue for 19th century theorists on conservation and restoration such as John Ruskin, William Morris, and Eugène Emanuel
Viollet-le-Duc. In the case study described above, the theory of Viollet-le-Duc has inspired a contemporary design methodology which intended to regenerate the original atmosphere of the building – however, translated into a contemporary program.

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An overall Sustainable Approach to Shape the Citizenship of Tomorrow: the Solar Decathlon Competition
Houses, almost worldwide, continue to be built more or less the same way they were being built at least fifty years ago. This means the house that will host us for 20, 30 or 40 years is designed for current needs while referring to an obsolete concept that the future is merely a reflection of the present. However, since buildings -at least in Europe- are responsible for more than half of the energy consumption and that -in Europe- it mainly comes from fossil sources 1, our society must now urgently update the design and theory of architectural practices to implement projects that ensure a new relationship between nature and men.

Therefore, in Architecture, education cannot and should not ignore this relationship. One of the main differences with the past is the rising temperature worldwide 2. This contributes to the ever-increasing need to cool the inside of buildings. This will require much more energy than ever needed before to warm them. Actually, lowering the temperature by 1°C requires three times more energy than needed to raise it by the same amount. It is therefore necessary to study housing models that can also defend themselves from the heat, rather than just from the cold as had generally been done in Europe in recent years.

At the same time, a new requirement connected to living conditions is the size of housing that must meet the new and modified households, which are different than the ones of a few years back in terms of composition, background and size. City users, immigrants, singles, divorced people and the elderly changed the demand and now require flexible answers and offers. Models that are more flexible and sized according to the real housing, European and, especially, Italian needs while maintaining affordability. Such social housing is addressed through the projects drawn for the Solar Decathlon international competition. Some of the details expressed by the University of Roma Tre, whose author was the coordinator, are exposed here.

Universities, companies and institutions come together with one common goal: living in the future

Data that was elaborated by DG Tren shows that buildings are responsible for more than 50% of the European energy consumption. This means that industrial, mobility and transportation activities account for the other 50%, which leads us to realize the importance of an architect’s role in fighting against consumption in Europe. A good part of this overall 50% consumption is attributable to residential housing. Such data shows an urgent need to modify the physical features of our houses, but also to review the lifestyle we have adopted in order to make it compatible with energy efficient constructions. Indeed, reducing the winter heating consumptions and the summer cooling ones is an important step towards improving environmental quality. At the same time, the ability to create a relationship between energy consumption and energy production, from renewable sources, makes it possible to reduce the consumption levels of the most general domestic functions. However, all this is useless if we do not have people who are able to manage efficient houses.

The general opinion is now that our buildings and homes especially turn into positive energy 3. This is needed for the environment, but also for ordinary management of our economic resources. It is also useful for our quality of life because green houses are more livable. We must commit ourselves to build buildings that can satisfy the requirements of indoor well-being while controlling their impact on the outside envi-
Environment, as to form tomorrow’s citizens. If the lifestyles adopted within these buildings are not compatible with the building itself, then even a sustainable home starts to consume.

How can we then make high efficiency buildings while learning the good behavior needed to use them, when implementing techniques and technologies aimed to reduce consumptions?

For over 10 years now, there is an international competition called “Solar Decathlon”, whose objective is getting the new generations involved in a competition on energy efficiency. The competition is for universities that participate at least with the Architectural Departments and whose students not only design, as in any other competition, but also build and manage real housing prototypes for a near future.

Such competition primarily focuses on the architect’s role with regards to protecting the environment from human activities. This makes him the protagonist of a holistic operation involving many production sectors: structural engineering, system engineering, electrical and plumbing engineering, industrial designs, sociology, marketing, economy, financial aspects, communication, etc.; all essential to reach sustainability and innovation.

**The Solar Decathlon competition**

Solar Decathlon is a competition whose objective is to make innovative, sustainable and self-sufficient housing prototypes thanks to solar energy in particular.

Twenty university teams are selected for every edition, which is held every two years and during which a prototype is designed and built for the same competition.
field, as to create a small *smart* district where the houses are tested and measured throughout 10 contests\(^4\).

The Solar Decathlon:

- educates students and the public about the money-saving opportunities and environmental benefits presented by clean-energy products and design solutions;
- demonstrates to the public the comfort and affordability of homes that combine energy-efficient construction and appliances with renewable energy systems available today;
- provides participating students with unique training that prepares them to enter their nations’ clean-energy workforce.

The competition was conceived in 1999 by the US Department of Energy and the first event was held in Washington DC in 2002, and was then followed by the 2005, 2007, 2009 and 2011 editions. However, the 2013 edition was held in Los Angeles, California, to promote energy production during the competition days thanks to a more suitable climate. At the same time, in 2010 and 2012, the competition was held in Europe, in Madrid. The 2014 competition, however, will be held in Versailles, France. Finally, since 2013, there is also an Asian version, which was held in China, near Beijing (a proof of the success and global interest of this initiative).

During every edition, the universities participate with multidisciplinary teams thanks to the scientific contribution of professors and the work of the students, as both are involved through the entire conceptual and implementation processes. Very advanced technical know-how is required and the economical and technical support of the companies is a basic requirement for the project. This initiates the comparison

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Fig. 2
between design and production and it involves mechanisms that trigger innovation. Indeed, it is not unusual to see these operations turn into patents, or to see them trigger spin offs for new industrial productions.

The general idea is to put the technical skills of the future architects and engineers into play with the support of economists and communicators. From the industrial design of furnishings to the technical design of photovoltaic roofing, from the conception of a strategy for energy to the measurement of the transmittance levels of a new wall stratigraphy, the entire conceptual process is involved up to the level of every single screw.

The Decathlon, 10 contests, assesses the architecture and engineering results, measures the domestic functions, monitors the energy production and compares it to the consumption levels of the thermal-humidity performance and to the quality of the air. It also evaluates the communicative abilities of the teams and their business plan, as well as the innovation that was triggered, the sustainability of the materials used, the production and building processes implemented and the transportation systems.

The proofs can be subdivided into two groups: those evaluated by a jury of three experts and those measured through a monitoring network that is equal for all.

The first group includes the proofs related to elements such as Architecture, Engineering and Construction, Energy Efficiency, Communication, Industrial Production, Innovation and Sustainability. The second group includes the proofs related to the Energy Balance, Comfort and House Functioning. These are determined through direct surveys.

**Solar Decathlon in Europe**

The European edition of this competition goes beyond the short housing project. In the years since environmental design became a research-based feature of architectural education, its horizon has expanded from science of interior environments to the ecology of entire planet. Sustainable ideas are not just about conserving the natural environment, but also involve serving the social and political lives of communities. Therefore, Solar Decathlon 2014’s program, which will be held in Versailles, requires thinking and solutions for the issues of the city. In addition to sustainable housing, land use, waste processing, water and food supplies and sustainable mobility will be covered. This will obviously impact the social and political levels, with more concrete implications at the educational level, so not through the typical theoretical approaches used in common university classrooms. Often, the local administration realities are involved in the project that addresses the real needs of the community; not just the current ones, but also the ones that are to be expected in the medium to long term.

An overall 360° view therefore allows us to explore the answers that could respond to the most current housing needs and the students will confront them by identifying the most urgent questions thanks to the support of institutions, research centers, professors and avant-garde companies. This togetherness is for sure bound to generate innovation. All the ingredients are there: youth, university research, businesses.

Since housing is one of the main issues on a global level, finding economical solutions that ensure well-being and livability at the same time, at different latitudes and for various cultures, has been one of Solar Decathlon’s challenges since it was founded.
Browse through the nearly 200 projects of the competition offers a broad view of the ideas and solutions that can already be implemented now to improve the livability of our planet without impacts and consumptions. This becomes even more important when considering that the models suggested can really be implemented, as verified on the real question relating to the possible evolution of the concept suggested and on the actual agreements made with future users.

Tendentially, the prototypes are solutions for new buildings that -especially in the European edition of the competition—focus on density and on land consumption limitation while trying to fill empty lots and to consolidate the frayed fabrics of the most recent settlements, but also by getting rid of illegal constructions around the town centers.

But many of the proposals received during the Solar Decathlon competition intervene on the existing edifices. They are made of small cells to be added to buildings and that can improve the energy behavior: cells that consume very little energy and that give the energy produced in excess to the building that hosts them. We could call them good parasites. This symbiosis does not only concern the energy topic, it also concerns the social diversity and self-sufficiency of the lifestyle of the new inhabitants that cultivate the green roofs on which they settle. A new and diffused type of social housing.

**Italy’s Solar Decathlon proposals**

MED in Italy is the name of the Mediterranean house that won third place at Solar Decathlon Europe 2012.

![Fig. 3](image)

The housing prototype MED in Italy.
MED in Italy adopts an efficient strategy for the hot-temperate climates of the Italian peninsula by revisiting the building traditions of the Mediterranean, going over a typologically introverted model, a patio house.

MED in Italy was designed to protect more from the heat than from the cold. It is indeed a house that was conceived for the typical climate of the Mediterranean, as illustrated by the suffix of its name, “MED”. Over the last decades, green architecture showed signs of more northern features than southern ones. However, in view of global warming and of the increasing number of summer cooling systems used, being able to defend ourselves from the heat assumed a more important role for the building field in general.

In the Mediterranean, there is an ancient tradition that was recovered and interpreted in the design to try to transfer the inertial mass of a typical Mediterranean building to a prefabricated building that can be assembled and disassembled. The MED in Italy house is therefore insulated from external temperatures during the hottest hours and opens when the sun sets while a patio and two loggias act as a buffer zones between the external environment and its confined internal one. A layer of mass in the vertical perimeter walls, in bulk sand, into contact with the internal environment, makes it possible to accumulate the thermal peaks by acting as a thermal flywheel.

The projects for Solar Decathlon 2014 must then find a real territory of reference. The team of the University of Roma TRE suggests a prototype made to satisfy the housing issues of the Italian capital. Therefore, “Rome” and “Home” are combined to form “RhOME”, the name of the team and project.

Being in the 2014 edition, whose theme is the city, we are moving towards themes such as density and the urban aggregation of renewable energy housing units. In this manner, there is not just emphasis on energy production. Indeed, we are seeing an increase in terms of affordability, efficiency and sustainability with regards to the production processes and materials, but also to the mobility processes and to the city in general.

The team chose to work in the Roman suburbs; where new buildings will recompose the most recent urban fabrics by replacing the illegal constructions, which are expected to be demolished to liberate the agricultural Roman lands and the archaeological remains from their presence. This is a very typical issue in the central and southern part of Italy, but it also clearly concerns other national realities on a global level.

_Five points for a new Mediterranean and sustainable type of architecture_

Five points define the philosophy of the MED in Italy and RhOME projects. They sketch a sort of guideline for today’s design practices:

1. emphasizing passive behavior;
2. optimizing active systems;
3. building in faster and more reliable times;
4. designing in an eco-conscious manner;
5. focusing on urban density.

Amongst these points, 4 and 5 satisfy a global vision of the issue. Actually, emphasizing the life cycle of a building and the processes, materials and products that com-
pose it and considering the urban implications of new housing settlements in terms of land use, mobility, water and electrical supplies and consumption gets the designers and builders -students in this case- used to a holistic vision of the issue that cannot be focused on the single technical aspects.

Fig. 4
The aggregation of single units starting from MED in Italy.

Fig. 5
The RhOME social housing solution.
The answer to the search for a real balance with the environment is based on a careful selection of the materials and which can be grouped into three different key words: renewable, reusable, recyclable. Focusing towards renewable materials, that do not deplete the planet’s resources because they compatibly regenerate with the lifespan of a human life, is the University of Roma TRE’s main choice: wood for structures and internal finishing, wood fibers for thermal insulation, natural-based fabrics, bioplastics. The reusable components are another frontier of eco-friendliness. This approach means the project must focus on the reversibility of the artifacts, whether they are entire buildings or the furnishings in them contained: designing replaceable and modular components without using nails or glues. Reusing materials is generally preferable to recycling them. In any case, this requires an amount of energy to trigger a reproduction process. Both, materials and components-products in the two mentioned projects, have been chosen assessing the amount of energy required for their production, such as the global quantity of primary energy embodied in all material, component and process included in manufacturing, transportation and building construction.

The project includes modular components that, in addition to being replaceable with each other, are also designed to be compatible with the size of the mobile railway containers, as to reduce the carbon emissions arising from road transportation.

For the Solar Decathlon Europe Competition, the prototypes are designed and built as to be able to work as independent housing units. However, this is not the best solution for two apparent reasons.

The first is due to the fact that the efficiency of a building also depends on the potential housing density, which allows less dispersion and more contained building costs.

The second reason is the fact that land must be preserved from a diffused anthropization due to pollution, the destruction of the landscape and the difficulties involved with providing aggregated services for the settled communities.

It is therefore important to make sure the types of features and constructive characteristics of these accommodations allow horizontal and vertical combinations according to the schemes, which will be adapted -from time to time- to their context.

MED in Italy and RhOME are thus the cells of larger and more dense complexes that plan to implement minimally expandable housing units built around compact bathroom-kitchen blocks and designed to accommodate different types of users.

These houses are however also designed to resolve the most urgent housing issues that we currently face worldwide.

On one hand, there is a new and increasingly stronger demand for responsible tourism and environmental attention. The houses are therefore designed to fit harmoniously into the environment and to work without any water, electrical and sewage connections. Such complexes, with small internal modifications, are primarily aimed to re-convert a kitchen module into a bathroom, which can also generate buildings suitable for hotels.

On the other hand, by simplifying the finishing and interior design systems and thanks to the quick times of production and assembly, we will also be able to create reception areas that can satisfy the demand of hospitality for political refugees, immigrants and refugees that continues to grow and that represents a pressing issue for the shores of the northern Mediterranean; but also emergency accommodations.
that can be quickly assembled to support communities that suffered natural disasters, such as the earthquakes the Italian peninsula is unfortunately subjected to.

**Designing and shaping buildings and the professionals of tomorrow**

Designing buildings that consume little is not enough because the importance of the competition also and especially lies in being able to set the all-around experience.

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**Fig. 6**

Two Screenshots in two different moments of the model in WebGL showing through an interface monitor the status of the house. Colors from yellow to red, highest, show instant power of devices that turned with the intensity of consume. Grey shows appliances turned off. Source http://www.medinitaly.eu/it/interface-smartcity

**Fig. 7**

The students who attend the Solar Decathlon Europe 2012.
These houses are “governed” by a team of Decathletes that must be able to manage them, to take advantage of the production peaks and, simultaneously, to reduce consumption. In this manner, the students involved must not only design and build, they must also cook, clean and live in the house in the most efficient and effective manner possible.

Selecting the design to support these tasks could be programming, with an integrated and defined intelligent system, the operation system needed to generate the comfort conditions required. On the opposite, the Italian projects chose to get the inhabitants involved as much as possible and to give them the tools needed to understand what is happening so that they can decide how to act. Therefore, it is not about Home Automation, but about open systems where the user is the active part. A fundamental point of this approach that focuses on the energy awareness of “tomorrow’s homemakers” is the storage of the use and consumption data into a web interface, where the history of the house can be accessed online by the inhabitants and others of other houses. The house is indeed presented online with a model that replicates what is happening inside to trigger a sort of virtuous competition between the uses and consumptions of different homes that are connected to each other. The system provides data on the energy production, consumption and comfort levels that the user may or may not choose to take into consideration. The model is integrated with a database and it is dynamically updated by a low-cost sensor kit that is stored remotely so that it can be retraced over time to understand how similar moments can generate different and always better consumptions.

In this way, students can see and understand how performances and consumptions are associated to behaviors and acquire an energy awareness aimed to define smart citizens according to homes and districts that are more and more inclined to put their energy information online.

This is a present future and, thanks to this experience, students not only learn and study, but they also design, live and test.

The Solar Decathlon forms students for their future practice, in which they will have to anticipate interaction with a world very different from today’s. This experience shape the students as the citizens of tomorrow and prepare them to the future way to live, design and build, in order to be as aware as possible of the direction in which the future lies.

Notes
1. Source: IEA OECD Europe—Summary electricity production and consumption Electricity Information, 2011, p. IV.59 Available through the OECD Library
2. There are many discussions on global warming, however, it’s not just the climate change that is being put into question, but also the importance of the CO₂-climate relation and, thus, human responsibility.
3. Buildings that consume less energy than they produce.
4. During the two-week competition, a smart grid is created and thanks to continuous monitoring, the data collected is published on the Internet in a dynamic mode: anyone can therefore connect to the link and compare the houses based on how they behave.
5. The European edition of the competition, as the others, is open to all universities worldwide. Therefore, the solutions collected pertain to all the countries to which the individual universities belong. In the 2014 edition, the countries involved are: Chile, China, Costa Rica, Denmark, France, Germany, India, Italy, Japan, Mexico, the Netherlands, Romania, Spain, Switzerland, Thailand, USA.

6. There were 18 prototypes from Brazil, China, Denmark, France, Germany, Japan, Italy, Portugal, Romania and Hungary.

7. A single unit is produced in one day in the establishment and is assembled in about a week.

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Cooperation of Students and Scientific Staff of Faculty of Architecture of Wrocław University of Technology with Industry
The activity of students’ scientific circles at the Constructions Department

Realizing the assumptions of approved programs of studies, scientific staff are aware of the presence of new, important subjects which are not included in the present programs. During recent years, the issues concerning the field of ecology, economy protection or revitalization of environment have become especially important. Some new, original problems and issues are pointed out by the students themselves. Other appear as a result of inter-university contacts and also as a result of cooperation of the university with industry. They are related to current needs of the society caused by civilisation development or are the results of origin of new scientific theories.

It is very important to skillfully use the latest appearing scientific and technical achievements in order to realize that educational mission should be accompanied by the awareness that the actions taken today influence not only the picture of the future world, of the countries, cities, villages, neighbourhood, houses but, most of all, the life of their inhabitants and the environment which surrounds us. In such situation, the didactic forms which are unconventional and not included in the program but which can make young people sensitive to the pace of the civilization changes and the contemporary aspects of the profession of an architect – designer, are of big significance.

Classes of cameral character which are meetings of young people with specialists of various branches of science and representing various non-standard views on the reality surrounding us and also the didactic forms inspired by the teachers and developed by the students seem to be the most appropriate form. Not only the experience gained during studies resulting from contacts with practitioners and producers but also the participation in the process of creation of real projects or their fragments which are the opportunity to actually influence the final shape of the product are important.

These reflections and the experience gained so far confirm the need of integration of students and making them interested in the actions not included in the program, which can be realized in specialist students Scientific Circles including the Scientific Circle at the Construction Department.

Such form of activities is successfully practiced in the work of over a dozen of scientific circles at the Faculty of Architecture, Wrocław University of Technology. The main assumption in case of a new circle with the profile of new constructions was that it should be created by the youngest students and that their actions should, in the form of workshops, contribute to “Instructa” annual international scientific conference. Making a direct contact with companies producing construction elements, signing cooperation agreements and the opportunity to use the effects obtained as a result of these activities – in practice – are also important elements of these workshops.

During the workshops accompanying “Instructa 2013”, the aim of which was to design a concept of exhibition tents, a group of students – members of a Scientific Circle – took part in specialist lectures which were an introduction to the subject.

During practical part of the workshops, experiments using the so called membrane, torque-free state were conducted using soap bubbles (phase 1-3). Next, the students in small groups, supervised by teachers, started working on various concepts of exhibition tents using the forms of drawings and models (phase 4-5).
Photo 1
“Instructa 2013” workshops – phase 1 – forming wire frames.

Photo 2
“Instructa 2013” workshops – phase 2 – examination of the so called membrane state.

Photo 3
“Instructa 2013” workshops – phase 3 – evoking the so called torque-free state.

Photo 4
“Instructa 2013” workshops – phase 4 – forming the shape of a future tent.
Photo 5
“Instructa 2013” workshops - phase 5 – the final result – a model of a fabrics tent (variant a).

Photo 6
“Instructa 2013” workshops – phase 5 – the final result – a model of a fabrics tent (variant b).

Photo 7
“Instructa 2013” workshops – phase 5 – the final result – a model of a fabrics tent (variant c).

Photo 8
“Instructa 2013” workshops – phase 5 – the final result – a model of a fabrics tent (variant d).
Students team – authors of tent from photo nr 5, (variant a): Konrad Onderko, Dobrochna Stobiecka, Magdalena Świat.

Students team – authors of tent from photo nr 6, (variant b): Dobrochna Fryc, Kamil Golec, Martyna Łykovska, Agnieszka Orzęcka.

Students team – authors of tent from photo nr 7, (variant c): Karolina Dyjach, Joanna Osiewała, Wioletta Sarara, Kamila Waszkowiak.

Students team – authors of the winner tent from photo nr 8, (variant d): Mikołaj Krawiec, Marta Mleczykowska, Dorota Ręclawowicz.

A contest, during which the Jury, with representatives of the company producing conference and garden tents, chose the esthetically and constructionally best tent, was the summary of the workshops. Trade mark procedure concerning the winning designs was initiated and the sponsoring team started working on the prototypes and implementing them to production. In the final phase of the workshops, the students supervised by constructors formed the chosen shapes of the prototypes in the courtyard of the Faculty of Architecture building (phase 6-7).
Small design tasks for students, including the subjects which the tent producers worked out earlier, are a further stage of cooperation. The ideas originated during brainstorming. Formulating the solutions satisfying all the parties was the final effect of cooperation of producers, students and university teachers. The students meeting within the scientific circle encouraged by the successes decided to widen their intellectual horizons. They organized a cycle of “open” lectures run by invited guests and lecturers from other universities and of other specialties. The lectures on, among others, international space station, architecture of the universe or the first Polish floating house managed to gather a full audience filling the largest lecture hall at the Faculty of Architecture (over 220 people).

Apart from these spectacular lectures for the members of the Scientific Circle at the Constructions Department, there are weekly “Lessons of Architecture” where the works of outstanding architects of different epochs are discussed.

**Studies of scientific staff of the Faculty of Architecture**

Starting a cooperation of lecturers and employees of the Faculty of Architecture of Wroclaw University of Technology with representatives of industry followed an intellectual stimulation of the students. The following latest projects can be listed here:
a) Among others, cooperation with the companies producing reinforced concrete elements for multi-story car parks was initiated based on the proposal of national and EU organisations concerning supporting experiments and cooperation of universities and industry. The design of a unique system of ecological multi-story car parks made of reinforced concrete or mix of cement and resin prefabrications in the form of beams and plates of the span of 16 m. (study in progress, authors: mgr ing. Krzysztof Janczura, mgr Ireneusz Janik, Prof. dr hab. ing. arch. Robert Masztalski, Dr hab. ing. Waldemar Bober, Dr ing. Michał Pelczarski, Dr ing. arch. Przemysław Stobiecki).

b) A unique idea using potential energy of vehicles parking in multi-story car parks appeared during the preparation of a common scientific project and as it uses the energy which has been ultimately lost so far, it should be considered as ecological and worth popularizing. (The idea has been patented, author: Dr ing. arch. Przemysław Stobiecki)

**Ecological force pump using potential energy of vehicles**

**Subject**

The appliance is an ecological pump of a new kind. It is built based on elements of proper construction objects. It is designed to press water (or another agent) from the level of the building foundations to the level of roof containers.

This appliance uses the work done by contemporary vehicles entering parking places, public transportation stop lay-bys, parking places in multi-story car park, petrol stations etc. The appliance uses potential energy resulting from the mass of these vehicles.

**Status of the technology**

The currently known solutions of similar appliances pumping liquids are built on smaller scales. Such an ordinary device as a medical syringe operates in a similar way.

![Axonometric projection of elements of ecological pump (rendered version).](image)
There is also a popular anecdote about the gate in Thomas Edison's garden which was pumping water to a container on the roof of the house of the famous inventor at each of its openings.

*The essence of the invention*

Using elements of construction objects and the weight of vehicles in ecological (without consumption of any additional energy) pumping liquids is the essence of this invention.

Vehicles coming to an inflexible plate, which is the piston of the pump, exercise pressure on it with their mass. In this way, they transfer part of the energy to elastomer gasket placed under the plate. The plate of the piston subsides by 5 to 10 cm creating pressure in the container. The excess of the produced energy is used for pumping the water which is in the container under the plate up to the roof containers using durable water pipes of a small diameter. The elastomer gasket pressed by the plate with a vehicle, additionally seals the bottom container of the device enabling production of pressure used in the pump. The working cycle of the pump finishes in the moment when the vehicle leaves the plate of the piston. The elastomer gasket gives away the absorbed energy bringing back the initial level of the plate. Filling the bottom container to the maximum level is the condition of an efficient work of the pump.

The pump's system can be additionally equipped with a blockade of the piston plate, a device lifting the plate (in order to run maintenance of the gasket and the container), cut-off valves, manometers and locks regulating the operation of the appliance, installations of hot water heated by sun energy supported by a heat pump, etc.

This appliance can pump cold water of the volume equal to the mass of the vehicle entering the plate. Cumulative volume of the pressed water equals the ratio of the piston surface multiplied by the difference of the plate levels before a vehicle enters it and after it. For passenger cars, it can be quantities from 1.5 to 4.5 t, which equals the mass of water of the volume of 1.5 to 4.5 m³. In case of using public transportation vehicles, the volumes of pumped water can be several times bigger. Placing the appliances of this type at the entries and exits of multi-story car parks, petrol stations, places of toll road payments ensures multiple cycles of the pump work during a day.

The pumped water can be used in ecological way for supplying water installation accompanying multi-story car parks – car-washes, toilets, waste water treatment installations, firefighting installations. Water collected in the roof containers can also be used in the houses located in the vicinity of the car park. It requires creating a hydraulic network accompanying the appliance.

*Advantages of the appliance*

The appliance works without using any other sources of energy. It uses the work wasted so far by vehicles during their stopping and moving again. When properly constructed, it will be fully ecological and self-sustainable. The bottom reinforced concrete container filled with water may stabilize and press foundations of a multi-story car park. Locating such appliances at entries and exits of multi-story car parks ensures multiple work cycles of the pump during a day. Locating the containers and pumps under the bus stop lay-bys will increase the pressure and amount of water in one cycle. The pumps of this type may become a part of larger energy systems using stored energy during peak time.
Construction of the appliance

The appliance consists of a reinforced concrete water container 1 with a specially shaped socket for an elastomer gasket 4. Water in the container should reach the rim 3. The container is also equipped in the drawn blockades 2 located symmetrically. The bottom container is connected by means of pipes to the pipes of water installation. Pipe no. 9 with a cut-off valve and a lock takes the surplus of water from the container. Pipe no. 10 with a cut-off valve and a lock supplies water to the container. Pipe no. 11 with a cut-off valve and a lock transports water to the top container no 7. Specially fitted and shaped elastomer gasket no 4 is located over the bottom container.

Plate no 5, playing the role of a piston, is located over the elastomer gasket. A vehicle no 14 goes on and leaves the plate. Upper containers no 7 are located on reinforced concrete roof plate no 6 and covered with the structure, e.g. reinforced concrete saw-tooth roof. Dark colour of external side of the roof causes absorption of sun heat, heating the reinforced concrete structure and the attic space. This heat is used to heat water in the roof container. In the space of the created attic no 15, there are also pipe and heat pumps installations serving upper containers 7. The collected hot water may be used and distributed by pipes no 13 equipped with valves. Similarly, cold water is distributed by pipes no 12. No limitations are foreseen as for the dimensions of the appliance. Planned optimal dimensions for the projection of the piston plate for passenger cars are 4m x 8m.
Proposed stipulations

The appliance works pumping water without using additional sources of energy but using the weight of the mechanical vehicles.

The appliance uses the work which has been wasted by stopping and moving vehicles so far. The elastomer gasket gives back the absorbed energy bringing back the initial level of the piston plate of the appliance, enabling this way a next cycle of pumping. A reinforced concrete container filled with water plays stabilizing and pressing functions on the foundations of multi-story car parks.

Summary

The fact that such ideas arise in the conditions favourable for exchange of thoughts and views – in this case in the academic environment – is very uplifting. The possible savings of either energy or water resources will positively influence the balance of costs of construction enterprises using the appliance of this type. The presented appliance should be considered an ecological solution which is very useful and simple in its design.

References


Note

Photos and own drawings, marked (*) from the following webpage:
http://www.mmszczecin.pl/photo/1077213/Wroc%C5%82aw-dom+na+wodzie have been used.
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EMUVE
(Euro Mediterranean Urban Voids Ecology)
Architectural Education from socio-economic perspective in environmental design

In recent years, the concept of sustainability has been extended from technological research fields to the whole architectural discipline, including its social, economical and political aspects.

EMUVE (Euro Mediterranean Urban Voids Ecology) teaching project intends to educate the future architects in environmental design through the search of innovative reactivation strategies for the excess of real estate developments and urban voids produced by economical crisis along the euro-mediterranean coastline. The aim is to teach the students a new kind of symbiotic relationship with urban and natural landscape. With a responsible consumption of the resources available, we will be able to give in return renewable energy production, environmental recovery strategies, economic reactivation of degraded territories, and cultural value enhancement as an added quality of the territory.

How to deal with the unbridled real estate developments which have produced thousands of square meters of vacant houses while a huge amount of people lose their homes? The answers are in the field of recycling strategies, low cost interventions, flexibility of functions, public space qualities, civic participation policies and the development of spaces that generate community and solidarity.

Through EMUVE architecture studio course, the students will develop an analytic work and a range of proposals that will try to answer the following questions:

a. How could we search for recycling intervention strategies for these large areas of degraded landscapes from a renewed environmental culture, as a tool for local/regional socio-economical growth and territorial cohesion?

b. Which are the ways to investigate and promote institutional and business model transformations of Euro-Mediterranean coast urban development towards more sustainable criteria in symbiosis with landscape and its natural resources?

c. Could we find alternative sustainable economic development for the Euro-Med local population beyond the present endemic dependence on unsustainable tourist urban development?

d. How could we improve the environmental quality offered to the visitors of the Euro-Mediterranean coastline, for whom this new relationship with the territory could be considered as an added value?

e. Which are the best eco-urbanism instruments and institutional coordination strategies with local stakeholders for the recovery of these degraded landscapes?

The principal aim of the present paper is to describe how EMUVE European project contributes to the awareness and training of architecture students in territorial, social and economic recovery strategies in the post crisis scenario at the Mediterranean context.

EMUVE Project. Euro-Mediterranean Urban Voids Ecology

The exponential planning developments at the euro-Mediterranean littoral in the first decade of 2000 until the bursting of the real estate bubble of 2008 have produced a
deep wound in the Mediterranean Landscape and in his local population. The strong pressures received in the last years by previous human occupation models are compromising seriously many of the coastal ecosystem services that are essential for human welfare and economic development in the long term. Recent studies \cite{1} show the decline of the Spanish tourism Industry, pointing out that this is the end of a development cycle based on unlimited housing growth and of bio-capacity overflow on natural resources.

Despite this saturation, the persistence of recent years in the construction of more housing developments, the bursting of the housing bubble and the global economic crisis from 2008 has produced not only an extensive vacant housing stock in the coast, but also a large number of half-built housing developments.

The Mediterranean coastline is facing a global change, which goes beyond the current situation of economic crisis to become a change of scenario and values, a change that will determine its future for the decades to come. This deep problem only should be approached from a restitution of symbiosis with natural processes of the coastline, in order to recover its landscape qualities and environmental resources.

The context of poorly planned development followed by an unprecedented housing crisis at the Euro-Mediterranean coastline leads to the presence of large number of half-built real estate, future ruins \cite{2} that are waiting for an economic recovery that today seems more than uncertain. Despite the change of the economic scenario in the last five years, these large tracts of buildings skeletons and empty urban developments, now mostly owned by banks that had financed its promotion, have remained untouched. After several years of paralysis, until the date any clear and open alternative future proposal for these buildings has been developed. The only expected destiny for these ghost constructions is their future completion, with the unrealistic objective of its sale.

![Map of urban territory increase in the south of Spain. 1998-2006.](image)

\textbf{Fig. 1}

Map of urban territory increase in the south of Spain. 1998-2006.
The University as a space that generates research and development offers innovative and alternative answers to the present and future problems raised by society. The principal aim of EMUVE architecture studio course is the search for recycling intervention strategies for these large areas of abandoned voids from a renovated environmental culture. It can be the first step for the landscape recovery and economic reactivation of the deeply degraded Euro-Mediterranean littoral.

As future architects, the students could play an essential role in the regeneration of the devastated territories of urban speculation. Therefore, they must be aware of the need to change the relation model with the territory and its economy. The training received will influence their perspective on how to lead their practice in the Euro Med coastline, as well as in other territories with similar problems. In the future, they will assume the role of mediators between the different interests involved, having a positive effect in the decision makers, as well as acting as catalysts of the social demands of the local inhabitants.

**EMUVE project teaching aims**

a. Understand the destruction processes of the Mediterranean landscape by real estate urban developments in the last 50 years.

b. Explore intervention strategies in symbiosis with natural processes of the Mediterranean coastline, in order to recover its landscape qualities and environmental resources.

c. Improve social and economic conditions of these post crisis abandoned areas.

d. Learn and develop performance systems based on the idea of landscape and architecture recycling.

e. Provide an understanding of instruments and methods for sustainable landscape recovery of the Euro-Mediterranean coastline through intervention on urban voids and half built developments stopped by economic crisis.

f. Search for innovative sustainable urbanization processes and good practices on landscape recovery projects in similar scenarios.

g. Utilize state-of-the-art methods and techniques from Landscape and Eco-Urbanism, urban planning, environment sciences, economic geography, urban sociology, anthropology, and history for the understanding of the Mediterranean coastline Ecology.

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Fig. 2
Algarrobico Hotel in Cabo de Gata National Park (Almería-Spain).
EMUVE teaching methodology

EMUVE teaching course length is one academic year, divided in three terms. After a theoretical training before the beginning of the project, the students will select by groups the most interesting case studies and will learn how to conceptualize them as paradigmatic examples of relevant aspects of the project. At the same time, they will learn how to develop a comprehensive analysis of each selected case, from a coherent perspective with these previous established conceptual models. To that end, they will discover their architecture, urban, landscape, cultural, social and environmental aspects interrelations.

1st Term

EMUVE Theoretical Introduction

The course will start with a theoretical introduction on the different definitions and contexts of urban voids and decreasing cities, as well as how they have been recov-
ered, recycled or abandoned throughout time. For this purpose, we will invite experienced academics and practicing architects to give monographic lectures on this issue.

These voids appear as territories where everything is possible, **ludic spaces** out of the preset order imposed by current urban planning. Since 1953, the Situationism movement proposed a new way of relationship with the territory by studying the psychological influence of the environment in the individual. The work of Robert Smithson and Gordon Matta-Clark about degraded architecture and *entropic* landscapes in industrial contexts is a stimulating background for the project. The perceptive work of Tony Smith, Cedric Price projects and the works of Solà-Morales offers a wide range of readings of these degraded landscapes. James Corner, Landscape Architecture Professor of UPenn and a founder of *Field Operations*, proposes *Landscraping* as a potential tool for intervention in post-crisis voids. He conceives the voids between buildings as “constructions” produced by an industrial logic and as reserves of “indeterminacy,” places of potential action. Charles Waldheim, Professor and Chair Department of Landscape Architecture at GSD-Harvard University, defined Landscape Urbanism as a branch of landscape ecology, concentrating on the organization of human activities in the natural landscape. Both are looking for a new hybrid urbanism, with dense clusters of activity and the reconstitution of the natural ecology, starting a more ecologically balanced, inner-city urban form in the void. The Eco-Urbanism research of Moshen Mostafavi and the instrumental research of Douglas Spencer at Landscape Urbanism Unit of the Architectural Association of London will also be studied for the development of analysis, representation and intervention instruments. The Mediterranean Cities Program developed by Prof. Eduard Bru at the Mies Van Der Rohe Chair in Barcelona, will be of great interest for the course by its search for common issues among the Mediterranean urban Landscape.

**Case study selection and analytic phase - Parameters and critic representation**

The first exercise of the course will be the selection and the analysis of the case studies where the students subsequently will develop a project. For this purpose, the course will focus on the following aspects:
Impact of economic crisis in housing prices decrease

As a first data for the selection of the most affected areas by previous urban development model collapse, we will manage the economic information of largest decrease in housing prices at the Mediterranean coastline in recent years. For this purpose, the students have to look for statistic data and documents at national and European levels\textsuperscript{17}, as the specific reports on this issue developed by the Ministry of Development of Spain\textsuperscript{18}. A graphic documentation will be elaborate where the degree of the economic impact of these price declines will be displayed together with its relation to the presence of unfinished housing developments.

Study of the existing post-industrial, unfinished buildings and interrupted urban developments in each case.

The urban voids under study in this project are named with the same acronym of the project: EMUVE (Euro Mediterranean Urban Voids Ecology). They are classified in three kinds, in many cases in close interaction between them:

a. \textit{Terrain Vagues (TV)}, free spaces out of urban planning regulations, or subject to obsolete planning rules after the bursting of real estate bubble. They have failed to be managed as public spaces neither as building land for future developments. However, the indeterminacy of these spaces is their potential, to be converted into areas of experimentation and new opportunities.

b. \textit{Future Ruins (FR)}, half-built buildings from real estate speculation and illegal licenses now paralyzed by economic crisis.

![Urban Planning Voids in Spain](image-url)
Fig. 6
Murcia Case Study.
Heritage and Future Ruins (FR).

Fig. 7
XIXth Post-Industrial Voids (PIV) in the Spanish Coastline.
c. Post-Industrial Voids (PIV) with heritage values, many of them abandoned or whose recycling process has been halted by lack of resources and inefficient management.

A research will be developed on urban growth prospects during the period before the economic crisis (1998-2006) and its subsequent abandonment process. This analysis will help to detect how many TV and FR voids exist in each case study candidate, and which are their potential to be transformed. To that purpose, we will contact planning departments of each studied city council and citizen platforms involved in the complaint and recycling of these spaces.

In the case of post-industrial voids, the information obtained from the consultation of heritage catalogs and related research papers will be combined with a graphical documentation where we will analyze the impact of PIV in the transformation of the territory, in both its historical productive phase and abandonment process.

Case study conceptualization

The students will model each case study within a conceptual framework which will focus on a specific aspect of the project. This will be a first step for the selection and interpretation of the information obtained. As an example, in Spain Marbella can be defined by speculative development and illegal urban license procedures, the northern coastline of Almeria could be defined as a landscape of exponential growth of urban voids, while Barcelona case will be identified with good practices procedures in social reactivation of abandoned urban spaces. Each model thus defined will develop an essential aspect of the overall project which could be used, through comparative studies of each case, for the development of conclusions and the study of recovery proposals.

Analysis of the historical evolution of economic models applied to each case study

Over time, landscape has been transformed by man through the use of available resources. In XIXth and XXth centuries, many areas of the Mediterranean coast focused on traditional intensive agriculture evolved to different models of industrial exploitation. Finally, in the last 50 years, they move to real estate monoculture focused on tourist customers. Exploitation models over time should be studied in each case, in order to know if they have been always unique or dominant, and if the local economy was more diversified throughout history. The current abandoned landscapes of real estate speculation are largely the result of a development model overly dependent on a sector that has been much more volatile than expected by investors.

It should also be studied how the development model applied in recent years has affected the resources of the territory. To this end, we will develop territorial mappings of economic uses in relation to the transformation processes and simulations of the model evolution over time.

Origin and evolution of EMUVE’s

The emergence of EMUVE’s will be explained in each case through the study of the implementation of previous urban development model, the urban growth prospects and the paralysis of economic activity due to the crisis. Other factors may be considered,
as the developments paralyzed by local governments after irregular licensing conces-
sions given by previous administrations. Students should reconstruct the history of
each EMUVE, documenting its planning and development process, as well as its sub-
sequent abandonment, degradation and biotic occupation.

**Social Impact**

Social pathologies caused by the crisis of this previous economic model will be iden-
tified, such as unemployment increase, conflicts between public administration
and private sector, loss of economic value of the area and marginalization of the
population.

**Environmental Impact**

The degree of landscape degradation caused by EMUVE’s will be studied, including its
visual impact, their contribution to land erosion, the unsustainable use of natural re-
sources available, the loss of biodiversity, if their location is within or near protected
natural areas, and the degree and type of pollution produced.

For this study, we will work with GIS environmental risk maps, environmental
impact reports and the information provided by ecology groups specialized in Euro
Mediterranean coastal protection.

**2nd Term**

**Project Phase**

At the beginning of this phase, students will receive a first theoretical introduction of
best practices in urban voids recovery and coastal landscape regeneration.

Among others, we will learn on previous successful intervention experiences on
voids intervention for large scale landscape recovery projects, as the reactivation
strategies for American post-Fordist voids in shrinking cities as Detroit or Philadel-
fia, the post industrial interventions of OMA in Mélon-Sénart and Zollverein, and
the works of Peter Latz and Florian Beigel in German reunification landscapes. The
work of Beigel was an important contribution for the appreciation of the devastated
landscapes of former German Democratic Republic, as well as to implement on them
cancepts in order to achieve a compromise between ecological and industrial per-
spectives. The social activism of Roma Stalker group of Francesco Careri and Lorenzo
Remito is also of great interest for the proposal development.

The best practice experiences developed by citizen platforms for appropriation
processes, self-management and negotiation with local authorities to activate aban-
donied spaces will also be studied. Barcelona offers a number of interesting experienc-
es, as Pla Buits, an annual competition promoted by the council for the activation of
urban voids and other successful citizen initiatives as Can Batlló or Espai German-
etes.

The qualities of the case studies and their EMUVE’s thus defined in the analytical
phase will anticipate the proposal strategies. The definition of urban, social and envi-
Environmental pathologies will help to establish a diagnosis for each case study, which will be treated with coherent intervention strategies that contributes with optimal and coordinate solutions to the problems raised.

The groups should establish the most relevant EMUVE’s in each case study, based on its potential to be recycled and the degree of impact that their transformation will affect the surrounding urban fabric, the environment and other less relevant EMUVE. We will focus on their morphological qualities, landscape integration possibilities, urban and infrastructural connections and the relation with the social fabric.

The recycling of these spaces could work as future cultural and economic magnets for the social and economic reactivation of these degraded areas into productive and ecological landscapes.

The recovery interventions on these empty spaces should address the following issues:

How can we make interventions in each specific EMUVE for the reactivation of the economy and employment of the whole case from sustainable criteria?

Do we have to develop local interventions on some specific voids that will positively affect their surrounding environment, or should we develop large scale recovery systems that link these spaces with existing urban landscape?

How can we capitalize the flexible and indeterminate qualities of EMUVE’s to become urban connectors or new public areas, in coordination with the open spaces network of the case?

In which cases the EMUVE’s should be reintegrated into the natural environment, taking precedents as the proposals for the city of Detroit?

What kind of links could be established between EMUVE networks and existing ones, such as networks of environmental interest and heritage sites?
In a first stage, large-scale interventions will be developed in groups. Then each member will focus on a specific EMUVE, in coordination with the rest of the team. Finally, the group will design a global project assembling the individual proposals of its members.

The final results will be presented in an exhibition at the architecture studio, where a critical debate will be developed, with a comparative review of the analysis and design methodologies of each group.

3rd Term

Comparative study phase

Based on previous review session, a comparative study will be carried out on the different methodologies used in each case study and the degree of success in providing answers to social, economic and environmental problems raised, as well as the level of collaboration with local stakeholders. To this end, this work will be developed by new groups, now composed by one member from each previous team. A critical summary report will be written to reflect the conclusions of this study.

Publication and public exhibition

One of the ultimate goals of EMUVE course is the development of outreach activities through a publication and a public presentation of results through a travelling exhibition. In collaboration with local and regional administrations, the exhibition will travel through the different concerned areas. The timely environmental, economical, social and political approach of EMUVE project has the aim to collaborate in the landscape recovery policies of the Euro-Mediterranean coastline. The outreach actions are intended to strengthen the relationship between the University as a think tank which provides new proposals to local authorities in charge of the protection of the environment and urban habitat. The ultimate goal of this project is to arouse the interest of public administrations, social platforms and private stakeholders of each case in order to develop with them the real implementation of these projects.

Thematic workshops for each kind of EMUVE (PIV, FR, TV)

As an additional teaching activity, three thematic workshops will be developed. In a limited period of two weeks, students will have to think and produce proposals for these three different kinds of voids, focusing directly to the production of a project. Unlike EMUVE annual course, in these workshops the case study will be a given data. The workshops will be held at the end of each term, and will be organized in each case study to collect directly the required information and test the proposals.

Conclusion

This teaching project has the purpose to aware students with the euro-mediterranean landscape social reality within the framework of the post crisis scenario, from sustainable and responsible perspectives. As Greenpeace notes in its 2012 report 27, this fu-
ture scenario should include policies to promote a change in the urban development model at the Mediterranean littoral, based on a new economic and environmentally sustainable culture, focusing on rehabilitation and reduction of existing infrastructure and its integration with a renewed nature, which would control urban growth, reduce the environmental burden, and improve employment and wealth. The present project has the aim to inspire and train a new generation of EMLU (Euro Mediterranean Landscape Urbanism) Architects, who will go on to devote their careers to ensure the future prosperity of present deeply degraded Mediterranean coastline. Therefore, the training program and the complementary skills have been designed with a variety of activities to strengthen their professional training and to establish strong links between the students, local stakeholders and experienced leaders in the field; to promote active civic engagement, advancing practical research and creative thinking about environmental, economical and social recovery Landscape planning practices.

The EMUVE training can be the basis of the knowledge necessary to the development of future landscape recovery projects and good practices guidelines towards the horizon of a new sustainable approach for the Euro-Mediterranean coastline. It will provide innovative insights and scenarios that can be used as a critical guide for the development of alternative sustainable urbanization processes and landscape recovery projects for the Mediterranean over the next 20 years.

**Notes**

1. According to reports from EXCELTUR association, which comprises the main Spanish tourism companies.
15. www.aaschool.ac.uk/graduate/lu.shtm
17. Eurostat European Agency, National Statistic Institute of Spain, Bank of Spain.
24. Plà Buits del Ayuntamiento de Barcelona
Theme 3

Computation: Environment and Architectural Innovation

Two prominent streams in architectural education currently are computational design and environmental design, streams which are followed almost entirely independently.

This theme examines the possible benefits that would accrue if the gap between them were bridged in ways that could motivate students to create new opportunities for architectural innovation.
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Performance Driven Generative Design Methodology: Interfacing Multi-Agent Simulation Driven Design Techniques with Environmental Modeling Methodologies in Architectural Education
Operating at a post-graduate level with a program spanning the entire Masters education (MSc1 to MSc4), The Chair of Hyperbody (Faculty of Architecture, TU Delft), has been carefully developing an effective performance driven design educational agenda. The agenda focuses on imparting a holistic architectural education, wherein urban, architectural, componential as well as fabrication techniques interface with cutting-edge computational and environmental design tools and methodologies. Instead of inculcating the attainment of a glorified form, the underlying pedagogy involves initiating a process involving iterative knowledge building computational experiments involving a relational mode of thinking for cultivating a variety of emergent (Johnson, S. 2001) spatial morphologies embodying different metric structures and embodied parametric relationships for deciphering creative, ingenious yet apt logics per design research experiment. This mode of operation focuses upon associatively developing a symbiotic relationship between dynamic contextual information such as environmental data, energy regulations, socio-cultural patterns and material property based form-finding techniques.

A research investigation termed ‘InfoMatters’ initiated by the author (Biloria, N. 2011), at Hyperbody, TU Delft, to understand the intrinsic linkage between digital information and material systems was thus set up in order to develop inter-disciplinary design driven processes focused on developing performative spatial systems. Understanding this informatics constituent specifically involved the development of datasets of spatial, environmental as well as social behavior as a medium for understanding the urban. This information field serves as an experimental set-up within which multi-agent simulations with differential yet inter-dependent agencies are generated. The multi-agent simulation idea is based on an understanding of iteration, differentiation and optimization based processes in natural systems, which result in multi-performative, adaptive, self-organizing formations (Bentley, P.J. 1999). These formations apart from displaying highly performative traits concerning structural, environmental and metabolic optimization are also equally interest provoking when understanding them in the context of polymorphic topologies (Hensel and Menges, 2006). A real-time adaptive process of evolution in time, corresponding to internal genetic regulations and external environmental factors in nature was thus seen as a vital domain of research.

Self-organizing multi-agent system based generative methodologies for evolving spatial formations in time, based on the impacts of associative relationships between the aforementioned data sets typically take three contingency areas into account: Agency, Structure and Behavior. Two sets of agents are typically considered, one being the higher order and second being the lower order. The higher order agents embody an agency covering a broader contextual background, updating and revising their behavior with respect to time. These have an impact on lower order agents which act as followers or trackers in multiple sub-swarms. This differentiation in agency makes the computational workflow faster and possible to run on computer systems with limited capability to handle calculations. These agencies can be further sub-classified and structured under swarms of agents catering to infrastructural, functional or even social routing streams attained from layered network definitions. These agents are further embedded with flocking (Reynolds, Craig W. 1987) behavioral instincts (alignment, cohesion, separation, directionality etc with respect to themselves and with other agent populations) which helps them to interact with varying agent
typologies, be attracted to or repelled by differentiated density zones within the urban. After a series of reiterative cycles of negotiations and simulation runs, a subsequent stage of multi-swarm optimization, involving typically involving self-organization based on obstacles, noise proximity, traffic allowance, power and field of vision of individual agents is embarked upon. Another behavioral attribute taken into account during this optimization, being density control, wherein incoming agents evaluate the density of the area based upon determinant factors like sensitivity to existing agent density and the number of similar or different flocking agents. Quintessentially the computational simulation makes decisions pertaining to the flocks self-organizing patterns and growth or eventually the option of fading out and dying due to entropy, forming clusters based on the overall agent saturation levels reached (prescribed for specific agents in a certain period, gained network intelligence and cluster distances within an environmental, social and spatial context).

The paper, via an experiment of such research driven design processes will exemplify the computational methodology and resultant performative outputs at different scales (urban, architectural and componential). Sustainable design via an integration of computational methodologies and environmental analysis driven iterative form-finding processes shall thus be put at the forefront via this research paper. A reduction in post-optimization routines of built form and consequently the development of a rational understanding of performance criteria and its impact on formal articulations throughout the design process is thus professed through the medium of this research article.

**Performance design experiment: Agriflux, Mikelli, Finland**

An example where the pedagogy involved in the aforementioned pedagogical approach towards performance design development can be traced in a recent (2012-13) graduation project by Anurag (co-author): “Agriflux”. Agriflux aimed to investigate spatializing the co-evolving relationship between digital information and physical matter for the generation of environmentally driven performative architectural formations. Focusing on the development of self-sufficient architectural scale urban inserts using performance driven computational techniques, the project deals with a complex issue of urban reconnect and regeneration of dilapidated lake-front creating buildings of a hybrid nature in Mikelli, Finland. The emphasis being on designing of a science center integrated with jetty/ public esplanades and public greenhouses. Utilizing the System design thinking theory as a logical framework within which multi-layered networks self-organize based on local rules and information exchanges.

A methodology has been adopted that combines performative design processes with a set of generative simulation tools, for mapping the dynamic behavior of the site and the functions dispersed within. The simulation tool is used as an input for the form generation. A secondary level of self-organization which reflects programmatic and organizational bound internal information which guides the process of form-finding to the next level of optimizing the spatial conditions has also been included. At this level one of the major influences is the Scandinavian weather with harsh winters, uncomfortable wind turbulences and low solar gain.

The methodology involved a networked interconnection between the following meta research components: Urban Context, Localization, Programmatic Dispersion,
Topology, Structural Optimization, Environmental Design, Fabrication Protocols and Material Translation. The prefix meta implying each component being the resultant of relational matrices of variable interlinked parameters.

**Research Components**

The following section shall illustrate each component in sufficient detail and in the process shall establish interrelationships between each component.

**Urban Context**

The site provided pre-defined urban attractor points in the form of existing land-use functions (residential, public facilities, retail, mixed used, wasteland, open spaces, etc.) with varying degree of weightage with embedded starting points for different agent typologies. Each agent scans every other agent from a specified flock and infrastructure obstacle boundaries, they either follow or move away from other flocks depending on the logics (here logics being the degree of attraction between various flocks, the power of separation, cohesion, alignment and obstruction) fed during the simulation. By doing this each agent successively gets a higher order in the network. Simultaneously each attractor point calculates the number of agents influenced by it. The agents which are influenced by these attractor points also receive very specific set of instructions valid for that spot as coded by the designer.

This exercise gives rise to various network typologies like hybrid, distributed, centralized, etc. (Figure 2a). The more the agents cluster around a specific spot, the more the probability that they reach a threshold and furthermore gain a higher popularity rating. This triggers the “KILL” command (thus culling swarming) and creating an inter-
connected cluster in 3D space depending upon the cluster distance provided by the designer for specific flocks. These clusters can further be classified into high density and low density areas. For a potential spot, the smaller the minimum distance of connectivity between differential agents, the higher the density that area will have and vice versa. The urban level configuration and spatial distribution networks generated from this first round of simulation again trigger an emergent behavior and inherit influence over the agent flocking at the local site level.

Fig. 2
a: Multi Agent simulation rules (urban context), b: Network layers.
Localization

At local site level, agents gather local information parameters generating dynamic density and forming clusters inheriting urban conditions from the first round of urban simulations. These local site level agents are programmatic agents and the topology of the programs are determined based on the F.A.R. (Floor area ratio) limits imposed by city planning authorities. In this example, the site is a myriad of functions and open areas, which come along with certain degree of historical and cultural aspects. This called for different layers of interactions, namely: Infrastructural, Transport, Functional and Landscape (Figure 2b).

Post urban simulation evaluation hints towards various infrastructure development trends for instance at an urban level, automobile connections show trends of better connection with existing primary highways. Hint of creating a new bridge dedicated to pedestrian influx to the site perimeters and new traffic infrastructure diversion for secondary and tertiary roads. Agriculture distribution system agents densify along the existing farmers market and warehouses. It rises and meets the highway dissipating produce throughout the city (Figure 3a).

At the local site level, the program agents such as the Science center tries to remain at the location close to the proximity of infrastructure for easier connectivity. The Exhibition area tries to remain neutral. The Esplanade act like a binding agent connecting all programs. Public areas tend to align close to the esplanade and exhibition areas. Esplanade topologies show differential heights and the possibility for landscape features. A unique typology connecting the science center - restaurant - shops and exhibition area into one complex also emerged. Access to pedestrian under the complex to the adjoining esplanade and lake creating unobstructed vistas of lake through it was suggested. Restaurant mostly acting as a bridging structure, elevated to offer better views and privacy to users, spatially a very interesting hybrid formation springing into the lake.

As a result of these first set of simulations, boundary conditions of different functions, the heights and the overall spatial distribution typology of different spatial agencies are attained (Figure 3b).

Infrastructure Cluster Abstraction: Post the two urban and local level simulations, Point cloud and Floor Area Ratio (FAR) value datasets extracted out of the simulations are interpolated generating topological surface conditions using a grasshopper script that create spatial and differential heights required to organize internal zones and peripheral boundary.

Programmatic Dispersion

The Programmatic Dispersion component operates within the obtained field of varying densities from the aforementioned simulations. Rather than considering the programmatic arrangement as the organization of platonic programmatic elements, here programs were considered as a self-organizing system of programmatic masses, which aggregate based upon weighted connections and parameters to specific anchor programs (these being the programs which would act as primary focal spatial nodes as per the architectural requirement). In order to meet specific programmatic requirements such as circulation, area calculation, accessibility and transparency lev-
els. A second degree of simulation was coded using Processing (open source software platform). The behavioral parameters embedded for this simulation being the program area, internal connections, crossover degrees, physical affinities, noise allowance, accessibility thresholds, transparency and height of the functions (Figure 4).

Fig. 3
a: Self organizing Multi-agent system based results, b: Multi Agent System based Local level self organisation outcome.
In the example, three cores of science center and greenhouse were chosen with a set of programs and parameters embedded within them to achieve differential distribution. The Processing sketch was executed multiple times with random seeds in order to achieve a manually optimized design regarding program distribution and form development. The next step was to make sense of these dispersions, after choosing a good random seed, the extracted geometry is judged based on the overall shape and geometry. Results displayed a degree of unison with the designers intention, for instance restaurants and labs were located more on the external periphery with better views, easy accessibility and distance from noise sources at the same time. Lobby spaces demanded better connectivity and hereby were located as main anchors with high accessibility. The chosen geometry/iteration is then exposed to circulation connectors based on minimal distance algorithm and environmental forces to produce better aesthetically articulated shape and efficient topology.

Geometry|Topology

The topology emerges from an exploration of technological possibilities and parametric modes of operation, which allow for information driven complexities, efficiencies and geometric possibilities previously incomprehensible. This methodology allows for the bottom-up generation of architectural complexity from individual component level to a collective spatial level. The allocation of programmes are determined by the trajectory of the Sun. A script was written using Grasshopper in which spaces adapt to the concept of a solar fan whereby meeting the performative requirements of the building. The solar computational abstraction especially plays a pivotal role in fulfilling the buildings’ lighting and solar requirements. In this case, the geo-coordinates...
impose harsh dark winters and comparatively lower sun angles. Here the script takes into account the base curve, the latitude, total sun exposure (range of months and daily hours), spatial definition inherited from previous simulations thus generating abstracted negative non-orthogonal vector shafts creating unique situations (Figure 5). These shafts give the building shallow plans and enhances diffused light penetrations much needed in those weather conditions.

**Structural Optimization**

Simultaneously another feedback loop is initiated at this moment to generate a structural mesh which takes into account the abstracted solar geometry and encapsulates underlying spaces. This is further refined using mesh refinement algorithms to generate a more cohesive structural vocabulary by the designer. Furthermore the structure is evaluated using Finite Element Method (FEM) Millipede package in Grasshopper to define beam depth, shapes, sizes and identify vulnerable structural elements (Figure 6).

In this example, the script takes into account a very essential performative element of the building, the roof performance optimization (3D Roof profile for facing heavy snowdrifts common in Finland caused due to strong winds which are translated into numeric slope angle simulation). The parameters taken into account for the roof involved Genetic Algorithm (GA) optimization using Galapagos, which took into consideration the following: roof slope normal inherited from mesh generation algorithm, negative snowdrift attractors (located in exterior periphery of the building where the designer wants to avoid the snowdrift to occur, mostly pedestrian routing fields), attractor positions where snow can be drained and the active vertexes whose degree of freedom in movement is evaluated during every GA run based on the FEM analysis.
fitness without compromising the overall structural stability. This cycle of simulation generates various options, the best one is chosen on the basis of the most satisfying result both in terms of performance and aesthetics by the designer. The roof optimization created a unique slope condition for facade at certain angles, which helps in breaking the snow falling off the roof.

**Environmental Design**

Apart from the solar and snow loading conditions, which informed spatial and structural refinements, wind conditions and the manner in which effects of wind turbulence could start refining the developing architectural aesthetics became vital. The structural results are thus further cycled via another feedback loop wherein the project has to mitigate wind turbulence using the classical aerodynamics principles. In fluid dynamics, turbulence or turbulent flow is characterized by chaos and is caused

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Fig. 6
Snow drift load based structural and spatial optimization.
due to rapid variation of pressure and velocity in space and time. It is an ignored aspect in current architectural design discourse but becomes relatively important in sites having strong and cold wind flow conditions. This optimization will result in increasing thermal comfort of the public spaces, which would normally be disturbed due to the turbulence created by the buildings topology itself. The building topology and its surroundings must interact to minimize its effects (Figure 7).

The shown 3D representation is the result of all the previous urban level CFD analyses carried out with Autodesk CFD Simulation 2013. The gradient goes from blue for laminar flow, to red for the turbulent motion. Figure 8 shows the aerodynamic perfo-
tive promenade, optimized using surface lining (the subdivided surface’s longitudinal edges). The parameters being: wind flow vectors, active promenade surface reparametrized to gain better control, pressure gradient (0-1), red for high and blue for low. These parameters became the input for Galapagos GA optimization where the main objective is to either deflect the wind above the promenade creating low pressure region behind or else make the promenade act as wind breakers. The same principle applies to the building as well, but the biggest challenge here is to satisfy functional and architectural aspects while meeting the performative aspects. In this example, the building is exposed to wind simulation setup with speeds averaging 38-40m/s, with the vulnerable facade segments with high pressure gradient ranging 32.9 to 63.2 Pa, in other words obstructing the wind flow. The impact caused by air fluxes creates even more dispersion. These were tackled by studying “air vent”, “wind spoilers”; possible air intake shapes and junctions inside the building to redirect wind and efficiently produce energy.

In the example, after analyzing various aerodynamic components, a pressure releasing component was finally chosen, which would be proliferated in a pattern on the extracted facade. This component would trap the exterior flow and channelize it further into vents for further being used either to generate energy using turbines or to just release it somewhere else. The ultimate goal is to recover the load loss, “giving pressure” to the system for better smoothness, continuity and reducing turbulence.

Fabrication

The fabrication based requirements were derived from the environmental performance criteria as regards thermal insulation and wind flow. The component will be fabricated using thermally insulated epoxy resin shell with a fibre transparent cover that would allow the light to enter but trap the wind (Figure 9). The transparent cover will thus allow light derived heat energy to be stored while trapping the cold exterior wind. The topology of the component is also developed carefully to release the pressure difference through inbuilt solid channels in the component.

Material translation

The choice of material comes from the logic of engagement. In the example characteristics of wood (Glulam) in conjunction with other materials like steel and concrete are used to create new and optimized hybrid material solutions. The primary structure is also chosen to be Glulam composite due to the local availability and manufacturing skill available in Finland. When compared to steel and concrete-wood composites, this composite was found to have higher air insulation, while steel and wood composite work out best in tension and for joints. Reusability and reclamation coefficients are also higher with the choice of this material palette.

Conclusion

The methodology presented in this paper outlines an integrated data driven computational and environmental design approach wherein typical issues of engaging
computational routines for glorified formal attributes takes a back seat. Instead, the collaborative knowledge sharing between different disciplines of environmental sciences, natural sciences, information technology, computer aided manufacturing and architectural design operate synergistically in order to bottom-up generate the logics of a holistic spatial system (Figure 10).

The implementation of layered operation of multi-agent simulations with specific variations in the degree and relationality of agency deployed per agent cluster results in valuable logistics for iterative computational experimentations. Per research component level, in itself relies on and at the same time provides an opportunity to the designer to re-evaluate the underlying results of each stage of simulation. As is clear from the elaborated example, almost all components: Urban Context, Localization, Programmatic Dispersion, Topology, Structural Optimization, Environmental De-
sign, Fabrication Protocols and Material Translation involve a strong co-relation with environmental factors ranging from sun directionality, snow loads, wind conditions etc. This results in a simultaneous, integrated approach towards generating architectural propositions and detail at various scales, which co-evolve from a quantitative and qualitative perspective. Issues of aesthetics thus take up a new dimension, namely performance driven design, rather than using computational tricks for generating complexity for the sake of the term. More importantly the parametric nature of developing performative façade systems coupled together with the systematic manufacturing and assembly of the digitally derived geometries offers fitting proof for validating the iterative computational methodology and for proving the realistic spatial nature of the final outcomes.

This inter-performing data-driven approach devoid of its reliance on architecture styles and typologies is thus deemed a democratic methodology to understand our built environment and to bottom-up produce sustainable architectural morphologies. An interdisciplinary mode of operation to invent a new take on pre-processing via integration rather than post-design optimization of architectural space for the sake of sustainability is thus seen as a vital outcome of the research and design methodology.

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Quadruple Net Value Analysis using Building Information Modeling and Immersive Visualization
Introduction - modeling value in land and property development and design

Advanced information technologies of Building Information Modeling (BIM), parametric modeling, simulation and immersive visualization promise considerable increases in the power of designers to conceive and prove new concepts for the built environment. The ambitious goal of this research is to identify what makes good architecture that can assure a successful land and property development project. As a corollary, our goal is to teach students the secrets to success as architects and developers. Sustainability in architecture arises not merely from technical virtuosity and high performance, but also from sensory awareness and appeal. At an intuitive level, we must acknowledge that we will protect, use, and ultimately sustain places that we love. In the Renaissance formulation of the Roman principles of design written by Vitruvius, ‘Well building hath three conditions. Commoditie, Firmenes, and Delight [sic]’ (Wotton, 1624: 1).

A consideration of value in architecture must address the fundamental purpose of building: the provision of desirable space through the land and property development process. A brief discussion of concepts in land and property development is necessary to bound a further discussion of architecture and urban development.

The purpose of land and property development is to create real estate assets. The three main asset classes in investment portfolios are: cash and fixed interest instruments; stocks; and real estate. Dependent on the stage in the economic cycle and the quality and performance of individual assets, the availability of capital to invest in each asset class ebbs and flows over time. To maximize the performance of an investment portfolio the relative weighting of each component asset class is managed through acquisition and disposal of individual assets at a price agreed between the buyer and the seller.

The valuation of individual assets in each portfolio is ascertained at a specific date through the process of appraisal. In the case of real estate assets the appraiser will inter alia have regard to comparable asset sales in the locality, net income stream of the asset, contingent liabilities, age, quality, design, competition, supply and covenant strength to ascertain market value (Shapiro, Mackmin and Sams, 2013: 1-10).

This market value is an economic or financial value, likely to accrue at the time of sale, to the owner of the asset. However real estate assets, unlike fixed interest instruments or stocks, are tangible, capable of human habitation, and have value not just to their owners, but also to those that use them, experience them, and visit them. As Sir Winston Churchill (in Hansard, 1943: 403), observed in an address to the House of Commons, ‘We shape our buildings and afterwards our buildings shape us.

Human settlements comprise buildings and the spaces in between that become the places (real estate) in which we live our lives. These places either facilitate and/or constrain our choices and behavior; they touch our lives and influence our experiences. These places therefore possess inherent liabilities and benefits for parties other than their owners, such as governments, and individuals and groups within society. Some of the externalities can be reduced to a dollar value and others are less tangible but may significantly impact real estate performance. It is the utility and attraction to humans of a place that creates its value. David Seamon articulated the value of a phenomenological approach to explore environmental and architectural issues when he concluded, ‘people and the environment compose an indivisible whole… Any object, event, situation or experience that a person can see, hear, touch, smell, taste, feel, in-
tuit, know, understand, or live through… has presence and meaning in the concrete lives and experiences of human beings’ (Seamon, 2000: 158-159). The ability to identify and read the phenomenological framework of place was provided in the mid to late 20th century through the work of Lynch (1960); Relph (1976); and Alexander (1977).

The virtual design and modeling of real estate assets is made possible through advances in personal computing and the development of software such as Computer Aided Design (CAD), BIM, and a range of other simulation programs. Nevertheless, real estate choices remain governed in large part by expertise, hunches, guesses and other tacit assessments. Successful developers often cannot articulate convincingly or in a replicable fashion the foundations for a successful project. Nor can many architects explain why one design will lead to success while another is associated with abject failure. Our research seeks to make explicit that which hitherto has been tacit knowledge of how to create successful real estate assets. In applying and testing this knowledge we wish to distill architectural and environmental solutions that improve both real estate asset performance and enrich the lives and experiences of human beings. Our purpose is to better align real asset creation with human needs and preferences and in so doing significantly enhance real estate value and return.

To achieve this objective we are incrementally developing a computer-based platform for land and property design and development that allows the user to rapidly generate alternative designs for real estate assets. Ultimately the platform will incorporate a full range of sustainable development metrics to include economic, social, and ecological value as well as a phenomenological and sensory assessment. However, our initial focus is on the combination of economic viability and the sensory value as derived from the project team’s tacit phenomenological and sensory knowledge of place.

This decision support platform is intended to enable land and property developments to be optimized and verified prior to capital commitment and construction. It is the purpose of our research, through the platform we are developing, to also capture non-owner economic, social/cultural, environmental and sensory elements of value that are often not reflected in the appraisers’ market valuation. All serve to enhance the sustainability of a real estate development’s value and determine whether it is a net asset or liability.

Sustainable development and modeling

The appraised value of a real estate project is typically confined to the expected financial returns to the owner (often referred to as the project’s feasibility or underwriting pro forma). There remains uncertainty and a significant level of volatility in the performance of real estate assets post construction due to a wide range of matters including:

- its relative energy efficiency, carbon footprint, and other operational expenditures;
- its social benefits and inclusiveness of stakeholders both rich and poor; and
- the effect that the project has on the lives and experiences of human beings.

To remediate this limitation in the current real estate appraisal method, our research is seeking to combine a relatively new method, Quadruple Net Value Analysis with the powerful information technology of Building Information Model and immersive visualization.
**Sustainability and the triple bottom line**

The concept of sustainable development was enunciated by a United Nations Commission chaired by the former Prime Minister of Norway, Gro Harlem Brundtland, in their report on the Environment and Development: ‘Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (United Nations World Commission on Environment and Development, 1987: 41).

To ascertain the component value of development options the Commission sought to move beyond traditional owner focused appraisal methodology to a triple bottom line that included not only economic sustainability but also social sustainability and environmental sustainability. In the Commission’s view a development project worthy of capital allocation and investment must not only prove economic profitability but also deliver social progress—a concrete improvement in the lives and experiences of human beings, and sound environmental stewardship.

**Quadruple net value**

The triple bottom line has brought a wide consensus on the existence of economic, social and environmental consequences of land and property development. There is however a fourth consequence that is too often overlooked: the sensory or perceptual consequence of the real estate project. Throughout our lives we assess place using our five senses: sight, sound, taste, touch, and smell. The places we find desirable to our senses we reward with repeat visits and in so doing create economic and social value and attribute to varying degrees environmental protection. ‘Place-making is the essence of real estate development and community building’ (Booth, Clayton and Kim, 2013: 4).

The addition of sensory value to the triple bottom line components of economic, social, and environmental creates Quadruple Net Value. Dennis Jerke developed the conceptual framework by seeking to measure the impacts of land and property projects using economic, social, environmental, and visual metrics (Jerke, Porter and Lassar, 2008: 251-254). Jerke’s standard range of metrics allows the determination of attributes and performance of real estate assets.

The argument is that a well-conceived and sustainable project provides a ‘sustainability dividend’ (Booth, 2008: 28) that can be measured to show the superiority of the project. Metrics for a project distill the sustainability dividend likely to be delivered through proper conceptualization, design, delivery, activation, and management of land and property projects. The Quadruple Net Value makes hitherto tacit knowledge of such projects explicit and thereby more transparent and capable of analysis and evaluation. It begins to explain much more powerfully why one project is successful and another is not.

There was however one flaw in Jerke’s work in that it focused too narrowly on only visual metrics. We have expanded this visual element of Quadruple Net Value to a more general concept of sensory value that allows us to draw upon the full range of human senses: sight, sound, taste, touch, and smell. Human resonance and experience of place—real estate assets—is a function of the syncopation of all five senses.

With these refinements, Quadruple Net Value Analysis works to identify the true costs and benefits of land and property development projects and enable us to understand how these costs and benefits accrue to the various stakeholders, including...
not just the developer and the owner but also governments, regulators, designers, builders, tenants, neighbors, and the public. By expanding Jerke’s initial focus from the visual to all five senses we are able to more accurately read and understand the qualities of place that enrich human life and experience and create and reinforce patterns of repeat visitation. The replication and application of this hitherto tacit knowledge by way of explicit elements in computer modeling will allow us to refine the economic, social, environmental, and sensory performance of real estate assets.

**Immersive visualization**

The capability of software to depict an environment realistically in an interactive mode that simulates our perception of reality is known as ‘virtual reality’ or ‘immersive visualization.’ The idea was implemented in the 1960’s in a crude fashion (Sutherland, 1968) and later was popularized by research to produce a CAVE (Audio-Visual Experience Automatic Virtual Environment) (Cruz-Neira, et al, 1992: 64 - 72). Various implementations have explored technology such as real-time animation, multiple screens to provide a full field of vision, stereoscopic viewing, heads-up displays or 3D goggles, gesture interfaces, and high levels of rendering realism to achieve an immersive experience that enables users to perceive the simulated world as if it were the real world.

In the field of architecture and construction, animation has been in common use since the 1980’s as a method to present a designed environment. Real-time navigation through a simulated space in 3D perspective projection is provided by tools such as Autodesk Navisworks. Real-time animation and display in an immersive environment are accepted as mainstream technologies for architectural design assessment.

**Building Information Modeling and parametrics**

With the replacement of computer graphics systems for Computer-Aided Design (CAD) with Building Information Modeling (BIM) systems, the application of computing in architecture has accelerated and expanded greatly. The key difference is that BIM tools integrate database management with computer graphics through the use of ‘intelligent objects’ that correspond closely to real world architectonic concepts. When using a CAD system, a wall is represented by graphic symbols of two or more parallel lines or a 3D solid, while in a BIM system it is represented as a layered assembly defining a 3D shape with attached attributes describing physical, economic, and visual qualities. This more rich representation enables BIM to automate simulation of the model, such as thermal and energy simulation, cost estimating, 4D CAD and construction simulation, code checking, and structural performance.

A second capability of BIM is its provision of a parametric change engine. Using constraint management, the architect can define not only the objects and their dimensions, but also the relationships among objects. For example, symmetry, alignment, and dimensional equality may be specified. As one object is changed, the effects of the change are propagated to other dependent or child objects. Furthermore, the relationships may be defined by formula, making possible the automated computation of complex shapes such as the fittings and panels of a curvilinear wall or roof assembly.

These two capabilities make possible the rapid simulation of the performance of a designed environment and the rapid production of design alternatives based upon relations and formulas that fix some elements but allow for variation in others.
A process for conceptual project analysis

Our concept for a real-estate assessment tool combining Quadruple Net Value Analysis and immersive visualization is the QNV-IV modeler. The QNV-IV modeler enables a designer and a developer to model planned real estate developments rapidly and assess them for sustainability using substantially automated methods. We anticipate using the system in several fundamental applications. It may be used to perform QNV analysis of a design project. Multiple analyses may also be used to calibrate sensory response analysis tools. The modeler may also be used to enable students to learn about the relationships between economic, social, ecological and sensory value in real estate and architecture.

The QNV-IV modeler can be explained through its components and roles, and a scenario of anticipated use. The next section will present our current prototype software in terms of user interface and products.

Components and roles in the QNV-IV

While a scenario of use is one of the best ways to understand a software systems, some discussion of the parts of the system and the roles of the human actors in the operation sets the stage for understanding the scenario. We conceive of a process that involves the interaction between two people assuming distinct roles:

Sensory expert: a representative of the design team or public who provides insight into the sensory value of the project by engaging in virtual walks through the model.

QNV analyst: a trained individual who is adept at adjusting parameters of the parametric urban model, initiating and inspecting QNV analysis results, and interacting with the sensory expert to identify modifications.

The software system that they use consists of the following components:

Parametric urban model: a BIM of the urban district that has been parameterized to allow for zoning changes and appearance changes.

Parameter switchboard: a display that allows the QNV analyst to adjust parameters of the parametric urban model.

Parametric modeling station: A computational implementation that provides for editing the urban model. This will be used primarily by the QNV analyst.

QNV dashboard: a display of key metrics resulting from the QNV analysis.

Immersive visualization station: A computational implementation that provides for large or multiple displays for achieving a strong presence in the virtual environment. This will be used primarily by the sensory expert.

Scenario

The use of the system consists of a pattern of initialization followed by iteration through a sequence of steps:

1. Initialization

Preparation for studying an urban district requires constructing a parametric urban model. The QNV analyst establishes setbacks, height limits, road widths, ease-
ments, and buildable limits as constraints in the BIM. Conceptual façade treatments and street amenities are also modeled as parametric components available for insertion into the BIM.

2. **Load in immersive visualization system**
   The QNV analyst loads the model in the immersive visualization station.

3. **Walk in immersive visualization**
   The sensory expert walks through the environment in the immersive visualization station gathering qualitative impressions of the design. The sensory expert sets values for sensory evaluations.

4. **Inspect QNV ratings**
   The QNV analyst triggers the automated calculation of quadruple net value metrics for the project. The software presents dialogs showing metrics for each of economic, social, ecological, and sensory settings.

5. **Suggest changes**
   The sensory expert and QNV analyst inspect the panels together. They each may suggest changes to the design. The QNV analyst may describe various options.

6. **Make changes using parametric modeling system**
   The QNV analyst uses the input from the participant to make changes in the urban model by changing parameters on the QNV switchboard.

7. **Repeat**
   The team of developer and analyst repeats the process from step 2 through 6 until a satisfactory solution is reached.

### Prototype implementation

Our implementation process includes development of templates in Autodesk Revit and custom software using the Revit Application Programming Interface and other tools. We currently are focused on the sensory assessment using real-time interactive video and immersive visualization, and the economic assessment using a pro forma financial calculation with a spreadsheet.

The initialization step has been executed for a mixed use development planned for land adjacent to the Texas A&M University campus. Figure 1 lists the constraints that have been parameterized for the model, allowing for adjustment in various scenarios. Figure 2 depicts a starting point model of the urban district as modeled in Autodesk Revit.

Inspection of the district in near eye-level views can enable assessment of the visual quality of a design. Figure 3 shows a low quality design with low density, low quality materials, narrow sidewalks, and dearth of streetscaping. Figure 4 shows a medium quality development. Figure 5 shows a higher quality development with higher quality materials, more sophisticated façade designs, greater density, street lights, on street parking and well-defined curbs, street medians, sidewalk cafes, and other elements. The comparison of the three alternatives makes clear the ability of the system to support sensory assessment, albeit in only a visual dimension.

The designs may be adjusted by using commands on the parameter switchboard, shown in Figure 6. Currently the switchboard controls planting, lighting, street furniture,
façades and windows, awnings, and arcades. In conjunction with the zoning parameters shown in Figure 1, this provides for a very large number of options that can be studied very rapidly. Examples of how to change the parameters are shown in Figure 7.

The 3D data-rich parametric model not only allows the rapid visualization of the phenomenological elements of alternative real estate design solutions, it also incorporates a development feasibility module that calculates both development cost and income. A command for quadruple net value analysis retrieves the dialog in Figure 8. In the example shown in Figure 9, each alternative design has been analyzed for square footage and expected use ratios, which are then used to calculate total development cost derived from rates per square foot leading to the projected net income of the
The analysis then capitalizes the net income figure to determine market value, thereby allowing the projected development profit to be calculated. It is a relatively small step to add an investment performance module that projects net cash flows over the investment term and discounts these to determine Internal Rate of Return (IRR), cash-on-cash returns, and other benchmark investment metrics.

Further development will address social and ecological factors in sustainability. We anticipate using energy simulation such as Autodesk Green Building Studio to assess the ecological performance. Research is needed to further quantify and substantiate the social impact of designs. More extensive visualizations, such as those in Figure 10, can also be easily produced by using rendering commands.

Fig. 3
Low quality urban development scheme.

Fig. 4
Medium quality urban development scheme.

Fig. 5
Higher quality urban development scheme.

Fig. 6
Switchboard parameter options.
Observations and implications

The software as currently constituted serves as a proof of concept. The rapidity of producing a scheme, visualizing it, and assessing it through Quadruple Net Value Analysis suggests that the software will be usable by future developers and designers. A design team will be able to collect more holistic feedback about the appeal of a project. Perhaps the software can be deployed effectively with focus groups of eventual users or customers of the completed real estate project.

Demonstration of value to developers may lead to adoption of BIM by developers. Adoption of BIM by developers is likely to provide a strong impetus for architects and designers to adopt BIM and prepare models for not only construction but also facility management, enabling the realization of the promise of BIM for supporting the entire real estate portfolio management process.

The QNV-IV system is a tantalizing apparatus for studying human response to the aesthetics of architecture. Continuing work is enhancing the QNV-IV system with sound to enrich the sensory experience. We anticipate conducting many trials with many participants to begin to discover which parametric values for an architectural setting have broad and significant appeal.

Tools such as this may have major impacts on the education of not just architects but all professions and stakeholders associated with the creation of all forms of real estate development. The model requires a different approach to design and analy-
sis—one that relies on hitherto tacit design and performance knowledge being made explicit and measurable in the parametric model. No longer will the design process be based on traditional approaches of sketching and drafting on physical drawing boards, but will be undertaken by the architect through the computer model. Electronic copies of each design will allow each design element to be both captured, analyzed, and preserved for future reuse to form an explicit base of knowledge for refinement. Rendering of each alternative using accurate computer-aided design will allow for rapid creation of measurable photo real visualization and phenomenological assessment. The syncopation of the visual and audio will provide for the evocation of

Fig. 9
Example financial pro forma analysis.

Fig. 10
Rendering of scheme.
all five senses in response to real estate development alternatives and provide for improved alignment with user needs, preferences, and perceptions.

The electronic platform of the QNV-IV system will allow for cost effective transmission and collaboration on interdisciplinary development conceptualization and design. It will provide for more efficient and effective project delivery, activation, and management. It will also enable virtual design to be compared with actual construction to determine variations and contract compliance. As more modules are added to the platform, the QNV-IV system will allow us to determine the economic, social, environmental, and sensory value of land and property development projects and to understand how these costs and benefits accure to each of the stakeholders. The compilation and retention of this data will expand our knowledge of architectural design and the drivers of real estate performance. It will fundamentally change the manner in which we educate not just architects but all professions and stakeholders associated with the creation and performance assessment of all forms of real estate development.

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The Intelligent Building Components’ (IBC) Approach: Integrating Digital Fabrication and Environmental Design in Architectural Research and Education
Intelligent Building Components (IBC), is a research direction of ATRU / School of Architecture / NTUA aiming at the integration of Digital Design, Digital Fabrication and Environmental Design under the same ICT/ Architectural conceptual approach. In research and academic curriculum the IBC approach links Digital Fabrication and Environmental Design in one direction that also integrates ambient intelligence with building components’ fabrication. Researchers, academics and students are invited to follow a Smart Sustainability direction integrating digital fabrication.

Definition

Intelligent Building Components (IBC) are structural building components that have a capacity of ambient processing power and thus can form ambient intelligence ecologies, in a local and trans-local scale. They can respond to the needs and activities of users and to the energy conservation and sustainable development objectives.

They carry integrated processing capacity and capability of perceiving (sensing) the environment through sensors or interacting with it through actuators while they communicate wirelessly with each other.

They can be associated to form larger space sequences (as external envelope or internal partitions). They could also act autonomously or in swarm configurations bridging the digital and the physical.

Intelligent Building Components can be:

• Attached to a building component (a place and an attachment mechanism – detail have to be previewed in the component’s design).
• Integrated to a building component (networks and AmI components).
• Smart materials forming the building component.

Similar research developments combining digital design and fabrication with ambient intelligence are the Hyperhabitat project, Guallart et al (2008), the works of Hyperbody, at the project Living Light (2009) of David Benjamin και Soo-in Yang at the WikiPlaza-Paris project, at the IaaC’s Solar House.

More closely to the IBC approach are the e-plants research direction, Goumopoulos (2011) and the Data Tree project by Areti Markopoulou (2011).

IBC, promoting the relation between parametric design and interaction design, included in the academic curricula, evolves them towards the integration of a more global digital approach. While concerning the software development, a total model will be produced on the subject of the design of integrated IBC in modeling building structures. In that direction digital design and manufacturing is totally integrated in the IBC approach.

Rationale

An evolving architectural space changes its behavior and shape according to context changes or evolving user requirements. It can be envisaged as a space that transforms its “soft” structure within the stability range set by its “hard” structure in order to adapt to changing requirements. Such a space integrates assemblages of flexible components on a “hard” structure which remains unchanged. The idea resembles component
based software development, Zacharakis (2011: 355). The Intelligent Building Components combine ICT and architectural technology in order to be able to sense the environment, perform restricted local computation, communicate with peer components, engage in local and global decision making processes and change their position or state within a limited range.

This clarification is important because it allows to distinguish the IBC’s rationale from the hard / soft building division of the ‘70s and the current “all transformable – moving building”.

Relevant to the fractal approach of the hard/ soft mode of existence is the aim to provide a vision of integrated components into an existing and even of conventional technology building fabric that could change and evolve through the components’ interaction with users and the environment.

IBC focuses on the definition, design, fabrication and application of Intelligent Building Components (IBC), cooperating to form swarm intelligence applications to architectural space.

We could distinguish:
- an IBC/l (logic) for their definition
- an IBC/d (design) for their design as integrated parts of the building fabric
- an IBC/o (ontology) for their classification
- an IBC/f for their digital fabrication
- an IBC/a (application) for their application.

Fig. 1
General scheme.
Some characteristics of the IBCs are:

- They are integrated into the existing building fabric, or replace parts of it.
- They evolve in time, transforming themselves and their environment.
- They exchange information between them, with the environment and the users.
- They are positioned to strategic places, following a location diagram.
- They have a common structure.
- They are grouped to form functional ensembles.
- They are interchangeable.
- They could support damages and mal functioning, since others nearby back them up).
- They are not simply distributed ambient computing elements, but they are also operators that change their context, indicate future trends and space transformations to the user, they catalyze new architectural forms and space activities.
- As Hyper-catalysts, they are the physical building blocks of interaction and interaction design.
- As they do not replace existing buildings but are integrated and transform them, their design modules will be integrated to the existing cad logic and transform it.
- Because the design of a building must also be the design of a building database that evolves and follows it through its lifetime managing information about uses, damages, renovations, costs etc. they closely attached to it.
- If produced first, constructed first, or will be the first to take a place in the construction site, they could command CNC for the production of other elements (living tags).
- They are attached to digital territories; they are their bridges between the physical and the digital.
- As building components, they can be integrated to renovations and to new buildings, increasing thus their application range.
- They have a parasitic dimension for they are hosted and after a time they develop a close relation of mutual dependence with their host.
- They are integrated in a layered way, as the first ones prepare the terrain (platform) for the seconds to come. This dimension is very important for the user acceptance of a totally new environment. Their layered introduction has to be designed in a way to accept possibilities that open to the unforeseen.

**Software Architecture and IBC applications**

The software architecture consists of four layers: hardware and communication, operating system, distributed framework (middleware) and an interaction metaphor to compose applications. Each layer is not treated as a closed stack of protocols and software, but as a repository of interoperable components. As an interoperability mechanism, an ontology will be developed. This ontology provides a shared means (a common language) for the communication and collaboration among IBCs, even though they may be produced by different manufacturers.
All parts of the system can be regarded as a potential component of a larger system, including sensors, hardware resources, and software modules, even people themselves, who are always considered to be part of the system and in control of the services. Each component has an internal part, which is proprietary and possibly closed, and an external part, which is public, thus making the component open to use.

Any degree of smartness in an IBC will be a result of perceiving the environment, being aware of itself and interacting with other IBCs. For this purpose an operating system (OS) will be designed, that supports the autonomic behavior of an IBC in an attempt to gain flexible control over increasingly complex computing environments. The main function of the local OS will be to manage the resources of the IBC and to support compose-ability. More specific the local OS will integrate transparently the hardware modules of the IBC, be aware of context of usage and treat peer IBCs as parts of this context.

An approach based on the “plug-and-play” metaphor is adopted, based on prototypes and research results of previous projects in this area. In this task, the findings of these are used to set the requirements for the middleware. Together with the component-based operating system, the middleware defines the core of the architecture on which applications can be built.

Even if an individual IBC has limited functionality, it can cause the emergence of more advanced behavior when grouped with others. This is possible by providing appropriate abstractions and the affordance of composeability that the IBCs should acquire. Composeability can give rise to new collective functionality as a result of a dynamically changing number of well-defined interactions among IBCs. Composeability is perceived by users through presentation of the IBCs connectable capabilities, and thus providing users the possibility to achieve connections and compose applications of two or more IBCs. Our approach uses the principles of software component technology as an enabling paradigm to describe the process where people can configure and use collections of interacting IBCs.

The parametric models of the structural building components are adapted to the final parametric model of the building and the Aml elements are integrated to form IBCs. IBCs lie in the intersection of the ICT and Architectural disciplines and have the ability to sense their context environment, to perform restricted local computations, to communicate with distributed peer components taking part into local and global decision-making processes, and changing their position or state according to defined limits. Particular IBC building sequences are specified in the final parametric model for the building. The behavior of the building is checked against the parametric model space, scenario activities and the energy conservation model. The physical space is bridged with the digital space through an Interaction Design environment that is defined by the parametric Design Tools.

IBC as Bridges in Digital Territories

In our study of Digital Territories (2006) we elaborate the concept of bridges between the digital and the digital space as one of the key elements of the digital territories general concept.

A Digital Territory is an ephemeral Aml (Ambient Intelligence) space: it is created for a specific purpose and integrates the will of the owner (an individual or group op-
erator) with the means to achieve it (including infrastructure, properties, services and objects) within an AmI space. A DT can be composed of sub-spaces, which are determined with respect to their services and usage.

*Bridges* are discrete elements disposing of certain autonomy in their conception and internal structure. Sensors, actuators and RFIDs are examples of bridges between the physical and the digital. When one builds a bridge between the physical and the digital space, it is in fact a bridge between activities that take place in remote physical spaces in the same time.

Building a bridge is a process. It shows intention, expected functionality, changes the nearby area of the two banks it links and probably, in the future, invites for changes or evolution of its structure according to new needs. Building a bridge is also a design decision. You must always decide which part you link with what, for how long and what type of actors you let pass. Bridging means that you create the conditions that allow communication and exchange of data to happen. It implies the answering to the following questions:

- Where bridges are located and how (location model)
- What type of context information is processed (context model)
- What functional – (network model) links them
- Who is the owner and how his activities necessarily produce the above three models.

Bridges consist of AmI components *distributed* and *integrated* to physical space, obeying to functionalities that serve interrelated activities -schemes evolving in time. Building a bridge between the physical and the digital implies the conception of a *locational model* to decide AmI components allocation.

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Fig. 2
Bridges between the physical and the digital.
AmI components are distributed in the physical space. Their distribution follows a logic. A location model represents the physical context as relationship between a (group or individual) activity, the space it occupies and the relative AmI components. A location model integrates a time parameter. We have different location models for documentation and management of physical space, for evolution – transformation of the physical space or for the digital extension of activities.

AmI components are integrated to physical space, for bridging the physical and the digital, in various ways described by the locational model. They could be fixed to one place or mobile, integrated to the fabric or clipped on.

Building a bridge between the physical and the digital also implies the conception of a context model describing what do we expect as context information context model from the physical world and what is needed in a DT. A captures the state of the physical world using sensors and is available to software applications. A bridge can be a mechanism that provides input to a context model, because it makes the information captured by sensors available.

Bridges could be temporal or ephemeral. A DT could be characterized by its ability to create new bridges, by the ease with which bridges are formed or broken. Openness and adaptability are thus defined. A DT must be able to accept a new bridge and integrate it to its overall functionality. A DT must be able to continue functioning if one of its bridges is broken.

Bridges can be mobile, they can be one-way or two way, personal or private (e.g. a pc used for access to e-commerce, e-banking, etc) and they may become commonly available for sharing information (e.g. phone’s loud speaker).

Bridges as physical elements are DT’s manifestation in the real world and thus are integral parts of their identity.

Bridging creates the possibility for interaction, represents a possibility, yet actually having data flow across makes a recorded event become a fact in the virtual world. The existence of a bridge is only potentiality and creates the conditions that allow communication and exchange of data to happen. Bridges are dispose to be activated and when referring to a virtuality of possible scenarios to happen.

Conclusion

IBCs, conceived through Parametric Design, realized through Digital Fabrication and hosting Ambient Intelligence operators form a privileged terrain of joint research education and new product development.

IBC’s development methodology could lead at the creation of a platform permitting the joint education on digital design / manufacturing and environmental design but also the research and development on new products in the cross section of informatics and building industry.

Nowadays most of the contemporary architectural design software limit themselves at the information management during design and construction, while interaction design remains an autonomous research field that meets applications in building structures that either are realized or their fundamental design has already been decided. Therefore parametric design concerns the design team and interaction design regards the users. The integration of these distinct topics will drive the progress of the research on building technology. The connection of parametric design with interac-
tion design in a uniform total design process will have an impact on architectural education as it challenges its established thematics. Jointly, it could lead to researches permitting to the building industry to advance to the design and production of smart building components integrating an IBC approach.

The development of IBC Ecologies could not be the work of one research team or academic institution, but the result of an open networked cooperation of all parties involved such as designers, users, academics, researchers, ICT industry, building industry, UbiComp developers, collaborating to the formation of an open catalogue of Intelligent Building Components.

Note
1. IBC is a research direction of the Architectural Technology Unit (ATRU), School of Architecture N.T.U.A. (http://atru.arch.ntua.gr/digital-design-fabrication/research/45). The concept was firstly elaborated in collaboration with Achilles Kameas and the Daisy Group (http://daisy.cti.gr/). In the ATRU working group participated Angela Kouveli, Yannis Orfanos, Dimitris Papadopoulos, Athina Stavridou, Sofia Tzimopoulou. A version of IBC was proposed at Thales research program with partners: NTUA (D. Papalexopoulos – principal coordinator), MOU (Achilles Kameas) and AUTH (M. Voyatzaki).

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Energetic Rehabilitation: Environmental Objectives to Learn Technological Design
The didactic experience (MIA)

The 2010/31/EU Directive, which replaces 2002/91/CE Directive since July 1, 2012, provides that buildings built after December 31, 2020 must be energy “almost zero.” This means that they must have high standards of energy efficiency and meet most of their energy needs through self-production, making extensive use of renewable energy sources.

Public administrations will be the first that from 2018 will have to build energy buildings “almost zero”, as the European Union gives a strategic role to the energy efficiency of public buildings.

Even in the 2012/27/UE Directive, the 5th Art. defines the “Exemplary role of the public authority buildings”. The Directive introduces the requirement to make energy rehabilitation, every year, at least 3% of the total useful floor area of buildings equipped with air conditioning, with areas larger than 500 square meters, owned and/or occupied by the central government.

This requirement is very significant because, in Europe, to secure the minimum although stringent requirements only for new buildings is not a sufficient measure in order to reduce the energy consumption. The new building has only a marginal (just over 1%) compared to the entire building stock. The public heritage, in particular, is mainly composed of old, obsolete and very energy consuming buildings, within which comfort conditions are often not guaranteed.

Therefore, in the post-crisis world, the challenge for energy sustainability is not design new buildings to nearly zero energy, but energy upgrade existing ones in order to reduce power consumption drastically.

For this reason, the experimental teaching illustrated in this paper deals with the issue of energy efficiency not of new but existing buildings.

The didactic experience is carried out within the Architectural Construction Laboratory (academic year 2011-2012, lecturers: Lab A - prof. M. Isabella Amirante; Lab B -
The laboratories have chosen, as common target, analysing energetic and environmental performance of a school building, a kind of public building particularly significant on the community.

The starting point was to explain to students the meaning of “net zero energy building” and what requirements must be met.

The school building, chosen as case study, has a very low primary energy demand, which must be met almost entirely using renewable sources.

To understand how designing the technological solutions for increase the energy performances of this type of building, the first step is doing a complete (electric and thermal) Energy Audit.

**Designing a zero energy building (MC)**

The building is equivalent to an open thermodynamic system that presents different kinds of flows of input and/or output heat, that cause, as a result, an increase or a decrease in temperature depending on the seasons. These flows can be originated within closed spaces (people, lighting, equipment), or they may be generated externally to the building system. These latter, which are due to climate, solar radiation and outside air temperature, are the most important from the design point of view. The magnitude of these flows depends on both the external climatic conditions and other characteristics of the building envelope.

The building energy quality, understood as ensuring adequate welfare conditions for the direct users with minimal resource consumption, depends on several factors, which orient not only the energy behavior, but also especially the relationship between building and its environment.

Currently, the rules used in Italy for the calculation of the building’s energy requirements are the technical specifications UNI / TS 11300. In particular, in order to assess the energy performance of the building envelope, the reference is the first part describing how must be calculated the net and/or ideal energy requirements for heating and cooling, without taking into account the performance of the systems.

In the winter season, to minimize this demand, the objective of design must be on the one hand to reduce the losses due to ventilation and for transmission, on the other to compensate, at least in part, these losses with solar gains.

The first objective is achieved by properly isolating the envelope, but it cannot be “hermetically sealed” because the wall’s transpiration is a primary condition to prevent condensation.

The second is achieved through proper placement and sizing of transparent surfaces. The characteristics of the glass are also very important. Just in the Mediterranean area, to design the transparent envelope is generally a very delicate aspect.

In fact, according to energy performance, the glass surfaces play a complex and sometimes conflicting role. They have the undisputed advantage of reducing the energy demand for lighting. In the winter season, it can be used to optimize the heat gain due to solar radiation for the purposes of the energy requirements for heating;
but they present problems related both to the excessive dispersions (also 5 times higher than those of opaque components), and the infiltration of air.

“The recent regulatory developments about the calculation and certification of building-plant system energy performance, gives great importance to transparent envelope design. A very important requirement is the glazing percentage - between the transparent surface of the building and its overall useful surface-. If it is below 0.18, it is possible directly to attribute the value EPI = EPI = limit to the building, where there occur simultaneously and other requirements on plants and on the envelope: thermal efficiency and transmittance. In other cases, it is very important valuating the effectively performances of transparent envelope (see DPR 59/09, article 4 paragraph 4: transmittance of transparent closings below the tabulated limits).

The D.Lgs no. 311/06 introduces some interesting innovations: the designer has to use better external environmental conditions and also features of spaces distribution to encourage natural ventilation of the building and introduces, with Annex I, the obligation of sun protection systems to control solar gain in summer conditions. In fact, during the summer season, the glass surfaces affect very negatively the heat load if they are not properly shielded” (Verde & Violano, 2013).

Therefore, calculating properly the ratio of glazing and the orientation of glazed surfaces is crucial to the overall energy requirements of the building. In particular, the south orientation is preferred, because it generally makes it possible, with simple technological solutions, to minimize both the energy demand for heating (maximizing gains in the winter season), and the energy demand for cooling.
The opportunity to take advantage of solar gains in the winter season, however, is limited. In the budget equation for the calculation of energy needs, this limit is expressed by the coefficient of utilization of the free gains. This coefficient depends mainly on the time constant and thus the Thermal Inertia of the opaque components.

The Thermal Inertia of opaque envelopes also determines the amount of energy needs for cooling. It may be determined by the coefficients of Attenuation and Phase Shift of the thermal flow. The National Guidelines on Energy Certification, in fact, use these coefficients to evaluate the energetic quality of the building in summer conditions.

In the summer season, it is also very important choosing the finish of the vertical and horizontal closings. The first part of the UNI TS 11300, about “Contributions solar thermal”, specifies that in the calculation of energy demand is also necessary to take account of the heat input due to solar radiation on opaque components, evaluating the specific absorption coefficient of solar finish surface of the component.

Generally, in order to reduce the cooling load of the building it is necessary to increase both the reflectivity to solar radiation (minimizing the Absorption Coefficient), both the emissivity between the surface and the celestial vault (promoting cooling of the surface).

The characteristic of materials, absorbing or reflecting the incident solar radiation, depends primarily on the colour of the surface (light colours are more reflective than dark) and kind of finishing (for example: smooth or wrinkled).

Therefore, energy-oriented design should aim first to reduce the amount of net energy, improving the performance of the housing in order to reduce, in the winter season, both losses for transmission and those for ventilation and / or infiltration.

However, this is not enough. In a place as Monte di Procida, it is also crucial ensuring summer comfort.

In general, the ability of the building to carry out, in the summer season, an adequate energy control, manifested primarily through two aspects:

• ability to reduce and move over time in the flow of heat input;
• ability to remove the accumulated heat (mostly during the night), through natural ventilation and passive cooling.
The natural ventilation can in fact be used not only to ensure an exchange of air within a confined environment (and therefore for the purposes of the control of indoor air quality), but also (in certain circumstances) to cool environments, through the control of both temperature and relative humidity of the air.

**Retrofit and Technological Design (AV)**

Energy retrofitting of an existing building is a more complex work than designing a new building.

For an energy-efficient upgrading, the first step is the analysis of the current performance of the building in order to identify the main problems. Starting from this critical points, it is possible to design appropriate technological solutions with high-energy standards.

The architectural design, before than transformation instrument, is a knowledge instrument.

The energy retrofit of a building, finalized to an innovated or simply a better functionality, requires the creative reading of embryonic architectural potentialities, the control of the flows matter and energy over-generously granted or denied a wise re-search of balance of technological innovation, functional quality and conservation.

Architecture is different from the other arts because it can give form to structures with specific use and meet needs, interpretable in terms of comfort.

In the specific case of highly dispersive buildings, as in the proposed case, the interventions must be focused on the envelope for making it efficient to the needs of the true protagonist of architecture: the direct user.

Therefore, the architect shall be responsible for interpreting the relationship between potential offer of building systems and direct users’ demand, according to a ra-tionality motivated by the comfort’s needs.

**Energy retrofit of the school building**

The school Dante Alighieri-Torrione of Monte di Procida is a building of two floors: the kindergarten is located on the ground floor and the elementary school on the first floor. The entire complex is surrounded by a garden, in a predominantly residential area.

![Photographic survey of the degradation.](image)
The building, built in the mid-80s, has a reinforced concrete structure. In the past, it has been subjected to several works of ordinary and extraordinary maintenance.

Currently the general conditions have deteriorated: the facades have disconnected plaster in several places, discoloration due to thermal bridges, water leaks, and rising damp.

The stratigraphy of the walls are a double layer of bricks with an air chamber, without thermal insulation. The roof is not isolated either. This causes considerable loss of heat in the winter.

In the absence of very detailed project data, the values of the thermal parameters of the components of existing buildings can be determined as a function of the typology and the construction period, as indicated in Appendices A, B and C of the UNI TS 11300-1. The estimated transmittance of an external vertical empty box walls, with a thickness of 40 cm, for example, is 1.1 W/m²K, that is almost three times higher than the limits imposed today by the law for the climate zone C, which are 0, 40 W/m²K.

All windows are aluminum, horizontal sliding double glazed and quite degraded. The performance of both thermal insulation and airtightness are poor. The windows are also no external shields and they have no other sun protection systems. The only shielding systems are colored curtains that since internal control provide a limited solar radiation. This results in the summer season, a strong overheating, especially in classrooms exposed to the east and south, which work from May to October, with the closed curtains, the lights on and doors and windows open to allow air to circulate.

The workshop is structured to conduct experimental teaching aims to produce a final project work divided into four parts.

The first part analyzes the relationship between the building and the assigned external environmental components: sunshine, ventilation and shading.

The site analysis is the first step to determine the needs and define design solutions.

Fig. 5
Shadings.
In fact, the building can not be considered as a system “isolated” with respect to the external environment, but it must be able to react to the stimuli coming from the external environment, mainly through the building envelope, in order to provide occupants with the most possible suitable conditions.

The starting point is a careful analysis of climate and microclimate, as the energetic quality of a building is to be assessed not in an absolute sense, but in relation to them.

Fig. 6
Rainwater system. 5
Checking the energy performance of a building essentially means in fact to consider how, in terms of energy, the climate component through the envelope interacts. Plants collaborate with the enclosure, especially in extreme weather conditions during the winter very cold and very hot summer.

Consequently, even a retrofit design must verify carefully the implications associated with climatic context: orientation, shape, size and integration of technology solutions choices.

In this phase, students calculate the Energy Audit, which is a systematic, documented and periodic assessment in order to obtain adequate knowledge of energy consumption: not only “how much”, but also “when” the building consumes. This allows them to identify and quantify energy saving opportunities.

The Thermal Energy Audit is a kind of picture of the status quo of the building’s heating requirements.

The main objective is to identify which energy redevelopment or improvement of managerial reduce fuel consumption. To do this, students must:

- identify indicators of energy intensity (power and consumption per square meter)
- Identify conditions of inefficiency in the building envelope and/or heating systems
- Identify conditions of management inefficiency
- identify redevelopment energy efficient in terms of costs.

Generally, indicator is a tool relating quantitative and/or qualitative data in order to provide a direct comparison between synthetic parameters and complex phenomena.

The Electric Energy Audit, however, is mainly aimed at the design of a building integrated photovoltaic systems.

The second phase is the Meta-Design. In this phase on the characteristics of the building organism as a function of the building system and conformation-morphological type are defined: spatial conformation, technological and functional.
The criteria for upgrading the energy efficiency of the building envelope are the reduction of fuel consumption and at the same time an improvement of the conditions for thermal comfort of the interior spaces, not only in winter but also in summer.

The third phase is Environmental-Energy Design. Students are encouraged to analyze the energy behavior of the building-plant system to get to define the project’s energy and environmental quality.

The didactic experimentation is aimed at solving the following problem of the project:

- to improve the structural characteristics regarding bioclimatic aspects
- to have the availability of green areas equipped
- to limit energy flows and maximize the use of renewable energy
- to manage properly the water cycle
- to enjoy the common areas differentiated by the type of student body.

In the post-crisis world, the energy efficiency of existing buildings cannot be considered as a temporary fashion or a marginal aspect of the environmental design, but it has a primary importance in the design process.

The notion of energy retrofit should be seen as improving the performance of building-plant systems not only by adapting it to the new regulatory requirements, but also to the needs of the users direct.

To restore an existing building respecting minimum requirements of energy regulations must be understood not as yet another legislative imposition, but as an opportunity for the re-perform through some sort of energy redesign of envelope and plant systems. The main innovation is mainly in how materials and components are chosen and integrated, and how traditional techniques and materials and technologies and innovative materials are integrated.
Moreover, to teach selecting and using innovative technology guarantees broadening educational horizons. New perspectives for innovative teaching methodologies are open, based on experiments of the benefits resulting from the use of renewable resources able to establish direct experience of learning, proposing attitudes, encouraging innovation and improvement.

These new issues that affect the school, relating quality of life and management of energy and environmental resources, profit the educational project. The school building, its space, its organization can present itself as a model of sustainable design and become a laboratory for energy-environmental education.

Notes
1. This picture is taken from the project work of students: A. Della Cioppa, I. Iannace, M. Lettiero, L. Maisto, A. Vila Garrido, of the Architectural Construction Laboratory (academic year 2011-2012 - prof. A. Violano).
2. This picture is taken from the project work of students: A. Della Cioppa, I. Iannace, M. Lettiero, L. Maisto, A. Vila Garrido, of the Architectural Construction Laboratory (academic year 2011-2012 - prof. A. Violano).
3. This picture is taken from the project work of students: A. Della Cioppa, I. Iannace, M. Lettiero, L. Maisto, A. Vila Garrido, of the Architectural Construction Laboratory (academic year 2011-2012 - prof. A. Violano).
4. The picture is taken from the project work of F. Perri (Degree in Architecture – Tutor: prof. A. Violano; Co-tutor: M. Cannaviello).
5. The picture is taken from the project work of student: M. Lettiero of the Architectural Construction Laboratory (academic year 2011-2012 - prof. A. Violano).
6. The picture is taken from the project work of F. Perri (Degree in Architecture – Tutor: prof. A. Violano; Co-tutor: M. Cannaviello).

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The Effect of the Atrium on Thermal Comfort
The traditional atrium form was frequently used in the historiography of Greek and Roman dwellings. It was an open four-sided courtyard which was located in heart of the building, next to an entrance door in a richly ornamented room. For the early decades of the 19th century, the atrium definition has been changed, although the atrium form kept its original space containing natural light and fresh air from the glazed wall or roof. Several scholars such as Atif (1994), Bednar (1986), Göçer, Aslıhan, and Özkan (2006), and Höppe (2002), are united in believing that reviving the atrium is one of the most significant factors in developing architectural history. Revival of the atrium has been known as a social center in the ancient Greek, up to the present time. This glass-enclosed space within a central building can offer a spatial soul and heart. Moreover, atrium buildings have a direct effect on the market value of buildings, in addition to both psychology and physiology of occupants’ moral.

It has been confirmed that the crucial role of atria leads to having a decline in energy consumption by keeping human thermal comfort (Taleghani, Tenpierik, & van den Dobbelsteen, 2012). Thermal behavior in the atria is an important aspect of energy utilization in building which is primarily related to lighting, cooling, heating, and also reduction of thermal stratification; due to the fact that the design method of the glazed atrium, a large public space, with more amenities is very sensitive.

Based on the several researches, overheating and over-lighting, however, are the main design problems of the atrium which designers are dealing with (Chenvidyakarn, 2007; Sharples & Shea, 1999). On the other hand, increasing the greenhouse effect during hot seasons and a decrease in stack effect in highly glazing atria cause the internal environment of atrium buildings to be more uncomfortable for occupants, in terms of the human comfort zone. Failures or mistakes in the early stage of atrium design occur frequently and cause some consequential effects on both the energy and indoor thermal performance of the building.

In Famagusta, North Cyprus, the atrium buildings are not recognized and are not as popular as the other architectural forms which is why the failure percentage is high due to lack of knowledge and experiences in this specific area. In line with the above mentioned studies, researchers decided to investigate the possible impacts of various atrium roof materials, changing the height of atrium tower, the difference in the windows’ opening percentage, and the impact of internal and external environment factors such as air temperature, solar radiation, wind speed and wind direction for the building’s thermal situation. Then, in the long run, the aim is to examine how poor architectural spaces can increase the energy consumption of the building by the growth in cooling and heating loads during the year. Finally, the present research contributes to collecting building problems by focusing on hot humid regions and by offering some useful modifications in order to enhance the thermal performance of the selected educational building.

**Research Objective**

In this review, the way of improving the existing thermal condition of the selected building in a hot, humid climate would be taken into consideration. Therefore, the goal of this investigation is to examine the thermal environmental performance of atria in buildings, plus undertaking research to find a suitable atrium form for this climate.
Literature Review

In order to provide a good atrium design, it is essential to carefully analyze the interactions of passive solar designs, which consist of daylight, heating and cooling requirements, with both the atrium space and its adjacent spaces. Based on Demers and Putin’s research (2007), the quality of daylight, reduction in the cooling load, has also declined in the heating load in the atria that are directly related to each other. Researchers suggested that to optimize the thermal comfort through the daylight, the angles should be considered lower than 60°; otherwise, the sunlight angle which is higher than 60° getting to reflect over 80% of their value. Furthermore, Fuziah, Azni, and Shuzlina (2004) found that the location, orientation, size, and also well-shading of atrium fenestrations are crucial to provide a comfortable indoor space. Berkovic, Yezioro, and Bitan (2012) stated that solar radiation mainly affects human comfort, so the orientation of atrium space is very important to determine the amount of shade which is produced by the atrium geometry for the inner part of the building.

In terms of heating strategies, atria are able to act like a buffer which maintain the average stable temperature and reduces the thermal transmission for indoor spaces. Voeltzel, Carrié, and Guarracino (2001) asserted that the geometry of an atrium space and its linkage to adjacent spaces are very remarkable in exchanging the exhausted and heat flow by the thermal radiation, as well as in providing cooling requirements of the building. Besser, Rodrigues, and Lau (2011), from their analyses, understood that the absence of connections between atrium and its adjacent spaces to prevent solar heat gains to transmit into the surrounded spaces from the atrium space. Consequently, to prevent interior atrium spaces from overheating in hot seasons by solar gain, atria apertures should be designed on seasonal climatic variation. Geros, Santamouris, Karatasou, Tsangrassoulis, and Papanikolaou (2005) represented that the natural ventilation at night can decrease the cooling load produced by air-condition roughly up to 90%. Also, efficient air flow, thermal capacity, and different temperature between outside and inside of the building during the night have a strong impact on the natural ventilation. Analyses done by Hussain and Oosthuizen (2013) demonstrated that if the height of atrium tower increased, sufficient air pressure would be produced to induce the air movement from the atrium to adjacent spaces. In contribution to maintaining the equal comfort conditions in each building storey, the inlets and outlets should be considered near the ground and on the top of the side walls, respectively. Experiences of Karava, Athienitis, Stathopoulos and Mouriki (2012) revealed that a tall atrium space with a high-glazed top lit assists the transmission of buoyancy-driven airflows to increase. Additionally, the cooling load saved in the building’s thermal mass can be enhanced by the low streams of internal air flows during the night. Hence, profound ventilation at night with the outdoor temperature is able to reduce cooling demands in the atrium building.

According to Laouadi, Atif, and Galasiu (2003), design parameters of top glazing buildings such as the proportion of fenestration surface, skylight and atrium form, fenestration types, and the connection between the atrium and its adjacent spaces can affect the annual energy usage and thermal performance in cold climates. Laouadi et al. (2003) found that a highly glazing atrium has the worst situation among the others (enclosed, three-sided, and pyramid/pitched form). It increases the discomfort situation as well as cooling needs. Secondly, the pyramid skylight in three-sided atrium building is more efficient in cooling load than the linear atrium.
Moreover, it attracted Laouadi, and Atif’s (1998) attention to compare the results of the field measurements with the ESP-r software – a building performance simulating program – on an enclosed three-storey building with a pyramid skylight. Their analysis results revealed that there is an agreement between the ESP-r predicted results and the field measurements; the only difference was around 4 °C in temperature measurements for both winter and summer periods, although the predicted temperature was higher than the measured one (around 2-3 °C).

It seems that when the mentioned design strategies work properly in combination with each other, the yearly cost of consumed energy would significantly reduce and the indoor space situations would become very close to the human comfort zone.

**Methodology**

In this experimental research, it was attempted to achieve the comfort zone through passive solar strategies in the Colored Building, without using mechanical devices. To support the theoretical part, data has been gathered from the previous researches, books, and internet sources. The primary quantitative data of the field study were obtained through field measurements and observations. To evaluate and compare the thermal performance of the selected building, TAS software was used to reach the highest building thermal performance through several simulations with various parameters. TAS software is one of the most powerful computer programs in predicting the dynamic thermal simulation. The outcomes of this research are based on the results of the TAS simulation analyses and environmental data monitoring.

These simulations were based on the various considerations like glazed roof, solid roof and different height of the tower added on an atrium, and were taken into consideration on March 21 as a typical spring day, June 21 as a typical summer day, September 21 as a typical autumn day and December 21 as a typical winter day, at 7 o’clock in the morning, 12 o’clock at noon and 7 o’clock at night. Likewise, doors and windows are considered with differences in their opening percentage, from 10% to 100%. In this study, along with solutions for natural ventilation strategies during hot seasons, heating capacity for winter days were also analyzed. Different window opening strategies were tried for optimum natural air circulation for summer cooling.

**Sample and Study Setting**

The study has been carried out in Famagusta, which is a coastal city on the Eastern part of Cyprus. Famagusta has hot-humid climate conditions which increase the temperature and consequently has a direct effect on the comfort of an indoor environment. Colored Building, an educational building that is part of the Architecture Department on the Campus of Eastern Mediterranean University in Famagusta, North Cyprus, was selected for investigation on the effect of its interior atrium space, adjacent spaces and classes according to their thermal comfort during the whole year as can be seen in Figure 1.

The colored building has three floors with a rectangular shape in plan. The atrium analyzed in this study is a four-sided form in plan with 10 m × 13 m area, covered by the glass on steel truss that is a gable roof as can be seen in Figures 2 and 3.
Fig. 1
Schematic Drawing Showing Direction for All Zones (Ground Floor of the Colored Building).

Fig. 2
External View of Colored Building Atrium Tower.

Fig. 3
Interior View of the Colored Building’s Atrium.
TAS Simulation Results

Based on dynamic simulations, the evaluation of Colored Building thermal performance was divided into two periods: winter (March and December) and summer (June and September). In addition, simulation 2 and 3 were carried out separately in summer and winter time, respectively as can be seen in Table 1. In order to compare the thermal performance of each simulation, only zones 1 and 36 were considered to be demonstrated in bioclimatic charts, which were the lowest and the highest parts of atrium tower respectively, as can be seen in Table 1.

Table 1
Differences of Simulations.

<table>
<thead>
<tr>
<th>Simulation Name</th>
<th>Duration</th>
<th>Doors &amp; Windows opening percentages</th>
<th>Atrium Windows’ Opening (%)</th>
<th>Atrium roof material</th>
<th>Roof height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Selected Months</td>
<td>100</td>
<td>100</td>
<td>Glazing</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>2. June and September</td>
<td>100</td>
<td>100</td>
<td>Solid</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td>3. March and December</td>
<td>0.00</td>
<td>0.00</td>
<td>Solid</td>
<td>5.00</td>
<td></td>
</tr>
</tbody>
</table>

Winter Simulations

First simulation was the existing Colored Building with 100 present opening for all apertures. At 12:00 pm, the external temperature was 17.80 °C and the relative humidity was 51% with 7.10 m/s as the wind velocity. Atrium roof was covered by a single clear glass with 10 mm thickness. The height of atrium tower was 2.50 m. The inside air temperature reached only 1 degree higher than the external one and the building lost its heat load. During the winter period, air flow through north side was more than the other building sides, especially on the ground floor.

At 7:00 am, the average range of internal relative humidity was 60% to 90%. In March, the difference in temperature between the north and south sides of the building reached around 7 degrees.

At noon time, the prevailing wind pattern flew from E; north side of the building was in shadow, besides south and east facades received more solar radiation; so that south zones were warmer and the atrium had an average temperature compared to other zones.

In the evening, the relative humidity of the present simulation was 5% to 12% below the ambient humidity. The atrium had a temperature of 2 to 3 degrees higher than the outdoor temperature. On 21st of December, the lowest temperature was 10.90 °C with a 62% relative humidity. Therefore, the building needed to gain more solar radiation to pose in a comfort zone.

In simulation 3, apertures were completely closed. The atrium roof was covered by solid material with a 5 m height for its tower. By the new modifications, the surfaces of the north and south side of the internal atrium tower could remove their tempera-
Fig. 4
21st December, At Noon Time (12:00 pm) in Simulation 1.

Fig. 5
Thermal Performance of Coloured Building on March 21st, Noon Time (Simulation 3).
ture variances, and have the same temperature. In this simulation in March, the building provided an internal thermal comfort for its occupants with an air temperature around 21°C and a 48% relative humidity as can be seen in Figure 5.

Summer Simulations

In simulation 1 with 100% opening for apertures, the internal air temperature was 3 to 5 degrees greater than the external one which was around 29°C. An average range of internal humidity at noon time was between 47% and 66% in June and September, although the external one was between 48% and 74%. Atrium space had the highest percentage of inlet air among the north and south sides of the Colored Building.

It seems that the critical time on June 21st was at noon. At the time, there was a dramatic drop in relative humidity of the external area and the building; the change was around 14%, changing from 74% to 60% in the atrium tower. Entirely, the atrium tower had the maximum temperature compared to the other zones.

Simulation 2 has the same situation with simulation 3 but all apertures were considered open. The dramatic decrease in temperatures occurred by closing all aper-
On September 21st at 12:00 pm, the internal building environment reached the comfort zone with the 25 °C air temperature and 48% relative humidity, although it was close to the comfort zone in June with 27 °C and 58% relative humidity.

Findings and Discussion

By taking a brief overview on all the represented simulations, it can be concluded that in simulation 1, the current situation of the Colored Building with the glazing atrium roof had been shown with 100% opening for apertures. Moreover, the internal temperature of the building was higher than the external one, although there was a moderate temperature in the atrium space in both hot and cold periods. The point is that the adjacent atrium spaces which were located on the ground floor had the highest humidity percentage and the lowest temperature compared to the upper adjacent spaces, particularly at noon time. Furthermore, the atrium tower was taller than the other parts of the building with around 17 m height, which is why it had the highest percentage of inlet air among the other parts of the building. Additionally, the building lost heat load in the winter period and gained extra heat in summer. One of the influential items at noon time which affected internal temperature of the Colored Building was that the north side was typically in the shadow. Besides the facades located in south, east, and west were under direct solar radiation from morning till afternoon. Therefore, indoor air measurements in north side had an approximate same temperature as outside. During the night, the amount of incoming air from the south side was increased, in contrary to morning and noon when the prevailing wind came from north direction. Generally, the temperature of atrium tower was approximately less than the other spaces.

By monitoring the results of simulation 1, there was a meaningful difference between the north side temperature and the south side. The results of inside and outside temperature measurements during the whole year were proved that the indoor thermal situation of the Colored Building was far away from the comfort zone. In June and September, to reach the comfort zone in the inner part of the atrium space, it was needed to decrease its internal temperature by the effects of a wind, with almost 4 m/s speed, plus 50% to 60% relative humidity. Besides, the internal thermal comfort of the existing building was not even near comfort zone in colder seasons as well. Therefore, the internal temperature of the building needed to reach 21 ºC with around 58% humidity to pose in a comfort zone.

In simulation 2 and 3, the height of the atrium tower was increased two times to become five meters and its roof was covered with solid materials. By new modifications, the interior air pressure decreased and significantly moderated all internal zone’s temperature, even building’s surfaces. Additionally, building heat transfer increased compared to previous simulation. The results demonstrated in June, Colored Building never reached the comfort zone and it needs to be cooled by the wind, although its thermal performance was reasonable in September. In cold months like March, the situation was near the comfort zone and in December, thermal performance of the Colored Building was on the comfort zone changing from 20 ºC to 21 ºC. Building in December needed to receive more solar radiation so to raise the internal temperature.
Conclusion

The atrium of Colored Building is the top four-sided atrium which is used frequently to obtain more daylight. This type of atrium may be problematic in hot-humid climates such as in North Cyprus well-known for its direct sunshine. The analyzed simulations and collected data on site demonstrated that an atrium with a glazing roof is not suitable and efficient for hot humid climates. It has negative impacts on energy cost and thermal comfort of the building. That is why the Colored Building reached the comfort zone in the recent simulations via the solid atrium roof, and extending the atrium tower height around 2 times. Also, apertures’ opening percentage has its own key role in increasing the quality of internal thermal performance of the selected building. The main reason is that the atrium space keeps the solar radiation inside of the building based on the greenhouse effect. Although, the greenhouse effect is advantageous in cold climates, it causes problems in hot seasons.

Briefly, in this research, the effect of penetrating solar radiation, internal air circulation, humidity percentage, atrium tower height, and roof material on thermal comfort were chosen to work on. Furthermore, research could explore the influence of atrium structure, windows’ arrangement, windows’ size, various types of shading devices, different atrium roof forms, PMV and PPD with the purpose of enhancing internal thermal comfort to provide a comfortable environment for occupants, and reduce the energy consumption.

References


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Design Tools for Asking Questions: Evaluation vs Generation
During the conceptual design phase of buildings and urban areas, the designer deals with several geometrical characteristics related to the buildings' orientation, height and width, in relation to open spaces, pedestrian sidewalks and surrounding buildings. New buildings may create a different microclimate, like changing the wind regime, and affecting daylight access and shading of existing buildings and neighborhoods. Protecting solar and daylight rights is a complex task, strongly influenced by early decisions made by the designer.

The determination of a preferable design solution becomes specially complicated due to mutual influences. For example, the orientation and proportions of streets will influence the exposure of facades and sidewalks to the winter sun, as well as creating the required shading during summer. On the other hand, ignoring the solar rights at the stage of the preparation of a master plan may cause un-repairable discomfort conditions around and inside the buildings, and seriously compromise their energy performance.

The early stages of the design process characterize themselves by a constant search of a design direction. Nevertheless, decisions taken in those moments can determine the success or failure of the proposed project (Hari A., 2001). This was also verified by a study on the design principles of high-performance intelligent facades for hot climates, in terms of both building energy consumption and user comfort (Ochoa and Capeluto, 2008). Figure 1 shows the relation between information and design freedom during the different stages of the design process (Ullman, 2003). As can be seen, despite the fact that there is not much information during the early schematic stages of the design process, there is a high degree of design freedom and then major significant decisions are made at this time.

For these reasons, it is imperative that design tools could support architects from the very beginning of the design process, providing meaningful information, according to the design stage. Such tools may allow designers asking questions (what if? what to do next?) instead of distract him with input issues and meaningless or incomprehensible results (what do these numbers mean?). However, existing design tools are still rudimentary and with many limitations for use by designers in early design stages of any architectural project. They generally are aimed to external consultants and require exact data in a stage when designers consider conceptual ideas from a range of

Fig. 1
Information / Design freedom relation along the design process (Ullman, 2003).
options rather than precise details and numbers. Design tools that suggest solutions based on ideas are still rare (Ochoa and Capeluto, 2009).

**Passive Design**

The consideration of solar rights in urban design is essential in order to allow passive heating of buildings in winter and to improve the comfort conditions of people in streets, sidewalks and open spaces. It can reduce the energy consumption of the building if used indoors, while insolation of exterior spaces may create climatically comfortable areas, which can be used for outside activities in winter. On the other hand, proper shading should be provided in order to avoid overheating of buildings and create pleasant spaces during summer.

The idea of ensuring solar access is not new; the Roman Empire had solar access laws; the “Leyes de Indias” (The Law of the Indies) that were applied on the foundation of new towns in America consider block layout and street orientation to allow solar access, and the Doctrine of Ancient Lights protected landowners’ rights to light in nineteenth-century Britain. Many cities and countries in the world defined regulations to keep solar and daylight rights. Some were created from a public point of view to keep open spaces and sidewalks insolated as defined in cities such as New York (NYC, Department of City Planning website), San Francisco (SF Planning department website) and Toronto (Bosselmann et al. 1991, Brown et al., 1991). In other places, regulations were defined to ensure the full use of private properties such as private open spaces and solar collectors. Additionally, several U.S. communities adopted solar access regulations in response to the energy crisis and as a way to save energy and reduce air pollution and costs. In Israel, the planning authorities of Tel Aviv Municipality adopted solar envelopes as a tool for urban development in a new business district (Capeluto et al., 2003). Lately, the Netherlands-based architecture and urban design practice MVRDV proposed a master plan for Bastide-Niel as an extension of Bordeaux city center, aimed to be a zero energy neighborhood. The buildings forms were determined in order to allow solar access to open spaces, building facades and solar systems (MDRDV website). In these examples, daylight and solar radiation are considered as significant factors in the determination of urban development policies.

**Active Systems**

Furthermore, interest in the building integration of solar systems, like solar water heating (compulsory for residential buildings in Israel) or photovoltaics panels, where these systems actually become an integral part of the building envelope often serving as the exterior skin, is growing worldwide. In different countries, governmental subsidy programs and green pricing plans have increased interest on solar systems and demand. On the other hand, architects are increasingly proposing solutions that reduce energy demand on one side, and allow using energy from a clean, non-polluting, renewable source on the other.

The local urban environment, as well as the location of collectors on different building surfaces and with different tilt angles, may affect the system performance, and as well the period of time over the year that they will be exposed to direct solar
radiation. Since the amount of unobstructed solar radiation is critical to the efficient operation of solar systems in new or existing buildings as a part of roofs, building facades, balconies or sunshades the solar access to the collectors and solar rights must be assured year-round.

**Daylight Access**

Lighting is responsible for 30% to 50% of all the energy utilized in commercial and office buildings. Daylight can be used to reduce lighting energy use and the heat gains associated with electric lighting. The efficient utilization of daylighting can dramatically reduce the total electricity load and the peak demand. Moreover daylight is very important to our health and well-being.

However, the availability of daylight in certain areas of the city can be difficult due to the influence of the external built environment. In medium and high-density zones, where generally public buildings are located, the lack of light from the sky at street level can cause design problems for the architect that wishes to use daylight to provide a high quality-working environment and as an energy efficient design strategy. Tall buildings and elongated obstructions can affect dramatically the amount of light received and its distribution inside the building (Capeluto, 2003, Li et al., 2006). Given that only the upper floor in multi-story buildings can eventually make use of skylights, generally the only source of daylighting inside the office space is through side windows. In addition, the provision of side-daylit offices places limitations on building depth and interior organization. In dense urban areas buildings’ arrangement is the most important factor affecting daylighting as well as the thermal comfort of public and private open spaces. The surrounding built environment can seriously affect the possibility of using daylight inside buildings.

**Design Tools**

Different design tools are available to students, designers and consultants that help understanding the environmental performance of a proposed solution. Broadly, we can classify these tools into evaluation tools and generation tools.

**Evaluation tools**, analyze the performance of a given design alternative. Although architectural design processes ends up with a single built design, during the design process numerous design alternatives are generally created and evaluated. Examining several design alternatives meant that labour had to be dedicated to the creation of every singular design alternative. As architectural design is often performed under tight schedule and budget, the amount of resources designers have to investigate design alternatives is highly limited.

In practice, the large majority of existing evaluation models is geared to simulate and evaluate finished alternatives. According to Ochoa and Capeluto (2009) they are unsuitable as practical design aids for architects, since they share the following characteristics:

- Not all of them follow the logic of the architectural design process, which involves an iterative and sometimes loose method based on incoming information, stated principles and mental schemes.
• Early design decisions are based on vague “ideas” that cannot be evaluated with tools that rely on exact data. They require complex input procedures, together with translations from one format type to another.

• The majority of evaluation programs are designed for use by consultants, generally engineering companies that enter the design field very late, when main geometric characteristics of the building are already fixed.

• Input of current evaluation models needs detailed information and precision not known and not relevant at the beginning. Tools can also have complex interfaces that require much time to learn and use. Both factors can distract from the design activity itself.

• Most tools are dedicated to evaluate and model a certain finished alternative, not to suggest and evaluate different design options and directions. This implies fitting an idea to the modelling tool, thus filtering out information that could be useful or distorting the process.

• Architects trying to use these tools are thus subject to evaluate finished alternatives using a trial and error approach. This slows down production schedules or forces to depend exclusively on factual experience.

• For complex projects on the boundary of his or her expertise, the designer has few criteria about which design direction to develop in order to pass from idea to concept.

Generation tools on the other hand, may aid to define the proper geometry to achieve a certain performance. Performance-driven form generation refers to the idea that performance data can be used to generate architectural form. Shaviv (1975) proposed a method and a computerized model for the design of fixed external sunshades. The method was extended later for the generation of solar rights envelope for the design of solar communities (Shaviv, 1984). Arumi (1979) developed a computerized model that determines the maximum allowed height of a building that does not violate the solar rights of the existing neighboring buildings. Knowles (1981) suggested a method for assuring solar access to each residential unit in a community. De Kay (1992) made a comparative analysis of various envelopes allowing daylight access. Schiler and Uen-Fang (1993) developed a computer program for the generation of solar envelopes for flat-rectangular sites based on Knowles work, and Koester (1994) presented energy armatures using passive resources like winds and rain water, for urban sustainable development. The model SustArc developed by Capeluto and Shaviv (2001) uses the Solar Rights Envelope (SRE), Solar Collect Envelope (SCE) and Solar Volume (SV) data as target functions (Fig. 2). These solar envelopes define the space of all possible design solutions that either considers solar insolation or solar shading. SustArc allows the generation of different building configurations, ensuring solar rights of each neighboring building, and open spaces like sidewalks, gardens and squares. The model presents the maximum available volume in which it is possible to build without violating the solar rights of any existing building, as well as the designed one.

The Solar Rights Envelope presents the maximum buildings’ heights that do not violate the solar rights of any existing buildings, during a given period of the year.
The Solar Collection Envelope presents the lowest possible locus of windows and passive solar collectors on the considered building’s envelope, so that they are not shaded by the existing neighboring buildings, during a given period of winter.

Clearly, it is possible to determine the volume between both envelopes. This volume is called the ‘solar volume’ (SV), and can be defined as follows:

The Solar Volume contains the maximum buildings’ volume to be designed so that these buildings allow solar access to all the surrounding buildings, and at the same time are not shaded by them, during a given period of the year (Fig. 2).

This type of generative design tools has the potential of providing meaningful information to support design decisions during conceptual design stages.

In the next section, we will demonstrate how existing tools can be enhanced to provide information with a new meaning for design. It will be done through the presentation of SunTools (SunTools website), implemented using Ruby scripting language as a plug-in for the Sketch-Up modelling program (Google Sketch-Up website), which allows visualization of sun position and the sun path; produces axonometric views from the sun to easily analyze mutual shading and solar access and penetration at any design stage, providing evaluation results that can be used as generative information. The analyses are easily done without the need of exporting the geometric data to external programs, using the same working 3D schematic model. These tools aim to serve students, teachers, architects and consultants from the early design stages, to include solar consideration in design.

**Meaning of Information in Design**

As stated above, decisions made during early design stages may have great impact on energy performance of buildings and obtained comfort conditions. SunTools was developed as an attempt to investigate the possibility of using existing design tools, widely used by architects, providing the designer all along the design process with new performative information that can help designers in the generation of energy efficient design solutions.

**Sun Path and Sun Position**

The key to designing a successful passive solar building is to best take advantage of local environmental conditions and climate. The ability to improve building perform-
ance and comfort as well as the quality of open spaces in winter and summer is fundamentally dependent on the understanding of the seasonal variations in the sun's path throughout the day in relation to the designed building.

Fortunately, common modelling tools widely used nowadays by architects very early in the design process provide capabilities of visualization of accurate shadow casting by the design during various times of the year. This feature allows quick visualization and understanding of mutual influences among buildings at certain times.

However, not all of them allow visualizing the sun itself or its path despite that they calculate internally its relative position in the sky, according to the geographical definitions of the model. Visualizing the sun path during a required period of the year or at a certain date and time can help to understand in a better way the impact of the sun in relation to the project and its surrounding areas (Autodesk-Ecotect website). Since this information exists in the model is very simple exposing it to the designer creating a new layer of information to work with (Fig. 3).

Fig. 3
Sun Path and Sun Position visualization as part of the working 3D model.
**Sun Penetration**

Furthermore, once the solar geometry information was incorporated as part of the working model it can be used and manipulated in order to broaden its meaning and perform evaluations of design alternatives. Using this information SunTools allows assessing Sun Penetration and Solar Access at any specific point (internal or external) of the project (Fig. 4). This powerful evaluation is produced taking advantage of common capabilities of modeling tools of producing custom views from pre-set view points and directions.

The evaluation allows designers using their own 3D working models understanding in one comprehensive view the periods of exposure and shading for the analyzed position in the project.

Furthermore, the designer can see and understand the times and causes of overshadowing, and modify accordingly the design in order to obtain the desired performance. This feature can be also applied to study Sun Penetration inside buildings, as shown in Fig. 5. In this example, the geometry of the shading devices can be easily modified interactively as necessary to protect the building and achieve the required performance.

**Sky View**

In a well-designed space, daylight reduces energy costs, enhances the visual quality, and provides others psychological benefits that are hard and expensive to imitate with electrical lighting. As mentioned before, the availability of daylighting in certain areas of the city can be difficult due to the influence of the external built environment.
The surrounding built environment can seriously affect the possibility of using daylighting inside buildings and compromise daylight availability at street level.

The penetration of daylight into the building depends on many design parameters, among them the depth of the room from the window wall, ceiling height, internal reflectances, window orientation, shape and size, and optical properties of the glazing. It must be stated that most of these factors are unknown by designers at the early design stages. However, the most significant factor is the availability of daylight outside the building, which can be seriously affected by external obstructions like neighboring buildings or trees.

According to Capeluto (2003), the sky solid angle (SSA) presents the solid angle subtended by the path of the sky visible from the studied point. The SSA is proposed as a means to assess the influence of the external obstructions on the availability of daylighting inside buildings. There exist a correlation between the SSA and the DFave, serving as an indicator of the daylighting potential of the site.

Fig. 5
Assessing Sun Penetration at a specific location inside an office building (up) and modifying sunshades dimension according to required performance (down).
The solid angle subtended by a surface is defined as the surface area of a unit sphere covered by the surface's projection onto the sphere. This method can help architects consider, evaluate and as a consequence make design decisions by keeping in mind the daylighting potential (or limitations) of the site, and its implications on building design. It can provide also valuable information for authorities trying to regulate development in a way that considers daylight as a key for urban development and ensures an acceptable access to light for different city zones.

Using SunTools, the SSA can be easily determined using the 3D model that contains the volumetric information of the studied built environment. The method consists in tracing rays from the studied point in all directions to the sky vault and determining if it is visible or obstructed from this position. In this way the SSA and the percentage of the visible and obstructed sky can be calculated. Moreover, the visible and/or obstruct-

Fig. 6
Visible (and obstructed) part of the sky vault.
ed part of the sky vault can be visualized as part of the working model. Supplementary information can be super imposed to provide extra information to the designer as seen in Fig. 6 (down) and Fig. 7 showing together sun paths and visible sky vault.

In the same manner, additional information can be added to the model gradually according to subjects and questions that may rise in any design stage, as solar irradiance on the design of building envelope or open spaces, providing new layers of valuable information as shown in Fig. 8 (IR4SU currently under development as part of SunTools). This new layer of information containing solar irradiance maps can be used by designers as an aid designing building facades and roof, besides of its quantitative value in assessing exposure of windows and solar systems.

**Conclusions**

This paper discusses how design tools can support architecture students and architects asking environmental related questions during their work throughout the dif-
different stages of the design process. It presents different approaches for design tools for architects allowing generation and evaluation of design solutions. It demonstrates through the development of SunTools, a plug-in for SketchUp, how existing design tools can be enhanced in order to overcome limitations of existing tools and provide architecture students and architects with evaluations that have generative value using a unique 3D working model. In this way they can make changes interactively to improve and adapt the design to a required performance. SunTools is being extended to include evaluations of additional subjects as new layers of information that may contribute to generate design based on solar and daylight access information.

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A Methodology to Develop Theoretical Models for Building Energy Performance Simulation Programs
An important issue for projects focusing on the environmental design is to assess and evaluate their energy performance. This may refer to a whole building energy consumption or to the effect of specific features on the energy performance of a building. The ideal approach would be to test the effect of different strategies during the design process in order to evaluate them and go back to implement alterations. That is rarely the case. This is why it is often useful at an early design stage to have some input on the energy performance of certain features or even some guidelines. This can be provided by simulating simple theoretical models that represent a specific types of buildings and carrying out a parametric analysis.

Tzempelikos, Athienitis and Karava (2007) carried out detailed energy simulations in a new building at a preliminary design stage in order to examine the effect of different scenarios regarding the choice of several features of the building envelope (façade, glazing and shading types, lighting control systems and natural ventilation) on the energy performance of a building, aiming at providing design recommendations. The case study was an existing project, a building at an early design stage. As mentioned above, the analysis of different options during the conceptual design stage of a building is not very common. In other cases, useful information can be provided by carrying out studies on existing buildings. Nikolaou et al (2007) carried out a research on the effect of shading on the energy consumption of office buildings, by simulating the effect of implementing shading devices in existing office buildings in Athens. Tsikaloudaki (2005) while focusing on the relationship between solar shading and daylighting, analyzing the simulation results on the visual and thermal condition of an existing office space for different shading strategies, also provided data regarding the heating and cooling load.

There are several cases on the other hand, where studies regarding the energy performance of different features of the design envelope are carried out on theoretical models using building simulation software. Dubois (2001) examined the effect of several design characteristics of a particular shading type on the energy use for heating and cooling of an office module. A similar type model representing an office space for two people was used in another study by Nielsen, Svendsen and Bjerregaard Jensen (2011) in order to evaluate the performance of fixed and dynamic solar shading on the energy demand for heating, cooling and lighting of buildings. Similarly, the impact of a solar shading device on the energy consumption of a building was examined by Laustsen et al (2008) using a theoretical model of a cell office. In the last three studies, the authors evaluated the performance in terms of daylight as well.

In other cases a different type of theoretical model was applied in the simulations. The model was of bigger dimensions and accommodating more people, as opposed to a cell type space mentioned in the previous studies. The energy demand was assessed by Palermo-Marrero and Oliveira (2010) examining different design parameters (window area and shading louver type) and by Santos, Laustsen, and Svendsen (2008) using different solar shading devices.

Detailed input data are required for the simulations mentioned above, such as climatic data, internal gains, occupancy patterns, HVAC systems and of course building envelope properties. With regard to the latter, the usual information provided is the U-value of the model’s surfaces corresponding to building components and sometimes there is detailed reference to the layers of materials these components consist of. Other features of the building envelope such as the windows area are usually a
parameter that is examined. There is no discussion however regarding the choice of these building components, which may refer to construction practices or design decisions. In other words, do these theoretical models correspond to the buildings they refer to?

This paper presents a methodology to develop theoretical models for building energy performance simulation programs. It is the preliminary part of the building energy simulation analysis that will be used as part of the author’s research on the effect of shading on the energy performance of office buildings in Greece. The aim is to determine the input data regarding the architectural aspects of buildings for an energy simulation study in order to assess the energy performance of a building with specific architectural features. The methodology to determine these key aspects is based on the analysis of contemporary office buildings in Greece.

Analysis of contemporary office buildings in Greece

In order to evaluate the effect of shading on the energy performance of office buildings using a building energy simulation program, the first step is to define the typical theoretical office space that would be simulated. Two key aspects need to be addressed. The first is to determine if the typical office building in Greece is an open-plan or a cellular type office, which would determine the dimensions of the theoretical model. The other key aspect relates to materials and facade construction.

Building selection

For the purpose of this analysis, office buildings built within 2005 and 2011 were studied. As in most cases, the selection of buildings is made through published work, hence buildings that were published in architectural magazines and periodical publications such as the annual review of architectural work in Greece (‘Architecture in Greece’). It is important to underline that the aim is not a critical evaluation of these buildings’ architecture, rather than an analysis of their features. In other words, the selection of these buildings was not based on specific architectural criteria. However, it is worth mentioning that quite a few have received awards and distinctions.

It has to be noted though, that even among the published buildings, there were some limitations. The study refers to private office buildings, not buildings that are designed to house public administration. Also, almost in every case the ground floor is occupied by commercial activities, or in the case of large companies, spaces such as auditoria. The study is focused on the main ‘block’ of the office floors. In the same sense, there were a few buildings that comprised of an exhibition or a sales area and the administration of the same company. The proportion of office and exhibition space is the same, meaning that the administrative activity is not the dominant use of the building. These buildings were excluded. There were also cases where there was renovation of an existing office building or rehabilitation of an industrial building for instance as an office building with quite interesting architectural aspects. These were also excluded, as they were not initially designed as office buildings. To summon up, private office buildings (26 in total) built between 2005 and 2011 were studied (Figure 1).
Building features

The selected buildings were studied in order to gather information on determining the theoretical ‘office’ model required for assessing office buildings’ energy performance. The first step is to determine the architecture-related key features that are required for building energy simulation. The physical properties of these theoretical models have to be defined. The most important for that is the plan-type because it is related to the physical dimensions as well as a required input which is the occupancy (no of people / floor area). Apart from that, studies are based on either a cellular type or an open-plan type model. It would be interesting to see if there is a dominant type in Greece and whether it affects the energy performance of an office building.

The next step is to define the external skin of the model, representing the office facade, thus the surface that is the element between the external and the internal environment. Two elements have to be specified: the windows area – corresponding to glazed and opaque elements of the building envelope and the cladding material. The first is more straightforward but the latter is more difficult, given the variety of building materials, which clearly have to be grouped. Based on that, the thermal properties of the external skin will be determined. The final element is the interior construction of the office spaces. More specifically, the construction type of the internal partitions (lightweight or heavyweight type) and whether there is a false ceiling or a false floor. Finally, since the focus of the author’s research is on shading and energy consumption, an additional element of the analysis will be the shading devices (if there are any), their type (horizontal, vertical etc), material and relationship to the orientation.
Analysis of the office buildings and their features

Greek office buildings | General Issues

26 buildings in total were studied and analysed as per the features mentioned in the previous section, listed in Tables 1 and 2. The majority of them (80%) are in Athens and its wider area (Attica). They are not multi-floor buildings. Approximately 2/3 of them comprise of a maximum of 4 floors (office space) and the rest reach a maximum of 8 floors. The majority of them are not in dense urban areas (1/4 in dense urban areas). In terms of an energy analysis, this means that there are more surfaces 'exposed' to the external environment, both in terms of heat loss and heat gain. Also, factors such as natural ventilation can be considered as an option to exploit or others such as noise do not pose such a problem, as they would in a dense urban area.

Table 1
Greek office buildings. Plan type.

<table>
<thead>
<tr>
<th>Office Building</th>
<th>Construction year</th>
<th>Area (m²)</th>
<th>no of storeys</th>
<th>Location</th>
<th>Plan type</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIAMAR</td>
<td>2005</td>
<td>800</td>
<td>4</td>
<td>Athens</td>
<td></td>
</tr>
<tr>
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<td>2006</td>
<td>600</td>
<td>4</td>
<td>Athens</td>
<td></td>
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<tr>
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<td>2006</td>
<td>300</td>
<td>4</td>
<td>Athens</td>
<td></td>
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<td>2006</td>
<td>3000</td>
<td>5</td>
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<td></td>
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<td>300</td>
<td>4</td>
<td>Athens</td>
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<td>1500</td>
<td>3</td>
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<td>600</td>
<td>4</td>
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<td></td>
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<td></td>
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<td>400</td>
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<td>Thessaloniki</td>
<td></td>
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<td>2008</td>
<td>900</td>
<td>5</td>
<td>Athens</td>
<td></td>
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<td>2008</td>
<td>3000</td>
<td>3</td>
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<td></td>
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<td></td>
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<td>16000</td>
<td>5</td>
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</tbody>
</table>
The plan type is an important issue. Staniek and Staniek (2011) have done an interesting work on office building typology. They have concluded to 6 types of offices: a) cellular b) open-plan c) group d) combination e) business club f) reversible. However, some of them (business club and reversible office) refer to large scale buildings. According to Table 1 the dominant types are the cellular (Figure 2) and the group-type plan (Figure 3). The cellular type refers to a plan with a series of work spaces lined up along the facade, accommodating one or more people (usually two). The group-type office is basically a different version of the open-plan office (Figure 4), minimizing the negative features of the open-plan type. The fundamental difference has to do with proportions and scale: the plan width is smaller in order to allow for natural lighting and ventilation to be accessible in most seats. In addition to that, this plan type refers to spaces that accommodate no more than 25 people (Staniek and Staniek, 2011).

Open-plan type offices (Figure 4) in Greece represent approximately 1/4 of buildings (Table 1). It is important to state however that half of them refer to small scale office buildings and relatively small floor plates. Therefore it is not a very common type. A less favourite type is the cellular office type (there is only one building). Although there are around 25% of group offices, the dominant type for office buildings in Greece, seems to be a combination of cellular and group office type on the same floor plate. This is not the combination office (‘combined’ type) (Staniek and Staniek, 2011), as this term refers to a particular office type, where the floor plate is divided in three zones, the ones adjacent to the facade comprising of the separate work spaces and the group-type work placed in the zone between them. It is also worth mentioning that there are cases where the office building is not of the same property, rather than private workplaces on the same floorplate. This type is considered as a group type of-
office, since its proportions do not correspond to a small workplace for 2 people and represent around half of the total group office types.

**Greek office buildings | Construction, Materials**

In terms of construction and materials, almost all the buildings consist of a reinforced concrete frame (Table 2). Only in one case there is a metal frame structure. A significant element for an energy simulation analysis is the proportion of glazed and opaque area of the facade, expressed as a percentage of glazed over the opaque area. In order to define percentages, the elevations of all the buildings were analysed. Once again, the focus is on the main office blocks / floors, not on other parts of the buildings such as the entrance or the double-height ground floor, were other activities are placed. The different windows areas as window-to-wall ratios are listed in Table 2. In the majority of the cases, as the elevations of a building are not treated in the same way, there are more than one values of window area. The value 100 refers to a fully glazed facade (transparent). It is characteristic that out of 26 buildings, only 5 have fully glazed facades and in fact, in three of these cases (buildings no 8, 13 and 19 in Table 2) this type of facade refers to certain parts of the building. Additionally, in the other two (buildings no 18 and 26), the glazed elements are not ‘exposed’ to the external environment, but ‘protected’ by building components (a ‘built’ screen and shading louvers respectively). Therefore, it can be argued that the fully glazed office building that is generally a dominant type, is not very common in Greece. The typical facade design therefore, does not consist of a curtain wall system, but of transparent and opaque elements. And even in this case the transparent area is usually between 30-60%, as can be derived from Table 2.

![Open-plan office. Diagrammatic plan.](image-url)
Several materials are used for cladding, in the opaque surfaces. Approximately 1/3 of the buildings are clad in stone, 1/4 in metal panels (mostly aluminum) and 1/5 consist of a rendered brickwork or reinforced concrete frame. These are the typical materials. As for the interior, the internal walls consist of a lightweight construction, plasterboards or office wall partition systems with various finishes (timber, PVC, plasterboard or glass), as stated in Table 2. False ceilings are a typical feature, whereas false floors are not very common in Greece (in 1/3 of the office buildings studied).
The next step would be to use the information analysed in this section in order to determine the properties of the theoretical models required for building energy simulation.

**Determining the theoretical models**

**Geometrical Properties**

The typical plan type for office buildings in Greece is a combination of the cellular and the group office type. Therefore, two theoretical models should be determined for an energy simulation. The cellular type consists of a series of typical office spaces, accommodating usually two people. According to the Greek Regulation for fire protection of buildings (Official Gazette (OG) of the Hellenic Republic, Greek Presidential Edict, Regulation for fire protection of buildings, 1988: article 8) the theoretical number of people for office buildings is 1 person / 9.0 m² of net floor area. Therefore a typical cellular office (Type A) is an office space of 18 m², 3.0 x 6.0 x 2.8 m, illustrated in Figure 5. For open-plan type office spaces with several workspaces the guideline for estimating the theoretical number of people is 1 person / 5.0 m² of net floor area (Official Gazette (OG) of the Hellenic Republic, Greek Presidential Edict, Regulation for fire protection of buildings, 1988: article 8). According to the office plans of the buildings studied, the average number of people in a group office is approximately 9. Thus, the typical group office (Type B) is an office space of 45 m², 7.5 x 6.0 x 2.8 m, as shown in Figure 5. In both types, the plan was designed with a typical planning module of 1.5 x 1.5m used in office buildings (Katz, 2002: pp.35).

Office buildings can be considered to consist of a series of these typical Type A or Type B office spaces lined up along the facade. In this way, there is only one external surface for the typical space, while the rest of the surfaces (walls, ceiling and floor) are adjacent to a similar if not the same type of space. In other words, the model’s surfaces except for the external one are considered as adiabatic (Figure 6).

The same assumption was made in some of the studies mentioned in Section 1 (Dubois, 2001; Nielsen, Svendsen and Bjerregaard Jensen, 2011). In others (Palmero-Marrero and Oliveira, 2010; Santos, Laustsen, and Svendsen, 2008) the theoretical models used were considered as having all the surfaces as external but these refer only to open-plan type offices and basically represent a single-storey office building, since all their surfaces are ‘exposed’ to the external environment.

In terms of the transparent elements of the building envelope, in Section “Greek office buildings | Construction, Materials” it was found that few buildings in Greece are fully glazed. Therefore, considering the model’s external surface as fully glazed, would not correspond to a common construction practice in Greece. However, in order to provide results of energy consumption that would enable a comparison between the energy performance of office buildings between South and North Europe, including the fully glazed type in the simulations could be justified. In addition to that, the energy simulation should theoretically enforce the common knowledge that fully glazed facades in areas with climate such as the Mediterranean should be applied only with a proper provision for shading. Overall, in the simulation process, different areas of windows in the external facade should be examined, ranging from 30-70%, as these is the range of windows areas in the buildings studied.
Finally, with reference to shading, it was interesting to find that nearly 2/3 of the buildings incorporated shading devices. The type of shading is directly related to the orientation but apart from that there are several criteria that influence the choice of shading device types (horizontal or vertical for example). Overall it seems that the most popular types are aluminium louvers (1/3 of the shading devices) and metal mesh (1/3 of the shading devices). The rest of the devices were aluminium venetian blinds, fins and overhangs. It is interesting to see that apart from the shading devices, around 1/3 of the buildings incorporated building components of overhangs in their whole design concept that served the purpose of shading as well.
**Thermal Properties**

A building energy simulation analysis requires input on the thermal properties of the building components of the theoretical model, basically a description of the materials. The reinforced concrete frame does not appear on the elevation. From the buildings studied, it was found to be recessed in the majority of the cases. Apart from the fully glazed facade, in the other type (opaque / transparent) there are three options, as stated in the analysis previously: stone, metal or render on brickwork or reinforced concrete. In all three cases there is a typical construction of brickwork and reinforced concrete frame and the cladding material on a secondary metal frame. The insulation is placed on the external face of the brickwork / concrete. The materials layers configuration that is assumed to correspond to these types is listed in Table 3. Density and thermal conductivity properties are derived from the Technical Guidelines T.O.T.E.E. 20701-2/2010 (Technical Chamber of Greece. Technical Guidelines on the thermo-physical properties of construction materials and the control of thermal insulation of buildings, 2010).

In all three cases a maximum U-value is considered, as per the recommendations of the Greek Regulation for the Energy Performance of Buildings (Official Gazette (OG) of the Hellenic Republic, Energy Performance of Buildings Regulation KENAK, 2010) for external walls and windows / external glazed facades (Table 4). This depends on the geographical area, as there are four geographical zones in Greece. Table 3 refers to requirements for climatic zone C, while implementing different values for insulation would provide the appropriate U-values for the other climatic zones.

**Table 3**

External wall construction types for the theoretical models.

<table>
<thead>
<tr>
<th>Cladding material</th>
<th>Construction layers</th>
<th>Thickness (m)</th>
<th>Density (kg/m³)</th>
<th>Thermal conductivity [W/(m K)]</th>
<th>U-value [W/(m² K)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal cladding</td>
<td>Inside: lime plaster</td>
<td>0,02</td>
<td>1800</td>
<td>0,87</td>
<td>0,42</td>
</tr>
<tr>
<td></td>
<td>Brick 200 x 150 x 330 mm</td>
<td>0,20</td>
<td>1500</td>
<td>0,51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>XPS board</td>
<td>0,06</td>
<td>30-40</td>
<td>0,035</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air space *</td>
<td>0,04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside: aluminium panel 4mm *</td>
<td>0,03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0,35</td>
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<tr>
<td>Total thickness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone cladding</td>
<td>Inside: lime plaster</td>
<td>0,02</td>
<td>1800</td>
<td>0,87</td>
<td>0,42</td>
</tr>
<tr>
<td></td>
<td>Brick 200 x 150 x 330 mm</td>
<td>0,20</td>
<td>1500</td>
<td>0,51</td>
<td></td>
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<td></td>
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<td>0,06</td>
<td>30-40</td>
<td>0,035</td>
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<tr>
<td></td>
<td>Air space *</td>
<td>0,03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside: stone slabs 20mm *</td>
<td>0,02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0,33</td>
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<tr>
<td>Total thickness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Render</td>
<td>Inside: lime plaster</td>
<td>0,02</td>
<td>1800</td>
<td>0,87</td>
<td>0,40</td>
</tr>
<tr>
<td></td>
<td>Brick 150 x 170 x 350 mm</td>
<td>0,15</td>
<td>1500</td>
<td>0,51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>XPS board</td>
<td>0,07</td>
<td>30-40</td>
<td>0,035</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside: acrylic render</td>
<td>0,01</td>
<td>1800</td>
<td>0,87</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0,25</td>
</tr>
</tbody>
</table>

*In the case of metal and stone cladding, the layers between the air space and the external air are not taken into account in the calculation of the U-value*
Conclusion

The paper has demonstrated a methodology to determine typical office buildings in Greece for the purpose of energy performance simulation. The objective was to structure a methodology for determining the key architectural features required to create theoretical models that represent specific types of buildings (office buildings) in order to assess their energy performance using a building energy simulation program. With regard to geometrical characteristics, two models were determined, while specific constructions were proposed, based on the analysis of office buildings in Greece.

This methodology refers only to the features required from an architectural point of view. In order for the simulation to be carried out, additional input is required: climate data, internal gains from people, equipment and artificial lighting, occupancy pattern as well as information on ventilation, infiltration and heating / cooling systems. The next step would be to carry out a parametric analysis, based on these theoretical models using a building energy simulation program by varying features such as the windows area, the orientation and several properties of the materials applied.

References


**Figure 1 sources**


Eyes that don’t See: Software Strategies to Build Environmental Awareness in Architectural Design Studios
A software class turned into a reality class

The first challenge for somebody asked to teach software in a design class is to avoid the opinion of people saying: “teach me what the software does”. After this first sentence, often coming from the students (but not only from them) another challenging opinion says: “I don’t need software, I define everything on my own, I might use it, but it is not essential to me”. In the first case, software is supposed to do something on its own: “It does this for me”. In the second case, software is unessential, it’s something that just reflects something else, that happened before its introduction.

Both cases are missing an important point, that we have attempted to address with one course at Roma Tre University between 2011 and 2013. The pre-existing course title, not chosen by us, was CAAD: Computer Aided Architectural Design. The intention embodied in that definition was to rely on CAD, to stay within the boundary of drawing. Even when 3D models were introduced, it still was representation. The course was a teaching module, of 25 hours, attached to Architectural Design Studios. One module for three separate studios, with a total amount of 220 students.

Our decision when we took over the course was to make a shift towards modeling in a broader sense, and to introduce students to the domain of analysis. In particular we chose to discuss and introduce the question of environment, seen as energy saving, environmental impact and life quality related with comfort of an architectural design.

The link that we found between software and environment was awareness.

It’s not easy to make people aware of environmental questions in architecture: comfort conditions, for example, are intangible. It’s not possible to “see” whether a space is more or less comfortable in terms of temperature and relative humidity: their

Fig. 1
The Installation by Transsolar and Tetsuo Kondo Architects at Venice Biennale.
combination, together with other parameters makes the way we perceive a space very different, and has a great influence on how we perceive space architecturally: it is actually a fully integrated part of it. But students of architecture have a hard time to embed this kind of spatial quality into their projects.

A beautiful installation has been built on this topic at Venice Biennale by the German office Transsolar, together with Tetsuo Kondo architects: a ramp allowed visitors of the installation to move vertically in the beautiful space of Corderie where the team “built” a cloud. Three different comfort conditions were perceived by moving along the ramp but they were also spatially understandable: below the cloud (Cool Dry, 18° 40% RH), within the cloud (Warm Humid, 25/35° 100% RH), on top of the cloud (Hot Dry, 37° 60% RH).

The installation was focused on making people aware of them, to link a different spatial condition with a different comfort condition. Transsolar office collaborated to other similar initiatives, aimed at “open the eyes” of visitors of a space to its comfort parameters and conditions.

In the class we worked on a similar topic: our intention was to “open the eyes” of the students, and make them aware of environmental parameters in the context of a design class, exactly like the installation linked a beautiful space to the awareness of comfort conditions. But in order to do this, we needed to take students out of two black boxes: the black box of computer, and the black box of architectural design.

And our instrument was reality. We will discuss this in the next chapter.

Open the eyes

A lot of commercial software offers energy and comfort condition analysis. Such software is targeted mainly at engineers and specialists, and can offer sophisticated analysis, both steady state and dynamic state, with a great choice in terms of calculation engines and available parameters. An interesting attempt in this domain was done, years ago, with the introduction of Ecotect, software developed by dr. Andrew Marsh and targeted not just at engineers of specialists but open to architects and to students of architecture, in first instance. Significantly, Marsh produced a beautiful user manual, that introduced the reader to all the scientific issues involved in using Ecotect, before starting the introduction of tools and user commands available in the program.

Several instruments, after the introduction of Ecotect, started to interact with it, or learned from its approach, and were evolved accordingly. We decided to go along this culture, and have the students interact with an experimental software, at the time of the class, called Vasari. Our goal was, as introduced in the previous chapter, integration: to put deeply together awareness of environmental parameters, inherently invisible, and their relationship with space, on the contrary purely visible.

Vasari was very interesting for our goal of integration, since it has been expressly developed as an integrated tool, bringing together in one interface 3D modeling and analysis. In fact, and very significantly, Vasari is not a new software, but a true operation of sampling, a combination of pieces coming from two of the major instruments of the wide range today proposed by Autodesk: Revit (parametric modeling), Ecotect and Green Building Studio (energy analysis and carbon footprint).
But introducing an instrument is of course not enough. In chapter 1 we already introduced our challenge, so how to avoid people trying to say: “now I have a tool, that will analyze the design for me”. The instrument to answer this class in our course has been “reality”, let’s see how.

**First assignment: testing shadows**

In the first class of the course we taught the students very few instruments of the software:
- how to set up a location (and consequently a Solar Path),
- how to model a box
- how to turn on shadows.

With these three simple instruments, we asked them to get out of the black box: go in the streets and simply “test” if what they modeled was correct: does the shadow fall, at that time, in the same place and with the same shape?

This simple operation had three effects:
- **Demystify the tool**: we asked the students if they would trust a tool. So why do you trust software, let’s go to see if it really works
- **Learn what a model is**: architects have the tendency to model everything, every single detail. Their instinct would be to do so– with this exercise they have been forced to an abstraction of reality, because they only knew how to model a box. We force them to a selection of parameters
- **Start to look differently**: the same street they walked into many times, the room, the courtyard, the garden they live in, it was looked with different eyes, and brought to a different sight: where does shadow go, and at what times of the day? Why is this happening, just orientation, or maybe also badly designed, located elements?

Everything in class happened online, every student had access to a personal blog, where to put every single assignment, that everyone else would see. So instead of seeing just screen captures, the first assignment showed to everyone the entire city,
and its surroundings: every student brought glimpses of his neighborhood, with the beautiful relationship between the everyday life, captured in photos, and the lucent abstract of shadows captured by student using the perspective tool of the software, as expressly requested in order to get the same result. This means to introduce in an analysis a way of representation typical of the architectural design. You would normally not do perspective views when you “analyze”, since it is considered a separate domain. Many images turn to be beautifully abstract, and that’s why we came in with the reference of Louis Kahn’s drawings of Siena main square, with its “dance of shadows”.

And students, asked about their experience said: “I have to admit I never looked at these aspects alone (meaning isolated): now I can see many things I didn’t notice before”.

Fig. 3
2012 class: 1st assignment - Louis Kahn Drawings compared to student work to show the abstract done by the students when modeling simplified volumes in order to extract the abstraction on solar behavior; Student: Giulia Ronconi.

Fig. 4
2013 class: 1st assignment – All the details and articulation of the facades are not modeled in the first exercise, to have students focus on abstraction and on orientation of volumes. Student: Simona Mazzei.
The evaluation we conducted for this first assignment was based, of course, on the amount of reality that the students were able to introduce in connection with their model: the more the comparison in photos, the matching of shadows and time of the day was accurate, the higher was the degree. Secondly, how much the exercise stimulated some reflections: some students, aside from matching what requested, started to notice which streets are always in shade, which ones get more sun, what happens in the courtyards, if there are differences in the apartments, and so on.

**Selecting the elements of a model**

*Details impacting solar radiation: the shading surfaces*

With the first assignment, the students started to learn how to set up a model, and what the model is, the second issue proposed in the second assignment was then what to add to the model: what are the most significant parts of the model, what are the elements of the building that have more impact on sun effect on the building and on the surroundings?

This allowed for the introduction of two elements:

- **Change in scale** - In the first assignment, thanks to the box simplification, students have been exposed to the understanding of the impact of urban location and orientation of the building on its radiation, and nothing else. With this assignment, they add elements and understand if and where they add performance at a minor scale;

- **Identify effectiveness of building envelope shading elements** - Identify what building elements are more effective in changing the impact of sun on the facades such as balconies and loggias that added useful shade on south facades, or on the contrary were useless on northern facades; or such as shutters that didn’t protect that much while some others were mainly decorative, once “verified” in their real impact;

In software, then we introduced the technique to model elements attached to existing surfaces (work planes), and make holes (voids). In this case, though, we also introduced the aggregate effect of sun on multiple days, with the software tool called “solar radiation”.

![Fig. 5](image)

2013 class: 2nd assignment – Details of shading elements added to the “box model” of first assignments; effect of balconies, loggias and shutters on multiple-day solar radiation of facades and glazed surfaces. Student: Eleonora Antonucci.
With solar radiation, students had to understand the cumulative effects on the building facades of the sun, and the combined analysis of winter and summer, enhanced by the introduction of loggias, balconies and cantilevers. Their shape, length and depth change their impact if in summer or winter season. Evaluation of this second assignment was based, mainly, on the amount of thinking applied by the students to the analysis sensitivity on selection of elements (less but well chosen, better than “modeling everything”), sensitivity on quantitative aspect, aside from the expressly requested qualitative (the software changes the color scale automatically, but careful students used the same settings to compare intensity, by applying the same scale to winter and summer analyses).

**Back on the site**

**Investigate effects: the introduction of the ground**

With the third assignment, the students were asked to go back on site, and investigate effects, “open their eyes” again, this time with the glasses given by the newly introduced tool of solar radiation. We asked the students, this time to try to identity effects on the built environment of different solar radiation conditions, identified already in the second assignment. With this assignment we introduced another element, since we asked the students to model not only the buildings but introduce another solid object to represent the ground. In fact, by representing the ground it was possible for us to introduce as key elements to investigate:

- **vertical surfaces: humidity and degraded plaster surfaces** – completely or partially shaded surfaces might show some signs of degrade or visible humidity;
- **horizontal surfaces: the ground** – grass, vegetation and different humidity conditions can highlight effects of the radiation on the ground;

Not all students were able to identify clear effects of different radiation, since conditions, finishing, age of their investigated buildings were very variable, but among the learning goals the issue of ground was successfully introduced, since streets, gardens, courtyards were finely analyzed by the majority of the class, providing another addition to the environmental awareness aimed by the course.

Fig. 6

2013 class: 3rd assignment –Details of solar radiation analysis of the ground. Green areas that work are placed on most irradiated portions of the ground. Student: Walter Menin.
Selecting elements of the model. Vegetation as solid objects

With the third assignment, the students were asked to go back on site, and investigate effects, “open their eyes” again, this time with the *glasses* given by the newly introduced element of the solar radiation. In the fourth assignment, we went back to the topic of the elements of a correct environmental model, through a necessity raised by the previous work conducted. The majority of students were unaware of modeling the environment with a focus on energy but once introduced to it, they found that their shadows were inaccurate, by modeling just the buildings, as they would normally do in Design Studios.

A very bad habit in Design Studios is the one that sees trees as generally added in rendering, or worked out in photoshop images. But trees, as students came to realize during the course, have a strong solid presence in space, and change not only the shading conditions, but its perception, its understanding. We asked them not to choose just a species, but to identify one particular tree, take as usual a photograph, and then try to model its envelope, or, better, its “shading shape”.

Again, this was a simplification of a very complex task, since modeling a tree in all its complexity would require iterative and sophisticated procedures. By having to model them, they had to first, understand the dimension, and another surprise came: many students were highly surprised to find dimensions up to 18 meters, and huge volumes. Rome is a city were trees play a great role in the shape of many streets, their choice was considered an integral part of architectural design by many Roman architects, but students were hardly recognizing them as contributors to their everyday urban landscape. Again, their eyes were opened, and the emergence of such topic got a great interest by Design Studio professors.

Significantly, even if rough, the “physical tree” added a necessary element to the composition. After its introduction, the feeling in student models was that “everything was finally there”. All the necessary elements were ready to provide a complete evaluation in the following assignments.
The interaction with design

With the 5th and 6th assignments, the course had to face the issue of applying what learned by a constant verification and observation on-site, to a completely abstract application, meaning the verification of the design being developed in parallel in the Studios.

Fig. 9
2013 class 5th assignment – generation and evaluation of alternative design schemes and their evaluation in single moments (shades) and on the overall thermal effect (radiation). Students were encouraged to reflect. Student: Stefano D’Uffizi.
We decided to establish the same sequence followed for the analysis: first we asked for a location of just volumes in the area of intervention, also to address the issue that the parallel Design course didn’t reach a point of starting the design yet. But we forced the students to generate three alternative layouts, in order to use the assignment to explore the area and judge its possibilities in terms of optimal radiation. By coming before, or in parallel to the first design exploration in the studios, analysis finally could become an input, rather than just a validation moment. This part used what learned in the 1st assignment.

After this step, the Design Studios projects advanced in their development, and therefore other constraints in building location came. At this point, with the buildings more or less “fixed”, we asked the students to introduce the articulation of the volume and the addition of shading elements, possibly through the articulation of the volume itself. They could fully use the experience of our 2nd assignment, then. This was teaching them that despite their new awareness not always the building location and orientation can respond to the optimal solar radiation, but that other measures might be used. Therefore loggias, balconies, openings are introduced and “tuned”, according to the internal layout of apartments, being done in parallel in the studio, and to urban image.

Conclusions

As mentioned in the introduction, this course involved 220 students of the 3rd year of the Bachelor Degree in Architecture, belonging to three different Design Studios, working on residential projects on different areas and overall dimensions. The course had a total amount of 25 hours, meaning 12 classes. Given, these premises, the accomplished results are satisfying. We adjusted along time the course structure: we started in 2011 doing both radiation and thermal analysis, including a final comparison of projects, but it resulted in being too much information to be structured and controlled by students. Therefore this paper shows the structure of the 2012/13 course, where the decision was to reduce the field and focus on a deeper understanding of radiation and its control, using orientation, shading devices and vegetation, for buildings, but also for the ground the open spaces. So thermal behavior is included, but as a side effect of radiation, in this case, where even in design studios, materials are not treated as a key element or decision.

From this experience we can identify two factors that we found successful.
The first is **sharing** – we obliged students to post their work on the course web portal, evaluating directly their work there. This means they had to provide a documentation of their work, instead of posting just the digital model by itself: crucial to avoid egoism and to have students closed into their black boxes. Therefore we could evaluate and promote their ability of synthesis and writing clearly their intentions, useful to introduce them to the scientific context, and also providing a glimpse of the collective thinking typical of the network culture. All the work was available online to students and to the digital community working on similar topics and so is at the time of this paper writing. Even trees and materials are all available for download, and references were available along the course, provided by professors, but mainly by other students to their colleagues. And finally, only an efficient, digital management can handle the numbers this class requested. Students were the exposed also to the use of such a complex systems, based on Google Apps for education.

The second aspect is **not leaving software alone** – we attempted to demystify software as much as possible through on site investigation, and we think it worked, but we ended up unexpectedly with the larger results of students getting a better awareness of the urban context of the city, of its trees, of its streets, even through the environmental key. And their awareness was the bridge with the Design Studios: they were opposing to the design professor advices some environmental considerations, since they had the chance to see the two aspects as one and the same: changing a building figure. Even if the final projects of the Studios had to accept some compromises, the students were ambassadors of integration, talking with their design professors, and raising all the proper issues.

And if a good question is part of the answer, we accomplished a good point for environmental awareness in architectural design.

**Notes**

1. See for instance the building called Edutainment Center Klima Haus 8° OST, located in the Harbour area of Bremen, Germany. The building contains several rooms equipped with systems that simulate very different climate conditions.


3. On the development of Ecotect and the relationship with the use at School and in practice: Marsh, A 2004, *Performance Analysis and Concept Design: The Parallel Needs of Classroom and Office, Between Research and Practice Conference*, ARCC and EAAE Transactions on Architectural Education, Dublin. In particular in chapter 2.3 Marsh addresses the question of a deeper understanding of building physics: “In order to promote and support use of the software described here, it has been necessary to provide more background information than would normally be required for a similar application in another field. This was initially driven by the needs of students and the lack of contact time within the course, resulting in the development of a website providing general information on a wide range of building performance issues. This site required both descriptive and quantitative content, providing users with tables of data and small applets from which material, usage and climate data could be read or calculated.” The website, originally available at [www.squ1.com](http://www.squ1.com) after the acquisition from Autodesk was moved to: [wiki.naturalfrequency.com](http://wiki.naturalfrequency.com) [Last visited August 16th, 2013].

4. Sharing and publication of other student work online has been a crucial factor, since we have been commenting some of the more significant work (not necessarily the best ones) in order
to direct the work that was being done and published between the assignments. Therefore the attention to the webportal was maximum, since students were eager to read and see “what the class wanted” and the source of information was dynamically evolving. This prepares students to a continuously evolving and changing knowledge, such as the technological and digital one, were great awareness is needed in order to stay informed and up to date.

References

Websites
All the class work, student by student, is published dynamically and is therefore entirely available online, including digital sources and files, at the class dynamic webportal: http://design.rootiers.it/tecniche2012/
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“Intelligent Building”
Linking Reality to Architectural Design based on a Properly Modifiable Database
Back to traditions – toward sustainability

Traditionally people built their houses with local materials (stone, timber, grass, fried clay etc.). They tried used building constructions for centuries, so they had enough experiences to develop the most appropriate solutions responding on their surroundings. It was true in case of building shape, functional arrangement, requirements and materials as well. Climate (sunshine, temperature and wind) has a crucial influence on all design decisions and parameters such as orientation, glazing, thermal mass, insulation, ventilation and zoning. The environmental impact of ancient houses was slight.

Traditional built examples in the temperate zone (Hungary)

Fig. 1
Brick walled provincial house.

Fig. 2
Pise walled provincial house.

Fig. 3
Shading system by porch.

Fig. 4
Local structures and materials.

Porches in front of the rooms provide shading in hot summer and appropriate lighting in winter. Roof covering was made of reed or tile, high thermal mass structure of walls was pise or clay brick. (Figures 1-4)
Recently the situation has changed. In the globalized market the building materials are achieved almost from all over the world and we use a huge amount of artificial structures created by the industry. The huge number of Information Technology Building Industry products (CAD etc.) gives architects the feeling that almost any geometrical shape may be physically realized. Consequentially, professionals envision increasingly unusual building types. Houses are more often than not, too complicated and too expensive. Required high level internal comfort is granted by mechanical equipments e.g. air condition, electrical lighting. Functional arrangement and shape are hardly determined by surroundings, but depend on the technical and economical possibilities.

*Built examples of contemporary architecture in the temperate zone*

Huge glazed façades and flat roofs claim high level of air conditioning resulting in big amount of energy consumption. (Figures 5-6) Structures are created of industrial products, not local materials.

Preserving our environment has come to the forefront of our society’s concerns and architects may not be indifferent. “Intelligent Building” could be a path for sustainable architecture seeking to minimize the negative environmental impact of buildings.

What does it mean “Intelligent Building”? One claps lights on, two claps music on? We don’t think so! We believe, that Intelligent Building means that the artificial space we design adapts to its real environment: both in shape and structure. “Intelligent Building” should reflect continuously on surroundings providing maximum internal comfort and at the same time minimum harmful environmental impact.

The research of Ibuchim Ogunkah and Junli Yang on green vernacular building material selection based on comparative analysis of the collected data pointed out that there are significant changes in building performance across countries, given their differences in building code restriction level in the use and mutual recognition of performance of materials, geographical and environmental conditions. They holistically aim to develop a set of useful knowledge bases and structured ‘selection’ systems that will serve as the basis for evaluating such building materials in terms of their sustainability, during the design process of a building project. This research consists of a suggested toolkit of material selection (Figure 7).
Careful consideration of surrounding impacts (climate: sunshine, temperature and wind, soil mechanics etc.) from the earliest stage of a design process can have an enormous impact on reducing subsequent operating costs and protecting our nature. The way we build should be in dialogue and reflect with the local climatic conditions instead of working against them. All over the world there are specific traditional ways of relating to the climate in order to utilize the natural conditions for the benefit of human comfort which could help us to develop a really environmental friendly design method of contemporary architecture.

“Intelligent Building” & Comparative analysis of design aspects

“Building design and construction use significant quantities of natural resources and materials. The building industry consumes 3 billion tons of raw materials annually — 40 percent of the total material flow in the global economy. The manufacturing process of new materials is water and energy intensive and contributes to environmental degradation and pollution. Harvesting, extraction, mining, and processing new materials pollute the air and rivers and threaten ecosystems and wildlife habitat. North America, Europe and Japan consume more than 25 percent of the world’s annual 4.5 billion cubic meters of wood production (Worldwatch Institute, 1991). According to
the Natural Resource Defense Council (NRDC), at present rates of destruction the rainforests will be gone by 2050. In addition, global wood production is expected to double over the next 30 years. Consumption of other raw materials and natural resources continue to accelerate. And the products we select affect the quality of the spaces we inhabit. We spend upwards of 90% of our time indoors in this country (USA), and the quality of air in our buildings has been proven to have significant negative health impacts on us. The choice of materials can improve or degrade our indoor air quality and we can affect that quality through the materials and products we select. In view of these environmental concerns, sustainable design embodies the following goals:

- Minimize consumption and depletion of material resources.
- Minimize the life-cycle impact of materials on the environment.
- Minimize the impact of materials on indoor environmental quality.

*Minnesota Building Materials Database [24]*

Structural selection is a complex and delicate task determined by the immense number of building material options. Likewise, multiple factors (cultural, economical, ecological etc.) should be often considered by the architect when evaluating the various categories of building materials. As a result, these sets of factors or variables often present tradeoffs that make the decision process even more complex. 12

Analysis of impacts, requirements, and structural performances of each design stage can be the common ground of the dialogue between the architect and the experts according to the Performance Based Design method (PeBBu - CIB) 18,16. In Performance-Based Building Design evaluation of each design factors and aspects focuses on demand requirements and on required performance in use. Performance requirements translate user requirements in more precise quantitative measurable and technical terms, usually for a specific purpose. The steps of evaluation process are given below (Figure 8 4).

The order of the performance based structural evaluation steps could not be changed and need to be worked out for each environmental condition (effect) due to the interaction of the conditions.

Efficiency of design process depends on the adequacy of the data applied. Architectural decisions can be correct only if they are based on a comprehensive, real, and up to date and appropriate site-specific local Database.

Fig. 8
Steps and order of the performance based structural evaluation process.
The building elements - materials and components - are arranged on a product oriented building element basis. (Figure 9) Clients may compare and select from structures or materials as they compile its specification. The elements covered are, external walls, internal walls and partitions, roofs, ground floors, upper floors, floor finishes, windows, insulation and landscaping. These extensive catalogues are continually being updated with specifications covering most common products.

Architects have difficulties in choosing the best product from these databases because of the huge amount of elements (one database division – e.g. thermal and moisture protection - could contain more than 10 000 enterprises with their several products!). To compare the data of different products sometimes is problematic because of the different background (standards, measurement methods, units etc.). In these databases there is no information about application of structures and materials according to the local climate conditions.

Computer aided design systems (CAD solutions) make the construction and drawing of building plans rapid and accurate. Projected physical dimensions and surfaces may be changed very easily. Architects have freedom of shaping, modification through computer modeling, contemporary simulation, and calculation methods of reality.

The computer database programs through Database Management Systems (DBMSs) are a ubiquitous and critical component of modern computing. Given these various options, a typical DBMSs needs to be compatible with many different connectivity protocols used by various client drivers. The structure of computer databases are hidden, the architect can use it through the Dialogue Boxes, windows. The storage and access of these data depends on the computer program so these are available only for those clients who have the appropriate software. These databases require the high level awareness of applied parameters (Figure 10).

![Fig. 9 Example of Product oriented architectural database.](image-url)
Sometimes this method results in reductionism replacing the holistic approach because measures of building construction are separated in independent processes and complex, comparative analysis of requirements and product performances in the context of the whole is missing. For example we have computer algorithms for measurement of thermal quality of building envelope (Figure 11) but it does not take into consideration possible contradiction in between of several evaluation fields, material performances (e.g. acoustical and thermal quality and load bearing capacity).

Fig. 10
Computer Database System - Cramerz Database Architecture.

Fig. 11
Algorithm of thermal distribution & measurement interactions.
This seems to suggest that there is a need for developing a systematic structural and material selection system that will enable architects to identify and prioritize the relevant criteria to effectively and accurately evaluate the trade-offs between technical, environmental, economic and performance issues during the construction evaluation and selection processes. Therefore, to enable a structured and more comprehensive approach in the design-decision making process, in order to facilitate the processes of comparing and identifying the best material option(s) across different categories, it is important that the design-decision maker (architect, designer or expert) takes into account several material-selection factors or variables.

The design process consists of the continuous development of architectural idea. The choice of materials is the crucial part of the building value. The material performances should be appreciated on the knowledge of the whole by holistic performance based approach.\textsuperscript{4, 6, 8, 9} First accomplishment of material during architectural design has essential effect on the final realization of the building. But the preliminary plans in scale 1:200 generally consist of only options of materials without structural evaluations according to the architectural envision supposed the choice is easily modifiable during later design phases. It is not true. As the attached figure shows the freedom of choice is the highest in the beginning, because later the decisions had been done earlier limit modifying of particular elements (Figure 12). As the project takes shape and becomes more detailed the degrees of freedom and the possibilities of choosing better alternatives are reduced.

Taking into consideration aspects described above such basic structural, material solutions should be defined from the very first step of design process.

When the framework is established it is need to choose between different structural alternatives.
Sometimes it seems to be complicated as the appropriate database is missing. A Multilevel Site-specific Project-oriented Database (MSPD) system developed from the very beginning of design process could help material choosing decisions. The basic level (preliminary plan) of MSPD could give material suggestion according to the application field (function, site, structural group and connections) taking into consideration the environmental, ecological requirements as well. The next level (permission plan) of MSPD could consist of complex and not only for singular professional purposed, systemized parameters of materials and structures. Required material performances data collection (e.g. density, fire resistance, load bearing capacity, thermal conductivity) should be defined according to the project and standardization. Recently accessible databases are too diverse, data too often are not comparable and do not consist of application parameters. The last level (execution plan) of MSPD could focus on numeric product properties satisfying special requirements calculated by experts (e.g. thermal conductivity value), evaluating the whole complexity of parameters.

The “Intelligent Building” design could really respond on the surrounding conditions based on a properly modifiable Multilevel Project-oriented Site-specific Database (MPSD)], taking into consideration the whole complexity of the building and interaction in between of the effects, requirements and material performances. This method could be used not only in design practice, but in university curriculum as well (Figure 13).
Preventive and remedial measures and decisions should always be evaluated in the context of the whole (holistic approach). Holistic Performance Based (HPB) design process provides awareness whole complexity of technical knowledge for architects. The architects will be able to develop a professional work, based on the data and calculations of the specialists, international recommendations and technical guidelines. By this way the architect will be able to develop comparisons among solutions and develop a self-critic evaluation, regarding his ethical and technological appetencies.

In such a design process the architect can go back to his previous stages and improve his decisions. By “feedback” evaluation in between stages effect on each others the architects can develop the most appropriate solutions (Figure 14). The designers in their practice conclude the design process, while they finally choose a specific design form, technique and materials.

The building construction designing and teaching process as a coordinated set of stages and sub-stages is a more conscious, rational, and theory-based approach. Choices and solutions for specific design problems, which traditionally were taken base on experience or individual thinking, can be now taken basing in technical awareness and attentive to potential alternatives.

This holistic teaching process intends to provide technical knowledge to the students. With such support, they will be able to develop a professional work, based on the data and calculations of the specialists, international recommendations and technical guidelines.

The architect and students will be able to develop comparisons among solutions and develop a self-critic evaluation, regarding his ethical and technological appetencies.

The analysing of the effects, requirements and structural, material performances on each stages of architectural design process can be the common ground of the dialogue between the architect and the experts; as well as this must be the method of the structural education.

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Fig. 14
Scheme of Feedback system.
Innovation as curricula for contemporary teaching of Architecture
Kolossa József

The Practice of Architecture today: internationality, interdisciplinarity, innovation

Before we discuss the possible directions of teaching Architecture, we have to take a look at the state of the practice of Architecture itself for a second since it is the market our students will try to prevail on. In fact we have to glance at the possible futures of Architecture, because the students we start teaching now, shall start their practice in at least seven years from now! But who can make predictions seven years ahead? Surely nobody, yet some unalterable trends are detectable, which we indeed need to at least consider:

• In the last decade the practice of architecture evolved to a truly international business. Even the smaller offices have planning commissions in more than one countries at once. Graduated students who want to find jobs and/or intern positions have to be prepared both professionally and culturally to work abroad. This means sufficient language and wide variety of computing skills, cultural flexibility and also disciplined teamwork skills.

• It has always been clear and obvious, that Architecture is a multi-disciplinary profession. However the complexity has escalated enormously. Even in the case of smaller commissions – not to mention the big ones – the architectural offices have to incorporate formerly unused solutions that shape significantly the architectural design: from the design phase to final completion countless experts and professionals are forming the interdisciplinary group that finally realize the building. In such environment the students have to prepare themselves to interdisciplinarity and flexibility. They have to stay able to quickly receive and process information.

• Architecture has been around for thousands of years, and thus had plenty of time to mature and to evolve. One could think, that there’s very little room for innovation here. However our day-to-day practice shows us different. The development of Architecture is far form finished yet, and in the ever ongoing race for commissions mostly the “innovation-capable” offices flourish – may it be intellectual, spiritual or technological innovation. For this reason a would-be architects shall have the necessary skills and aptitude for innovation.

Teaching Architecture today and a new approach

The several thousand years old tradition of Architecture has established the traditional forms of teaching Architecture. Regardless of countries the basic teachings of Architecture are almost the same: the comprehension of space, of scale, of size, of function; the basic laws of tectonics; urban context etc. But after having transferred the basics, the curricula is somewhat perplexed: How can we teach everything? How could we possibly prepare the students for contemporary practice of Architecture? And maybe most important of all, how do we deal with issues of the changed view of the world of the younger generation?
It is obvious, that we can’t teach everything. It is also obvious, that our times and the “Y-generation” we offer the knowledge to are so much different from any generations before. The young-adults of today are very independent, self-conscious, yet oftentimes feel insecure and lost unless they feel connected. They require attention, they want to feel important and they have a unquenchable thirst for reality. They constantly require – even demand – everything that’s new and ultimately they want to have fun.

The statements above and findings led us to developing a new approach to teaching architecture: we believe, that one of the keys to contemporary high level architecture-education is the institutionalization of innovation. We concluded, that working in innovation-groups may be the platform, where students can have the best options for learning the curricula:

- students can work toward a common goal in teams, they can learn from each other;
- students understand their work to be important;
- inter- and multidisciplinarity is unavoidable;
- creating something new essentially requires the understanding of the existing solutions;
- innovation inevitably leads to something new;
- an innovative project is easily expanded to an international level, leading to connections, and widening the students’ perspective;
- an innovative work-group demands focus, professionalism, and gives routine in a workplace-like environment;
- possible business perspective is appealing to students;
- results of innovation projects lead to new curricula regeneration and knowledge-recycling.

In order to institutionalize innovation in our undergraduate curricula, we introduced a new subject on or Department of Residential Design under the name of Departmental Research. This is a course open for every student regardless of year or previous results. At the beginning of the semester together with the signed up students we discuss, the attractive and possible innovation areas, create the focus-groups, and make a time-table for the semester. The time-span of a semester is really short – only about twelve weeks –, plus our course is only an electable, so we our aim has to be realistic: we only want to professionally start something, not finishing it. We found, that if this one-semester-project-start is successful, the students will continue working on it regardless of credits or curricula! One such project is presented in the last chapter of this paper: Intelligent Building – Intelligent Environment.

**Case study: Intelligent Building – Intelligent Environment**

**A successful innovation project with students**

In Nature vegetation adapts and optimizes itself reflecting environmental conditions: trees for instance grow to a site-specific shape to maximize energy gain from the Sun and to balance the disadvantageous environmental factors.
40% of the world’s energy consumption is done by the energy consumption of the buildings. A very small amount of energy-efficiency improvement on this filed could lead to significant economic savings. A building’s “energetic DNA” is hard-coded in the architectural concept: the possible deficiencies of architectural design decisions can only be balanced by costly engineering solutions. In addition, the planning of building-energetics is not a site-specific in most countries at the moment. Designers and engineers only use coarse, averaged weather data base and building standards, and codes – the microclimate created by the topography, surrounding objects, water, etc. is not taken into consideration. The buildings planned are therefore not optimal: little / too much insulation, suboptimal orientation, suboptimal building geometry, suboptimal solar gain, and unnecessarily large engineering installations (heating / cooling), high operation costs, suboptimal ecological footprint are the results. Therefore, if there were site-specific data for the architects to use, and if these information were embedded into easy to use architectural applications, than energy efficiency could be the part of the focus already in the earliest design phases, thus the buildings “energetic-DNA” would improve significantly, resulting more optimal energy consumption.

So on the Budapest University of Technology and Economics, Department of Residential Design together with students and interdisciplinary partners we invented measuring equipment and software system – called DROID –, which provides site-specific and geometry-specific building energetic-data aiding architectural design. Based on the information retrieved from the database generated by the DROID, we can bring coherent and energy-consumption-conscious decisions already in the earliest design phase. The result is significant energy and cost saving, and last but not least the local, site-specific architectural character may reappear again!

The DROID consists of three parts:

• the measuring unit: a device designed and built, which logs the environmental impacts and data which are critical for building energetics on different planes and orientations.

• the evaluation algorithm: together with building energetics, students and meteorological measurement technology experts we have developed an evaluation algorithm, which clarifies how the data provided by the measuring unit can be applied to actual calculation, resulting an about 20% more accurate site specific dimensioning.

• visualization software: a 3D visualization software has been developed that receives the measuring unit’s data, also reads the architect’s modeled building concept, and performs a simulation which shows, how the building would “behave” in terms of local environmental energy utilization if it was built on the actual site according to the concept. Thus, the architects design flow may become an energy-sensitive process as well, resulting a better “building-energetics DNA”.

Figures 15-17 show the developed design phases:

First phase - measuring site-specific energy characteristics
Second phase - Network and Database
Third stage - Evaluation and design applications
Fig. 15
First phase - measuring site-specific energy characteristics.

Fig. 16
Second phase - Network and Database.
This paper’s main focus however is not the research itself, but the teaching method behind the process: how the students were involved, what they have learned, and how this experimental innovation process has affected their career and their understanding of Architecture.

Back in 2010, we originally opened up sign ups for thirty students to take part in the innovation aimed departmental research. The application list got filled within quarter of an hour. During the first week we formed groups with different focus points: existing measuring methods, existing calculation and simulation methods, possible partner organizations. These groups worked for two months with regular weekly meetings and interdisciplinary discussion sessions. After having narrowed down the actual research focus, we formed smaller groups: application development, programming, engineering, design aspects, measuring system realization etc. These teams worked for one semester under several professors’ supervision. At the end of the semester we had a big presentation and a study trip to Prague. Both the presentation and the trip was fun, with 100% of the students attending.

We thought the project to be ended, but the students insisted - we should push the innovation process forward regardless of working for no credits. This has happened two years ago and since than we have plenty of achievements:

- operating prototype / 2012
- over ten student and innovation competition wins /2011 - 2013
- registered Hungarian patent / 2012
• PCT application / 2013
• proof of concept / 2012
• market research - Convinsive Consulting / 2012
• investment audition - MFB invest / 2013

At the moment a spin-off startup company is about to form – student being partners in it (!) –, and next semester we will recycle the knowledge gained innovation process by starting a fresh new course – Energy Efficient Site Specific Planning. All this done by involving over thirty students!

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Innovative Development in the Environmental Building Design: Design-Based Research
Technological and scientific development, particularly during the last century, has a decisive role in the evolution of the construction industry. The result of this progress has been the dependence of building constructions on climate conditions and, at the same time, the use of heating systems, cooling, air and lighting systems (Jencks and Kropf, 2006; Klotz and Cook, 1974; Lampugnami et al, 2004). All of the above have had a negative impact on the natural environment and the threat of an energy crisis has become more prominent. The realization that each building unit is a system interrelated and bound to the environment, subjected to the various seasonal and daily climate changes, has brought about the introduction of environmentally-responsible building design (Milne and Givoni, 1979; Markus and Morris, 1980).

The University of Cyprus, School of Engineering, responding to the challenges of the environmentally friendly design, established in 2010 an interdepartmental Masters Program in ‘Sustainable Design and Energy Technologies’. The objective of the program is the systematic involvement with the broader scope of sustainability in order to increase the stock of knowledge through research and experimental development (R&D), through interdisciplinary research and education in engineering science disciplines.

The program courses offered; aim at developing critical thinking through the review and evaluation of sustainability issues in the built environment. Moreover, individual courses provide expertise in the field of integrated and environmental design of buildings, covering different construction scales. In addition, these courses aim to offer knowledge in the field of sustainable built environment, based on high energy performance of buildings and the integration of renewable energy systems, having as ultimate objective the improvement of human comfort and environmental protection.

Within this framework, the course ‘Environmental Building Design’ offered by the Department of Architecture during the spring semester of 2011-12 and 2012-13, addresses three thematic directions in particular: bioclimatic architecture, energy in architecture and ecological aspects in building, covering an important part of the multidimensional field of environmental design approach in architecture (Phocas, Michael and Fokaides, 2011). Through the process of the integrated architectural design, the specific course attempts to introduce students from different departments of the School of Engineering to the methodology of environmental design-based research.

Environmental Design in Architecture: The Theoretical Framework

The three aforementioned thematic directions – bioclimatic architecture, energy and ecological aspects in architecture – constitute the integrated object of study in the course ‘Environmental Building Design’. Students have the opportunity to attend a series of lectures on the theoretical background of environmental building design, including presentations and analyses of applied bioclimatic design and energy efficiency buildings, energy performance studies and software simulation of comfort, as well as environmental parameters. In working groups of 4-5 persons, consisting of students from all four departments of the School of Engineering (Department of Architecture, Civil and Environmental Engineering, Electrical and Computer Engineering and Mechanical and Manufacturing Engineering), they have the opportunity to design a small scale building, integrating within it the fundamental principles of en-
environmental building design. The environmental building design aims to connect the theoretical knowledge gained through the lectures with architectural practice.

Parametric analysis of bioclimatic characteristics and energy performance of the building envelope ensures the optimization of comfort conditions and/or energy efficiency. The optimization process refers to the exploration of alternative interventions in the building envelope (geometry, materials, technical systems), according to the particular needs of each functional program. The process aims at environmental improvement of the building’s envelope, in parallel with the architectural development.

In particular, the area of bioclimatic design aims at the optimization of the comfort conditions (thermal, visual, acoustic comfort, and air quality) of indoor spaces (Fanger, 1973; Keller and Rutz, 2010). The bioclimatic design incorporates a series of design principles, including passive heating and cooling, natural lighting, and the improvement of microclimatic conditions of the surrounding environment (Milne and Givoni, 1979; Randall, 1996). As part of the design process, the bioclimatic approach significantly determines the architectural composition – concept, form, function – and construction. The positive contribution of the application of bioclimatic design principles in the built environment is noticeably perceived by the occupants. Quantitative investigation of the bioclimatic design contribution can be performed through environmental simulation, with the use of appropriate software (Ecotect Tool software, v5.5; Desktop Radiance, v.1.02; Weather Tool v.1.10; Remund, Lang and Kunz, 1999).

Designing for energy efficiency refers to the minimization of energy consumption of the building, the use of appropriate technical support systems for air-conditioning (heating, cooling, and ventilation), and, of course, lighting. It also refers to the installation of advanced monitoring equipment for controlling and providing management of the technical systems. Energy design also refers to the installation of systems that exploit renewable energy sources, such as systems that utilize solar radiation, soil thermal inertia, and less often in building applications, wind energy (Randall, 1996; Hegger, Hartwig and Keller, 2012). Integration of renewable energy sources into the building envelope adds value to the architectural design and offers opportunities to investigate and redefine contemporary architectural expression. The investigation and quantitative assessment of the installation of energy-efficient systems can be performed using the SBEMcy, v3.3.d software, which was developed by the Energy Service, Ministry of Commerce, Industry and Tourism, for the energy certification of buildings.

Finally, the materials and methods of building construction constitute an integral part of the design process, with significant contribution to the environmental design approach of the building. They refer to the selection of appropriate building materials to reduce the environmental footprint (carbon dioxide, low emission, and low embodied energy materials), and to the selection of appropriate building techniques that allow the re-use of construction materials of a building (drywall techniques and assembled constructions). Furthermore, the application of contemporary construction systems (double-skin façades and ventilated walls) ensures suitable thermal performance of the building envelope (Randall, 1996). The quantitative determination of the environmental footprint during a building’s life cycle can be performed through bibliographical references (CO₂ emissions, embodied energy) and through software (SBEM-cy, v3.3.d) able to estimate the annual carbon dioxide emissions during the operation of the building. As an integral part of the design process, the construction design and
the design of construction details directly affects the architectural expression of the building.

The parallel investigation of these three pillars (bioclimatic design, energy in architecture, and construction) of the environmental aspect of architectural design enables a holistic approach (Michael and Phocas, 2012). This leads to the improvement of indoor comfort conditions, and to the reduction of energy consumption and environmental impact, thus emphasizing the importance of the integrated design in the architectural design process.

**Environmental Building Design-Based Research**

A number of design projects developed through design-based research methodology within the frame of the course ‘Environmental Building Design’, are presented below. Apart from the integration of environmentally friendly principles within the design proposals, each one of the proposals focuses on the investigation of one or more interrelated environmental parameters and employs them as design-generating elements.

The first design example deals with the investigation of natural lighting in the indoor environment. The use of natural lighting ensure visual comfort for buildings’ indoor spaces while, at the same time, it contributes significantly to the reduction of energy consumption in buildings, while reducing heat gains caused by technical lighting during the cooling period.

A light-weight structure for multipurpose uses of dimensions 10x10x10 m. is taken as a case study. Each of the four façades of the structure consists of one hundred prefabricated removable panels of dimensions 1x1 m. For the purposes of this study, the building is defined as a laboratory space and as such implies high requirements of lighting levels (> 500 lux). The study focuses on the investigation of lighting levels, lighting uniformity, as well as to the avoidance of visual glare. Through software simulation (Ecotect Tool, v5.5; Desktop Radiance, v.1.02), a series of parametric analyses were contacted. Combinations of percentages of openings in each façade are demonstrated, ensuring adequate lighting levels, uniformity and avoidance of visual glare for each of the three daily (09:00 am, 12:00 mad and 15:00 pm) and three annual periods (summer and winter solstice and spring equinox) were examined. The analysis and results of the design-based research are presented in the figure 1.

The second design example deals with the energy efficiency of a small scale building through the investigation of building’s geometry. The energy performance of a building envelope is related to the application of a series of bioclimatic design strategies, which refer to passive heating and cooling. The exploitation of direct solar gains through south-facing openings is the main strategy during the winter period. At the same time, sun protection of the openings through the use of appropriate sun shading devices, enables the reduction of the undesirable direct solar radiation during the summer period. These two, seemingly opposite, strategies of bioclimatic design are the object of investigation in the present study.

An extendable container, which schematically consists of three façades without openings and from of a glazed façade with south orientation, is taken as a case study. The movement of the glazed façade inwards results to the creation of a linear cantilev-
er above the glazed surface, which provides shade and reduces the direct solar radiation. Respectively, the movement of the glazed façade outwards results to the expansion of the glazed surface into three sides (solar space), which maximizes the function of collection, storage and transfer of solar energy to the interior of the building envelope. Energy simulation using appropriate software tools (Ecotect Tool, v5.5; SBEMcy, v3.3.d) allows the comprehensive investigation of heating, cooling and lighting loads, for the different positions of the glazed façade. Moreover, it allows the comparative

Fig. 1

Fig. 2
evaluation of the energy consumption of the building envelope for all the months of the year. This parametric analysis allows the evaluation of the energy performance of the different building geometries and draws important conclusions with regard to direct solar gains (insolation) and sun protection during the entire year. The results of the design-based research are presented in figure 2.

The third design example deals with the optimization of visual comfort conditions through the investigation of an external shading device. As a case study, a moveable pavilion ‘info point’ of dimensions 10x10x10 m. has been used. The requirements of the specific functional program, to host exhibitions and promote information activities, presuppose the existence of large openings, which provide visual connections, as well as the possibility of physical connections with the external environment. Moreover, functional requirements refer to the exploitation of the natural lighting. In order to provide sun protection to the building’s openings an external shading system has been used. This sun shading system consisted of different sun shading elements (fixed or mobile, horizontal or vertical), appropriate for each orientation.

The study focuses on the investigation of the penetration and distribution of natural lighting through the specific shading device. The configuration, geometrical characteristics (width, slope, in-between distance) and materiality (color, reflection) of the sun shading elements have been investigated due to optimization of visual comfort conditions of the info point’s interior. The lighting simulation (lighting levels, lighting uniformity, visual glare) was performed through appropriate software (Ecotect Tool, v5.5; Desktop Radiance, v1.02), for different times of the day and periods of year. The investigation also includes simulation of technical lighting, both as supplementary, as

Fig. 3
well as primary during the night time. The analysis and results of the design-based research are presented in figure 3.

The fourth and final design example presented herein, deals with the investigation of natural lighting in buildings with a central courtyard. The formation of the courtyards constitutes an essential means of passive design in architecture, ensuring natural ventilation and penetration of natural lighting in spaces situated near the central courtyard. The existence of vegetation and water features in courtyards, forms a natural protected environment which shades the building envelope and provides evaporative cooling during the summer period. Beyond the improvement of microclimatic conditions and consequently of comfort conditions, the relationship of the built and the natural environment, also provides a pleasant visual incentive with significant effects on the emotional and psychological state of the users of the building.

The present study focuses on the investigation of the penetration and distribution of natural lighting in the indoor spaces of a building, through the central courtyard. The design proposal refers to a residential building, with a floor plan of 20x20 m. For the purposes of this study, the central courtyard is considered to be the only source of natural lighting for the building's interiors. Through software simulation (Ecotect Tool, v5.5; Desktop Radiance, v.1.02), a series of parametric investigations and analyses contacted, related to the determination of an appropriate position and size of the central courtyard. Upon completion of the above, investigations for two-storey and

Fig. 4
multi-storey buildings, were performed. The study could give important outcomes for the use of courtyards as a natural lighting element in spaces with large depth. The methodology followed as well as the analysis of the natural lighting investigations are presented in figure 4.

**Open possibilities for further investigation**

The design proposals presented herein are related with the environmental investigation of hypothetical design proposals. The investigation is achieved through the use of simulation software programs that allow the evaluation of alternative design scenarios (building geometry, construction materials) and consequently the optimization of the environmental performance of the design proposals. Possibilities for further environmental investigation, in the context of the course ‘Environmental Building Design’, appear in the field of the investigation and evaluation of comfort conditions and energy performance of existing buildings. The evaluation of existing buildings could be performed both through qualitative approach and through in situ monitoring of environmental data (temperature, relative humidity, etc). The parametric investigation of alternative architectural and construction interventions will allow the optimization of the conditions of interior thermal comfort and building's energy performance, ensuring the establishment of an environmental-driven approach in the upgrading of the existing building stock.

**Conclusion - Outcomes**

The investigation of the three pillars that contribute to the environmental approach of architectural design enables a holistic approach to the issue concerning the improvement of the comfort conditions of indoor spaces, reducing energy consumption and preventing environmental consequences (Michael and Phocas, 2012).

The application of the bioclimatic design principles aims to ensure adequate living space and to improve the users’ comfort conditions. The field of bioclimatic design is directly integrated into the process of the architectural design. The alignment of the building envelope with the constant environmental changes and the ability to face dissimilar climatic conditions may constitute the most complex and challenging requirement of bioclimatic design. In the design projects that were presented, the application of bioclimatic design principles has dynamically contributed to the production process of the building envelope and has defined the architectural composition.

Energy design aims to ensure the appropriate technical support of the building and to minimize the use of conventional energy sources. The investigation of the integration of renewable energy sources and technical systems into the building envelope adds value to the architectural design and offers opportunities to investigate and redefine the contemporary architectural expression.

Finally, the construction substance and the materiality of the building constitute an integral part of the architectural proposal, with significant contributions to the issues of energy consumption and CO₂ emissions reduction and thermal protection of the building’s envelope. From this perspective, the environment is recognized as a finite precious resource and conscious limitation of any negative influence on it is at-
tempted. Construction design and the design of construction details, directly affects the morphological expression of each architectural proposal.

In the design projects presented herein, the investigation of architectural composition in parallel with environmental issues – associated with both indoor environment quality and energy performance of the building envelope – ensures the comprehensive environmental approach of built-up spaces, evidencing the importance of integrated design in architectural education. Through design-based research, further primary knowledge has been gained regarding the interrelation of energy efficiency and architecture, which have been complemented by experimentation and innovative development.

Acknowledgements

The research described in this paper is based on the course ARH 538: ‘Environmental Building Design’ offered by the Department of Architecture within the Interdepartmental Masters Program ‘Sustainable Design and Energy Technologies’ of the School of Engineering, University of Cyprus, which developed and supervised by Aimilios Michael, Visiting Lecturer. The author would like to especially thank students for their consent to present the design-based research developed within the context of the course. He would also like to thank Ms. Maria Sanoudaki, PhD candidate, Department of Architecture, University of Cyprus, for her teaching assistance during the spring semesters 2011-12 and 2012-13.

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Innovation in Environmental-based
Architectural Education
through Digital Experimentation
and Construction Workshops
An experimental and innovative environmental-based architectural education approach is described in this paper through a 10-day Timber Construction Workshop organized by the Cyprus Architects' Association in collaboration with the Department of Architecture of the University of Cyprus in the summer of 2012. Architecture students from various universities in Europe, as well as recently graduated architects, participated in the workshop having a first insight into the real scale architectural design and construction development process focusing on a series of environmentally-driven strategies. The thematic framework of the workshop was a parallel investigation of environmental-based architectural and construction design accelerated by digital design processes associated with the development of complex, non-standard geometries as a result of existing environmental and other design parameters. A number of other aspects were taken into consideration in this investigation including the functional usage of the proposal, its architectural expression as well the alternations of its transparency and views.

The introduction of environmental-based principles in a conceptual and construction design process, within an architectural education framework, aims to develop environmental awareness among architecture students and recently graduated architects providing, at the same time, an alternative opportunity for experimentation in regards to the conceptual design of the architectural object under investigation, its development process and its implementation.

Recently, architectural discussion in regards to environmental, technological and design issues has paved the way for an interdisciplinary direction in architectural design education, allowing investigation in different directions including digital design and manufacturing, among others. Architectural design based on environmental concerns focuses its attention on the design and construction processes aiming to enhance students’ awareness and achieve environmentally friendly results. Within this framework, the development of architectural design ideas and the parallel investigation of environmental issues are gradually becoming a fundamental aspect of any contemporary experimentation focusing on sustainable outcomes. Various phases of design and construction development are distinguished, examining environmental issues in relation to conceptual design, prototyping, etc. In all levels of the design process, of conceptual as well as detailed design and construction development, a series of design strategies are taken into consideration in order to obtain results with certain environmental benefits.

To achieve the above objectives the use of new digital design and manufacturing tools was introduced. Latest advances in the computational design field, discussing ‘bottom-up’ design principles as an alternative approach for the development of emergent morphologies, distinguished these from conventional ‘top-down’ strategies where results are predefined and specified from the start. The ‘bottom-up’ terminology originating in biology where the growing potential of natural organisms consisting of individual cells is described (Thompson, 1992), is also applied to other fields of studies in order to describe the construction procedure aiming on higher-level structures through lower-level details (Flake, 1998). Among other disciplines, the ‘bottom-up’ approach may be applied to architecture where the given problem might be broken down into sub problems and then recombined together in a new whole (Rowe, 1987).

This methodology leads to flexible, yet adaptive, forms to be generated allowing a large number of design possibilities to emerge, influenced by environmental or oth-
er conditions. According to this concept, the development of construction modules, that are combined together based on simple rules of interaction and proximity, lead towards the production of complex, yet non-standard, outcomes. The customization of the design results, according to various influences, is achieved through the parametric control of individual units at local level. Similar or other related principles have been used in architectural education aiming to provide students with an understanding in regards to the new digital tools and methods applied, stressing the importance of workflow from digital design to fabrication (Voyatzaki and Papadianotopoulos, 2010; Wiertelarz, 2011). Within this frame, a number of advantages relating to environmental concerns emerge including sensitivity of material usage; for instance, the use of waste objects as raw materials in new design interventions (Vergopoulos et al, 2011) strengthening, at the same time, their architectural and aesthetic possibilities especially within a sustainable design context (Baerlecken et al, 2012).

In the prototype construction stage, appropriate building techniques, as well as construction materials, allow further investigation into environmental-based design and construction processes. More specifically, the selection of appropriate construction materials could minimize the ecological footprint of the structure. Additionally, the life cycle of materials and construction components includes the phases of extraction, production, construction, use and rejection. Among these, the construction phase is of utmost importance, as it can drastically affect the other phases (Anink et al, 1996). The design and construction – bearing in mind their future disassembly rather than demolition – can influence their ability to be reused or recycled. This mode of construction (Evangelinos, 2004; Berge, 2003) is being referred to as ADISA (assembly for disassembly), stressing that the principle that should be followed during the construction phase should aim at the separation of its different layers, the possibility of separation of materials and the use of standardized components made of one single material (monomaterial components).

The different directions mentioned in previous paragraphs might be organized in the following design pillars: the selection of appropriate building materials, the use of standardized construction components and the use of appropriate constructions techniques. A fourth design pillar must be added, which regards to the coexistence of the structure with the installation area, its spatial conditions and views. The aforementioned environmental strategies constitute the starting point of the proposal for an innovative modular construction described herein.

The integrated application of digital design and environmentally friendly construction principles under a holistic architectural design approach, allow a number of important issues to be raised opening new directions in environmental-based architectural education, enhancing, at the same time, students' awareness in regards to environmental design approach in architecture.

**Conceptual design and parametric associative design logic**

In order to achieve the above environmental-based architectural education objectives, the investigation of conceptual, detailed design and construction process concentrates on the four pillars described in the previous section. These are used as the starting point for any decision made, either in the design or construction phase, aiming to develop a utilitarian architecture construction system.
Focusing our thematic framework on the idea of developing global results through local interaction of a large number of identical elements, the use of individual standardized components that are produced, replicated and arranged in space following environmental-based principles is discussed herein. Students are asked to initially investigate design possibilities based on the above principles, aiming to come up with a final design idea that can be materialized in 1:1 scale. In the conceptual design phase, a combination of sketches, physical prototypes and parametric associative design software is used as a tool for experimentation, design development and representation of design ideas. In more detail, the experimentation starts by introducing and discussing ways of using and synthesizing standardized components from one single material as a decision made at a preliminary stage, leading towards low cost outcomes capable of positively affecting environmental concerns. Within this frame, morphological results are evaluated in accordance with their ability to adapt their form based on site-specific conditions. These are developed taking into consideration their coexistence with the given area, their function as a social gathering point in the camp area and finally their ability to serve as a shading devise allowing, at the same time an unobstructed view to the sea. A number of results are produced and discussed which direct the design development strategy (Figure 1).

In a later stage, ideas and different conceptual design directions merge into a single final solution for further investigation and realization. Specifically, final decisions are made in regards to the individual standardized component’s morphology that is specified in the form of a cube with specific dimensions and two opposite sides opened. A number of identical cubes are arranged in the overall system using local rules of proximity and rotation between individual units allowing overall results to emerge. Their initial investigation is achieved through manual calculation and conventional digital design approaches. Using CNC laser cutter, a scaled-up prototype is developed in order to specify the desirable morphology, the static behavior as well as a first attempt to define the construction procedure (Figure 2 and 3).

In the refined stage, observations in regards to the physical prototype development are made to specify explicitly the individual components and the overall system as well as their materialization. Due to the system’s geometrical complexity, the parametric associative design software Grasshopper (plug-in for Rhino) is used to enable the accurate design of the whole system, investigating, in parallel, alternative solu-
tions based on specific design criteria and parameters presented in this case study. Through a series of investigations, the final result is digitally encoded defining the accurate dimensions for individual structural components, their position and rotation in space and hence the overall dimensions of the architecture construction system.

This is achieved through organizing the identical structural components in 6 horizontal layers alternately consisting of 17 and 18 units that are arranged and rotated based on a parametrically controlled sine-like series of reference points in space. Important aspects that were taken into consideration include: the static adequacy of the
overall system that is achieved through overlapping of cubes in each layer, the rotation of each individual unit in order to provide view from any position in the camp area and the facilitation of site-specific activities. Figure 4 shows the final parametric result.

In addition, the parametric control of the architectural construction system allows alternations in lighting and shadow effects as a result of densification and dilution of unit elements. At the same time, the given geometrical status provides the potential for its habitation by the users consisting a utilitarian landmark within the camp area.

In regards to the environmentally-driven principles applied, which suggest standardization and local interrelation of individual structural components with each other, the assembly technique focuses on specification of local relations. In this way, the assembly process is simplified overcoming the drawbacks and difficulties which occur in cases where accurate, yet low cost, techniques for constructing complex systems are examined. In order to achieve this, a CNC laser-cutting machine is applied to produce accurate cardboard patterns used as models in the assembly and construction stage. Specifically, two types of patterns are produced, the pattern for the construction of standardized components and the pattern for the on-site positioning and rotation of each component in relation to other adjacent components. Figure 5 shows the CNC fabrication steps for producing cardboard patterns used in 1:1 scale assembly and construction process.

**Construction stage**

The construction stage is considered to be an important outdoor activity distinguished from the typical design development process which takes place in design studios or other design courses. Hence, the specific construction workshop aims to strengthen students’ experimentation and experience in regards to construction techniques. In a pedagogical framework, students are introduced to the workflow, moving from the conceptual design and digital development of ideas to the actual scale materialization forming an overall framework of construction development.

The materiality of the design proposal, as well as the construction design and process, constitute significant parts of an architect’s education. The selection of appropriate building materials and the application of contemporary manufacturing technologies, directly affects the architectural expression of the product.

The environmental approach to design refers to the selection of appropriate construction materials. For the specific workshop, the unit components were formulated as cubes made of one single material, marine plywood block boards. The use of wood as a main material ensures the minimization of the ecological footprint of the structure (low emission CO₂, low embodied energy).

In order to further reduce the environmental damage, apart from the use of appropriate construction materials, standardized modular units with dimensions 40 x 40 x 40 cm were used, Figure 6. The appropriate detailed design and the high degree of standardization and prefabrication of the modular units ensure the reduction of the units’ production time and consequently the required total construction time, as well as the embodied energy of the entire project.

Moreover, the reduction of environmental damage involves the use of appropriate building techniques (drywall techniques, assembled constructions). In the specific
structure, the unit components were organized in the system, based on digital geometrical data and information related to their position, their proximity and thus their overall composition in the system. The wooden cubes were assembled appropriately in order to achieve stiffness of the component and hence static adequacy. The development of cubes in vertical direction was achieved through adequate mechanical connecting of the elements (Figure 7). The assembled technique allows the re-use of all used construction materials, which ensures recycling without downgrading of the initial quality of materials.

The application of contemporary construction methods adds value to the final construction product and increases the effect of the contribution of construction design to the enrichment of the structure’s image (Figure 8).

Following the process of design, development and assemblage, parameters equally important and undoubtedly interactive and interdependent, the structure aims at co-existing and inter-connecting space with the users. Through its materiality, it creates spatial conditions that allow the transformation of experiences, interacting with
the natural and built-up environment, as well as with the users in the area. The structure seeks for a new role in space, enabling its interpretation even as a cultural field of activities.

Finally, apart from the above-mentioned environmental characteristics of the structure, it is important to stress the multiple possibilities for architectural expressionism that it presents. The different potential variations of the structure can be exploited as synthetic elements, which can lead to a variety of architectural design solutions. The different combination of the components can create, in terms of the assembled façade design, a sculptural, three-dimensional effect with varying and moving shadows which might provide varying appearances which give the design product an enhanced architectural value.

**Open possibilities for further investigation**

The frame of the particular exploration consists more a development of a system rather than a fixed construction unit product. The principles of sustainable architecture...
are integrated in the design through this basic construction unit. Within this framework, a number of possibilities appear in regard to the bioclimatic characteristics in the construction system under study.

At the same time, apart from the development of the construction system, this process offers opportunities for enriching the qualities of the specific component. The development of the construction unit could facilitate distinct bioclimatic strategies, depending on the requirements of prevailing climatic conditions. Consequently, its dimensions and shape could vary according to the performance criteria set in each case, based on parametric combinations that produce the desired adaptations demanded by the particular environmental conditions. Thus, a whole new range of possibilities and variations of the construction component could emerge based on a bioclimatic-driven approach. Depending on the prevailing climatic conditions, the design of the unit could be adapted to promote thermal insulation, enhanced ventilation, shading or other bioclimatic strategies.

The construction component could be both architecturally appealing and promote the climate-responsive design solutions of the structures to which it will be integrated.

Conclusions

The design development and the process of realization - construction and manufacturing - which are experienced in real terms, show that the individual thematic sections are interdependent with no clear boundaries and with substantial overlaps between them. The works of the particular workshop aimed at the parallel investigation and promotion of environmental-based architectural and construction design supported by parametric experimentation.

The introduction of environmental-based principles - materiality, standardization and construction techniques - in a conceptual and construction design process, within an architectural education framework, aims to develop environmental awareness. At the same time, it offers alternative opportunities for experimentation and innovation in regards to the environmental aspects in the design process starting from the conceptual stage to its development and implementation. In this investigation, a number of other aspects were taken into consideration including the functional usage of the design proposal, its architectural expression and coexistence with the everyday usage of the area as well the alternations of its transparency and views.
The investigation and application of all aforementioned aspects ensures the comprehensive environmental approach of built-up spaces, evidencing the importance of integrated design in architectural education.

Acknowledgements
The research described in this paper is based on the works of the International Timber Construction Workshop organized by the Cyprus Architects’ Association in collaboration with the Department of Architecture, University of Cyprus in the summer of 2012, supervised by Odysseas Kontovourkis, Lecturer and Aimilios Michael, Visiting Lecturer. The Timber Construction Workshop was funded by the Cyprus Architects’ Association and the Paralimni Municipality, Famagusta. The authors would like to express their appreciation to the architecture students and recently graduated architects for their participation in the workshop.

References
The need for environmentally controlled buildings is widely acknowledged in modern societies, and has become a major concern of architectural education in recent years. As a result, a considerable number of courses on bioclimatic or sustainable design are taught in architecture and engineering schools in Greece, both on undergraduate and graduate levels. (Kontoroupis and Stournas-Triantis 1996, Triantis 2005, 2006). Some of these courses search to integrate comfort issues in the design process, claiming that architecture should not be considered as a static “work of art” but as a dynamic environment responding to changing conditions of climate, place and use patterns. It follows that the design process should be based more on the experience of architectural space, both from the point of view of the architect and the user, than on geometric and formal aspects (Triantis et al 2004, 2005). Moreover, the analysis of environmental parameters in this holistic approach to sustainable design, should be based not only on performance assessment, but also on the combined evaluation of thermal, visual and acoustic comfort for building occupants (Triantis et al 2006, 2007). As a general rule, however, various design principles and techniques, mostly concerning single environmental aspects, are considered in building practice and research, often independently of each other (Tsangrassoulis et al 1999, Hossam and Holoszyn 2004, 2005, Sotiropoulou et al 2009, Ibarra and Reinhart 2011, etc.) This occasionally results in awkward situations in which, designing for comfort with respect to one environmental aspect, may be at the expense of another; for instance a building oriented to the South may have full benefit of bioclimatic parameters, but this may be at the expense of acoustic comfort, should a noisy traffic artery pass along its Southern façade. Surprisingly, however, there have been scanty efforts in modern literature, to investigate integrated design principles and techniques capable of satisfying combined environmental requirements. Such a tendency in environmental design would certainly contribute to cost effective buildings, improved comfort for the user, and a more holistic approach to architecture.

The aim of the present study is to selectively review some basic environmental design principles concerning bioclimatic and noise control aspects in buildings. The effectiveness of the reviewed design principles will then be discussed with reference to combined thermal and acoustic performance for the user.

**Review of past work**

A number of studies reported in relevant literature, which investigate design principles satisfying combined environmental aspects in buildings are outlined below. Amongst the earliest studies in this area, is the work at CSTB in the early 1980’s (Auzou et Mathieu 1983). This is an experimental study in the laboratory, investigating the acoustic performance of thermal insulating partitions in buildings. The research demonstrates that considerable improvement of sound insulation around resonance can be achieved, thanks to thermal insulating quilt added to the wall.

Much later, Oral et al (2004) investigated the performance of the building envelope with respect to thermal, visual and acoustic comfort. The authors proposed a mathematical model for predicting the combined effect of the above modes of comfort.

The environmental performance of underground train stations in Athens, has been the object of scientific investigation of an interdisciplinary research team at the NTUA (Triantis et al 2007, Sotiropoulou et al 2010). Measurements showed that in spite of elevated noise levels in all cases, environmentally designed stations exhibited...
smooth variations with respect to thermal and visual comfort levels, thus functioning as effective transition spaces between surface and underground space if compared to conventional stations, and contributing to a better integration of underground stations to the city as a whole.

In another research at the NTUA (Ghantous 2008), acoustic and thermal performance of building partitions were compared. This was an analytical work, leading to the following conclusions: i) combination of layers which are either porous or of high density could improve both thermal and acoustic performance of wall partitions, ii) cavity walls have the advantage of satisfying thermal as well as acoustic insulation needs, while saving dead loads, iii) wall thickness, by and large, is proportional to both sound insulation and thermal insulation.

A later study by Savvopoulou et al (2012), investigated the correlation between room acoustics and thermal insulation parameters in buildings. This research proposed an algorithm predicting thermal performance of wall finishes as a function of the reverberation time of the enclosure.

Finally, the contribution of south facing balconies on the combined environmental performance of ordinary buildings in Athens, was investigated in another study at NTUA (Sklavou et al 2013). It was found that balconies are capable of reducing summer solar heat on external building walls by up to 3.5 times, and b. they are equivalent to doubling the surface weight of the external wall. Also, the relative importance of street cross section for low and medium height storeys was demonstrated; thus relatively low street-cross-section was found both to efface overshadowing from opposite buildings during winter, and to discourage deleterious inter-reflections of street noise between building façades.

It is obvious that further investigation is necessary in order to establish integrated building design techniques for combined environmental performance of thermal and acoustic parameters in Mediterranean buildings.

**Method of analysis**

Bioclimatic design principles in buildings are often classified in three groups, depending on environmental features involved, namely: i) building surroundings and layout (location, orientation, form, etc), ii) building envelope fabric and finishes and iii) building infrastructure (heating and cooling systems, mechanical services, energy management system, “noise parfum”, etc). The present paper will mostly refer to i) and ii) above. Furthermore, most design principles reviewed are applicable to multistory residential buildings in Athens of the 1950’s, 60’s and 70’s. This type of building is well represented in Athens, and is mostly characterized of terraced housing with no front yard and narrow balconies. In most cases, design and construction of these buildings involve no deliberate environmental concern.

**Review of environmental design principles and techniques**

**Building surroundings and layout**

- In almost any relevant scientific article, south facing building facades in Mediterranean climate and not only, are considered optimal for bioclimatic purposes (Tsan-
grassoulis et al 1999, Papadopoulos et al 2008, Axarli 2009, Tzouvadakis et al 2010, Leon et al 2012, etc.). By contrast, noise protection design is independent of solar orientation of buildings; in this case, orientation with respect to environmental noise sources becomes important, and it is recommended that main building façades are turned away from noise sources (Berndt et al 1967).

The above considerations are important in town planning, i.e. in designing street direction in relation to residential terraced housing, the main façade of which is also noise sensitive, and needs to face a quiet urban sight.

• The building location within the land plot, allows for control of the street cross section by means of locating buildings in recess with reference to the street border.
The bioclimatic and noise control merits of relatively wide street-cross-section have been demonstrated in earlier studies (Sotiropoulou et al 2009, Sklavou et al 2013) some of which are outlined in “Review of past work” above.

Modern Greek Building Regulations (1989) concerning urban areas with dense population, acknowledge the merits of such street-cross-section, and give the designer the choice to allow for a front yard. As a consequence, many urban buildings over the last two decades, have taken advantage of this, therefore contributing to environmental upgrading.

- It has been demonstrated that the façade form, can play an important role in noise protection (CIRIA Report, 1986) and thermal performance of buildings. For instance, staggered row or terraced housing is capable of shielding some windows from noise (“noise barrier” effect), while maximising the surface of south facing apertures, therefore improving thermal performance (Figure 3). Recently revised Building Regulations in Greece (1985) allow the designer the freedom to use any façade form.

- Recent research, as briefly outlined in “Review of past work” above, has demonstrated the importance of south facing balconies as an effective tool for combined environmental control. (Sotiropoulou et al 2009, Sklavou et al 2013) This has been an important element in Mediterranean architecture and continues to be used, especially in new multi-storey residential buildings all over Athens.

- An extension of the concept of balconies on building façades is the use of awnings. This is a non rigid and flexible facade accessory, the bioclimatic performance of which is comparable to that of balconies. Moreover, awnings have the advantage of achieving various tilts, therefore providing relatively improved solar protection. Awnings are insignificant, however, regarding environmental noise protection.

- Vegetation. As demonstrated in relevant research (Tzanakaki 2011), evergreen trees located on the North side of buildings, can inhibit deleterious northern winter winds. In the same way, deciduous trees planted on the South side of buildings, can control excessive solar radiation during summer, and allow winter sun to penetrate the building. The concept of vegetation as an effective noise barrier, requires that vegetation be dense and occupy a land zone of considerable width; for instance, a width of 10 meters, can achieve noise attenuation of 1.5dBA (Egan 1972). Unfortunately, this is rarely the case in urban buildings in Athens. An extensive application of vegetation can be seen, however, on South facing balconies as well as on roofs. The former plays a bioclimatic role as explained above; yet roof vegetation can also improve local thermal microclimate in the summer, and contribute to sound and thermal insulation of buildings.

- The use of water as a part of environmental landscaping (water pools / fountains etc.), can be beneficiary for local microclimate in the summer, since judicially planned elements (water pools, fountains etc.), may contribute to lowering local environmental temperature, provided there is recycling of water. Also, the “white noise” which is naturally associated with the sound of moving water (fountains etc.) can occasionally be useful as masking noise. Water pools unfortunately are currently heavily taxed in Athens, despite any effort being made to improve bioclimatic performance of buildings.
• **Noise barrier effect.** Considerable noise protection can be achieved by using, for instance, less noise sensitive buildings of considerable height between a noisy street and residential buildings (Berendt and Corliss 1976) (Figure 4). However, such an arrangement may be at the expense of bioclimatic amenities. For instance, a relatively high building, which is beneficiary as a noise barrier, may cause overshadowing of the building behind. A way around this, is to choose low rise buildings facing South and away from the noisy source.

• The principle of *buffer zoning*, when applied to *internal building layout*, can be effective concerning noise protection as well as energy conservation (Figure 5). Buffer zoning comprises spaces less sensitive in terms of thermal and acoustic comfort, such as kitchens, bathrooms, utility rooms, stairs etc.; when properly located, such spaces can protect more sensitive spaces from adverse environmental conditions, provided that quiet and thermally advantageous side of the building concerned are on the same direction.

• For best protection, *apertures* need to be *minimised* on the noisy side as well as on the windy and less sunny (northern) side of buildings (Figure 5). It follows that in...
case noisy urban streets are oriented vertically to south facing facades, the latter can enjoy the benefits of large openings away from environmental noise. (Figure 1).

- In addition to the general principles discussed above, special design techniques or systems have been developed to enhance particular aspects of a building’s environmental performance. Some of these are outlined below:

The lighting shelf (Figure 6), located over south-facing openings, eliminates glare from direct sunlight and provides the space uniformly with diffuse sunlight. This device, owing to the way it works, can be applied only to façades without balconies. The noise protection significance of lighting shelves is comparable to that of shallow balconies, which were discussed above.

Ventilation/lighting wells are features widely used in Mediterranean architecture, mostly in order to provide natural ventilation and daylighting for interior spaces in urban multistory buildings with no access to building façades. There are several drawbacks to their efficient performance, however, such as inadequacy of daylighting, and cross circulation of polluted air masses between adjacent flats using common ventilation well; also, such wells can be cross paths of noise.

A descendant of the classical ventilation/lighting well is the ventilation shaft, (Figure 7) which has been conceived in the context of modern bioclimatic architecture. This feature is individual for each residence, and allows for natural ventilation of interior space without the need for opening windows, therefore contributing to less environmental noise penetration. Nevertheless, ventilation shafts are likely to create noise at discrete frequencies, owing to the air flow through the relatively narrow cross-section of the shaft. A way around this, is to use absorptive lining on the inside boundaries of the shaft (silencers); the same applies to solar chimneys which will be described further below.

The form and cross section of each air duct are important in order to optimise air flow in a natural way. Natural air flow can be boosted by an electric fan, if necessary; the latter could be a problem should the associated machinery noise not be damped. Ventilation shafts can also contribute cool air down to the interior space, in summer; for instance through the combination of wind intake and water evaporation.
Solar chimneys (Figure 8) are designed as natural coolers and ventilators of indoor spaces during the summer. In particular, this device is capable of warming up air masses, since the top of chimney is exposed to the open air and oriented to the south. It can thus absorb solar heat and boost air flow by convection, so that warm air flows away from interior space through the chimney.
Building envelope fabric and finishes

• Amongst classical ways of improving thermal insulation of external building envelope is the use of heavyweight cavity walls with thermal insulation in-between, which is also capable of achieving satisfactory sound insulation (Ghantous, 2008). In the case of existing external walls, a common way to improve thermal performance is to apply, on the exterior of the envelope, a thermal coating finished by thick mortar. This technique is also capable of improving sound insulation performance.

• The Trombe wall (Figure 9) takes advantage of the solar heat gains of a south facing façade. This wall comprises a glass surface at small distance ahead of the external wall; warm air in this cavity flows indoors, through openings at the top and bottom of the wall. Despite of solid thick wall involved, sound insulation of the Trombe partition may be impaired due to the air paths through the wall. One way round this problem is to use absorptive lining (silencer) along this path way.

• Thermal Storage Building Elements. This system involves massive wall, floor or ceiling elements, capable of storing heat; the latter is paid back to indoor space with a time lag, so that a relatively steady room temperature is achieved. Thermal storage elements are used either as part of the building shell, or as internal partitions, and can also be sound proof, thanks to the thick and solid mass employed (Ghantous, 2008), provided that no flanking transmission occurs. In case increased sound insulation is needed for acoustic comfort, however, wall cladding or false ceiling elements should not be installed in contact with thermal storage elements, so as to allow free coupling of thermal mass to the interior space. Additional surface mass should be used instead in this case. Moreover, if internal noise should be abated, absorptive cladding ought to stay away from room boundaries for the same reason (Baker and Steemers, 2000).

• Glass house. A variation of the Trombe wall is the so-called “glass house”. In this case, the air gap between glazing and solid wall is vastly enlarged so as to create an entire space (Figure 10). This type of construction is not unusual in old apartment houses in Athens, where open-air-verandas have been converted into “glass...
houses” for a number of reasons, such as improved sound insulation, increased inhabitable space and improved thermal performance of the exterior wall.

- Recent research at NTUA (Tzouvadakis et al, 2010), has put forward a versatile tile (Figure 10), which can be used as an external wall finish on south facing façades; this tile functions as an “intelligent skin” which, depending on season and needs, can provide heating, shading, cooling, electrical energy etc., to the building. The tile comprises louvers fixed on a glass surface located at a small distance ahead of a thick and solid external wall. The solid wall allows for air-flow in same way as Trombe wall. During winter the system operates as a Trombe wall. The underside of the louvres is porous and is moisturised during summer, through a water supply system; evaporation, in the near vicinity of the louvres creates cooling of glass which is then transmitted to the air gap between the tile and the solid wall; this, in turn cools inside space through air flow. The louvered nature of this tile can possibly improve attenuation of road traffic noise along the building’s façade. This is an innovative tile which is still being investigated.

- Façade glazing and accessories: Classical ways of improving thermal insulation of window glazing include, first, the use of double glass pane with air-gap in-between, and secondly, the use of airtight seals. Both these principles can ensure thermal as well as sound insulation. In case openable windows are used, however, there should be detailed designing of appropriate window openings, in order to reduce transmitted sound and provide sufficient air flow for natural ventilation (Baker and Steemers, 2000).

More recent techniques include the use of thermal-discontinuity frames as well as special thermal-proof panes. The former is based on the principle of thermal discontinu-

Fig. 10
Example of glasshouse.
ity, and is independent of the sound insulating performance of the frame. The special thermal proof pane is capable of diffusing sunlight but it is relatively less clear than common glazing (transparency 45-80%). This is a kind of laminated glass (triplex), and has extensive applications in building façades, in residential as well as commercial buildings, whenever large glazing is employed. Special thermal-proof panes could be revised in order to improve also their sound insulation around resonance. This can be achieved by way of analogy to laminated sound proof glass, of which the middle layer has relatively low modulus of elasticity.

A common bioclimatic accessory of facade glazing is *louvered curtains (blinds)*, with either vertical or horizontal louvers; unlike ordinary net curtains, blinds can be adjusted to control incoming sunlight. This device is independent of sound performance of the window.

**Conclusions**

The above review has demonstrated: i) that a number of common environmental design principles and techniques exist, which refer to distinct environmental aspects, such as the principle of buffer zone which applies both to bioclimatic design and noise protection design, ii) environmental design techniques can successfully combine bioclimatic and noise protection aspects in most cases, provided that certain conditions are fulfilled, such as, for instance, the location of a south-facing building façade on the quiet side of a building. iii) Integrated environmental design systems concern a wide range of building features and accessories, such as building surroundings and layout, building envelope fabric and finishes etc., which should be further investigated.

This work illuminates some of the ways environmental design techniques can be combined effectively, thus contributing to cost-effective and comfortable building design, which is called for, in the current world of environmental pollution and crisis. Furthermore, this concerns architectural education and research, and could be a source of inspiration for integrated architecture in the 21st century.

**Acknowledgments**

Gratitude is expressed to professors S. Simopoulos, rector of the Tech. Univ. Athens, Hel. Maistrou, Dean of the Sch. of Architecture, and D. Papalexopoulos, Head of the Division of Architectural Technology in the Sch. of Architecture, for their support in our work. Part of the present results have been produced in the context of Diploma thesis of student A. Sandalakis, in the Tech. Univ. Athens.

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Zero Pentathlon:
a Holistic Environmental Design Assignment
Inspired by, but also as a criticism on the Solar Decathlon, which is an international competition for students in architecture (US Department of Solar Decathlon; SD Europe Solar Decathlon), the Zero Pentathlon design assignment has been set up at our faculty two years ago. As many other schools of architecture worldwide, also our school was interested in participating in this international competition in the U.S. or in Europe, as a way to offer the students the experience of designing and executing a zero energy solar building in an international context. However, the intuitive reserve to actually participate was strengthened after reading Precedents in zero-energy design by Michael Zaretsky (2009) in which he criticizes the goals of this competition in view of a broader environmental context. The lack of attention for passive design rules, the paradox between designing for local climatic conditions versus in situ evaluation during the competition week for the climate of Madrid or Washington, the focus on new construction solely and the huge ecological footprint related to the logistics of transporting the actual building and the team to the competition site (and back after the competition week) were the catalysts for not participating, but instead developing a new environmentally improved design assignment.

This paper first describes the concept and set up of the design assignment. It then discusses the concept of the computational design support tool, developed at our faculty, and the role it plays in the design assignment. Subsequently, the outcome of the designs is presented, followed by a description of the evaluation of the assignment by means of feedback sessions and surveys. Finally the results of this evaluation, with a focus on the role of the computational design tool are discussed and conclusions are drawn.

Description of the design assignment

Concept of the assignment

The problems of climate change and depletion of natural resources are a huge challenge for our society and also architects have a responsibility in this. Due to the extremely long lifespan of buildings compared to other goods, the impact of decisions by architects during building design is very large. Therefore awareness and inclusion of this impact during the design process is indispensable for architecture to be responsible nowadays. Up to now many efforts in sustainable architecture were focused on new buildings. However, the existing building stock is very extensive and its environmental impact has been neglected for many years. Furthermore, many of the houses in Flanders, Belgium, built in the ‘50s-’80s are, apart from energy-devouring, also currently underutilized, as these are large houses, occupied by baby-boomers of which the children have left. At the same time, there is the altering housing demand due to the changing family situations (more newly composed families, more singles, more aging people and people in need of care). Therefore, instead of looking for sustainable concepts for new buildings, more attention should be paid to the social and ecological improvement of the existing building stock.

In this context, the Zero Pentathlon design assignment has been set up since two years for our master students in architecture. Aim of the ‘competition’ is to redesign an existing large single family house into a multi-family house. The final design is evaluated on 5 criteria (therefore called Pentathlon): 1) net zero energy consumption for
heating and domestic hot water, 2) ecological water management in and around the house, 3) ecological material use, 4) good architectural and functional qualities and 5) good constructional logic. Students are also encouraged to consider additional sustainability aspects (accessibility, land use, food, mobility,...) or to integrate their personal visions on sustainability in the design.

Net zero energy consumption for heating and domestic hot water means for this assignment that the energy needed for these functions should be fully covered by renewable energy produced on site. As the house is connected to the energy grid (gas and electricity), the surplus of renewable energy production during summer can be injected into the grid and recovered during winter, when renewable energy is in short supply. So, the zero energy balance should only be achieved on a yearly basis and the house does not have to be autarkic.

Furthermore, in order to avoid that efforts on energy consumption for heating (for instance by means of large glazing areas) should go at the expense of the indoor climate and create a substantial need for cooling, the risk for summer overheating has to be evaluated too and the need for cooling has to be kept very low. Since Belgium has a moderate climate, it is perfectly feasible to create a good thermal comfort in summer with architectural measures only, without need for an active cooling system.

**Practical set up of the assignment**

Although the Zero Pentathlon design assignment does not belong to the design studio, it is a real design assignment, yet within a theoretical course on construction in the first master year. Students work in groups of 4 to 5 students. They start by searching per group for a detached dwelling with garden, built before the ‘80s in a suburban residential subdivision (predominant typology in Flanders, Belgium). Apart from the 5 criteria, the design program is only vaguely defined: the final design should contain living space for at least 2 households and students are free to choose the type of households and the degree of privacy between the households, depending on the relation between the households. A limited newly built extension of the house is allowed.

The design process is supported by means of expert lectures, visits to pilot projects of zero energy renovation (Wijk van Morgen) and two computational design support tools in SketchUp, specifically developed for energy and summer comfort evaluation during the design phase (Macris et al., 2012; Weytjens, 2013). In order to maximize the use of architectural measures to achieve the zero energy level and to avoid that student should rely too much on technological measures, students have to focus during the first weeks explicitly on the passive and architectural measures to optimize the net energy demand. With the feedback from the computational design tool, they can easily align the architectural concept and the energy concept in an iterative way by balancing transmission and ventilation heat losses and solar and internal heat gains (further discussed).

The assignment spans a period of 9 weeks with 4 contact hours per week and a strict planning scheme in order to guarantee that the design efforts are balanced for the different aspects. Otherwise, students would remain within the conceptual design stage too long, thus risking to neglect some of the environmental objectives. The scheme is established as follows:
- Week 1: introductory seminar on the assignment and approval of the selected dwelling
- Week 2: lecture on and visit of pilot projects of zero energy houses (new and renovation)
- Week 3: in depth analysis of the strengths and weaknesses of the existing dwelling; design of the preliminary architectural concept for the renovation program;
- Week 4: optimization of the net energy demand by only focusing on passive and architectural measures, by means of an iterative alignment of the architectural concept and the energy concept with the help of the computational design support tool;
- Week 5: integration of ventilation, heating and renewable energy systems and control of summer comfort with the help of the computational design support tool;
- Week 6: analysis of material use and water management;
- Week 7: expert lectures on constructional detailing and start of constructional detailing;
- Week 8: constructional detailing continued and completion of the assignment
- Week 9: presentation for and evaluation by a jury of internal and external experts, among which architects with experience in environmental design.

Description and role of the computational design support tool

The computational design support tool has been developed within a PhD research project at our faculty, with the aim to enable architects to perform a simple and quick energy and summer comfort analysis of their design from the early design phases on (Weytjens, 2013). In contrast to many existing energy simulation tools that are developed for specialists (often engineers) and require expert knowledge, during the development of this tool the focus was strongly on the designerly way of thinking and working of architects in order to bring energy performance assessment closer to architects. As research showed that architects prefer simple sketch design tools (Weytjens & Verbeeck, 2010), an energy and comfort evaluation design tool was developed in Excel and integrated in SketchUp. Main characteristics of the tool are: 1) use of a well defined range of default values for U-values, air tightness, system characteristics,… to solve the problem that many input data needed for energy assessment are not yet available at early design phases; however, architects always have the possibility to overrule the default values and define own values; 2) automatic extraction of necessary, geometrical data from the 3D design in SketchUp and automatic transfer of these data to Excel; 3) real time feedback on energy and summer comfort performance; 4) the Excel calculations for energy and summer comfort are invisible for the architect so that he can remain in the familiar SketchUp environment and the design process is minimally interrupted; 5) the underlying calculation models are based on the Flemish version of the EU energy performance regulation EPBD, so that the output directly allows control of legal code compliance; 6) the most important output is visualized in the actual SketchUp building model: values corresponding with legislation are shown in small coloured text boxes (the colour, green or red, refers to the compli-
ance with the legislation) and summer comfort results are also directly shown on the model; more detailed output can be found in the Excel model; 7) no prescriptive approach: different performance indicators are given as feedback, but without prescriptions on what to do to improve the design. In order to respect the architect’s design freedom, the decision on how to alter the design to achieve the goals set is left to the architect. This, however, assumes the architect to fully understand how architectural parameters affect the performance indicators.

As the main objective of the PhD was to develop the framework and the underlying methodology for this design support tool, not to develop a fully functional software tool, the tool, integrated in SketchUp and used by the students is only a prototype, sometimes suffering from the bugs, typically for a prototype. In case the connection between the Excel calculation models and the SketchUp environment did not work well, students could use the calculation models, directly in Excel. The drawback of using the tool in Excel was the manual input of geometrical data, but the other features of the tool (real time feedback, use of default values, output visualization) remained active. Figure 1 shows some screenshots of the SketchUp tool with an overview of the default values (left) and the output boxes (right) (Weytjens, 2013). The Excel file gives also more detailed output on the net energy demand for heating and

Fig. 1
Screenshots of the SketchUp design support tool: overview of default U-values (left) and output boxes with energy performance indicators (right) (Weytjens, 2013).

Fig. 2
Screenshots of the output in Excel: energy performance indicators (top left), net energy demand for heating and cooling (bottom left), contribution of ventilation losses, transmission losses, solar gains and heat gains (centre), summer comfort indicators (top right) and indoor temperature evolution in July (bottom right) (Weytjens, 2013).
cooling, the contribution of ventilation losses, transmission losses, solar gains and internal gains to the net energy demand and the evolution of the indoor temperature during the month of July (normally the hottest month in the Belgian climate) in comparison to the comfort zone. Figure 2 shows an excerpt of the output screen for energy (left) and summer comfort (right) (Weytjens, 2013).

Fig. 3
Overview of the design of group 6 (year 1).
Results from the design assignment

With the help of the design support tool, all groups were able to achieve the goals set for energy and summer comfort, namely zero energy for heating and domestic hot water and an indoor temperature within the comfort zone during the month of July. The tool output also served as a proof of the achieved performance for the jury. For ecological water management and ecological material use, the requirements were less strictly defined. For the assessment of ecological water management, the quantitative indicators were the percentage of water-permeable and water-impermeable area on the lot, and for material use the amount of original material removed, original material reused, recycled material used and new material used. Figure 3 gives an overview of the design of one group of year 1. The sketches on top left represent the original and the final design, with the pink volume being the extension; the graphs on bottom left show the final energy performance indicators; the pictures on top right present the applied material and water management concepts. Figure 4 shows the evolution of the design of a group of year 1, including the corresponding energy performance indicators of the different variants (zero energy is represented by an E-level around 0) (Weytjens, 2013).

Evaluation of the impact of the design support tool on the design assignment (Weytjens, 2013)

In order to be able to assess how the tool was used by the students, they were asked to keep a log book to document the intermediate steps during the design process. Furthermore, the students had to fill in a survey on the assignment and the tool two weeks after the jury. The first year, also feedback sessions were hold with each group of students (in the second year this could not take place due to lack of time).

Although not all groups kept track of their design decisions in a punctual way, from the available data in the log book and the intermediate files, it appears that it is not self-evident for students to fill in the Excel files correctly (in case the SketchUp

Fig. 4
Overview of the evolution of the design of group 9 (year 1) with the corresponding energy performance indicators; left is the original design, right the final design (Weytjens, 2013).
tool did not work well) or to interpret the output data. The architectural parameter that was changed most frequently is the glazing area, often in combination with solar shading. Building compactness was changed to a lesser extent. This might imply that the tool was only rarely used to assess specifically the impact of the building shape. Other parameters that were changed during the design process were the U-values and the systems for ventilation, heating and renewable energy. It was clear that some groups also used the tool to determine the number of solar panels needed to achieve the zero energy requirement. The feedback sessions and the surveys gave more information on the way the students approached the design assignment, their perception of the tool regarding usability and their level of understanding.

The feedback sessions revealed that the tool was considered useful by all groups for the design of a zero energy house. There even was unanimity that it would not have been possible to achieve the goals set without the/a tool. In general, the tool was not perceived as a restriction of creativity, but neither was it perceived as a support for creativity. Nevertheless, some groups explicitly mentioned that they used the tool to deliberately assess the impact of the window area (to find the highest possible window area without causing problems of overheating) or other modifications of architectural parameters. Regarding the output, most groups found the output clear, but at the same time, it appeared that most groups only looked at the overall performance indicators and only a few groups considered the more detailed information on heat losses and heat gains to make determined design decisions. Furthermore, some groups mentioned that they did not always know what adjustments to make and that they used the trial and error approach. A lack of understanding the basic physics behind the energy performance of a building, which is necessary to know how to affect the performance indicators certainly is one of the reasons of this trial and error approach, as became clear from the surveys.

Apart from the questions on the perception of the tool, the surveys also included a general question (only in year 2) to track the students’ understanding of two important energy performance indicators for which the Flemish energy regulation has legal requirements, being the insulation level (called K-level) and the overall energy performance level (called E-level). In a list students had to mark the parameters which they thought having an impact on the K-level and the E-level. Figure 5 shows the parameters indicated by the students for both performance indicators (K-level left and E-level right) (Weytjens, 2013).

The K-level actually only depends on the compactness and on the U-values and areas of the building envelope components (roofs, façades, floors, windows), whereas for the E-level all parameters mentioned in the checklist have an impact. To make a correct interpretation of figure 5, two elements are important: 1) red bars represent parameters that unjustly have been marked on the list by students, but that actually do not have an impact on that particular indicator; 2) 30 students participated in the survey, so in case of a perfect understanding of the indicators by all students, all ‘green’ parameters should have been marked by 30 students.

Similar questions were asked to track the students' understanding of the overheating indicator and the net heating demand (two more performance indicators of the Flemish legal energy performance regulation). Figure 6 presents the results (Weytjens, 2013).
The surveys further revealed that the overall perception of the tool by the students was positive. The students appreciated the use of default values to keep the focus on the architectural design parameters in the early design stage and they agreed that the use of the tool assisted in creating an energy efficient building (Weytjens, 2013). There was no clear agreement on whether the tool had helped to increase their knowledge on energy efficiency in buildings, but half the students did agree that the tool made them more aware of the importance to integrate energy efficiency in their designs (the other half was neutral towards this statement) (Weytjens, 2013). Most positively was the perception of the students about ease of use, simplicity and quick results from the tool (Weytjens, 2013).

Fig. 5
Number of students indicating a certain parameter having an impact on the particular indicator. (number of participants is 30) (MVHR = mechanical ventilation with heat recovery; DHW = domestic hot water) (Weytjens, 2013).

Fig. 6
Number of students indicating a certain parameter having an impact on the particular indicator. (number of participants is 30) (MVHR = mechanical ventilation with heat recovery; DHW = domestic hot water) (Weytjens, 2013).
Discussion and conclusions

In general, the students were very positive about the design assignment, as, according to them, this was the first time in the curriculum that they had to consider these environmental aspects during design to such an extent and also that they had to take into account so many aspects simultaneously. They further agreed on the usability and the helpfulness of the design support tool during the design assignment and admitted that it would have been difficult to achieve the goals set without such a support tool. However, as the feedback sessions and the surveys showed (figure 5 and 6), there still is a strong lack of understanding among the students how the architectural parameters can affect the energy performance of a building. Despite a course on building physics in the 2\textsuperscript{nd} bachelor year, a course on heating, ventilation and renewable energy systems in the 1\textsuperscript{st} master year (both with a very strong focus on energy efficiency) and a course on ecology in the 3\textsuperscript{rd} bachelor year, students appear not to be able to integrate the knowledge taught in these courses into their designs. The understanding of the parameters influencing summer overheating appeared to be higher (figure 6 left). The fact that in most design studio assignments, the energy or environmental performance of the design is never evaluated neither by the students nor by the tutors, might be one of the reasons. Nevertheless, students expressed explicitly their interest in this topic. Hopefully they learn it by doing, once in professional practice.

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Theme 4

Interface: Objective Design and the Human Experience

Environmental designers tend to focus their attention on the physical attributes of spaces, without looking closely at how their occupants will inhabit and interpret them in reality. They appear unable or unwilling to tread beyond an imaginary interface between the built and human worlds. This theme considers ways of dissolving the interface. It asks what means are available for doing that, and whether they would give access to a richer reality which is more inspirational to students.
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The Evaluation of Building Performance in Relation to Users’ Behaviour: Overcoming the Division between Objective Parameters and Subjective Perceptions
Buildings are responsible for more than 40% of energy consumption, the energy situation is critical and the European legislative framework is more and more restrictive; within the European Directive 2010/31/UE and 2012/27/UE about energy performances of buildings, in the frame of the Strategy 20-20-20 and within the European Action Plan for Energy Efficiency (PAEE 2011), Italy requires benchmarking tools and methods that use actual consumption to verify theoretical estimations. The absence of readily available energy use data matched with descriptors for physical forms, indoor environment characteristics, occupants’ use of space and behaviour affects the accuracy of predicted energy consumption at the design stage and prevents the development of transparent and validated strategy for modelling energy use in buildings (Preiser e Vischer, 2005).

A good way to reconcile economy logics with sustainability ones seems to be in the identification of opportunities and pitfalls through rapid feedback. Unfortunately, this seldom happens and the built and human worlds have become separated by an interface that creates an artificial objectivity. In fact if dwelling represents the aim, building is the artificial action men take to transform natural environment in relation to life. The real transition to a green building economy can become effective only overcoming the mere sustainable design (a necessary but not sufficient condition) and aiming for a sustainable dwelling (Boffa et al., 2012).

This discrepancies between operational versus designed performance of buildings is also reflected in the teaching of environmental design in schools and universities: in fact students are accustomed to carry out exercises that often do not take into account the human factor in the buildings they design, as if architecture were not built for those who have to live there.

Furthermore Italy, compared to other European countries such as UK, lacks a suitable benchmarking, aimed at monitoring comparative performances, and Post Occupancy Evaluation protocols, apt to evaluate building performances after a time from their occupancy. In addition to the updating of the legislative frame of reference and technical norms, further commitments become necessary to sustain actions in this sector. The assessment made at the design stage is supported by other certifications, but these tools, rating buildings in classes from A to G, are only theoretical tools, since they refer to assessment by software based on linear equation and stationary state, not taking into account the real actual performance of a building in use (Bianchi et al., 2009).

A Framework for platform development

The research described in this paper, within the Internationalization project: “From design to management: a benchmarking process for the energy efficiency of buildings”, carried out by University Roma Tre (Department of Architecture: Prof. Paola Marrone, responsible, Prof. Lucia Martincigh, Prof. Lucia Fontana; Doctorate of Sustainable Urban Design, XXVII course; Department of Engineering and Automation: Prof. Luca Cabibbo) together with UCL (University College of London, Faculty of Built Environment, Bartlett School of Graduate Studies: Prof. Dejan Mumovic) and AEDAS (Research and Design: Judith Kimpian). This work - still in progress - starts from the English experience of Carbon Buzz (http://www.carbonbuzz.it), an Evidence-Based design online platform, funded by University College London (UCL) and developed by a consortium of partners led by Aedas R&D and supported by other important partners (CIBSE, BRE, RIBA and others).
Using the UK CarbonBuzz as an example, and considering the limits of the English version transferred to the Italian reality, the project intends to develop an Italian Evidence Based Online Design Platform having the aim of:

- analyzing the content and application of the original platform in the English society and legislative body and gathering aspects in common with the Italian situation, in order to make a possible comparison;
- modifying parameters that have no comparison in the Italian legislation and implementing new parameters, which can result more useful to the Italian users of the platform (users of buildings, planners, facility managers, producers, etc.).

The Italian platform aims to become, as it was developed by the Department of Architecture of University Roma Tre, a useful tool for designers and materials’ producers, as well as a valuable support for the teaching of environmental design: by using the platform, students can compare buildings taken as case studies and take indications for new design and refurbishment.

**Analysis of the British and Italian legislation**

After having carried out the analysis of European Directives and their implementation in the member states, the British and Italian legislation for energy was studied, focusing on differences and needs for adjustment.

A fundamental step, to achieve the above-mentioned objectives, is represented by the understanding of the purpose of the data entry in both platforms. In the English platform the purpose is to verify that the emission of CO$_2$, concerning the consumption data calculated at design and in use stage, is lower than a benchmark, set depending on the building category and use, and calculated in CO$_2$ kg/m$^2$/year. In Italy the legislation in the field hasn’t elaborated yet the calculus output concerning CO$_2$ emissions (even though this is an indication present in the new Directive 2010/31/UE). The limits of the present law are defined on the base of the index of Energetic Performance (Epi limit), that is evaluated in kWh/m²/year (for residential buildings) and kWh/m³/year (for non-residential buildings); this index though deals with the performances of winter heating only. Such law requires that the building to be assessed be characterized by an Epi lower than a stated minimal value, defined depending on two basic factors, showed in tables by ranges:

- the heating degree days - HDD (the sum, extended to the days of a conventional heating period, of the daily positive differences between inside temperature and outside daily mean temperature) of the climatic zone, where the building is located (Italy is divided in 6 climatic zones representative of the existing different climates: to each climatic zone corresponds a range of heating degree days);
- the form ratio of the building - S/V (a coefficient, depending on the ratio between S, the surface enveloping the warmed volume and loosing energy, and V, the gross heated volume).

In order to homologate the Italian complex procedure of calculus to the English concept of benchmark and to the EC legislative trend, the Italian version of the platform set the objective of turning the Epi lim, concerning the building input data (estimated
in kWh/m²/year or kWh/m³ year), into the related emissions, measurable in CO₂ kg/m²/year, using the conversion factors of the employed energy (estimated in KWh), on the basis of the used fuel and of the electric factor applied in Italy.

In this way it was possible to create a sort of benchmark for the Italian version too, in order to allow the comparison of the data inserted in both platforms at least from the point of view of unit of measurement.

**Comparison of the two platforms: data structure review**

The English web platform, through a benchmarking activity on design solutions, products and technologies, supports on the one hand architects and engineers and on the other producers and builders, in making choices, being aware of their real contribution to improve the energy performances of buildings. By sharing data on the energy consumptions of existing buildings, both estimated and real, the platform contributes to individuate “proofs” of the real efficacy of design solutions in reducing energy consumptions. Being an on-line application, accessible to everyone by a simple log-in and password, the platform can be used even by people who are not technicians, but just users of the buildings inserted in the database, and thence become a useful tool for getting a feedback as regards the building use and management. This platform is based on a database enabling to make a double comparison: on the one hand to compare, within a sample of buildings belonging to the same category, the electric and non-electric consumption parameters and CO₂ emissions; on the other hand to compare, within a single building, the design data, or those related to the certificates compiled before building occupancy, with the in use data as reported in the actual bills. By this analysis, in a phase of deep study, it is possible to separate the energy final uses and then understand where and how to act, in order to make the considered building or buildings more efficient.

In the Italian version, some changes were made to the input parameters. They concern the translation of the general parameters, but above all the modification or ad-

![Fig. 1](image.png)

**Fig. 1**

Screenshot of a panel of the Italian platform.
justment of the ones that are not consistent with the Italian context, both because of geographical conditions and law differences; finally some parameters tailored to the Italian context were integrated.

In both versions the platform structure is made of two sections subdivided in various panels: on project details and annual energy details.

For the project details, a series of general information in order to locate the building and to understand its consistency (surface and volume) were added (Fig. 1).

In particular, since the Italian regions, being in great part non homogeneous from the climate point of view, have specific laws and have the decisional power on the energy issue (Romani et al., 2011) it has been necessary to add parameters regarding the climatic zones.

In connection with the Italian legislation requirements, it has also been necessary to add a parameter for considering the Form Ratio (S/V). This coefficient, depending on the form and indirectly on the building structure and techniques, is emblematic of the Mediterranean “modus costruendi”, characterized by continuous supporting structures, built with heavy materials and high thermal inertia, taking to more compact and regular organisms, with more controlled dimensions that are to be preferred, in Italy, to the Anglo-Saxon one, characterized by wood frames, with walls in light materials, taking to organisms that are less compact and regular, more extensive. These traditional building techniques are connected to natural sources and of course respond to different climates, and, as it concerns Italy, to major thermal excursions between day and night; their final aim was, and still is, to reduce the recourse to heating, and above all cooling plant systems.

Concerning the annual energy consumption, the main difficulty was in splitting the so-called “energy vectors”, that is to say in identifying consumptions depending on final uses (heating, cooling, lighting, other loads etc.) as in the English platform; in fact, it is usually very difficult to read these detailed values in the bills, since the specific consumptions, electrical or non-electrical (gas heating and hot water) are not shown in dedicated meters. In the scheme below is possible to see the differences between the two platforms (Fig. 2).

**Developing the prototype: creation of a case study database**

The energy performance feedback to be informative needs to capture both building design and performance data; a data collection study was carried out in Rome to identify potential problems in translating English data structure to the Italian regulatory environment.

A sample of buildings hosting some faculties of the University of Roma Tre was chosen; such choice wasn’t made only because of the easier accessibility of information and premises, but also of the greater opportunity to sensitize a large number of people and transform a pilot project into a real service to be offered, as ‘best practice’, to other Universities and public buildings. The work was structured around four key phases.

**Selection of case study buildings**

Six buildings were selected to cover a range of ages, building types and building systems. The buildings were listed in three macro groups, following a criterion related to the current plant system:
a) buildings using non-electrical energy sources for heating with no cooling systems or mechanical ventilation;
b) buildings using non-electrical energy sources for heating with electrical cooling and mechanical ventilation;
c) buildings using electricity both for heating and for cooling (heat pump) or mechanical ventilation.

**Acquisition of data by technical survey**

Information on the chosen buildings were gathered at the University Technical Office, in order to make a baseline of input elements; the data concern: architectural and
morphological features, uses, constructive-technological features, plants, governance of energy performance (Fig. 3).

Some early analyses on design data and data deduced by energy certificates were made.

As part of the data collection the team carried out a series of site visits to verify the information obtained from the desktop study. For having a more complete idea of each building consistence, a comparison among case studies, based on the above-mentioned parameters, was carried out.

**Acquisition of electric and non-electric consumption data**

All the bills for electric energy and methane gas pertaining a reference year (2011) were collected, in order to draw considerations on consumptions and draft a comparison between theoretical data in hand, concerning the project and 2009 energy certificates, and data due to actual energy use. The latter were dual:

- electric consumptions learned from the bills, split per month and time band use (Fig. 4);
- electric consumptions obtained directly from the electric energy supplier, values gathered hour-by-hour for kW supplied every day of every month in the year of reference, for every analysed building (Fig. 5).

These data were elaborated in working sheets and graphics showing the hours and the values for supplied electric energy; the charts concern:

- the trend of energy use and the partition of the different “loads” of various “energetic vectors”;
- every month of the reference year;
- the comparison among four representative months (March, May, June, October);
- a sample week of one winter and one summer month.

![Diagram of Form Ratio for the case study buildings.](fig3)
For methane gas consumption it wasn’t possible to split end uses (heating and sanitary hot water). Moreover data acquired by bills (in m3), in order to be summed to the already mentioned electric consumptions (in kWh), were converted by a specific factor that is proportional to gas heat power.

**Data entry in the platform**

Thanks to the wide-ranging of these analyses it was possible to make a first separation of the final uses and draw some considerations about the energy management of these sample buildings. Afterwards the data were inserted in the platform, where information concerning the case studies can be read both individually and in a synoptic way (Fig. 6). This has allowed to highlight some positive aspects and critical features of the database and platform.
After the construction of the Italian platform and database, a part of the research developed towards the study of users’ behaviour in one of the buildings previously analysed: the Faculty of Architecture of the University Roma Tre. Here, indeed, the topics of energy efficiency and consume reduction reach a great number of people in a short time; both students, teachers and employees can get a sense of responsibility towards more sustainable behaviours in the use of energy sources and work as a catalyst for a low carbon management.

An operative approach more pertinent to the real situation considers that scientific and technical data be combined with occupants’ and users’ opinions and assessments (Gupta & Chandiwala, 2010). The study of their perceptions and behaviours could in fact enable designers and producers to make a systematic choice of solutions and technologies that meet users’ requirements better and, by doing so, induce them to behave more correctly; this could help to reduce the gap between expected and actual building performances, if accompanied by virtuous and positive management systems too (Stevenson & Leaman, 2010).

This operation is based on the use of a survey that can be applied to assess the performance of a building, identify areas needing improvement and provide useful feedback to designers and operators about specific aspects of building features and operating strategies (Zagreus et al., 2004).

The methodology applied is based on the contextual analysis of subjective and objective aspects (Martincigh, 2009). Subjective aspects are connected to the perception building occupants have of the objective situation and existing wellbeing conditions, depending also on their behaviours, more or less conditioned by such setting. Objective aspects are strictly related to the building environment, to its structure, construction, management and performances. The aim is to prepare and apply tools that make it possible to understand the correspondence between requirements and performances and then to identify which aspects need to be modified in order to get people to improve their opinions being more comfortable.
Various tools were adopted: questionnaires for students, professors and employees, to detect both users’ perceptions and opinions, and their assessment of the existing situation; forms to report the results of the instrumental survey, measuring and assessing objective parameters, that is some environmental characteristics of the spaces where the questionnaires were administered; technical files to note specific features of the spaces in question; forms for the observation of users’ behaviours, to be run together with the technical survey.

**Enquiry about users’ behaviour: by questionnaire and forms**

The questionnaire administered in classrooms and offices is aimed at analysing the different typologies of occupants, using the building for diverse purposes and in different times and ways. It is made of two parts; the first contains general information about the interviewees (identification code, gender, age, role) and the context (time, classroom, location). The second part concerns five defined enquiry fields. The questions are formulated in order to point out if users are more or less satisfied with different aspects characterizing the actual situation and how important these aspects are for them. The answers can be expressed by a Likert-type scale, featuring four values in the case of satisfaction: 4 points when the user is “very satisfied” and 1 point when is “not satisfied at all”, and five values in the case of importance: 5 points if the item is “very important” and 1 point if it is “not important at all”; the intermediate points are used for expressing other nuances of evaluation. The questionnaire concerns two different period of time: wellbeing conditions referred to the heating period (November, 1st – April, 15th) for understanding causes of dissatisfaction and consequent physical problems experimented by occupants; wellbeing conditions concerning the time and place (May 2013, classrooms and offices) in which it was administered, for comparing subjective opinions to objective surveyed data.

The five enquiry fields are related to thermal comfort, air change, air quality, natural lighting and environmental comfort; for each one of them groups of questions on satisfaction and importance, related to the two over mentioned different periods of time, were provided for (Fig. 7).

While users answered the questions, the people administering the questionnaire filled in forms, aimed at making clearer the answers given by interviewees and at tracing, in a more immediate way, possible motivations. The forms are organized in three parts: the first reports the same general data present in the questionnaire; the second and third report some notes, consequent to the observation of the behaviours taken by users inside and in the vicinity of the analysed space.

**Survey: by instruments and by observation**

While the questionnaire was administered, some measurements of environmental parameters, likely to be connected to the enquiry fields considered in the questionnaire, were carried out together with some observations of the building.

Environmental parameters were measured using specific instruments: temperature, speed of air, relative humidity and illumination. The form is organized in two parts: the first concerns some general data (time; date; instruments used for measuring and their position, regarding orientation and structure of the building, reported on a map; thermo-hygrometric conditions of outdoor air); the second concerns unit, value, spot of the measurements taken for each parameter.
Meanwhile, an architect filled in a form, reporting the observed technical characteristics of the space in which the environmental parameters were measured, the questionnaire was administered and the users' behaviour observed.

**Data elaboration**

To assess the satisfaction and importance scores given by occupants as a whole, arithmetical means were then used for each enquiry field considered in the questionnaire. Such means were represented in two Cartesian planes, taking into consideration satisfaction and importance at the same time (Fig. 8).

The first reports the assessments on the environmental conditions related to the heating period (when the heating system is on); the second reports the assessments on the environmental conditions as perceived when the questionnaire was administered (when the plant systems are off). This representation of data can be used to grab quickly evaluation changes in the two analysed time periods.

Cartesian planes are subdivided in four quadrants by axes drawn on the basis of the means of the two variables; in this way a customised reference system can be built. The satisfaction level is reported on the x-axis (given the variable range from 1 to 4) and the importance level on the y-axis (given the variable range from 1 to 5); in the fourth quadrant the fields that users consider as not satisfied and important are located. The positioning of each indicator in the four quadrants helps then to understand in which ambit it is more important to act and which are the priorities of action; this allows addressing the issues that are most urgent and relevant for users and then to focus on possible improvements (Martincigh, 2009).

The subjective results drawn from the satisfaction/importance assessments, expressed by the interviewees, of the wellbeing conditions at the time in which the

![Scheme of the questionnaire administered to occupants.](image_url)
questionnaire was administered, were compared with the results of the instrumental survey of the environmental objective parameters measured using specific instruments at the same time: temperature to thermal comfort, speed of air to air change, relative humidity to air quality, illumination to natural lighting (currently this was made for classrooms).

This procedure enables the understanding of congruences and incongruences between perceived and measured conditions and proved to be very useful. It will be therefore deepened to analyse and relate users’ behaviours to their opinions and evaluations, to building and plant system characteristics, measurements and management.

References


More Documentation, less Automation
A strategy of user involvement in domotics at Solar Decathlon 2012
Introduction – Open electronics and the architecture for the “internet of things”

For many contemporary designers, architecture is still about designing static environments. As a matter of fact, designers have to face the emergence of devices and sensors increasingly embedded into buildings that provide dynamic information on its behavior: comfort conditions, energy usage but also user interaction. A full set of technologies is calling for the inclusion in design of these dynamic issues, reacting to house behavior, and therefore pushes the boundary of a domain once confined in the definition of “Domotics”.

Sensors are not new in buildings. Many lights already embed sensors (garden, loggia lights, ecc), many gates, water taps, and many objects that are around us. Even our smartphones have many sensors, but in all these cases, sensors are hidden into their hosts, they don’t look as “building materials” but as parts of components, that can either be included or not in a project, but not shaped. Bruce Sterling helped to foresee a new possibility by describing new kinds of components, that would include an inherent electronic part, called spimes. These newly designed components are estimated to become over 50 billion networked appliances and sensors worldwide by 2020, constituting a vast global network of data-generating devices such as sensors and their URLs, bringing to reality the picture introduced by Sterling for the so-called “internet of things”.

A generation of researchers and designers went along this path in the first decade of 2000s and started to produce projects based on shaping electronic devices. People like Usman Haque and Adam Somlai-Fischer started to directly build and prototype electronic devices and digital spaces, often combining them. They have done some interesting activity together as pioneers of the customization of electronics for architecture in several occasions, such as the “Low-tech sensors and actuators for architects” research, where a series of components were designed as “bricks” of a possible interactive physical space. Or, later, a prototype called “Reconfigurable house”, built on the purpose of not being constrained to one, particular behavior: "constructed at ICC in Tokyo, Japan, and open to the public until March 2008, the project is a challenge to ubiq-

Fig. 1
Two images of the “Reconfigurable house”, by Usman Haque and Adam Somlai-Fischer.
uitous computing “smart homes”, which are based on the idea that technology should be invisible to prevent DIY. Smart homes actually aren’t very smart simply because they are pre-wired according to algorithms and decisions made by designers of the systems, rather than the people who occupy the houses. In contrast to such homes, which are not able to adapt structurally over time, the many sensors and actuators of Reconfigurable House can be reconnected endlessly as people change their minds so that the House can take on completely new behaviours”.

Haque personally launched a web portal built as a crowdsourced data collector from various types of sensors called “Pachube”. The crucial and important point of Pachube is that sensors publish their data over the internet in a community and can be freely interfaced and linked remotely. According to Haque’s description on its personal website: “(…) Pachube is a convenient, secure & scalable platform that helps you connect to & build the ‘internet of things’. As a generalized realtime data brokerage platform, the key aim is to facilitate interaction between remote environments, both physical and virtual. (…) Pachube is a little like YouTube, except that, rather than sharing videos, Pachube enables people to monitor and share real time environmental data from sensors that are connected to the internet. Pachube acts between environments, able both to capture input data (from remote sensors) and serve output data (to remote actuators). (…) Apart from being used in physical environments, it also enables people to embed this data in webpages, in effect to “blog” sensor data”. The Pachube website, launched in 2008, had a great success and growth, and was subsequently evolved into a service called Cosm, and acquired later by big companies (Xively at the time of this paper writing). Adam Somlai-Fischer, originally founder of an office for interactive architecture called “aether architecture” later founded a company for interactive online presentations called “prezi”, now with 120 employees in Budapest. Significantly, both Haque and Somlai-Fischer ended up not developing a “product” but an instrument, an environment, that allows other to produce. In one word, a framework.

In this context, a booming and large-scale effect has been given by the launch of the “Arduino” board, from the initiative of Massimo Banzi. The Arduino board can be programmed to manage inputs and outputs in a custom configuration. It’s an open hardware. It allows, therefore, electronics to be designed with a quite easy programming language, using a normal laptop or desktop computer, connected via USB to the board.

And most importantly for this paper, Arduino was born in a learning environment. Arduino, in fact, started to be applied in 2005 during the classes at the Interaction Institute of Ivrea, a school dedicated to the emerging –at the time- discipline of “interaction design”, a hub of studies in the field where Usman Haque also was Invited Researcher. The School stopped its activity in the same year, due to withdrawal of the main sponsor, but Arduino, instead, started to be industrially manufactured in the same territory and gained soon an international fame and diffusion. Arduino opened up electronics to non-technicians. The purpose of the tool was not to enhance skills of existing technicians, but to shape new generations of professionals, less constrained into professional boundaries.

A great starting point, says its creator Massimo Banzi, is to disassemble and modify existing electronic components installed in toys, lights, or wherever good to find. Just to make the start and the approach to technology as smooth and easy as pos-
sible, and get the first results in few days. Break as much barriers as possible, and learn from practice, from discoveries and play. The word Banzi found for the Arduino way of learning was “tinkering”.

Even the defined “interaction design” domain, loses its boundary when components involved into projects like the ones of Arduino become not just aimed at interactive installation, but use all the hidden electronics today present in the spaces we live every day, like our homes. In these cases, the context of application becomes much larger, and requires a learning space where professional boundaries are encouraged to be open, since each one of them is likely to be extended in an integrated design: for this paper such context was offered by the Solar Decathlon Europe competition.

Solar Decathlon and Med in Italy: a Mediterranean approach to energy efficient advanced houses

Solar Decathlon is a competition, born in United Stated in 2002, that makes University teams compete on the realization of prototypes of advanced and energy efficient homes powered by solar energy. The design and realization of such projects in a limited time span (one and a half year) requires a high level of integration in a fully multi-disciplinary team, involving people with very different background, mindset and, more importantly, age and experience. The base requirement of competition, in fact, is that the entire operation runs around students: they participate to design, engineering, communication, funding, transportation and even physical assembly, on site, of the house.

Fig. 2
Monitoring Section of the Solar Decathlon Europe 2012: temperatures of living rooms are compared during the competition week. Interface allows for the choice of the houses to be compared.
Students learn to stay on the boundary between engineering and architecture during the competition, and understand challenges and flexibility of each field. This happens during design and engineering, but the peculiarity of this experience is that it goes beyond that.

In the Solar Decathlon competition not only houses are compared, but teams are involved, because during the competition they have to simulate the normal life of a house as perfect housewives: cooking, showers, washing and drying clothes are done daily, as well as other activities such as home electronics. All these data are captured in real time, and published online allowing them to be compared. The competition, during the two weeks, establishes a “performance race” on these daily tasks: Who performs better? When? How? How much are we consuming? What are our temperatures? How are we going, compared to others? Why?”

Students have the opportunity to learn by running the house, and this is the aspect that our team, and this paper, will challenge. The Med in Italy team, in fact, decided to adopt an energy strategy based on the highest possible level of sustainability, meaning that the first concept for an energy efficient house is that it does not consume energy, or has the lowest possible consumption. We put a great emphasis on passive behavior of the building, by working on thermal mass, natural ventilation and buffer spaces in order to enhance all the possibilities to get naturally an efficient behavior against the heat.

In one sentence, we introduced all the concepts of traditional Mediterranean house into a lightweight wood construction, easy to assemble and disassemble, with big openings getting into the space the maximum daylighting. All features that would normally not be associated at all with a good passive building for warm climates.

But aside from a special construction and layout of the building envelope, a crucial aspect of the Med in Italy system is, in fact, the reduction of automation, in favor of the possibility for the users to manually perform actions that can impact performance: opening windows for ventilation, turning on and off devices at different times of the day and with different weather conditions and therefore of production, and so on. In Med in Italy, this active role of inhabitants recalls, as in other aspects of the project, the Mediterranean tradition, where a strong passive behavior of the house envelope

![Fig. 3](image-url)  
Interior view of the living room of the Med in Italy house. It includes an exterior patio, to suit traditional typology, but includes big windows and a skylight, features normally not present in traditional Mediterranean homes.
guarantees an optimal performance against the heat, but is combined with a know-
how on how to use the house, what to maintain open and when, when to close cur-
tains, when to ventilate, and so on. Such know-how is one of strongest aspect of that
tradition, where Mediterranean is, above all, a lifestyle.

Our grandmothers knew very well how to “operate” their Mediterranean homes. And
it was instinct, their knowledge came from tradition. In our strategy to bring Medi-
terranean tradition back into contemporary housing we aimed at the active partici-
pation of inhabitants to management of the house energy behavior. In our case, the
students.

The user involvement has been increasingly recognized by several authors and in-
istitutions as being a key factor for energy savings. The European Environmental Agen-
cy (EEA) focused on this topic in 2013 with a Technical Report titled “Achieving energy
efficiency through behaviour change: what does it take?” where an estimation and criti-
cal analysis on the impact of user involvement is conducted using several case studies
including a wide range of measures, going from smart meters to community-based
projects (UK and The Netherlands, initiatives called EcoTeams, CRAGs, Green Streets) to
dress code (Japan, the CoolBiz and Warm Biz campaigns, launched in 2005-2006 that
provided estimated 2.55 million ton reduction of carbon dioxide) and so on.

Very important projects based on smart metering, such as Google Power Meter, or
Microsoft Hohm failed and were both withdrew in 2011. There are many explanations
for the service withdrawal, and other new companies are trying to overcome those
problems, like the U.S. based Opower, but for sure they lacked user involvement.

In the case of Med in Italy the first, and most important step of this involvement
has been information. Information has demonstrated to be very important in several
recent successful experiences of energy efficiency implementation in existing build-
ings. The Empire State Building renovation, for example, has an estimated contribu-
tion from the so-called “Tenant Energy Management” of about $386,709, the 8% of
total savings in the first year. A big portion, considering that the intervention also
included some structural changes to the building systems and envelope.

The Home Automation strategy of Med in Italy is, above all, an information ma-
chine for the team members and the future users. It relies on a web-based system,
where all data on the behavior of the house are saved in order to build up a “timeline”
of house use. We called it the “Dwelling Green Box”.

The Dwelling Green Box: more documentation, less automation

For many technicians, Domotics is about automation: users are “clients” of the sys-
tem, their involvement is not requested at any time, since everything is pre-establish-
ing the behavior of systems at given conditions. Automation is considered the final
achievement of these systems, sometimes expanding also to possibilities of prevision
and learn from practice, but its independency can become very frustrating for the in-
habitants, that have no control and understanding of what happens around them.

The Home automation system of the Med in Italy prototype tries to solve this frus-
tration with a strategy that has been defined a “Dwelling Green Box”, because it ap-
plies to Green Houses the concept of data saving of a black box, such as the one in-
cluded in ships, trains and airplanes.
These data, in this case, become transparent and available thanks to a data flux that is established between a local server with a network of wireless sensors, and a remote database, where data are sent every 15 minutes. Everything is then made available to users over the web, with a complex interface where one can go back in time, and explore the consequences of its actions on the house behavior through different kinds of graph and data visualization. This system gave to the students, a clear and direct understanding of the actual power absorbed by each action or appliance, including HVAC (heat pump and heat recovery unit) and DHW, and the changes in temperature, relative humidity, CO\(_2\) concentration consequent to window opening, people visiting.

Sensors were clearly identified in the rooms as wireless, designed objects, therefore making clear where and how data were captured. After a few days, this direct and clear relationship helped to build a precious awareness. Students knew exactly how much power and for how long each single appliance needed in order to run (for instance the location of power peaks for appliances like the oven, or the relationship between heating power and absorption for the Magnetic Induction Cooktop) but also understood how much time the house needed in order to clean up the air and re-establish a good level of CO\(_2\) (few minutes), while what would it be the drop in temperature when the same windows are open to clean up air, and how long would it take to re-establish the former temperature (much longer).

Almost all these data were “site-specific”, meaning that the width of windows, the orientation of rooms, their relationship, were specific of that house in that location. The understanding of its specific behavior, then, also would give immediate and long lasting benefits on how to use the house. During the competition, the team would then be very good at “adapting” the strategy of ventilation, heating and cooling, cleaning the CO\(_2\), cooking, preparing appliances to work at each single day weather conditions. The graphs of the single appliances, the information on the times required for temperature recovery, were crucial in adjusting the daily strategy of the team, by looking at the data already archived.

Fig. 4
Interior view of the living room of the Med in Italy house. It includes an exterior patio, to suit traditional typology, but includes big windows and a skylight, features normally not present in traditional Mediterranean homes.
The most relevant addition to the system, introduced in Med in Italy has been a 3D data interface to the house, using the innovative standard called WebGL, used among others, by Google and diffused a lot for 3D visualization and videogames online 7.

The Med in Italy model was developed using the Processing programming language but the peculiar aspect of the system has been the link established between objects of the 3D model and data on the behavior of the house. Color and position of objects changes according to values of an online database fed by the local server of the house. By moving along time in the interface, the system gives an “instant picture” of what happened in every specific moment, as well as intervals and total consumptions of that day, or week. The model gives a videogaming interface to the behavior of the house, but the game in this case becomes serious, since it involves performance, and more importantly, is a great source of learning. It provided a playful space, instead of a frustrating object.
New users for new homes: learning from housekeeping

This active and adaptive role of the students has proven to be very successful in the performance of the house, that qualified in the first places in all the contests related to actual performance of the Solar Decathlon (2nd place in House Functioning, 3rd place in Electrical Energy Balance) but also in their learning of the best practice to run the house. From this understanding through practice, then, they came back to building physics, and a deeper understanding of the logic of the building behavior, with the great addition of quantitative information.

Students learned a lot from such system, in a way they would not have achieved with a strong separation between fields. Other teams had separate groups, and electronics were bounded in the definition of a fully automated system, or anyway independent. We found that the above described strategy has a much stronger impact on learning, for students of architecture, that were our main focus, but also for students of engineering, who learned a lot from the practice of design and adaptivity.

But this experience is also a test case for the extension of the system to actual homeowners. The need is for a political move, much more than technical, meaning that the effort must be put on exposing systems to users. Many sophisticated systems fail after installation, since their low understanding makes users set them to default or in override mode. And for sure, with no learning on the behavior of the house, of the dynamics of comfort, and finally no fun.

In that sense, the experience of Med in Italy has shown as key attractive factors for the student learning: the presence of some kind of energy production, to be compared with consumption; the technological evidence of data, and the possibility to play with them, in our case strictly linked to the possibility to “play” physically with the house; and finally the comparison with other homes, in one word: the network of homes.

These lines of research are then the directions to follow in order to achieve the aim of the Med in Italy case, that exactly as in the cases described in section 1 is to subtract technical behavior of the house to technicians, and finally put the users as protagonists of a space built not “for” them, but finally “around” them.

Notes
1. “The internet of things”, a definition introduced in the early 2000s, has been discussed as topic by Bruce Sterling in several lectures. It is for instance the title of its Keynote lecture of the O’reilly Emerging Technology Conference, 2006. Sterling bounds together several concepts that outline a change in how to conceive objects and their design. From the abstract: “In the future we may be able to find lost keys with a simple google search. Science fiction writer Bruce Sterling imagines how physical objects will be part of the internet as they become trackable in space and time. Bruce discusses the theoretical and technical challenges that we face as we try and think about and develop the Internet of Things. From Spimes to Thing Links to Blogjects, the terminology and verbal framing devices currently being used are pulled apart in this keynote address”. The concepts are expanded in the book: Sterling, B 2005, Shaping Things (Mediaworks Pamphlets), The MIT Press, Cambridge, MA.
3. As introduction to the features and the technology behind Arduino, Banzi starts, in the introduction, with a chapter called “Intended Audience”: (...) this book is designed to help beginners understand what benefits they can get from learning Arduino and its philosophy (...) This book was written for the “original” Arduino users: designers and artists. Therefore, it tries to explain things in a way that might drive engineers crazy. Actually, one of them called the introductory chapter of my first draft “fluff”. That’s exactly the point. Let’s face it: most engineers aren’t able to explain what they do to another engineer, let alone a regular human being. Let’s now delve deep into the fluff (...) : Banzi, M 2008, Getting Started with Arduino, - The Official Guide, O’Reilly, Sebastopol, CA 1st Ed.


5. Both Opower and Google Power Meter relied on partnerships with Energy companies, and both also focused mainly on software services, rather than on hardware. The main difference, though, seems to rely on the “option” for the service. While for Google it was an “opt-in” service, meaning that the user has to explicitly decide to have the service, for Opower it’s an “opt-out” service. Customers of the companies in partnership with Opower, get e-mailed reports and online services automatically. Other competitors, at the time of this paper writing were OWL (software and hardware, for electricity and comfort), Onzo (mainly software), Wattson (portable energy monitoring device), EnergySmart (including physical consulting), and so on.


7. WebGL standard provides graphic libraries that can be used in web HTML 5 code to embed 3D geometry into a tag called "canvas". It does not require any plugin in order to work on standard latest generation browsers.

References


Websites
The reconfigurable house 2.0 website is available online at the address: http://house.propositions.org.uk/ (Last visited August, 16th, 2013).

The automation system of Med in Italy is available online at the address: http://www.medinitaly.eu/it/interface (Last visited August, 16th, 2013). It uses the WebGL standard. Compatibility can be checked at: http://get.webgl.org/.
An Integrated Approach for Open-air Fruition in Archaeological Sites
This contribution deals with the issue of sustainable fruition within the archaeological sites sharing the concept of sustainability in the meaning of rational use of the cultural resource. The observations will be developed starting from the didactic experience carried out as part of a degree thesis in Architecture, of which the author is the tutor. The thesis object is the archaeological site of the ancient town of Cales, today Calvi Risorta, located in the province of Caserta. The paper, based on the outcome of the analyzes conducted in the thesis, is intended to show the strategies adopted and the scientific reasoning that have guided them. The user – with his needs – and the archaeological object represent the cornerstones of the approach proposed in the thesis, approach which derives its fundamental in the doctoral end post-doctoral research of author. In fact the application of methodology aims at the elaboration of a visit-path that, starting from the material datum (archaeological object, existing streets), is able to involve the virtual datum (non-excavated object). The real/virtual alternation, enriched by the surrounding natural environment, created starting from the selection of the real datum and supported by the development of the tale, represents the main innovation of the proposed fruition approach.

It’s strongly focused on end-users’ needs, as well as on their involvement, issues for the most part referable to the two different meanings with which the word accessibility has been defined. On one hand, it is meant as an overcoming of a physical barrier to the fruition of a space, while on the other, as an overcoming of “cultural” obstacles to the correct understanding of the exhibition. When deciding to work on “involvement”, it is not possible to ignore the fact that every person, according to his/her own specific inclinations, socio-cultural background and level of interest for the issues faced, needs a diversified educational approach. Such a custom design may be obtained through the use of didactic-information supports, based on his/her own participation: both manual and virtual. Unintentionally reaching superficial conclusions, as it has been widely shown by studies carried out on visitors’ behaviour in museums (Antinucci, 2004), the use of didactic supports oriented to the interaction with the end-user, contributes positively to understanding information content stimulating the curiosity in those who use them (Frettoloso, 2010).

The “humane experience”, if understood as the fruition experience of end-users, becomes the common denominator of the project as well as of the methodological apparatus. Thus, the objectives design will be defined starting from the “desirable” fruition experience.

Open issues and research results about archaeological fruition

In order to prevent an inappropriate use of cultural resource (non-renewable resource), it must determines what are the conditions so that this heritage is not just put under protection in an institutional but also in a concrete way. Methodological apparatus capable of defining outcomes that result from the balanced composition of different variables involved must be prepared. These variables are closely related to the peculiarities of the object to preserve and enjoy. In this case, concerning the archaeological heritage, a type of good that, as Sandro Ranellucci (1996: 76) carefully observed, is identifiable with an complex monumental articulation, with a system of documents which, using current methods, stems from a rigorous stratigraphic investi-
igation, with a complex structure in which not only the “presence”, but also inextricably to the “absence” shall be assigned the role of a communication from the past.

For several years my interest in these issues has stimulated me to investigate the critical aspects of the enjoyment in multiple dimensions: the physical one, linked both to the matter and to real visit, as well as the virtual dimension, connected to the sphere of communication of the heritage.

Proceeding very briefly, my research has led to the planning of a fruition model characterized by a systemic vision of the archaeological park understood as a “place of complexity” both physical (stratigraphic nature of the archaeological resource; ecosystem balance) and cultural (values, meanings, traditions, ...).

From a methodological point of view, this meant thinking in terms of over - sys - tem, divided into environment (natural and built) on which the area insists, and spatial context, defined by the set of relations with other local cultural realities, as well as sub - systems composed of the environmental units and the spatial elements for which it is possible to create an archaeological park (accesses, paths, parking areas, media information, etc.). The environmental units have been the subject of a performance redefinition and they are the basis of the fruition model in my research called “augmented path”.

The word “augmented”, which has been associated with the concept of use, is clearly derived from computer science and indicates a key aspect of the model: the integration of advanced technologies (virtual reality) as a cognitive support to direct visit, able to guide the visitor and making the learning experience of visit more enjoyable and constructive.

Going beyond the debate between proponents of virtual reality and tenacious opponents who invests the terms real/virtual, it should be noted that the interest in these technologies requires the creation of a systematic project that presumes an active user interaction with these instruments. I share the opinion expressed by Tomas Maldonado (2007: 78) about the role of “direction” that the user can assume with these advanced forms of information and communication technologies, ‘therefore it’ll depend on us whether, in the future, we would understand these tools, in the name of an ideology of universal de-materialization, an alienating use, or instead, as I believe that we should do, an use that fully utilizes the considerable potential as cognitive, design and creative interface of man with the world. Not a fuga mundi, but a creatio mundi’.

From the research to the didactic experience

The hypothesis developed within the research is heavily focused on the need to select those goods that, not only individually but above “systematized” in range of thematic paths, have the ability to “tell”. The concept of selection is now the basis of the more innovative museum strategies. It is no longer unthinkable to expose anything that a museum has. Similarly, in an archaeological context, it is necessary to work according specific themes, making a choice not so much on the absolute value of the ruin to be selected, but rather on its importance in relation to the story which we want to stage.

Interesting the reflection made by Umberto Eco about the forms of the alternative museum. In the essay I’m referring to, starting from the concept of cultural deposit, the author makes a critical reading individualising a series of “risks” linked with
the tendency of the traditional museum to create some objects-fetishes, to hide what it doesn't exhibit, not to make the hierarchies of value existing among different objects clear, to abound with information making “enjoyable not any objects but some sequences” (1998: 30). However, there are some alternatives in respect of these traditional forms of layout; in many museums innovative ways of fruition are experimented that U. Eco himself brings back to some theoretical typologies of “alternative museum” that can find, in their integration and fusion, interesting exhibit solutions for the user.

I find particularly pertinent the “didactic museum to synecdoche” as alternative to the pursued methodological approach. In my opinion, it constitutes the most innovative form of museum, “it is focused on an only work or object, we get to, through a path that gives, in various way, all the necessary information to understand the work or the object in question” (Eco, 1998: 30). The unique work can vary, or it would be interesting that the museum exhibited its works in rotation, elaborating a specific cultural project each time and using the non-selected material, in a consistent way with the layout in order to introduce and explain better the main object of the exhibition. Therefore, we return to a concept already expressed previously, concerning with the opportunity to make a “selection” among the most meaningful objects, then building on them the main plot in turn supported and explained by other works, that will constitute the secondary plot, at least for that occasion. The concept of “augmented” path takes its cue also from these theoretical presuppositions, above all about the hypothesis of the “minimum intervention” (excavation in progress) feasible also thanks to the technological evolution, both in diagnostic (non-invasive) and in expressly communication ambit. Especially in the archaeological field, where the difficulties of comprehension concern the absence more than the presence of the datum, the exhibition of sample elements is one of the bravest hypotheses, also compatible with the conservation aspects.

On the one hand the need to systematize different entities by type and physical location in an archaeological context, especially when it is very large, the other the new demands in terms of both physical and conceptual accessibility of the museum, suggest diversified ways of enjoying cultural heritage that get a chance to use integrated of traditional and technological information tools.

The new information technologies can help to realize, in fact, two conditions required to make tourist flows: the visitor motivations and the heritage accessibility. They work on two components which determine the success of a learning process (Antinucci, 2007: 7-8): ‘the first, the cognitive component, is the understanding of the learning object: we cannot learn what we do not understand. The second, the dynamic component, is the motivation: to be interested, motivated to learn, the will to know; nothing is learned if there is no interest in doing so’.

**The user needs and definition of performances**

At present, the area has an amount of problems, mostly due to its extension, reduced maintenance and the presence of infrastructure for mobility (highway and the ancient Roman road, via Casilina) representing the true physical and perception barriers. Moreover, the historical and urban evolution of the area is particularly complex, as shown by excavation surveys conducted until now, however partial, and supposes the presence of the ancient Cales early as the fifth century B. C.
Fig. 1
The Roman Theatre, Old Cales (Picture by A. Zanga).

Fig. 2
Archaeological survey, Old Cales (Picture by A. Zanga).
The accessibility of the site is provided by roads such as the Casilina as well as the highway, but at the same time is not supported by the presence of parking systems. The general idea is that of a situation left to chance, without a project that takes into account the important aspect of connectivity of area with its territory. Also the accessibility to the site is rather reduced, some areas are closed to the public, or it is difficult to access due to a poor or no maintenance. From the point of view of the systems for the fruition, in fact, except for the northern zone of the archaeological area, there are no dedicated paths and information supports, making the site difficult to understand. In addition, the morphological profile of the site has a number of various heights that, especially in some places, also hindering the fruition of the area from a perceptual point of view.

These are the results of the analysis conducted by student over the entire archaeological area (about 700 thousand square meters). The study was aimed at the formulation of hypotheses about the historical and urban evolution of area, as well as, at identification of existing performances (eco-technological reading). In particular, the student has deepened, in a systemic manner, the architectural heritage with the support of prof. Riccardo Seraglio (Aggregate Professor of History of Architecture), but also the existing vegetation, margins and barriers, the morphology of the soil, the micro-climatic characteristics, the infrastructures for site mobility (internal and external to the area).

The results of this survey, which lasted some months, have led to the formulation of project objectives mainly concerning the systematization of the ruins in the whole area according an integrated approach to fruition. The presence of numerous and heterogeneous archaeological ruins, often located at a considerable distance from each other, could be a deterrent for visitors, discouraging the visit. In addition, it ran the risk of not being able to create stories, or otherwise, of areas with a prevailing theme. These issues are therefore to be overcome by identifying three main archaeological sites, belonging to three different historical periods (V sec. B.C., Late Imperial Age, Middle Ages) which are part of a larger circuit that also incorporates existing green areas. However, each macro-area can be visited individually because it’s like a small archeological site.

The student has been stimulated to reflect on the importance of working on the integration of the large existing green areas and the areas to be allocated to the archaeological park, as well as on the need for an integrated fruition approach (pedestrian/bicycle path, real/virtual, direct/indirect).

Only after, it was possible to work on defining strategies for use through the development of the meta-project both of environmental units and related technological systems. Starting from the user needs, the student was guided in the formulation of the requirements and relative performance of the functional areas in which the new park was divided: Preparation area, study-yards, areas of collective and individual interaction, workshop areas (the name and characteristics have been derived from research conducted by the author).

Then, the infrastructures supporting the visit are been dealt with (the closed volumes, the pedestrian and cycle paths, squares, Finger-Landmarks).

The meta-design definition of the elements that compose the open-air archaeological site is crucial for a correct reading and fruition. It often happens that the elements of the open space are not sufficient or they doesn’t give the correct informa-
tion to users who will enjoying it thus generating responses that the designer did not expect. These unexpected behaviors, in an archaeological site, can generate various problems and points of conflict, compromising both the learning outcomes of the visit and the protection of the heritage. It is important to emphasize the need for a continuous comparison between design strategies and the need - performances framework. In the complex relationship between user and archaeological heritage the designer/student must never lose sight of the end-user satisfaction.

The integrated path

The different areas of the archaeological site are put in system thanks to a layout of historical and set-up museum paths which offer different modes (walking and cycling) and levels of fruition (direct and indirect use). In this perspective, dealing with appropriate fruition modalities will also mean contribute to the research of quality through the control of the relationship between the built environment (project objects) and the natural environment (including the archaeological objects).

The theme of the fruition has been dealt with two different levels: the first, on the design of a general circuit of visit which integrates archaeological areas with green ones, the second, specific for each of the individual macro-areas.

The identification of points and methods of access, currently they are spontaneous and uncontrolled, was a preliminary step in order to define the general circuit of access and the relative direction determined taking into account, in particular, the chronological evolution of ruins. The idea was to create two access areas on the ends

Fig. 3
Meta-project of environmental units (edited by A. Zanga).
of the whole area near the existing roads and to connect them by a shuttle service. In both cases users can decide to visit the whole area or a part of it.

In addition, the access areas are designed for users who wish to spend some free time in a green park from which you can look from a distance the ruins (indirect use). The green areas, in fact, play an important role in the organization of the whole park, not only because they physically connect the various archaeological sites but also because they offer the opportunity to host functional areas supporting the visit. The individual interaction area, which represents a voluntary step and applied only to those who want to explore some aspects, is located within one of these broad existing green areas.

The student is then passed to the definition of the paths within each macro-area deepening the first – (in order of priority of access), the choice is motivated by the fact that this area well summed up all the problems observed in the site. Proceeding very briefly and without going into the detailed description of the path, it is important to highlight its innovative aspects. I am referring to the alternation between “direct visit”, that is conducted on the site in contact with the ruins, and “indirect visit”, carried out through a distance, using multimedia tools and so even in the absence of artifact. Another qualifying condition of the integrated path regards the different interaction way in each functional area. I suggested to the student to consider and indicate the type of educational support to use, depending on the kind of artifact enjoyed as well as the level of user involvement expected. In general, the degree thesis has focused mainly on the role of users and on what strategies fruition of put in place so that the user could enjoy the archaeological heritage in comfort conditions and without barriers, both physical and conceptual.
Concluding remarks

The research as well as the teaching experience confirm the need for design tools which consider the user the focus of the conservative and frutitive process. Although the reference to a methodological apparatus based on the definition of project per-
Performances helps to ensure adequate outcomes both to the specific design objectives and to the end-user satisfaction, a more operational approach would be desirable. I refer to the opportunity to experiment with small pilot areas within the project areas, in order to test especially the behavior of the visitors (feedback). It is obvious that the considerations and the design choices made in the degree thesis take the cue from researches that have analyzed the relationship between the fruition logics - human behavior - protection of the archaeological heritage, as well as from the critical analysis of several national and international case studies but, I think that the quantity and the dynamic nature of the variables involved would also require a preliminary experiment.

Acknowledgments

The Degree thesis in Architecture, entitled “Integrated systems of fruition. The old site of Cales” is edited by student Antea Zanga. Tutor prof. Caterina Frettoloso (SUN); co-tutor prof. Riccardo Serraglio (SUN), referee prof. BART JANSSENS (Artesis University College of Antwerp, Department of Design Sciences, Architecture); expert consultant in archaeology arch. Alfredo Maciariello (person in charge of the archaeological site of Cales).

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New Environment: Disappearance of the Thresholds and the Hybrid World
And I look from man to his house, and from the house to the man, and I can not see any difference.

I see a single skin, which here is shelter, and then it becomes the road and it rises to fold itself in mountains and valleys and it sinks in the sea, and it returns to the man, the same but eternally different and it surrounds him as epidermis, reads his desires and projects them as light, it reinvents him as building, shapes him into a new language, in new bricks which chasing themselves in living architectures.

**Information Technology: the new structure of society and architecture**

Turning attention to the world scene in the field of architecture and environmental design, from the late eighties to the present, what we can undeniably define as the watershed between old and new ideas, while being aware of the endless interdependence between them, is the coming of Information Technology, not just as obvious computer tool tout court, but especially as cultural baggage of the new generations in approaching the matter of design Van Berkel, to this end, says: “I have always been very determined in maintain that the digital aspect of the architecture of the last sixteen, seventeen, was so important to the profession since the introduction of reinforced concrete in architecture” (cited in Sollazzo, 2010).

The opportunity, by the side of designers, to focus attention on the physical attributes they can easily predict through drawing and simulation, is only an early stage, we could say basic, compared to scenarios opened by Information Technology. Check computationally the final result of a designing through rendering and virtual simulation programs is now common practice of the new generations of designers and students.

But the word “final project” is precisely that which brings with it a limit. The limit, in a rapidly evolving society, it is the static nature, physical and conceptual. Already important attempts to unhinge this conception were made with New Babylon, in the sixties.

Kas Oosterhuis does not talk about it at random as kinetic structure saying: “In Yper-architecture of New Babylon (a city where atmosphere, materials and techniques are constantly changing), the nomadic citizen-gypsy never returns to the same place, simply because there’s no place that stays the same over time. If the urban gypsy after months of endless intuitive navigation through the facilities of New Babylon returns to the place where he started, this can be changed completely, in both software and hardware. New Babylon is a huge kinetic structure that operates in an economy of transformation” (2007).

To deeply understand the new structure of society it is essential to the design. Saggio (2010) speaks of change that concerns the very concept of space. The paradigm tied to the industrial world was obviously related to Newtonian physics. Today, from Einstein onwards, the space is a set of relations that deform and create the space itself and the object in close interdependence. Gilles Deleuze, in his book The Fold, talks about the new object: “this new object we can call objectile. […] this is a very modern conception of technological object: it refers neither to the beginning of the industrial era nor to the idea of the standard that still upheld a semblance of essence and im-
posed a law of constancy (‘the object produced by and for the masses’), but to our current state of things, where fluctuation of the norm replaces the permanence of a law; where the object assumes a place in a continuum by variation; [...] The new status of the object no longer refers to its condition as a spatial mold – in other words, to a relation of form-matter-but to a temporal modulation that implies as much the beginnings of a continuous variation of matter as a continuous development of form. In modulation is what Leibniz is defining when he states that the law of series posits curves as “the trace of the same line? In a continuous movement, continually touched by the curve of their convergence? His is not only a temporal but also a qualitative conception of the object, to the extent that sounds and colors are flexible and taken in modulation. The object here is manneristic, not essentializing: it becomes an event.” (Deleuze, 1993, p. 20). In architecture long since Peter Eisenman and Greg Lynn carry on with this idea of interconnected space, where there is not a distinction between object and context (Bonafede, 2012), but the disappearance, in fact, of the threshold.

We are talking about living fluid megalopolis of more places and more levels in constant transformation (Sollazzo, 2010). We speak, essentially, to deal with the removal of certain thresholds. Between the designer and environment, between building and user, between landscape and building.

Environment: Mental Landscape reification

Essentially those who have so far characterized the architecture splitting it in various cognitive branches, with their own notional and operative kits, then dividing building and landscape and building in structure, form, function, in favor of a more general
(because of the homogeneous structure, both own and as it is defined by contemporary design) Environment.

This environment, understood as the natural environment, physical environment, a set of physical and relational webs of values underpinned by society, is an explicitation of the physical and perceptive Mental Landscapes formulated by Saggio (2010).

The Mental Landscape, such as shared set of values associated with a new aesthetic, connotes an Environment, which is nothing but the modeling of a space in constant evolution through a series of relations. If space is a set of relations what is the structure of these relationships? The structure is communicative, i.e. the information flow is the lifeblood that permeates everything and allows these relationships. Everything communicates, everything is data vector (Oosterhuis, 2007).

What we want to investigate in this short essay is the threshold between Environment / Mental Landscape Reification (Saggio, 2007) and man, who lives, shapes and permeates the space, through a communication linked to a very peculiar data stream, which is an emotional, cultural, social data flow. Not by chance that in the European Landscape Convention, “Landscape” means an area, as perceived by people, whose character is the result of the action and interaction of natural and / or human factors (2000). The words perception and interaction are fundamental and are the key to find a way in teaching and planning that takes on account the complex contemporary world.

As we mentioned, we must first deal with a world hybrid that is nature, natural and artificial landscape, and the one and the other together, and the same can be said of the relationship/ threshold landscape-building until the disappearance of the threshold public space / private space which are increasingly flowing into one another.

Fig. 2
Let us dwell for a moment on the last concept, the Home: a space so intimate is hybrid, constantly changing, with no threshold to the surrounding world?

In this regard yet Saggio talks about the Dolmen as primitive home, in the meaning, as I specified in a written brief on-line of: “The gesture of man coming into the world, the towering statement, the appropriation infixed in the ground and looking toward the sky, connected to nature, [stones of dolmen as] individual elements, on time, in an open enclosure, symbol, σύμβολον, of a community gathered in a circle around the fire. Democratic assembly, without hierarchy, of peers. Here’s the first home. [...] With the sky as roof and the horizon as walls. The whole world, the whole universe, chosen as the home of man” (Garramone, 2013).

We are not so far from the analysis of Diller and Scofidia, which in 1981, in Plywood (Kinney) House, analyzing the window as the threshold between inside and outside (they will do it with refined outcomes ten years later in the Slow House, but it is a ‘another story).

Examples

Let us now briefly discuss a few examples that make us better understand this conceptual and formal whole in which contemporary architecture moves and realize that the possibilities of Information Technology go far beyond a simple check and a true representation of the project. We are talking about processes, data flows, interactive architecture, which communicate, and are tied to territory in its most intimate fibers, becoming themselves the territory.

In 1983, Zaha Hadid designed the complex The Peak, in Hong Kong. The same texture used for the area draws the context. It is all one: from landscape to building, from building to landscape.

And Eisenman and Gehry had already started research related to landscape on the end of the Seventies. This is the beginning, where the mental landscapes are reified through computerized means, but they are not generative, planning DNA. We have to wait some years, because the computer tool is integrated into the design process as structural part.

Van Berkel and Bos make of territorial analysis, a founding tool of generating design. It is no longer simple to talk about the genius loci, but to collect a set of data related to dynamic flows, to time, to forces passing through a territory through its users. A huge set of data that are processed by computer by providing an array of vocations and potentials of the site tied to the man and are not the data, but the relationships between them that determine the project, we think for example to the project for the Station Arnhem in Holland, 1996.

We also take the Salt Water Pavillion of the ONL, 1997, which takes data from a weather station on a buoy in the North Sea and reworks them into signals that guide the fiber optic lights and sound sampling.

It is still signed by Diller and Scofidia one of the most interesting projects of the Swiss Expo 2002, Blur Building, which, thanks to 31,500 water nozzles, turns water into a cloud of water.
Fig. 3

Fig. 4
Fig. 5


Fig. 6

Extraordinary for the future implications is certainly D-shape of the engineer Enrico Dini, a machine that works like a 3d printer to real scale, using inert materials such as sand and a special binder. Remarkable if we think of a site, its materiality may arise an architecture that is literally one with his land through a computer process. Finally we think about the project of Plasma Studio, Flowing Garden, in 2009.

Here the ground hybridizes itself with an artificial one, no longer subordinated to the buildings (Bonafede, 2012), and the buildings disappear into the landscape. All is organized according flows: human, of data, of parameters, of relationships that led to the planning and construction. The architect now working in swarms (Oosterhuis, 2007).

This organic hyper-rationalism (Garramone, 2013), where rationalism means efficiency, economy, ecology and democracy, welfare, social sustainability, shapes the Environment, where single man and community, public and private space, nature and architecture, progressively lose their thresholds.

If, however, there are clear the frontiers of architecture in the new field of Information Technology, a key aspect, which we have deliberately neglected until now, is the interaction relationship between man and Environment. All the examples discussed underlie an effort towards the emotional involvement of those who visit / live / edit these architectures.

Bonafede (2002) for the project Flowing Garden speaks of stimulation of sensorial and psychological perception in visitors; Diller and Scofidio’s Blur looks for an iteration, physical and emotional, with the visitor (Marotta, 2005); Saggio (2003) speaks of physical interactivity, as the changing of the architecture based on needs and desires, what we might call the thousand plans of the subjectivity of desires that are opposed to the objectivity of the needs of the Modern Movement (Marotta, 2005).

**New Frontiers**

Certainly the interaction with the man has always been one of the ambitions of the architecture: in Vers une architecture Le Corbusier says “The architecture is a fact of art, a phenomenon that elicits emotion, outside of the problems of construction, beyond them. Construction is to take on: the Architecture is to move” (Le Corbusier, 1923), e Zaha Hadid, speaking of not yet built MAXXI in Rome, said “It’s about giving life to a space in a variety of ways that offers people pleasure, fun, comfort and well-being similar to those experienced in a landscape” (Giuliani, 2002) but the new frontiers of technology have enabled impressive developments.

In 2009 Alice Rawsthorn, famous reviewer of the New York Times, explains the new frontiers of techies called human interaction systems used in design in her article “The Demise of Form Follows Function” talking about G-speak, which was developed by Los Angeles-based Oblong Industries as a means of operating computers through physical movements and gestures, rather than keyboards and mice. And another option, explained by the author of the article, is to swap physical means of controlling technology with voice recognition systems, which are already used in some devices. San Francisco-based Emotiv Systems worked with the IDEO design group to develop the...
Epoc, a headset that enables you to play video games by monitoring electrical activity in your brain. It literally reads your mind through 16 sensors, which then relay your instructions to the console.

Because these studies are so important to us? We talked about the Environment, a new physical landscape that is responsive to the new aesthetics of the Mental Landscapes, generated, influenced, created by and thanks to the computerized tool. A kind of Blurring, allow me the term. Think about Guardiola House in Cadiz, in 1988, the first example of the new process of Eisenman’s design, conceptual reinvention of the moving architecture. The architecture is linked to the movement from a long tradition, which is also a way fairly explicit and explained to link itself to the man, from Greek ἔντασις to Van de Velde (Garramone, 2013), just think about Mendelsohn’s EinsteinTurm (1920-24), with its wonderful compliance with Einstein’s theories about the curved universe, which is permeated by energy moving through lines and grids forming the living matter.

But for Eisenman this movement becomes multiple, as if it would enclose the thousand plans, the thousands of possibilities, which are not real except in potentiality but they exist in traces. This concept, because we talk about architectural theory before about operational process of design, is the same which implies the new architectural landscape that I call Environment. A landscape that has thousands of plans and has the traces of what acts on it, formed by Hyperbodies that react to the thousands of natural and artificial stimuli moving really. This is the case of Graphideas, Conference Center designed by ONL to Budapest in 2002. It consists of seven elements that move independently through a program that adjusts the speed and the amplitude of the different movements.

Man, Architecture and design: complex emotional links

Now, if these movements were not simply dictated by weather requirements but were directly driven by sensorial and emotional experiences of the inhabitant/user? If we can organize data flows in human input legible by machines?

People are already able and mentally prepared to make complex experiences of iteration. The role of the architect and designer now is to make sure that this communication is successful, and in the most simple and stimulating as possible. The ability to improve the lives of citizens through concrete experiences autopartecipative are already on the agenda, and through seemingly basic tools.

Just think of the interventions related to the Favela Painting Project in Rio De Janeiro, which, thanks to the recoloring of Santa Marta’s Favelas (2010), have succeeded in emotionally communicating with the residents, who have collaborated in “taking care” of the urban environment. Same goes for the English Idea Stores, authors of the not only urban, but also social redevelopment of Tower Hamlets, London’s East End town, thanks to, among other things, transparency and color (Muscogiuri, 2009).

These examples are very important to educational level, as numerous experiments carried out in the self-construction in developing countries or in degraded suburbs in the Western world, because they put the designer directly in contact with the population and its needs. They are attendance tools already partially used in Urban Planning and ever more so important in requirement for agreement and customization of urban space. Although belonging to other fields, falls mainly into this need also the occurrence of urban gardens self-organized in many cities. In addition, these experiences are all events that underpin the transformation of the private-public threshold in multiple gradual blurred thresholds which in some cases already arrive until disappearance.

“I communicate, therefore I am” (Antonelli, 2011) is definitely one of the most important statements of our contemporary world, from everyday objects you don’t expect anymore the bare function for which they are bought, but an inborn communicability.

Examples

Certainly the world of the contemporary architect can not ignore the need for representativeness and emotional communicability sought by the user at every level. An interesting example, among others, is the IKEA universe, with the sale not of design products, but of emotional environments, both in the catalogue and in store, the customization to which is driven the user, who is able to create, through furnishings that are cheap just because highly industrialized and serial, hyper adaptive environments, flexible thanks to modularity, and customizing, in fact, thanks to the range of possible solutions, all compatible with each other.

Interesting is also the website management, which provides for Anna, the virtual assistant, with the graphical interface of an IKEA salesgirl, complete with smile and uniform, with which you can literally interact. The emotional contact developed by the company is impressive, since it brings, among other things, to a cultural fusion that makes you perceive the industrial giant as “close”, “positive”, “trusted”.
The MoMa tried to put together all these new isms in a great exhibition Talk to me in November 2011, with 194 projects. Paola Antonelli (2011), Senior Curator, says "Talk to me explores the communication between people and things. All objects contain information that goes well beyond their immediate use or appearance. In some cases, objects like cell phones and computers exist to provide us with access to complex systems and networks, behaving as gateways and interpreters. Whether openly and actively, or in subtle, subliminal ways, things talk to us, and designers help us develop and improvise the dialogue. The exhibition focuses on objects that involve a direct interaction, such as interfaces, information systems, visualization design, and communication devices, and on projects that establish an emotional, sensual, or intellectual connection with their users. Examples range from a few iconic products of the late 1960s to several projects currently in development—including computer and machine interfaces, websites, video games, devices and tools, furniture and physical products, and extending to installations and whole environments."

In the field of architecture, Information Technology enables the amazing example of E-motive House, designed in 2002 by ONL.

Kas Oosterhuis says about that: "What mood today is your home in? Does it not feel good? Why recently your house has a behavior so strange? Do you care enough about your house?" (2007). Here the designed house is a fully programmable muscular structure that changes shape in real time and it is programmed on emotional bands within which it can take even a behavior independently of the inhabitants. The house becomes a social prosthesis semi-independent of the human body of its inhabitants.

Fig. 8
Interesting educational perspectives

From the educational perspective, for which Oosterhuis minds similarly in *Hyper Bodies, Towards an E-motive Architecture* of 2007, strongly recommending to work in creative teams composed of multiple professionals from different disciplines, more interesting is the work carried out by the architect Juvenal Baracco in Lima, Peru, who, mainly in the field of academic experimentation, recalls the bergsonian concept of Embodiment, bodily experience, proprioceptive knowledge, as essential cornerstone of design.

His method is based on creating a relationship of physical and emotional continuity with the built environment making sure that the student in the first year starts understanding the fundamental natural structure of his own body, and to do this he requires the construction of a life-size mannequin. The next step is the inclusion of this mannequin in *Habitaculo*, a cocoon, a home, a shelter, which is also full-size built to accommodate own dummy.

The following years are used to explore before an area of great historic heritage from which to infer the antique, deep relationship with the context and then to build a *Metáfora*, a vision, a dream which stimulates, when the design tools are already more defined, we are in the last few years, the dream-creative-emotional relationship with the design, conscious, thanks to previous studies, of the strong link with the context, own embodiment and territory. After finally you are ready to design a complex building, a part of the city.

The way carried out by Baracco seems to me to be viable in teaching, not so much in practical forms, but in the conceptuality of unicum between man and environ-

![Fig. 8](metaforayperformance.files.wordpress.com/2012/01/emilio-acosta-001w.jpg) [Accessed 10 January 2013].
ment. I am working, for example, at the Design II Course in “Sapienza” University of Rome on an interesting project methodology, focusing directly on a real problem of territory with inhabitants. We ask for designing an area of Rome of strong social emergency, through cooperation with institutions and active citizenship. We are coming to expose projects showed by the students during the semester in a exhibition that involves the choice of one of the projects, voting by local people, which will expand by us and actively propose to the Municipality of competence. Another interesting way is to make students aware in the search, using new technologies, for a meaning deeply rooted in emotional life and well-being of man, seen as a single personality, and not as a mass. New Technologies have got a huge potential, but are likely to come down to design anything in a spectacular way tout court.

Certainly the world of the contemporary architect can not ignore the need for representativeness and emotional communicability sought by the user at every level, also the spectacular nature required to architecture just now. And we can not even ignore the level at which we have already arrived in the planning of “living” objects with the aid of graphical interfaces, diagrams, home automation smart programming. But the goal should always be the man, his life and his social, personal, physical and emotional well-being.

Essential References


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New Harmonic Exterior Attachments in Historic Museum Buildings
Throughout the history there has been an attempt to improve the quality of indoor spaces through better architecture; this was mainly done by designing appropriate building envelopes. The building envelope, in general consists of different physical components some of them which are composed of transparent glazing materials applied as the building envelope to get light and create a visual link between indoor and outdoor environment that is obviously happening in courtyard annexes in historic buildings.

This issue of using transparent materials in indoor envelope is more extended and become one of the main issues in extending the outdoor part. Using of glass as transparent material by improving of its quality, nowadays become one of the most important material in use here, in this research, the role of glass related with historical building extension will be analyzed too.

While the discussion is about the historic building that totally is perfect and serves the people is different from the other discussion that historic building needed to change and in time periods some new parts added to it, especially in recent time. New extension with totally different architecture caused some contrasts in the new current building architecture, but more important than outdoor façade is the indoor architecture changed after annexes added by modernity that seems to be changed more. The distance between indoor architecture styles is the most obvious part.

Building envelope attached the interior spaces as the exterior assembly, the role which the envelope of building plays in architecture is like a mediator between the interior spaces and the outdoor environment. Through the periods, among other requirements and needs of human being, building envelope in approach of new extension has been developed. The shape and the way of construction of it have been changed according to the availability of materials and preferred architecture style of different decades.

**Performance Requirements from Building Extension**

There were always different ways to improve the quality of indoor spaces; one of the architect’s attempts during this process happens while the new extension added to the old buildings. This was mainly done by designing a proper building envelope. Building envelope in new situation, after new extension added, totally consist of different physical components, some of them which are composed of transparent glazing materials applied as the whole building envelope (annex + current building) to get light and create a visual link between indoor and outdoor environment.

The annex with transparent façade should provide the expected function and required performance. Moreover, for achieving a glazing materials and their characteristic physical components and then problems that caused by the transparent building envelope, should be defined. Depends on the function of the new extension part, problems that may occur can be fixed and solved. Some problems that may happen like thermal problems, proper visual contact, controlling sound, safety and security and also durability, all of them needed to choose the fixing system to fix the glazing materials to the main structure of historic buildings.

**Transparent Building Extension**

A transparent building envelope is composed of different types of transparent, glazing materials and their construction systems which are required for creating this trans-
parent envelope. It could perform as a small window, skylight, glass doors and curtain walls to provide expected demands which are receiving light, supplying ventilation and circulation, and to have visual contact to outdoor environment.

Performance of the transparent building envelope depends to a the large extent on the characteristics of its physical components and materials applied on them and the awareness of the problems that might happen. The important aspect of transparent building envelope is the subdivisions of transparent components, the size and proportion of the relationship between the glazing and their applications through the rest of the building envelope. The dispositions of transparent envelope have the most profound effects on the indoor comfort and appearance of the building.

**Sky Light**

The Skylight is a transparent or translucent envelope which could be applied on the roof by incline less than 60 degrees with indoor space under it or it may stand on a flat roof. The Skylight is one of components which give the chance to the occupant to get light and ventilation. There has been desire to get light from the top of building in the past as well (Figure 1).

![Fig. 1 Types of Skylights.](image)

Nowadays there are varieties of skylights making it easier to choose the proper one for different positions; skylight could be categorized as fixed, operable and for low sloped applications. Skylights can be made in different shapes such as dome, circular dome, pyramid, trapezoid, asymmetric, wedge and flat glazed.

**Modernity in Museums**

Throughout the 1980s, and into the early 1990s, a wave of museum construction swept across Europe. The reason behind this trend is relatively clear. Wherever the great cathedrals of the past may have been potent symbols of the wealth or importance of European cities, culture seems to have replaced religion as the most obvious sign of success.

One good example for this act happened in France, France under Francois Mitterrand engaged in an unparalleled series of cultural projects. The most visible and perhaps the most significant of these efforts was undoubtedly the Louvre Pyramid designed by I.M. Pei that was called directly by president without any prior competition, to redesign the greatest museum in the world.
In architecture: meaning and place, Christian Norberg Schulz laments the way that place and art effects have lost meaning for modern man:

“In general, the loss of the things and places makes up a loss of world. Modern man becomes wordless, and thus loses his own identity, as well as the sense of community and participation. Existence is experienced as meaningless and man becomes homeless because he does not have any longer belonged to a meaningful totality. Moreover he becomes careless since he does not feel the urge to protect and cultivate a world any more”.¹

The cultural image shows distinct and meaningful position of which architecture is a part. It mirrors a people's view that promotes keeping people culturally in place, accompanied with a belief that local culture knows best.

Since the monumental historic buildings mode of building is seen as having authentically emerged as a response to local culture and the genius loci (and, indeed, to be an important part of that culture), it is the model for new building. Materials, colors and building forms draw on these old buildings. Buildings are highly contextual, following Christopher Alexander’s quote “new development as healing the city, of repairing wherever the authentic place is damaged by earlier inappropriate work. So that the new building is expected to rework rather than reproduce the vernacular, to be identifiably contemporary while eminently respectful of the past”.²

In an interview about his design work for the Reichstag parliament building in Berlin that was about adding glass roof to building as an annex, the architect Sir Norman Foster said:

“Since Stonehenge, architects have always been at the cutting edge of technology. And you can’t separate technology from humanistic and spiritual content of a building… This building is highly engineered … great mirrors bring high light down right into the debating chamber… it looks forward to the day when buildings will give off no pollution, no greenhouse gases”.³

The important point while designing the new extension to historic buildings is to notice that do they really need that part? Or the new parts do match with the old one? Also does the neighbor culture accept the new design style? These are the questions that in design process challenge the architect’s minds. For better design and in respect of historic building there are some principles that in historic environment should be noticed.

At first all new buildings should follow the compatibility with size, scale, materials character of the building and neighbor. It is not a force but it is a way of respect, although the modernity and contemporary architecture thinks different. If consider that they are falsifying the character and culture of the historic building, it will be not true, because even if their design style in new added part and extension of historic buildings evaluated in different categories but by looking in some case studies that are about transparent extension and material in use, glass, it seems that glass this aged material can matched itself with two different design style and without falsifying the character of old building and environment, can match with contemporary and modern architecture, somehow it can be one of the benefits of this material because traditionally choosing and using material in historic area is by choosing and using traditional and common building material found in historic areas and similar in color with adjacent building. Glass with its transparent and none color character can be used in different positions.
By passing the façade character that can be tolerated by glass the other principles should be noticed too, like rhythm, height, massing, roof, street line, sky line and decorate elements such as window, door, etc. the main attempt is all of these factors that will design, should be harmoniously with the established rhythm of historic building and environment, the size of elements would be in harmony of main building’s elements.

It is important that being not out of scale, means traditional setting exist and it’s the way to be kept, new extension in historic parts should be clear, should be able to distinguish. “The master pieces of the past show us that each generation has had its way of thinking, its conceptions, its aesthetic, it’s their culture”.

**Case Studies**

**Zeughaus Museum**

*Architecture: Andreas Schlüter*

The Zeughaus in Berlin, designed by Brandenburg Elector Frederick III in the baroque style between 1695 and 1730, as an artillery arsenal and in 1875 the building was transformed into a military museum (Figures 2, 3).

In 1952 the government completely redesigned the Zeughause and opened the museum of German History to public. Between 1998 and 2003, the inner courtyard with the cap stones covered by Glass Roofing as vertical roof annex, Glass roofing was
The new building with a surface area of 2,700 square meters was opened for temporary exhibitions in 2003. Designed by I. M. Pei, it used modern architecture concept in contrast to the style of the original historic museum building. By this addition, the unused space as a passing way changed to much useful one and adds more beauty to this museum, changing this place to one of the most beautiful ceremony halls.

**Lille Palace of Fine Arts**

*Architecture: Jean-Marc Ibos and Myrto Vitar*

The Lille Palace of Fine Arts is one of the largest museums outside Paris. Built in the 19th century under the instructions of Napoleon I and designed by Berard and Delmas in the style of the Louvre Museum, as part of the popularization of art. This building in 1997 was restored (Figures 4, 5).

Ibos and Vitart won in modern competition, they chose a glass building-screen horizontal annex as new construction. The exterior glass-pane is a narrow building (6.70 m of thickness, a facade of 21 m on 67) which located directly behind the museum, reflecting the back of the main building and make the building isolated from the center of the city. The glass building-screen reflects the old palace, doubling its image and redeeming the idea of the original historic design. Architects quote about this design:

![Fig. 4, 5](image)

*Lille Palace of Fine Arts.*
“we wanted to go towards the meaning of the building, with the idea of taking advantage of its qualities”. The glass building-screen serves as conservation department, administrative offices, the Prints and Drawings Room, the restoration workshops and in the ground floor is a café-restaurant.

Certainly, the most important elements in the interplay of reflection and perspectives are the new building-screen, and the false pond, also made of glass which has reflection of the original Berard and Delmas design. Building-screen panels opens and closes electronically and the sensors measure the sunlight direct, the temperature and wind speed. Also between the distance of glass wall and building located the underground floor and connect the glass wall to the main building. Rhythm, color, size and its harmony makes this annex to be successful combination of modernity and historic architecture.

**Louvre Museum**

**Architecture: I. M. Pei**

The Louvre Palace is one of the world’s largest museums, and a historic monument it is an earlier royal palace which was built in the medieval period and evolved since the 16th century, in 1789 this building chosen as Louvre Museum. By 1874, the Louvre Palace had achieved its current form of rectangular structure (Figure 6, 7).

![Fig. 6, 7](image)

Louvre museum.
The Louvre Pyramid located in the main courtyard of the Louvre Palace in Paris and is a large glass and metal pyramid which surrounded by three smaller pyramids, because of some problems in original main entrance, the largest one serves as the main entrance to the Louvre Museum, Visitors entering through the pyramid descend into the spacious lobby then going into the main Louvre buildings. It has become a landmark of the city of Paris (Figure 8).

Not only Pei, master of modern architecture, succeed here in giving appropriate form to Mitterrand’s ambition to place culture at the heart of France’s political agenda, but he also mastered the extremely delicate equilibrium that had to be obtained between the symbolic weight of a great historical monument and the requirements of the modern age. As president Mitterrand said during his speech for the pyramid, “the former Cour Napoleon parking area was nothing more than dangerous place to go at night, whereas after the intervention of I. M. Pei, it added a great new square to central Paris, no small accomplishment in itself.”

The construction of the pyramid started to disagreement opinion, many people felt these new structures are completely out of place in front of the Louvre Museum with its classical architecture. In other side some people lauded pyramid complex, as a successful merger of the old and the new, the classical and the modernity.

**Conclusion**

The building that was constructed in a certain period was based on the requirement of its time. With time in some situations, the old building needs to be change to support the new requirement, new spaces, but the problem that occur while the annex design attaché is the original building style, in some cases architects pays less respect in making harmony of the two building concept compare, annex and original building.

Even if this complex of annex and original building doesn’t match but together serves the requirement which changing by the time. The important point is that historic values of building as an architectural design of the past should obviously be identified and new addition beyond keeping the characters of its own time also by
respect of the main building should provide a new background of combination of two old and new generations, not as a two separated part. In this background, new extension without falsifying the old building should resuscitate the characters of historic building again by respect of physical characters like façade, size, scale, color, material and rhythm.

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“Nicosia Buy/Sell Point”
– a Hands-on Experiment
The summer workshop was organized by the University of Nicosia and the Cyprus Architects’ Association with participant architecture students and young graduates from local and European universities. The primary aim of the workshop was to offer students the unique experience of realizing an architectural concept.

The title of the workshop was Nicosia Buy/Sell Point and the theme of the workshop was the design and construction of a “flexible/sensible” market stall to be installed in a public space in Nicosia. The aim of the workshop was to trigger the social and environmental awareness of the participant students but also the public.

**The context of the project**

The selection of a primary programmatic use, “the market stall”, in combination with the responsibility of actually building, installing and operating the structure, intended to bring students into contact with key environmental design objectives, the reality of inhabitation and users behaviour, the multiple and ever-changing needs. References to historical relevant subjects both from theory as well as from practice provided the base for the workshop. The idea of the primitive hut, temporary delineation of places of worship such as the early Jewish temple, deployable /nomadic structures, places of transaction and exchange of goods (markets) and ideas (agoras). Discussions on issues of buildings’ inherent unpredictability of use, disuse, misuse and abuse, as well as the shifting of emphasis on appropriation of space rather than prescription of use.

![Fig. 1](image)

**Sensible / Flexible**

The idea of “sensible” meant that students had to employ a wide range of recycled and recyclable materials and the idea of “flexible” meant that they should deal with deployability and reusability, as key environmental strategies.

The idea of sensible may be understood as a process that is cyclical, initiated by the user, and continuing with design, construction, re-use and back again (to the new user). It also includes notions such as economy of means and doing more with less (material, energy, time, waste, tools etc.). Buildability as a sensible strategy affords cross-checking with availability of required technology, expertise, budget, material, as well as how much of it is sensibly needed. Logistical aspects including transportation of materials and the process of erection and its timing are central to the idea of sensible, as is a conscious habit for under-designing and employing low-tech. Limiting the need for skilled labour and excessive expertise is also a parameter.
The idea of flexible may be understood as allowing for the design and construction to have a life in depth of time, adapting to the ever-changing needs and the unpredictability of inhabitation. It may also consider possible deployability such as by unexpected life termination as well as reusability. Additionally it may deal with logistics in terms of flexibility of performance with reasonable ease and intelligence. Finally flexibility may be understood to be the state between material and immaterial, meaning between and encompassing both actual and experiential construction.

Flexibility was a driving force throughout the workshop in terms of future use adaptability and logistics. Students accessed the current use as well as potential futures uses, even unpredictable ones. Inevitable and desired issues of investigation included the potential for multiple performances and operations, user engagement, user customization, minimizing dead weight, durability etc. The students had to not only design for transportability, but actually build and transport the structure themselves. The design had to be intelligently flexible in order to allow on-site adjustments after its transportation as well as user appropriation.

The objective was the design and manufacture of a modular structure, with an inherent assembly and potential dis-assembly process as well as possibilities for deployability that would allow easy transportation and potential erection in various locations.
Innovative material development

Students were asked to focus on experimentation through testing, inventing and developing new lightweight cast materials, new processing/manufacturing methods and construction techniques. They started with a list of ‘raw’ and “as found” readily available, low cost materials including: recycled paper and fabrics, metal and timber waste fibres, resins, metal mesh and lightweight metal frames. As the aim was to invent new cast materials that would also be lightweight, the above-mentioned materials were also used as aggregates to mainly concrete and adobe mixtures.
Essential to developing new cast materials was the process of hands-on testing/failing - testing/accomplishing; a cyclical process of evaluating options and techniques. This was a unique opportunity for students to attempt realization of ideas via the opportunities and limitations offered by actual construction. Part of the workshop experience was on-site training about recycling materials and metal welding, as the students had to immediately use their newly found skills in order to test their propositions.
The time dedicated to design was reduced to only one day, so that experimentations would concentrate on the actual hands-on implementation of the project. The underlying setup of the construction system was given: a lightweight metal frame with infill units. The design was refined and continued to evolve through the practical testing.

At the beginning students were presented with a list of programmatic and performance criteria for the market stall like dimensional coordination, an inventory of units/elements, detail design such as edges/connectors/clippings/locking mechanisms etc.

Students were allocated into working teams with specific tasks as well as shared tasks; the metalworking team, the 2D units team and the 3D units team. Subsequent sub-groups were formed with regard to different materials for experimentation.

Already during the first day of the workshop students produced a sample unit at 1:1 scale. The 2D units were finalised at 90x30x2.5 cm, whereas the 3D units at 90x30x25x2.5 cm; this resulting in a dimensional coordination system that informed all parts of the market stall. Following the first sample the teams proceeded with a series of alternative options in terms of: primary structure, formwork types and re-usability, material recipes, detailed dimensioning, time of erection and process, textures, colour and overall system intelligence and quality.

The workshop took place at the laboratories of the University of Nicosia, whereas the first overall market stall was transported and erected at the remote municipal Nicosia fruit market location. The students actually tested the structure by operating it as a fruit, drinks and vegetable market stall for a day, therefore experiencing and interpreting intimately what they had designed and built.
Extending the generic flexibility of the installation additional detailed customization was necessitated by the specific site and usage. As-found materials within the market site such as fruit crates and fabric canopies were appropriated into the installation. On site customization of system parts in order to provide various shelving, storage, containers configurations depending on the products to be sold.

The horizontal elements of the market stall (floor and roof) were deployable to allow for easy transportation. Likewise vertical members had a flexible handing possibility, to accommodate an array of arrangements; for example a shelf could transform into a canopy or a showcase or a container...

The market stall remained active for a period of approximately two months in its initial location and subsequently was used as a bar and canteen at the premises of the Architecture Research Centre, of the University of Nicosia.
Designing for the full spectrum; from design through depth of time

Through the workshop proceedings, emphasis was placed on objective design not as a singular goal but as one that could facilitate a multitude of mutations and transmutations. In order to account for a broad-based set of objectives, a multitude of scenarios had to be imagined. These would have to consider both operational as well as perceived qualities. The eventual constructed environment had necessary shifting programme, as well as a shifting site. For example it needed to satisfy drastically varied uses such as market stall, guard’s house, info-booth, outdoor bar and school canteen. It also needed to facilitate installation in different environments such as indoor/outdoor, market, school, garden, parking lots. The common feeling of “tyranny” often associated with users was here partly alleviated by allowing free habitation, modification and even customisation. Parts could be exchanged as needed, modified or omitted. Instead of students having to anticipate the future users’ experiences, expectations, desires and preferences, they tested generic open-ended actual and hands-on construction. Instead of designing by imagining the actions and reactions of users, the installation provided a multitude of possibilities, so the emphasis was shifted to observing in actual time, the actual user reactions.

Bridging the gap between the imagined and simulated possible reality which is what by rule is asked of architecture students, with the “built-and-lived” experimentation such as through the “Nicosia Buy/Sell Point”, may reactivate the students’ awareness of the influence of inhabitants on the environmental performance of buildings.
As hands-on construction projects within the architectural curriculum tend to be necessarily limited in scale, certain aspects such as longevity of habitation or measurement of carbon footprint during usage may not be applicable, but other aspects such as flexibility of usage, recyclability, social sustainability and human experience and behaviour can easily be applied. As a result similar projects could offer students access to a richer reality and inform the way they design with regards to the influence of inhabitants in the environmental performance of buildings.
Conclusion

As an educational experience this workshop allowed students to approach design issues from a new perspective that goes beyond the usually idealistic strategies and scenarios that they investigate in a design studio; beyond speculative representation and even simulation that is often unable to predict complex attributes of environmen-
tal performance. Furthermore the fact that the actual structure was tested in a public space, enabled students to observe and understand the complexities of creating new spatial conditions and the unpredictability of users.

It enabled them to access the realities of often mundane themes of environmental and social sustainability that are increasingly becoming relevant in the post-crisis world. To understand the actualities of operational sustainability, energy efficient construction, adaptability, inhabitation flexibility, interactivity and low-cost, low-tech intelligence, is essential towards an environmental design culture that is and will be relevant and fine-tuned with primary human needs.

**Participating students**


**References**


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Environmental Design
as a Medium:
the Sacri Monti and
the Narrative Spatial Sequences
Nowadays architecture, as well as all visual disciplines, is strongly conditioned by the world of communication and it is often described and theorized as a real medium (Saggio, 2007). Many contemporary architects and designers, e.g. Kas Oosterhuis, NOX and Diller+Scofidio, are trying to create an intelligent architecture, able to act as media, able to connect people and to interact with them. It is an architecture that is changing its leitmotiv from de-formation to in-formation (Kipnis, 1993). In this context the environmental design has to be seen like an opportunity to create a connection between what is built and what is lived, between physical space and inhabited space. It should be a system able to bridge the gap between architecture and human experience and to bring back the man to the center of a global connected dimension (Bateson, 2007). The concept of environment actually overtakes the more historical idea of the context and the artistic view of the landscape, in order to redefine the territory in a new biological dimension to be preserved and respected. By arguing that the main goal of environmental design is the establishment of this surface of connection between human experience and built space, one implies that the knowledge of this discipline should be based on communication theories. Thus, the environmental system can be imagined as a real medium and as an extension of human body (McLuhan, 2001), able to relate our sensitive and perceptive dimension with architecture: it could be an interface, a critical space of connection and interaction (Virilio, 1998).

Architecture developed as a medium should be capable to design an environment in which intangible dimensions become reality: the IT (Information Technologies) and the virtual seem the way and the system to realize it. Following the progressive disappearance of volumes (Baudrillard, 2003) (Virilio, 1998), shapes decrease their dimensions, hiding an infinite and complex world made of images, connections and information: a world of data. This concentration of meanings, that involves different disciplinary areas, represent for architecture a new kind of aesthetics (Saggio, 2010). Furthermore, the approach between physical spaces and human beings means that architecture becomes more participating: nowadays architecture is no more a simple static scenery, but an active character of our cities (Boeri, 2000). Like in the Città Invisible of Italo Calvino, the environment is a journey across places and inhabitants, inside desires and fears that we feel when we live the city, when we suffer it (Schank, 1990). This architecture, active and interactive, represents the way to rebuild our contemporary cities. We are called to give a shape and a place to a new kind of space, we do not have to simply construct a built world, we have to construct events and relations (Barzon, 2003).

By arguing this parallelism between the environmental design and the media of communication, the narrative sequences of spaces are a fundamental concept. Actually for every kind of media the narrative structure is very important: it consists in a logic system edited to transfer the message, strongly related to the concept of time.

The traditional media are usually characterized by a linear kind of narrative sequences. Starting from Greek and Latin alphabets the sequence of letters represents the way to create different messages with few signs, and sequences of words have an obligatory form related to the meaning of phrases (De Kerckhove, 2001). Indeed, the act of reading or decoding a message depends on the typology of the narrative sequence of the media. Our life is a story and we usually learn following a story. In-
formation are actually memories and the sequences are strategic to remember them: the past exists if movement, distance and duration exist (Henri Bergson in Jormakka, 2002). This fundamental concept of space and time influenced directly human acts and theories for a long time.

Only in the last century sequences started to be manipulated and recomposed with the introduction of a new concept of time. Classical perception of time was twisted: the idea derived from centuries of thought, culminated with Hegel, becomes obsolete and antiquated. Starting from the Industrial Revolution and until the Information Revolution, space and time are stressed and totally changed. In the contemporary system of IT, the new media are characterized by a kind of narrative which is no more linear but dynamic (Manovich, 2002). The users have to be conceived directly into the narrative space and not as motionless or trapped in some fixed points of a linear sequence: there is no more a before and an after, only a timeless net of points.

In architecture, narrative sequences are systems to arrange the space based on the construction of a complex interface between architecture and human beings. They are a way to design the environment and to connect people with the context and the landscape. This modality of design, that seems so new and contemporary, is actually a traditional way to conceive the space. In the past there are several examples of architectures based on the concept of sequences and in which the narrative connections defined the entire environment. The Egyptian Temples, the Acropolis, or the Villa Adriana are all architectures based on different kind of path composed by settled points, connected through movement. Starting from Renaissance and the invention of perspective, several spaces are also developed by linear spatial progressions (Engeli, 1999), and subsequently some Modern and Postmodern architects explored the implications of the frame and developed cinematic concepts into architectural theory and design.

Sacri Monti, or Holy Mountains, are an Italian invention dating back to the late 15th century and then spread through all Europe. The Sacri Monti are based on a peculiar system of sequences, characterized by the aim of forming a narrative structure all along a route: they are devotional paths composed by a series of chapels which narrate, by stages, the life of Jesus or of a Saint.

The early Sacri Monti were nine (since 2003 World Heritage Site of UNESCO) and they were realized in the Pre-Alps area in wonderful contexts, surrounded by mountains and lakes. The choice of the area was motivated by the fundamental role of San Carlo Borromeo, who strongly promoted these Christian systems during the Counter – Reformation, and by the strategic position of the territories in proximity of Reformed communities (Zardin, 2005). Not only: all these Sacri Monti should have to be ideal Jerusalem of west, made for those unable to do the pilgrimage over the sea, and the places were considered beautiful and perfectly suitable with this goal. They are Cities of Faith created in the middle of woods; architecture, sculpture and painting were the tools to give a shape to these cities.

Considering specifically the narrative sequences and the environment, the most significant example is probably the Sacro Monte of Orta. It seems, even now, a real little holy village upon the mountain standing above the urban center.
Fig. 1
The *Sacro Monte* of Orta on Lake of Cusio.

Fig. 2
The Chapel IX of the *Sacro Monte* of Orta.
Orta is a town across the Lake of Cusio very close to Varallo, the city in which the first *Sacro Monte* was built, and it has a long religious history. The wonderful little island in front of Orta was the place of the legend of Saint Julius, who used his cloak to arrive to the island, to fight dragons and snakes and finally to convert all the people. The grave of Saint Julius, placed on the island, was for centuries destination of pilgrimage. The *Sacro Monte* of Orta was wanted by the community that, in 1583, deliberated the creation of an holy mountain. This was a flourishing period for Orta and the construction of a *Sacro Monte* symbolized the will to create a devotional path, following the example of Varallo, but also a research of an identity for the territory, independently from the island, and, finally, a financial investment (Mattioli Carcano, 2005). The influence of the Franciscans in the area was probably the reason of the choice of the theme: the life of Saint Francesco. Furthermore, the life of the Saint Francesco is a kind of emulation of Christ’s life and it represents a perfect model to retrace for the observant.

The *fabrica* started in 1590, especially thanks to the abbot Amico Canobio, and the project was on order to the monk Cleto da Castelletto, novice of the Tibaldi ². In this first design the *Sacro Monte* of Orta was composed by thirty-six chapels (only twenty were built) and it had the specific aim to recreate a sequential path with a global narrative structure along a route. An important character of the developing of the *Sacro Monte* of Orta was surely Carlo Bescapè. The Bishop of Novara, friend and collaborator of Saint Carlo Borromeo, was the one who followed the projects when Borromeo died in 1584. Carlo Bescapè was able to decline the will and the aim of the *Sacri Monti* after the ecumenical Council of Trento. An important theme of the Council was whether to allow or not the use of images: in the end the Christian Church decided that images were too important to diffuse the faith and to educate the believers, almost all illiterates. However, they decided that a strict and severe control on the iconography was necessary³.

Bescapè organized the *Sacro Monte* of Varallo and subsequently the *Sacro Monte* of Orta with scrupulous attention and modified every detail differing from the Holy Writ. He wanted to educate people and he tried to make all the scenes as clear as possible. He prescribed, for example, that every character who appears more than one time, in different chapels, had to be made always with the same features: even if they were realized by different artists they will be recognizable to the observant in order to understand the narrative sequence. For the same reason Bescapè changed also the position of some chapels and redesigned some scenes (Mattioli Carcano, 2005).

Furthermore, the architectonic style of Cleto da Castelletto, in a measure referred to the classical repertory of Renaissance and to the model of Alessi’s chapels ⁴, is also related to the beginning of Baroque. Indeed, the *Sacro Monte* of Orta had a theatrical mark typical of Baroque (Pellegrino, 1999) which gave, together with the instructions of Bescapè, more credibility to the narrative sequence. One of the fundamental aspects was actually the spiritual experience lived believing to be in the Holy Land and this illusion was the key to develop the first model of the *Sacro Monte*. For this reason all the scenes, reconstructed inside chapels, were composed by full size statues, with real hair and clothes of the time. In this way the believers were surrounded by a perfectly reconstruct parallel world in which every details were studied to increase this pathos. Furthermore, the designers used sculptures to create ensemble groups and they designed movements and facial expressions with a powerful narrative strength.
Fig. 3
The scene represented in the Chapel XIII: Saint Francesco was taken around naked on the streets of Assisi.

Fig. 4
The scene represented in the Chapel XX: Saint Francesco was canonized.
Characters are proposed with direct immediacy, usually using persons taken from everyday life as models, and some of those occupy a part of the scene: everything was made to involve and to wonder the observant. In this way Cleto made the scenes full of naturalness and human feelings and he created, as Franciscans want, a popular place in which every believer could recover himself and empathize with the holy histories. They used theatricality and the power of drama, combined with the trend of pilgrimage, to approach the believer. Similarly to Shakespeare's plays, viewers become actors and every real person is a character (De Kerckhove, 2001).

Furthermore, the path of the Sacri Monti is a way through several chapels designed as little temples with peculiar dimensions. As well as the Tempietto of Bramante in Rome, these chapels are scale models, representation of buildings and not building themselves. The chapels were thought as stages and the entire Sacro Monte symbolized an Holy Place or a City of Faith: they represented other than reality. It is a kind of popular theatre in which time and space are twisted by history. Consequently architects and sculptors did not try to impose their styles to make chapels, they usually copied other buildings using those as models. The environment was perfectly studied to make the Sacro Monte an attractive touristic system able to show at the pilgrim the marvels of arts and nature: it is a park (Stefani Perrone, 1991). Differently from the Sacro Monte of Varallo, there was not the will to recreate a City of Faith: the nature become the fundamental character of the devotional path and the architectures were realized in relation with it. The narrative structure, also, was strongly related to the environment, e.g. the chapel positioned on the top of the mountain is not the last one of the sequence but the most cathartic, in which San Francesco received the stigmata. This is the moment in which God reveals himself and thus the point closer to the sky was the one chosen to represent it.

In the Sacro Monte of Varallo the narrative sequence is less strong and the chapels are more disconnected. Furthermore, the distribution of spaces is related to Renaissance: buildings follow rules of rations and perspectives, gardens and paths are more regular and controlled. The goal is to create an ideal and perfect city. Instead, in the Sacro Monte of Orta the aim is quite different and the environment becomes more important, i.e. perspective was used to underline some natural views. It is a kind of Pre-Enlightened naturalism which removes every type of enclosures and geometries of gardens: 'Men do not educate anymore the nature following principles of their reason or their feeling, but it is nature itself that contains the pure values of beauty and goodness; clearing the fog of social preconceptions, nature educates men to rediscover their deep naturalness meant as a both ethical and aesthetical value’ (Carlo Giulio Argan in Stefani Perrone, 1991: 32).

The organization and distribution of space is also fundamental to create those complex systems of the Sacri Monti. Indeed, Sacri Monti were usually developed following a general plan. This plan was a global design of the mountain through which the devotional path, the narrative sequence and also the architecture of every chapels were studied. Despite the construction of the Sacri Monti could last many centuries, the overall view remained unique, always strictly related to the sequence. In this way the architect of the project had the chance to create a complex and logical system with coherence. Considering this, we can consider the plans of Sacri Monti as urban plans (Quercioli, 2005): the holy mountain was thought as a new area of the town. Fur-
thermore, there is an attention to the context that was extraordinary for the time: the Sacro Monte is not composed only by the built part but all the environment is a fundamental part of it. Plans were all developed basing on the morphology of the places. The direction and shapes of devotional paths, the specific position of chapels and also the scenes were chosen accordingly to the environment. Orography, vegetation, and also views, became instruments to develop the story, to increase the suggestion of the place and to better involve the believer.

The Sacri Monti, in particular, are quite different from any other kind of Christian devotional path, mostly for the importance of the environment. The Calvaries or the Viae Crucis, for example, were realized with no particular connection to the environmental context, while Sacri Monti were all realized upon the top of a mountain. The concept of Holy Mountains is an universal symbol with cultural heritages and theological meanings (Leigheb, 2004). All societies and cultures had found in mountains the image of land limits and the closer point to divine. Starting from the Olympus, or the mountain Meru of India and the Ziqqurat of Mesopotamia, the mountain is a stair to heaven.

Fig. 5
The Chapel XIV of the Sacro Monte of Orta.
In particular, the *Sacro Monti* are places based on the human physical experience and not only on a geometrical parameter or design: thus, they are a kind of architecture in which the idea of narrative sequence is fundamental. Exploring the concept of sequences in architecture, Bernard Tshumi underlined how the spatial sequences are indeed always related more to movement and experience rather than to composition of shapes. In all the architectures characterized by spatial sequences the concept of narration is implicit. It is a narration related to the method, the function or the shape, and which combines the presentation of an event (or a series of events) with its progressive spatial interpretation (Tshumi, 2005). This perception of the space is solved by a series of relations and information which involve a mental kind of process. As Ejzenstein sustained the editing of an art work is fundamental: the act to assembly different images is very similar to our cognitive process. Indeed, the juxtaposition of two images is more than their sum, it creates a new idea in our mind, a new original thought (Ejzenstein, 2011). This idea represents our interpretation of space, it is the way in which we live architecture.

In the *Sacri Monti* the movement from a chapel to another was strongly symbolic: it represented the way of redemption of believers. Concept of movement is all along connected to the suffering and the will of salvation. Starting from the pilgrimages, Christian history is full of lore and habits related to this idea of strain during a path:
Fig. 7
The Chapel II of the Sacro Monte of Orta.

Fig. 8
A detail of the Chapel XIII: the hands painted were added in order to indicate the path to follow for the believers.
it is a penitence, a reconciliation and a preparation for meeting divinity (Zanzi, 2004). Usually all these devotional routes were along the way direct to a holy place, but sometimes they were recreated smaller and closer. In order to design the sacral value of the Sacri Monti the role of the environment is fundamental. The way in the wood has to be a divine path in which the climb symbolized a real ascent of the believers. For this reason, this path is not regular or linear, but it is a meandering and winding route realized to represent all the human difficulties to reach salvation. It is an hard itinerary, through a natural chaos ruled by the divine reason: all the evil temptations were defeated by God and the observant himself had the chance to retrace the same path and to defeat temptations (Ravasi, 2005).

Thus, the powerful of the narrative sequence is fundamental to transfer the idea of movement to the believer. The story told along the path become the key to develop the Sacro Monte and to create a relation between the physical space and the human beings. The concept of narrative sequence, indeed, influence directly the perception of the space all along the route: walking, for example, is a system to write and to read the land (Careri, 2006). As we walk we are creating a direct relation with the environment, our movement is a tool to understand not only the space but also the time. Starting from the Menhir, land changes its nature and, through the human act of writing it, becomes place. As well as a piece of paper, the territory is a tale to live and to walk, while the narrative sequences are the process to write and compose the sentences of this tale. The space exists, in social terms, only related to an activity in virtue of walking6 (Henri Lefebvre in Bruno, 2006: 51).

The Sacri Monti are perfect examples of how an organized and hyper-connected narrative sequence could be the way to create a reagent environment in which the man becomes a flâneur (Benjamin, 2006). Indeed, devotional paths are almost sensorial and strongly related to the landscape. The interpenetration between the story and the environment is fundamental to create a different world in which time and space are twisted and in which the believers can lose and find themselves. The nature and the context are characters of the project and, especially in the Sacro Monte of Orta, they increase the suggestion of the history, being active parts of the narrative sequences. Thus, the environment is an active kind of space developed by the strong perceptive relation between object and subject, a corporeal unicum in which everything is connected (Merleau-Ponty, 2011).

The Sacri Monti function exactly because they were organized following a narrative sequence: they are a medium and they were developed as it. The editing of the path and the chapels was studied starting from the will of the message and from the potentialities of the space tools (i.e. architecture, sculpture, vegetation, etc.). They are an old type of interdisciplinary system in which the connection between the built space and the believer is not a simple feature but rather the key to define the entire environment.

Considering an architecture which is more and more related to the world of communication and the IT, the sequences are a necessary instrument. In order to develop architecture as a medium, the editing and narrative process represents the tool to transfer a message. However, if the parallelism with other media is appropriate and also valuable, architecture has to be considered as a specific medium with its rules
and features. In particular, a strategic and fundamental feature of contemporary architecture would be the capability to bring back the man to the center of a global and connected environment. It would be an architecture able to bridge the gap between the built space and the lived space, a medium which connects these different spaces.

In view of all these considerations, the narrative sequences is the method to elaborate this active environment. Indeed, their similarity to the mental processes made the narrative sequences perfect instruments to design a connected contemporary space in which men are an active part of it. Thus, they could be the way to organize and to develop our contemporary cities and architectures: an integrate interface able to connect the objective design and the human experience. In this manner the environment could be an active system in which everything is connected and through which the human being could exploit every connections.

Notes
2. Pellegrino Tibaldi, called Pellegrini, was an important Italian architect and painter of the XVI century, bounded to the Italian Mannerism.
3. I.e. the text Instructionum fabricae et suppellectilis ecclesiasticae written by Carlo Borromeo in 1577, which reported a list of strict rules regarding architecture, painting and sculpture of religious buildings taken during the Council of Trento.
4. Galeazzo Alessi was a quite important architect and urban planner from Perugia, appointed in 1560 by Giacomo D’Adda, a rich and powerful man of Milan, to realize the Sacro Monte of Varallo.
5. Translated by Carla Molinari.
6. Translated by Carla Molinari.

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The Aesthetic and Ethical Experience in Architecture Education
We initiate a path of reflection about the challenges imposed on us in contemporary education. Inevitably, how to educate towards a sustainable future? The crisis which we live, economical, environmental, but primarily, cultural, through the void of ethical and social values, leads us to this discussion: How to educate? Can we remain as neutral educators or should we assume a more intervening role? What is the role of the teacher? Is it the structure in which the consciousness of the student sustains itself? Like ivy? Or should the teacher be the gardener? Pruning here, watering and fertilizing there. The use of the analogy of the teacher-gardener of Comenius, puts the focus on learning to learn, a process of self-awareness, self-regulation and metacognition by the student. In this process, as educators, we are limited in our intervention by the necessity to promote the autonomy of the student. In this way, in design studio education, we assume the role of the teacher-gardener, but then we face a problem: How can we prepare the student to the reality of the ideal, when the ideal is distorted by the imperfections of human society? In the history of education we find some answers to this question in Plato, Comenius, Rousseau and Dewey, only to name some of them, since this is a recurrent problem in education. In this paper we will focus essentially in the ideas expressed by Dewey because they are more intrinsically related to architecture education. Firstly, we will start by defining an educative experience and its relationship to an aesthetic experience, trying to come up with a sketched definition of this last. Secondly, we will be concern with the definition of an ethic experience. Finally, we will try to answer this question: Can we educate through an aesthetic and ethical experience, in architecture? This discussion brings us to the analysis and to the subsequent construction of some guidelines that could help us when preparing design studio exercises, based on experience, that join together different dimensions of human activity and that provoke a reflection about the limits of our role, both as educators and as architects, in the cultural transformation of our societies.

The aesthetic experience as an educative experience

John Dewey as the main representative of the progressive educational movement through its work argues that we learn mainly by experience but he also warns that not all experiences are genuinely and equally educative, and that it could even be miseducative experiences by the way they promote negligent and careless attitudes, and restrict the possibilities of richer experiences in the future. Therefore what are the criteria that can define an experience as educative? On his book “Experience & Education” (1938), Dewey reflects on the dialectical relationship between experience and education and answers this question. He identifies two criteria that qualify an experience as educative, namely, the principle of continuity of experience and the principle of interaction with the environment. This means that educative experiences must be connected on two simultaneous ways: in time, linking the past experiences, alive in memory, with the present and future experiences; and in space, linking the present experiences with the cultural, social and material surroundings. Bearing in mind these two qualities of an educative experience, we are now going to focus on the definition of an aesthetic experience by this author, trying to answer these questions: Can we say that an aesthetic experience is always an educative experience? Or that an educational experience has always an aesthetic quality?
In the book, *Art as Experience* (1934), Dewey describes reality as a dynamic system of adaptation, ruled by laws of opposition and conflict, in which form arises whenever an equilibrium is reached. Changes are articulated and in a system of symbiotic relationships, order is imposed. In this description of a living complex and dynamic system, we found the key elements of the aesthetic experience, namely, form, balance, rhythm and order. Therefore Dewey characterizes the aesthetic experience as an inseparable element of life. The human consciousness apprehends by sensory perception the real. The sense organs connect us to the real and describe it either by images, sounds, tacts, flavors or fragrances. In this synesthesic relationship of real recording, our minds process the sensory information and manage to identify persistent objects each time it finds them in experience, construct memory and form concepts. This construction of memory and the relationship established between experiences of the past and of the present, constitute themselves as the essential characteristics of an aesthetic experience. Thus, we find here the first point of convergence between an educative experience and an aesthetic experience, the principle of continuity of experience. And he continues describing it as the experience where human consciousness is aware of the path, of the constraints and of the objectives of the action. Wish to understand and is concerned with that which crosses its way, on a dynamic and dialectical process. Thus, we find here the second principle characteristic of an educative experience, the interaction with the context. And we can say that an aesthetic experience is always an educative experience. Thereby we learned mainly by experience and more exactly by an aesthetic experience.

Another author, Rudolf Arnheim, in his book *Consideraciones sobre la educación artística*, states that human cognition consists of two distinct resources. On the one hand, perceptual intuition that is the primary way the mind has to explore and understand the world, and on the other, intellectual reasoning. Through sensory perception, the mind identifies and classifies the objects it encounters, formulating intuitively perceptive concepts. Then these concepts evolve, transforming themselves into intellectual concepts. This evolution is significant to human thought, these are the concepts to which scientists aspire. However, it represents also a loss. When crystallized, they lose the flexibility of thought, the ability to metamorphose themselves according to the context. The value of this dynamic perceptive as an instrument of knowledge of human consciousness is described by Arnheim in three essential virtues. Firstly, the ability to see beyond the visible, to grasp the functioning of the mind, to explore its dynamics, referring to self-awareness and metacognition. Secondly, the construction of a metaphorical language of assigning meanings. And lastly, the psychological phenomenon to which Arnheim dubs resonance, by the way it resonate on the body, through physical phenomena, the sensations that the environment or the images provoke on it. This third virtue emphasizes the value of the experience in architecture education, taking into account that involves the body in relation to space, and simultaneously justifies the need for a space-time literacy.

We have now a better understanding of the meaning of an aesthetic experience and of its role in architecture education. We could said that we can not construct knowledge without going through an aesthetic process. But returning to our main question: can we educate through an aesthetic and ethical experience, in architecture? To answer this question we have now to clarify the concept of ethical experience.
The ethical experience

Some authors, like Herbert Read and Schiller, argued for the existence of a common ground for ethics and aesthetics. In fact, if we take the definition of ethics, as a rational articulation of good (Cunha, P. 1996), the aesthetics would mean the intuitive articulation of beauty. If human consciousness, in a classical revival, desires the good, the beauty and the truth, these different paths must be at least parallel and convergent on the utopian line of our experiential horizon, and in no other field of human activity, as in architecture, we can seize this convergence.

Education is a social process that deals with the duality of developing the self and its singular and innate consciousness, at the same time that it is concerned with the construction of a social consciousness. The singularity of the self, secluded, has no social value. It is only when reconciled with the social unity that this value is made concrete. And then we cooperate, that is, we participate in the construction of a collective identity, offering that which is particular to us. On the other hand, the singular value of society, can be described as the society's contribution to our personal development. The way society shapes and constrains our individual consciousness. The way how the consciousness of the self is born by the confrontation with the consciousness of others. And is by this dialectical relationship of constraining tensions by duty and of cooperation by reciprocity (Read, 1942), that human consciousness constructs its unique ethical sense and this balance constructed is always ephemeral, constantly put to the test. This duality is dubbed Anthropo-ethics by Edgar Morin.

"It is up to humans to develop at the same time, the ethical sense and our personal autonomy (our social responsibilities), ie, our participation in mankind, because we share a common destiny." (Morin, E. s/d).

But can we educate for autonomy and simultaneously socially integrate? Are we educating for autonomy or for freedom? Pedro da Cunha distinguishes autonomy of freedom, differentiate it positively. While freedom is a negative concept, we are free from something, autonomy refers to a free and individual consciousness, governed by laws that are hers, chosen and interiorized. In turn, the concept of freedom in Rousseau is the freedom of consciousness, formed in autonomy, social preserved from corruption, and the birthplace of critical and divergent thinking. Thus, freedom in Rousseau is an ethical freedom or a responsible autonomy, which results in a natural education that we also find in Dewey:

"The only freedom that is of enduring importance, is the freedom of intelligence, that is to say, freedom of observation and of judgment exercised in behalf of purposes that are intrinsically worth while." (Dewey, J. 1938)

And we are now confronted with the question: In this system of education what is the role of the teacher? Can we remain as neutral educators or should we assume a more intervening role? As we have seen our intervention is conditioned. Different authors have describe it as a mediation. For Dewey, the role of the teacher is this role of a mediator, concerned and responsible for the articulation of different educative experiences in time and in space and sustained in the cooperation established in the social groups of learning. The teacher is part of the group. His role is to encourage the expression and development of the self from within, focusing on building experiences linked to its previous and current experiences, and to progressive organize free activities that provoke
reflection habits on the participants of the learning groups. But how could be these concepts applied to architecture education? Actually, some principles that we have been pointed out have already a place in design studio education, for example: the principle of the interaction with the environment, when students visit the site where they are working, to observe, to sketch, to photograph, in synthesis, to construct knowledge about it; and the principle of continuity of experience, when on the first year of design studio education it is proposed to students a small housing project where they could easily refer to their experiences and memories about the theme, and progressively the exercises proposed through time increase in complexity. However, we are concern with a distinct subject. How to educate social consciences? Why is this so relevant in contemporary society? In 1987, the Brundtland Report, *Our Common Future*, defined the model of sustainable development as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Thereby we can framework this principle as an ethical principle. We are talking about ethical responsibility for those who succeed us. And we finally come to the main question: Can we educate through an aesthetic and ethical experience, in architecture?

**The aesthetic and ethical experience in architecture**

This question brings us to the analysis and to the subsequent construction of some guidelines that could help us when preparing design studio exercises, based on experience, that join together different dimensions of human activity and that could provoke a reflection about the limits of our role of architecture, in the cultural transformation of our societies. However, firstly, we have to focus on the meaning of an aesthetic and ethical experience. As we have seen and discuss, we learned mainly by experience and more exactly by an aesthetic experience. So, we can say that an aesthetic experience is the first moment of a process through which we construct knowledge about the world around us. Through sensory perception, the mind identifies and classifies objects it encounters, formulating intuitively perceptive concepts. Then through intellectual reasoning these concepts evolve, transforming themselves into intellectual concepts. This second moment of the process is the moment where ethical values have their origin, through a rational articulation of good. Nonetheless, this process is an ever-evolving process, and to maintain the flexibility of reasoning the dynamic quality of the aesthetic experience, based on perception, is essential. In synthesis, we can say that an aesthetic and ethical experience is the aesthetic experience through which the consciousness of the self, confronting reality, articulates ethical principles. For a better understanding of this definition, we are going to analyse an example.

Twenty years ago, in the first year of the graduate course of Architecture, in the *Faculdade de Arquitectura da Universidade do Porto*, one exercise was presented to all students, by the curricular unit of Anthropology. They have to choose, to visit and to study social and spatial connections in the so-called *Ilhas do Porto* (*Oporto Islands*) and write a report about it. These Ilhas do Porto, despite the beautiful name, are a serious urban phenomenon that results from the Industrial Revolution and that still remains present in our days. Hidden from the city traveller views, there are insalubrious small houses organised along corridors, with common bathrooms and some times common kitchens, where dozens of families live. There is only one way out through a door that communicates with the city and that also serves as a views blocking device.
As one of the students confronted in the process of this exercise with this tough reality, I can say that this experience formed my view of the role of architecture. Architecture cannot remain as an abstract idea drawn in a studio with abstract tools. Architecture must meet and be connected to the social needs and the cultural context, and understand the reasons for social exclusion. On this singular exercise, through an aesthetic experience that confronts reality, the students constructed their own ethical principles. And the teacher could remain as a mediator.

In this moment, we can return to our main discussion and say without doubt that, in architecture, we can educate through an aesthetic and ethical experience. In fact, we do it every day through different exercises in schools of architecture all around the world. But are we aware of this fact? Are we, as educators, conscious of it? This paper intends to clarify these points and highlight some guidelines that could help us prepare effective design studio education. In short:

• We learned mainly by experience and more exactly by an aesthetic experience;
• Educative experiences must be connected in two simultaneous ways. In time, linking the past experiences, alive in memory, with the present and future experiences (principle of continuity of experience). And in space, linking the present experiences with the cultural, social and material surroundings (principle of the interaction with the environment);
• We must value the dynamic perceptive as a knowledge instrument of human consciousness, described by Arnheim in three essential virtues, the ability to see beyond the visible, the ability to construct a metaphorical language of assigning meanings, and the psychological phenomenon of resonance;
• The teacher is a mediator, concerned and responsible for the articulation of different educative experiences in time and in space, and sustained in the cooperation established in the social groups of learning;
• His role is to encourage the expression and development of the self from within, focusing on building experiences linked to its previous and current experiences, and to progressively organize free activities that provoke reflection habits on the participants of the learning groups;

• Education is a social process that deals with the duality of developing the self and its singular and innate consciousness, at the same time that it is concerned with the construction of a social consciousness;

• It is by the dialectical relationship of constraining tensions by duty and of cooperation by reciprocity, that human consciousness constructs its unique ethical sense;

In 1881, William Morris defines architecture as an omnipresent element in all transformations imposed by human needs. However, if so, should not this answer on a better way our needs of quantitative function: shelter and comfort, but also our needs of a qualitative form: in an aesthetic experience? Is it possible to consider a change in civilizational paradigm that unifies, interconnects, on a multiple willingness, full of diversity, form and function, quality and quantity? And where the artistic stimulus transforms the vision of the world as a machine, into the vision of the world as an organism? Maybe. If as architects, we take the responsibility for educating social consciences.

Notes

2. As we have seen, the principle of experimental continuum, characteristic of the educative experience, argues the quality of experience measured in the influence or effect in future experiences. Therefore this principle is common to both.

3. “...if we imagine a stone, which is rolling down hill, to have an experience. (...) The stone starts from somewhere, and moves, as consistently as conditions permit, toward (...) an end. Let us add, by imagination, to these external facts, the ideas that it looks forward with desire to the final outcome; that it is interested in the things it meets on its way, conditions that accelerate and retard its movement with respect to their bearing on the end; that it acts and feels toward them according to the hindering or helping function it attributes to them; and that the final coming to rest is related to all that went before as the culmination of a continuous movement. Then the stone would have an experience, and one with esthetic quality.” (Dewey, J. 1934: 39).

4. “Out of this personal scouting structured in the body experience of those who draws, there could be no conscience or instrumental acquisition.” (Carneiro, A.1995: 67).

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IRELAND

Art/Architecture: a Collaborative Approach to Environmental Studies
Commonage, an action-research project based in Callan, County Kilkenny in Southern Ireland, is a collaboration between artists and architects, which provides an indeterminate space for architects to develop social, entrepreneurial and research skills. The project demonstrates how collaborative practices between the two disciplines could supplement existing methodologies used within environmental design, which typically rely on abstracted data comprising surveys, maps, and metrics. Instead, Commonage has adopted a model whereby architects consider the environmental impact of architecture using skills that are more commonly associated with artists. Specifically, who builds what, where, how and for whom? Consequently, by changing focus from the objectification of architecture to its consequences and its context, and engaging directly on a human and experiential level a closer investigation is possible of people and place.

This case study forms part of an ongoing doctoral thesis on the catalysts, conditions, and contribution of collaborative practices between architects and artists. This particular paper will illustrate how Commonage is a Pandora’s Box, which highlights some of the key benefits and challenges of collaboration within environmental design. It will also argue that, by disseminating architectural and environmental knowledge within communities, there is the potential for an increase in their level of engagement with architects and artists in rural development issues.

Firstly, the paper will outline existing scholarship in the area of collaborative practice between artists and architects. A description of the Commonage project will follow before presenting a fuller discussion of the research findings under consideration and the key questions these raised.

**Existing research and methodology**

Contemporaneous research suggests that collaborative and participatory practices are the panacea for architects to experience and respond to the environmental condi-
tions of people and place (Peter Blundell Jones, 2005, Forsyth, 2010). Very often, these involve architects working with artists or using practices normally associated with them. Yet despite this, and the fact that the two disciplines have historically enjoyed close aesthetic and cultural association, there is little in-depth research undertaken regarding how architects and artists work together. The texts generally associated with this subject are *Art and Architecture: A place between* (Rendell, 2006) and *Two Minds, Artists and Architects in Collaboration* (Fernie, 2006). Both, from different theoretical perspectives, comprehensively document the physical and intellectual nature of ‘site’ and the subject matter of current forms of practice. And although, in recent years there have been a number of similar investigations into the places and the product of collaboration i.e. the ‘where’ it occurs and ‘what’ occurs; (Bjone, 2009) very little research has taken place into the ‘how’ and ‘why’.

This study adopts a research-lead, sociological and anthropological approach investigating these questions through case studies and interviews, a methodology that acts as a fulcrum for the research rather than proscribing it. Although, the research is contingent on the inherent limitations of case studies, the intention is to elucidate aspects of collaborative practice, raise new questions, and stimulate new research in this under-represented area.

**The Commonage project**

Currently a number of projects, such as *Rural Studio*, illustrate how architects work collaboratively within communities in rural environments. These often occur as an extension of the activities of architectural education (Hursley, 2002). However, what hap-
pens when these models are re-imagined by three young artists (two of whom were training at the time to become architects), who look at architecture and the environment through different eyes? This paradigm shift occurred in Commonage, an art and architectural project held annually since 2010, in Callan a small rural town in Ireland. A close examination of this project took place over a three-year period, which followed the project’s development and analysed the metamorphosis that occurred each year because of the reflexive critical practice of the curators.

The idea for artists and architects to work together within the community originated with Patrick Lydon. As a co-worker at Camphill, a community for children and adults with multiple disabilities, Lydon is a charismatic and articulate humanitarian. Although not formally trained in art or architecture he possesses a remarkable understanding of both subjects. Moreover, in common with Camphill’s ethos (based on Rudolph Steiner’s (1861-1925) principles of anthroposophy) Lydon advocates that art and architecture together, can have the ability to shape communities. Indeed, the Camphill philosophy is a persuasive one and presents an inspiring example of social inclusion.

One of a number of Camphill communities is situated on the outskirts of Callan, County Kilkenny, a town with a medieval architectural heritage and, typical of many Irish rural towns, is experiencing problems of unemployment and dereliction due to the negative economic effects of globalisation. Lydon, to encourage the local community to take control of their own destiny, and inspired by a similar project in France Mémoire en Demeure (2004-2007), invited art curator Rosie Lynch to set up an art and architectural initiative in Callan.

Fig. 2
Consequently, in 2010, Lynch, Joanne Butler, and Tara Kennedy established *Commonage*. The inspiration for the name came from their intention to investigate collectively owned or managed sites within the town. Described as a five-year architectural research project, it initially had a loosely defined brief that suggested how artists and architects might together explore conceptual ideas about architecture within the community (Commonage, 2010). Over the following three years, slowly and reflexively, they built up a remarkable body of work.

In the first year, *Commonage* created an art and architectural exhibition in the previously disused Co-Op on the town’s main street. They also organised a series of temporary installations throughout the town. One of the most memorable was *Missionary 52,-7* by *The Good Hatchery*). This involved a temporary outdoor installation on top of the Motte Hill in the centre of Callan, a site of considerable historic significance but with underdeveloped access for townspeople and tourists. The temporary architectural forms and high-powered lights (attached to a high-loader) dramatically illuminated the night skies. The installation succeeded in catching the imagination of the local community during its construction, which involved local co-operation to get the machinery, materials, and services to this relatively inaccessible location.

That year Butler and Kennedy, working as *Culturstruction*, observed how the local teenagers used spaces off the main thoroughfare to meet and congregate. In response, the artists built a temporary platform entitled *Glittery Embrace* behind a sewage pumping station at the end of Clodeen Lane, which overlooked the river. At night, the illuminated platform glowed and provided a picturesque riverside meeting space. Furthermore, throughout the town, the artists situated other installations, and in new and innovative ways re-imagined public spaces that were previously undervalued.

![Fig. 3](image-url)

*Culturstruction (Jo Anne Butler & Tara Kennedy), Glittery Embrace, 2010. Photograph: Henrietta Williams (2010).*
In a letter to the Arts Council Lydon described how events had unfolded in a way he had not anticipated (Lydon, 2010). These had highlighted the town’s environmental and heritage features and had exposed some members of the community to new skills and opportunities. He explained that although Commonage 2010 did not propose any solutions to Callan’s infrastructural problems they inspired the local community to see their environment in new ways. He also noted that a number of local trades people (some of whom were unemployed) volunteered to be involved in aspects of construction. He commented on the level of interest in the Co-Op as a cultural centre and the fact that young people were ‘beguiled’ by the platform created for them.

In the Commonage team’s own review of the 2010 architectural festival, they came to realise that the clearing out of the old Co-Op building was the most important thing they had achieved. Moreover, they saw parallels between the student’s contribution to this process and the Irish ‘meitheal’ – a tradition where rural communities would collectively build a house or a barn (Stevens, 2007: 86) a concept that had originally inspired Commonage. To build on this in 2011 the curators changed the format of the week-long festival to explore the potential of collective building; this comprised a series of temporary built interventions, an exhibition, a summer school and symposium.

However, shortly before the 2011 festival, an event took place at the Co-Op store, which caused the curatorial team to pause and seriously consider how they engaged with the community in Callan. They explained that ‘severe acts of vandalism to these buildings in spring 2011 directly called into focus our ideas of engagement and publicness’ (Commonage, 2011). Their concerns reflected the fact that for the Callan Community, the boundaries between Camphill and Commonage were often difficult to distinguish. Although some of its stakeholders, such as Camphill and The Kilkenny
Leader Partnership (KLP) - the state development agency in the area - might view this project as a ‘community project’, this was not Commonage’s intention. Consequently, and mindful of the community’s positive responses the previous year to the reactivation of the derelict Co-Op building, they decided to develop this resource further. This resulted in Butler and Kennedy (practicing as Culturstruction) designing an outdoor multi-purpose arena, Breach (2011) in the Co-Op yard. Moreover, the team employed local tradesmen and sourced local materials in its construction. To help install sound and lighting systems for the various events they employed Callan youths who they subsequently assisted to set up in a new company, Flashlight to sell these newly acquired services. Ultimately, they provided the town with a new cultural focus in a building that, for many residents, held special memories as a meeting place.

That year 26 participants comprising a variety of disciplines attended the newly initiated summer school. In addition, the provision of the multi-purposed space had facilitated holding a one-day seminar. This allowed the team to invite speakers of international standing, such as Oliver Lowenstein, Editor of the UK journal, 4th Door Review and Eyal Weizman, Director of the Centre for Research Architecture at Goldsmiths, University of London. The seminar provided a vehicle to disseminate and redefine Commonage as a forum focused on both doing and thinking. The summer school attendees also participated in the construction of two other commissioned interventions in the town designed by Architects TM and artist Rhona Byrne. The positioning of these works was designed to open up an under used right-of-way and walkway. This ran from the Friary Meadow, along the proposed route of the river walk, under the Edmund Rice Bridge and over the Millrace to the historic and difficult to access, brick-lined walled garden of Westcourt Demesne.

By 2012 the summer school had grown to fifty attendees from Ireland and abroad (Commonage, 2012). Moreover, the team described the project as a ‘curatorial, design and research studio’. In recognition of the fact that the project was already developing its own narrative Holly Kearns, art historian, joined the curatorial team. Highlights of the public events that year included a talk by architect Nozomi Nakabayashi entitled, ‘The Big Shed’, which described the UK based Architectural Association’s, Design and Make project at Hooke Park. Also Ruth E. Lyons and Carl Giffney of the Good Hatchery, Nuno Sacramento of the Scottish Sculpture Workshop, and Adam Sutherland of Grizedale Arts (on Skype) joined the Commonage team in a debate entitled, ‘Following Farming’. These and other events provided a broad platform to discuss various social, political, and environmental aspects of architecture. The participants were encouraged to debate and contribute their own ideas; thus providing artists, architects and other cultural practitioners a relatively unique opportunity in Ireland to talk about their work and their aspirations for architecture in a public forum.

Commonage’s intention for 2012 was to focus on participation in the building process and in particular to investigate the, ‘thinking, making and doing of architecture as a research project’. Accordingly, the curators proposed that, ‘during the summer school we will continue to explore the building process as a collaborative and shared non-hierarchical event’ (Commonage, 2012). As a result, the programme centred on three collective building workshops, with the participants forming teams which rotated every few days between each project. Workshops comprised The Sea-
sonal Bridge, facilitated by Deidre McMenamin and Dougal Sheridan of LID Architecture, which explored how we experience landscape and how this informs design.

Secondly, Callan Gate, lead by Gearóid Muldowney of Superfolk, addressed universal access and collective design within local craft tradition. Thirdly, a collaborative endeavour for the Camphill farm at Westcourt to build a cow house was lead by the Cowshed Collective. This latter group comprised recently qualified UCD School of architecture graduates: Michael Hayes, Samuel Kane, James Kennedy, Scott Morton and Albert Tobin.

For artists and architects Commonage provided opportunities for creative practice to occur where the normal constraints of architecture were suspended. This was a bohemian milieu, where artists and architects engaged to actively research and talk about architecture on a level playing field.

**The architect as an entrepreneur**

In Commonage, the young artists have acted as cultural entrepreneurs. They have shown that they are willing to take professional risks with a ‘get-up-and-go’ mentality. At Art College the students’ claim they were encouraged to create their own opportunities to build practice. In contrast, within Irish architectural education, students are comparatively conservative and practicing Irish architects generally conform to the traditional methodologies proscribed by the professional institution. However, in the current economic recession in Ireland, new ways of making and initiating architectural practice in Ireland make sound economic sense. Creativity, innovation, and motivational skills, are increasingly valued within the business world as flatter operating
structures replace traditional hierarchical models. However, entrepreneurial attitudes and behaviours develop by offering opportunities for these to take place; providing a space for this to occur for students can be a challenge. Business educators Alain Fayolle & Heinz Klandt suggest that entrepreneurship is nurtured somewhere ‘between academia and practice’ (Klandt, 2006: 2-7). Commonage provides this space, between architecture’s three key influences, academia, the institute, and the commercial world. In this space, collaboration between artists and architects has created opportunities to nurture and enhance entrepreneurial skills in architects.
Understanding the rural condition

*Commonage*, through its collaborative approach, succeeds on a relatively ambitious scale to provide an opportunity to consider the environmental consequences of architecture and to research the rural condition. Moreover, current academic thinking goes beyond the object of architecture and accepts that it has social, economic, and political implications. Richard Sennet (Sennett, 2008: 146-8) talks about the responsibilities of the makers of things to consider their consequences which the thinking/making process allows. Indeed, *Commonage* facilitates a phenomenological and intellectual appreciation of aspects of place-making not easily captured in abstracted data, maps, or surveys that architects normally consider. Lucy Lippard describes this type of knowledge as a ‘kinaesthetic’ understanding, which she ascribes to ‘the flavour of a society, the beliefs and activities of people who make up a given place’ (Lippard, 1997: 33).

Furthermore, Elmes et al (2012) consider that providing an opportunity to experience directly embedded knowledge within communities can facilitate entrepreneurship amongst sociologists. In the same way, collaboration enables architects to apply innovative ways to address the architectural needs of communities. It also provides them with an opportunity to consider the social, economic, and political consequences of architecture in a small rural town. Indeed, UCD alumnus Kevin Roche (RTE, 2013) advised architectural students “To try to create a living and suitable environment for the community, to move the community forward;” also “at times we think of it [architecture] as a profession but our responsibilities go way past that”. Indeed, *Commonage*’s engagement highlights the actual detachment of the architectural profession generally from these issues, as rural studies have received less academic attention than urban studies. Furthermore, since the 1990s, a strengthening of urban centres in Ireland has taken place at the expense rural communities, which have experienced a decline (Gurdgiev, 2006: 101).

Empowering communities

On a national level, planners and economists generally struggle to influence strategic environmental decisions. However, Knox and Mayer in *Small Town Sustainability* (Mayer, 2009: 268-71) suggest that at a local level it is possible to influence prospects by cultural and creative activities. They describe the process within small towns as one that is intrinsic rather than instrumental. Moreover, *Commonage* succeeds not only in improving architects’ capacity to engage in environmental design but also, in improving communities’ capacity to engage with architects and artists on these issues. In 2010, Patrick Lydon wrote:

> While local people do not have the language or concepts of architectural change, they are painfully aware of the conflicting experiences of a proud heritage and advancing dereliction... (Lydon, 2010).

In this regard, *Commonage* illustrates how this type of collaborative project can provide a lens to enable the wider public to focus on architecture’s role in creating better environments. By working directly within the community, it is possible to illustrate how the skills and concerns of architects comprise more than normally associated with them as designers and purveyors of buildings. Importantly, open discussion in
talks and seminars facilitates the demystification of the language and knowledge of architecture. This embedded learning model also occurs through praxis by involving the community in the various projects; and it is reinforced as local tradesmen develop new skills in traditional craft methods and technical skills. In this sense, Commonage has built social, cultural, and civic capacity within the community to effect change. Indeed, Patrick Lydon exemplifies the phenomenon of building capacity in the users of architecture to empower architects. As an ‘agent of change’ within the community Lydon, with his knowledge and interest in architecture, advocated its potential to shape environments and initiated this transformative process (Nishat Awan, 2011:30-33). In doing so, he illustrates the benefits of a wider public engagement with architectural and environmental studies outside of traditional formal education models.

Commonage reflects how, at a local level, communities can influence their prospects by supporting collaborative projects between artists and architects, and the project delivers on a number of the criteria cited by Knox and Meyer (2009:268-71). These include the re-purposing of the Co-op building, the creation of the platform for teenagers to gather and The Seasonal Bridge. In addition, between 2010 and 2012 other physical changes in the town occurred, as local shops and cafes decorated their premises and modernised their retail offering to attract the new visitors to the town. Local families provided accommodation for students attending the school bringing in valuable extra income.
Defining project frameworks

*Commonage* has created an indeterminate space with loosely defined cultural boundaries. However, creating this space within a community does not come without responsibilities, which require consideration, as highlighted by the acts of vandalism to the Co-Op store. These concern the project’s representation where there are apparent contradictions that are worth considering. As in similar initiatives, *Commonage* is reliant on funding from the State and as such, it is politically constructed (Phillips, 2009: 88-99). Moreover, although Camphill’s community ethos was fundamental to the project’s success a co-dependency existed which was not always transparent. This occurred in 2012 when, Camphill provided materials and determined the choice of workshop projects. Consequently, some elements of the community in Callan could negatively construe Camphill’s influence.

This dilemma faces architects working in similar situations and is one that artists have grappled with for a number of years. It underlines the distinction between ‘community architecture’ and an architectural action-based research project based in a community. One works with a community for their collective benefit, the other is an independent project whose goal is to create critical practice on the subject of architecture. Although not necessarily mutually exclusive, the curatorial goals of different strands should ideally be transparent and separately framed. For *Commonage*, to ensure transparency, the activities concerned with Camphill should ideally be ring-fenced from others, not aesthetically, intellectually, or practically constrained by the relationship.

A Collaborative process

In 2010, *Commonage* started their conversation about place in Callan, building on ideas previously developed by KLP and the Camphill Community (Kilkenny County Council, 2009). In particular the intention to develop the river walk. Without attempting to impose any grand master-plan, the team undertook localised investigations in parallel to those ideas. In this process, they created interventions, making new connections between commonly owned spaces including the platform for the youth to loiter, the installation on the Motte and the Co-op building. As a result, they presented new perspectives to the community’s original intentions. Between 2010 and 2012 they followed a slow deliberate process of interventions and events; allowing time to reflect and consider the consequences and possibilities of the previous year’s work. This approach is in stark contrast to the iterative process that architecture normally employs and it would appear to have certain advantages. In a traditional planning process an underlying set of predispositions informs layers of decisions which are built up until the solution emerges in sharper focus. Decisions are developed iteratively often to a point where, if these are found to be fundamentally flawed, it is difficult to start again. Moreover, the planners’ approach encourages singular overarching concepts of development for something that is constituted of a set of multiple and complex parts. In the way that *Commonage* approached this process, they developed elements, or aspects of a plan, that they as artists found to be interesting. These aesthetic investigations were not individually required to meet a functional brief or provide a measurable set of outcomes. Nevertheless, they did open up spaces and suggest possibilities
as a result which allowed the consideration of multiple ideas without long-term commitment. In addition, this initiated discussions about place where the community acted as collaborators in a participatory mode of practice. This combined iterative and interventionist approach shows the benefits of these types of associations. Namely, how the focused innovative intervention (which can also act to release embedded local knowledge), works in parallel to the iterative application of topographical knowledge (reflected in surveys and mapping). Commonage indicates how adopting these types of process can have the potential to affect significantly planning outcomes resulting from a collaborative investigation about place.

Conclusion

In conclusion, artists and architects collaborating in Commonage 2010-2012 succeeded on a relatively ambitious scale to provide an opportunity to consider the environmental consequences of architecture. That is to say, who builds what, for whom and where? This unique cultural initiative in Ireland has provided opportunities for both disciplines to engage in creative practice where the normal constraints of architecture are suspended. As a model for architectural critical practice, the project has established an innovative curatorial framework a space between the commercial world, the institutions, and academia where artists and architects can work together. Within this space, there is an opportunity to nurture cultural and social entrepreneurial skills in architects that are more commonly associated with artists. In addition, architects can experience new methodologies and aesthetic approaches to investigate aspects of architecture and the environment that are not normally the subject of the narrow focus of the profession. This approach has also shown the value of adopting artists’ reflective processes in investigating place that the iterative processes normally employed by architects and planners do not normally facilitate. Moreover, embedding this model within the community empowers that community by inculcating new skills, including an opportunity to learn the language of architecture and the environment. This also serves to raise awareness about architectures’ role in shaping environments as well as facilitating a wider discussion on these issues. Commonage has been a journey, an experiential investigation. Although, this is still a work in progress, it is fair to say that this project has certainly earned a position in the history of art and architectural collaboration in Ireland by its sheer ambition, its vision, and its extraordinary achievements. Ultimately, Commonage 2010-2012 has provided a potential model to demonstrate the benefits of collaboration, between artists, to consider the environmental impact of architecture. Consequently, by changing focus from the objectification of architecture to its consequences and its context, and engaging directly on a human and experiential level a closer investigation is possible of people and place.

Note

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Spatial Analysis as a Means of Exploring and Predicting Human Inhabitation of Space
Spatial analysis of human use of space

Spatial analysis is generally carried out by geographers and planners using Geographic Information Software (GIS) as an analysis tool. Research and analysis tend to focus on large scale environments. Road networks are modeled using GIS network analysis tools which allocate impedance values of distance, time and other variables to relationships between origins and destinations.

Spatial analysis and modeling of smaller scale environments such as buildings and building complexes has tended to be specialist in nature, and within the discipline of architecture, often largely related to energy conservation agendas.

Space Syntax theory and analysis examines the relationship between spatial configuration of buildings or settlements and social effects. (Hiller and Hanson, 1984) This school of thought proposes that the patterns of human inhabitation of space that arise are both responsive to and generative of spatial structure itself. This process is seen as being driven by visibility and movement, resulting in space that is socially experienced as public or private. Research has expanded this understanding to examine social behaviors that are known to be sensitive to public and private space, and to movement generally, and to relate observed real life evidence of such behaviors to spatial configuration.

Environmental design and spatial analysis

There are many ways in which spatial analysis of various types can be of use in relating human occupation to spatial design driven by an environmental agenda; the following are some examples, the latter two related to the research presented in this paper.

- Spatial analysis of space defined by environmental design parameters such as temperature, lighting quality or any combination of variables could similarly be related to human occupation using standard GIS analysis methods. Preference evidenced by occupation by choice of particular environments could establish effectiveness of design parameters in particular cases. Movement patterns within larger environments could be found to relate to particular environmental provisions amongst other variables. Such research could provide valuable feedback on the real life inhabitation of such space.

- Social behavior and how space is used in both buildings and urban environments is understood to be affected by the extent to which space is perceived to be public or private. Understanding the spatial parameters that define public and private space can enhance fit between environment and occupier and create smoother functioning environments, which intrinsically conserve energy and resources in operation.

- With regard to the urban environment, urban activity is seen as sustaining urban life and healthy urban environments. Analysis using either visio-spatial or movement networks reveal high correlations between measures of network connectivity and pedestrian movement and presence. High pedestrian movement and occupation levels are associated with urban activity, particularly retail activity, which is dependent on passing trade. Knowledge of spatial configurations that support urban activity in this way is of value in managing and building healthy urban space.
• Pedestrian movement is seen as a desirable travel mode choice, as it has a low carbon footprint; pedestrian friendly environments are seen as environment friendly. Spatial analysis can identify configurational connectivity that maximizes potential for general movement within a network of routes. Specific distances for particular trip types or travel modes, such as pedestrian and bicycle modes can be incorporated to identify suitability of spatial configuration and routes that encourage non vehicular travel choices.

The list is far from exhaustive. The last two items focus on my area of interest in the field of urban design, specifically urban activity and urban networks.

**Existing research in spatial networks analysis**

Research techniques within the field of space syntax use graph analysis of the relationships between spaces defined by axial lines of visibility to explore human inhabitation of space. Such analysis can be applied at the scale of building layout or urban settlement. Visually well integrated space in both buildings, urban space and street networks have been correlated in research with high usage in terms of human occupation and movement in the network under analysis.

Graph analysis of buildings or well defined spaces can be as simple as a single justified graph of connections between spaces in order to establish which spaces are “deep”, “go through” or “go to”. Changing the starting point of the graph changes the appearance of the relationships. In simple systems such analysis is possible with pencil and paper. Figure 1.a shows a typical example taken from *The Social logic of Space* (Hillier, B. and Hanson, J. 1984) ¹

Visual graph analysis takes this a step further and analyzes the relative degree of visibility within a defined network of spaces with regard to the whole network: i.e., from all starting points within the system. ² This requires specialized software, such as Depthmap, available from Space Syntax for research purposes. Figure 1.b. illustrates an analysis of the Tate Gallery and extension taken from the Bartlett School of Graduate studies webpage.

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¹ Hillier, B. and Hanson, J. 1984
² Space Syntax Ltd.
Urban Networks can be analyzed within space syntax theory using the same software. Figure 1.c. shows an example of “global choice (betweenness)” measure of Washington DC mapped by Space Syntax Ltd. Patterns of space identified using integration measures defined by least number of turns bias long, straight streets or sight lines within structures that intersect with lots of other streets or sightlines. In complex grids such as those evolved over time, these lines or streets form a global network structure often representing major thoroughfares, radial, concentric and diagonal, along which major movement in the system passes. Research has found correlations between pedestrian presence and integration measures. (Hillier et al 1993, Turner 2003)

The relationship between these configurational measures and movement were contested on the basis that the relationship breaks down in a regular urban grid, such as that of Manhattan Island, New York City. (Ratti, C., (2004)). Amongst other criticisms, Ratti observed that visually continuous lines run the length of the island, and have differing qualities of movement and occupation, yet are treated within analysis as a single entity. Argument followed regarding movement prediction potential by axial graph analysis based on topological networks versus metric weighted network modeling. Subsequent space syntax analysis methods examined the inclusion of metric effects within topological axial graph analysis, using “restricted radius mean metric distance analysis.” This has the effect of describing local network patterns: multiple centers or patches emerge, differing relative to the degree of metric measures applied. In the same paper urban space is described as seeming to “be globally topogeometric but locally metric” by Hillier et al (2010).

Contemporary and subsequent approaches within research attempting to define spatial network analysis measures using metric dimensions have seen the development of various network analysis software plug-ins for standard GIS software, sometimes combining metric and topologic functions, such as “metric reach” and “directional metric reach” developed by Peponis, J., Bafna, S., and Zhang, Z. (2008) and more recently Urban Network Analysis Toolbox for ArcGIS (Andres Sevtsuk and Michael Mekonnen, City Form Lab SUDT/MIT), which incorporates both metric and topologic network analysis and additionally offers a third unit of analysis: building blocks as network components.

**Research question**

The question posed in my thesis (O’Dea, 2006) could be re-phrased as follows:

*Can “service level” measures (similar to “metric reach”) using pedestrian trip distance parameters map urban potential realized as nodes of urban activity in Dublin city centre?*

Urban activity nodes are pedestrian footfall dependant. Pedestrian movement is distance sensitive. Intuitively, distance should have some part in the determination of spatial configuration measures that relate to pedestrian movement.

The degree of the relationship of configuration to pedestrian movement or presence is not in question here; the aim of this research is to determine whether simplified single variable spatial analysis within commonly used commercial software can produce predictable results.

Finding a suitable metric measure likely to predict pedestrian presence or movement was the first task. Some existing measures were examined as follows:
• The “restricted radius mean metric distance analysis” in space syntax analysis introduces such a metric component. It acts to reduce the analysis to local areas of determinate distance, which naturally produces a patchwork of results within the larger network fabric. The meanings of the patterns are less clear, despite analysis attempts using further graphs derived from the results.

• Measures developed by Peponis include “metric reach”, which he has suggested measures “urban potential”, in that it identifies street configurations with a high value of urban frontage with potential for urban interface. This measure, while using conventional metric network analysis and GIS software, still uses centers of street segments as the starting point for measuring distance, and street segments as the units of analysis.

The above two measures take account of streets as distinct spatial units in some way. This understanding of space as larger cognitive units is pervasive in urban design and architecture. In contrast, movement based analysis uses points of departure and destination as primary units of analysis. This is commonly used in commercial GIS software that includes road network modeling.

• Within commonly available commercial software, the ArcGIS metric network analysis tool that calculates “service level” is similar in concept to Peponis’ “metric reach” measure, the main difference being that the measurement of travel distance is calculated from the node or junction instead of the centre of the road segment. This was chosen as a convenient and appropriate spatial analysis measure within a commercial software package. Figure 2 illustrates the measure graphically.

Fig. 2
Graphic illustration of service area of 400 meters at one node in the study area.
A Case Study in Dublin City

A 5 km² study area in Dublin was selected to contain a number of inherently different spatial patterns in order to reveal concentrations related to variation of connectivity and configuration. Spatial patterns included are regular blocks, cul de sacs, radial and concentric larger network roads, peninsulas, and rail and river route constrictions. The area lies to the south east of the central shopping area, and due east of the historic centre, which is not included in this study. Land uses are mixed residential and commercial, and population density varies accordingly.

A metric network map of centerlines of roads and pedestrian routes was constructed with ArcGIS from map sources and verified by site survey. Intersection junctions formed the nodes of the network and connecting lines were weighted with their metric distance. The ArcGIS software network analysis tool “service area calculation” was used at each intersection. The distance value used was 400 m, the conventional maximum short trip walking distance to shops. The values at these nodes were then used to generate a heat map using Kriging interpolation and banded in 400 meter intervals from 0 to the maximum value generated by the analysis. Figure 3 shows the results overlaid with satellite imagery.

GeoDirectory Database (A Post and OSI) of commercial and residential addresses was overlaid on the heat map to do a visual check for general alignment of warm areas with commercial addresses and cooler areas with residential addresses. Figure 4 illustrates the results.

Nine hot spots with values of over 4000 m were identified for further examination. This cut off point was chosen because it was the lowest threshold at which some known small retail nodes occurred. Figure 5 illustrates these hot spots.
Nine cool spots with values of under 2400 m were identified for further examination. This cut off point was chosen because it identified the majority of the cul de sacs within the study area. Figure 6 illustrates these cool spots.

**The research findings**

- Initial visual inspection of the alignment of heatmap and address database overlay was promising; the red dots denoting commercial addresses generally lay in warm areas. These commercial addresses are not exclusively retail in nature (they comprise offices, guesthouses and other uses) and as such are not necessarily footfall dependant in the way that retail is. Exceptions to the pattern, that is commercial addresses in cool areas, occur in the newly developed Docklands area to the north and top of the map. This is a planned regular grid with a large block structure and zoned landuses, primarily office use, bisected by the barrier of the river. This incongruity can be explained by the fact that land use is zoned rather than opportunistic, and commercial rather than retail. The other exception is where commercial addresses follow one of the radial routes out of the city through a cool zone at the bottom right of the map. This can be explained by strip development as a recognized pattern of urban growth combined with the fact that the cool area it crosses is a large single land use (the Royal Dublin Society exhibition grounds) that in itself is a generator of adjacent commercial activity.

- The cool spots illustrated in figure 5 were examined for evidence in contradiction to the research question, i.e. the presence of retail in unlikely locations of low pedestrian reach. No retail was found, although in area 3 the contour used as a cutoff point defines the edge of a number of restaurants around the Docklands devel-
opment basin. Cul de sacs and islands formed by natural barriers and large block land uses (sports grounds behind residential roads) are easily identifiable by their low pedestrian reach.

Fig. 5
Cool spots.

Fig. 6
Hot spots.
• The hotspots illustrated in figure 6 were examined for evidence of retail and nodes of activity. Retail was found at all locations. However, the extent did not relate to the values mapped. The hottest area did not support the largest number of shops, and vice versa. This suggests there is no obvious quantifiable direct relationship between pedestrian reach measurements and urban activity, other than a general relationship of likely co-existence. This was expected, as the analysis uses only one of many variables upon which urban activity is dependant.

This research further examines the relationship between spatial configuration and urban activity viewed as a product of human occupation and pedestrian movement. It also explores the predictive potential of simple single variable relationship analysis between spatial configuration and human occupation using conventional commercial GIS software.

**Conclusion**

Spatial configuration has been shown in research to relate to human behavior and occupation. Spatial analysis is a powerful tool for examining relationships between environment and inhabitation. Mapping a single variable as shown here illustrates how simple spatial analysis can yield valuable information about urban activity potential embedded in spatial configuration at a general level. Figure 7 shows subsequent extension of this analysis to the whole city roads network, which revealed yet more identifiable nodes of retail activity, including identification of the main city centre retail area and several sub centre retail areas. High land values, plot subdivision, maximiza-
tion of connectivity and accessibility, increased density and intensification are associated with centre formation. Simple measures of pedestrian reach reflect the spatial configuration that evolves from this complex interplay of factors, if in a general way.

**Recommendations**

Use of spatial analysis is not as widespread within architecture as it could be, possibly due to the complexity of existing analysis software and methodology. Some approaches to remedy this would be:

- Education and CPD that introduces the use of GIS and spatial analysis tools via workshops and web based learning forums. This would facilitate greater uptake of spatial analysis as a tool in research and design.
- Increased collaboration between associated disciplines who use spatial analysis techniques (planners, urban designers) and architects in research and practice.
- Development of simpler spatial analysis tools with a more intuitive interface, possibly within popular freeware such as Sketchup or other frameworks, could bring such analysis into wider use in research and design in Architectural disciplines.

Environmental concerns are likely to remain a fundamental driver in design disciplines for the foreseeable future. Relationships between human occupation and experience of design proposals need to be understood for successful realization. Spatial analysis is a powerful tool that can be used to examine those relationships.

**Notes**

1. One such informal analysis of my own home revealed that the room chosen by my partner for his study complied with this theory: it was the “deepest” room in the system, consistent with his desire for private space. Other predictions of the theory relating to “go through” space as public space also held true to varying degrees.

2. In this example there is no “starting point” as all spaces are analysed relative to each other. This example was used to examine how different configurations of extension affected integration measures defined by intervisibility: the optimum configuration for maximum integration comprised a perimeter circulation route with clear long lines of visibility. This also has the effect of increasing legibility. What emerges is a formal courtyard configuration, a configuration that is both traditional and intuitive in its form, endorsed by both theory and analysis.

3. Topological network analysis examines the relationship between elements without assigning a metric value parameter; number of turns or segments traversed are used as proxy distance measures. Metric network analysis assigns value parameters to the segments related to real life conditions, i.e. metric distance or travel time in the instance of movement networks.

4. In effect this entails using a defined boundary of chosen radius- 500m, 1km, etc- to select a portion of the network for analysis, and relating each of these subsections to each other.

5. Metric reach is the sum of actual distances traversable within the network from an origin up to a defined distance and is similar to service area presented later. Directional metric reach adds the further condition of a limitation on the number of turns or changes of direction permissible, in keeping with previous space syntax research findings.

6. The three recommendations can be broadly summarised as 1. Learn to use existing complex spatial analysis- an easy enough task for computer savvy architects as much open material
is available—my own learning curve was steeper. 2. Work with those who know how to use complex spatial analysis. 3. Dumb down the analysis methods and the software. I hope that the research presented in this paper demonstrates the effectiveness of simple analysis and shows that this is not a dumb suggestion; in addition, the freeware Sketchup has shown how software tailored to architectural intuition can become a universally used tool in design of all disciplines. Simplified analytic software is freely available and widely used: the next step should logically be simplified intuitive spatial analysis software for use relating human activity and response to spatial environment.

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Environment vs Landscape?
Where are we now?

Global Context

We are living in a moment of history when the globally recognized power-system is setting down. The capitalist system is creaking and consequently the way of making architecture, which for decades has been the emanation and the material manifesto of this system: Architecture as a product recognizable and reproducible on a global scale, symbol of the architect who creates, picture of the global market.

The context has become global and we are becoming aware that it is dying and architecture and the building process in general are some of the main causes of the global environmental crisis.

For the first time we have a responsibility that goes beyond the client and the city. It reveals a civil liability in which the priorities of the project are to be re-read. There are a number of parameters that we must improve and for which to change our own approach. Sustainability has led us to a reinterpretation of the meaning of Architecture: knowing that wherever you put your hands on the planet, you have to be careful.

At this point to talk about Environment and Landscape is therefore far from obvious. From the research already carried out it is clear the delay in which the debate at European level, not to say the world, is stagnating.

Italy

Housing in Italy, the warped culture, according to which the territory has value only if converted into cubic meters to be built (only new building creates tissue - the culture of concrete) is anachronistic and still deeply rooted in public administration and in its strategies. Between 1990 and 2005, the utilized agricultural area was reduced by 3 million and 663 thousand hectares (Istat). In the WWF dossier (2009:3) on the consumption of cement 2009 year of cement “from 1956 to 2001 the urbanized area of our country has increased by 500% ... the land consumption has traveled at a rate of 244,000 hectares per year ... every day in Italy are cementified 161 acres of land.” According to the Istat report also “in the period 1995-2006 the Italian Municipalities issued building permits for an average of 3.1 billion cubic meters, equivalent to over 261 million cubic meters per year, of which just over 80% for the construction of new buildings”. Istat recorded between 1991 and 2001 an increase of 15% of the urbanized areas, 37.5 times greater than the population growth from the same period of 0.4%.

In the Municipality of Rome an additional 70 million cubic meters are expected. In the Agro Romano from 1995 to 2000 the urbanized area has already been multiplied by seven and the overbuilding provided by PRG amounts to an area of 15000 hectares.

Due to these numbers several paradoxical facts blow up and make the management of the landscape in Italy really contradictory.

Italy has the lowest rate of growth in Europe, but the highest rate of land consumption.

Italy is among the few countries in the world that have the protection of the landscape and cultural heritage in its constitution.

Italy has a long tradition of reflection on these issues, but a landscape education in Italian schools doesn’t exist.
Europe

European experiences, such as French or Spanish, seem to give the rightful role to landscape. They try to offer new perspectives and interpretations of the territory and its interaction with people. Paris is wondering about how to be the metropolis of the new millennium, without forgetting the lesson of Kyoto (and its failure), by putting landscape in the center of the debate of our totally technological / virtual era. Barcelona is recovering degraded or peripheral areas with the rethinking of public space and of its mineral landscape, where the infrastructure of streets and squares fits in constant dialogue with nature.

Re-read the parameters of the sites under this view with a global line of thought, it is more than a formal solution, it can be considered a new settlement.

Building in Africa or Northern Europe bears two different approaches, but there is a common thread that unites them and that goes beyond the technological development or the local formal typologies. The way of being an architect, his conscience, is the thread that wherever you go, whatever is the way you approach to environment, it must not be missing.

We must also record the widespread hope that whatever we do not know how to do it will be resolved by the European Union. In front of the maze of words that prevents any effective protection of the landscape, many countries call for an European Landscape Convention.

This hope implies an European Union that builds itself not around finance, market economy, etc., but pays attention to the cultures that make it up, taking from each country the best it can offer. Just imagine European central institutions that, instead of adding all the complexities and bureaucracies of 27 countries, create simple and decisive standards.

But the European Landscape Convention:

a) is not an act of the European Union, but the Council of Europe;
b) is not and can not be subordinated to national laws, much less their Constitutions, and therefore it can not do anything to improve the intricate legislative situation;

The European Landscape Convention is an initiative of the European Council, an organization geographically broader EU but politically lighter, which includes 47 countries, almost all in the European zone, from the Atlantic to Russia. The Convention was signed by 36 States but ratified by 30, of which only 21 belong to the European Union. Among the states that have neither signed nor ratified the Convention are Iceland and Russia. In the EU, Austria, Germany, Estonia, Malta, Sweden and Switzerland have signed but not ratified.

Italy, the protagonist in the first front row of the launch of the Convention, signed on October 20, 2000 in Florence but ratified only 6 years later.

It is a text of great ambitions but also of profound limitations.

The Convention defines landscape as “a certain part of the territory, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Article 1a), and commits member countries to “recognise landscapes in law as an essential component of people's surroundings, an expression of the di-
versity of their shared cultural and natural heritage, and a foundation of their identity” (Article 5a).

The text contains an irreconcilable conflict between efforts to establish a legal concept of landscape, resulting in regulatory obligations (Article 5), and the vagueness of the definition of Article 1, almost thwarted by art. 2, according to which the Convention “applies to the entire territory of the Parties and covers natural, rural, urban and peri-urban areas… It concerns landscapes that might be considered outstanding as well as everyday or degraded landscapes”.

By creating an overlap of the parties, and without a hierarchy, the text of the Convention is open to too many interpretations that risk to arrive to say that because everything is landscape, nothing is landscape. But the Convention is not a European Union standard and it has not being automatically adapted by the Italian. It is only the attempt to promote a culture of protection in Europe (Settis, 2009:253,257).

A great merit must be recognized, however, to the same: while the Italian legislation has created an intricate overlapping of competences in conflict between them (state, regions, municipalities), generating senseless divorces between landscape, environment and territory, from the point of view of the Convention the equivalence between landscape and territory has been obtained.

**Environment Landscape Architect**

Today more than ever we are affected by a mission. More than before architecture is not only art, it is not only a complex technical engineering, but a social and political position.

We need to rediscover the dialogue with the outside world which too often has been underestimated.

**A “new” knowledge**

We must recover the knowledge that the architect, through his commitment and his work, is at the service of the city, being conscious that it is not only an agglomeration of inhabited buildings but that people live in the buildings. They are not just inert objects but active spaces ready to host life.

To the inhabitants of both the project or the city we must increase the ability to intercept their needs, that does not end with the satisfaction of the functional requirements.

“Here is an expression that summarises a condition that is fundamental to our work, being the marvellous combination between the concept of location (here) and that of being (are), commonly called the context in architecture.” (Jallon and Napolitano, 2011:3).

**Rediscovery and separation**

It’s only few years that we have understood the urgency of giving environmental responses with architecture. New software are already able to provide faster information about sun, air flows. We can talk about a rediscovery of what is called ancient knowledge, the deep culture of the place where we live. It’s interesting to see that in
order to reappropriate this forgotten knowledge we have to enter the virtual world, the aseptic one of the computer.

We have sectorialized so much knowledge that it is difficult to put in place the process of interdisciplinarity that should characterize the formation of the architect. This also happens in teaching. We are able to find any kind of information on the environment but can we really metabolize it and make it useful for the project?

Today a student can know with quick operations everything about the environment surrounding the architectural object that he is designing, but has no awareness of the input that the exterior area can suggest.

Yet it is clear as Mario Cucinella points out that “... the end result of this reasoning is to make a building of which we should be able to figure out if it really works, if it consumes, or if it doesn’t, whether it is efficient or not. In the history, this relationship between climatic conditions and the form of architecture has always been there. The reason why by traveling we are ecstatic by the variability of shapes lies in the fact that these architectures respond to the environmental features of its territory or the geographical areas in which they are born and their compositional and aesthetic characteristics are for the most part the realization of the answers to the many harshness of the climate. From boundary conditions complex shapes arise, very different from each other. Discover or rediscover that there are buildings constructed in 1200 to make ice without any source of energy, nothing, it’s a way to make this a reflection on the relationship between matter and form... I would not want that this speech was interpreted as an endorsement of the new regionalism whereby in Oslo should continue to make the wooden houses painted in red while in Sicily should be built in clay. Conversely, for me to talk about aspects of climate, environmental contexts, means opening a spectrum of languages and not reduce them. Speaking of energy is not speaking about Watt and the calculation of the energy consumption of a building, while important, it remains a technical aspect we put on engineering. A prerequisite, however, is that these issues confronting the designer must necessarily provide a different solution. It is not permissible to make a building made of glass in Abu Dhabi and even if you have made it really, this building absorbs enough energy that they will be forced to demolish it when this energy is no longer available.” (Sassi, n.d.)

**Conflict**

Is there now a conflict between enviromental design and landscape design? There is a risk that, being aware of the delay for knowledge that for years has been put aside, we are forgetting the deep sense of making architecture, which can not be just technical knowledge. Today you talk about context, and this seems destabilizing. It is not surprising that the younger generation of architects use this term. We have to realize that they are doing the important attempt to give a meaning to the word, suitable for the world in which we live, which is perhaps the post-crisis era.

The context, today, is not made of archetypes, types, and styles. It’s an attempt to deeply understand the environment in which we live and to which we must give answers. At the same time, you are likely to talk about environment only when dealing with calculations, cooling, passive buildings, the study of fluids. Instead we have to understand that environment and landscape are elements of a system to be known in...
all their complexity, made up of data, stress and social factors. Only the study of these complexities can give rise to a new aesthetic.

In the introduction to his book, *Flesh and Stone and the city in the Western Civilisation*, Richard Sennet explains the motivation for his research: “I was prompted to write this history out of bafflement with a contemporary problem: the sensory deprivation which seems to curse most modern building; the dullness, the monotony, and the tactile sterility which afflicted the urban environment. This sensory deprivation is all the more remarkable because modern times have so privileged the sensations of the body and the freedom of physical life”. (Olley, 2004:318).

**Beyond the conflict**

**The case of Bure**

The project for the EDF Archives Centre by LAN Architecture seems to be a good model to indicate a possible reunion between the environment and landscape.

**Landscape**

A three-hour drive east of Paris is located the rural part of Bure. Here the environmental reality is light years away from the Ville Lumière, the metropolis of the great architectural and urban transformation. The Mairie de Bure is a small town populated by little more than ninety souls. It remembers those fractions always equal to themselves that are found on the Italian territory whenever you exit a highway and “not-toll” roads are being rediscovered like a spider web that outline the territory.

The highway cuts this small rural aggregation and leads, going for a few kilometers to the south, to the EDF Archives Centre. The typical red clay of the French countryside and the informality of the fields of cultivation extend around, which makes this

![Google Earth, view of the rural area, Bure - Saudron.](image-url)
area a quiet, green plate and sporadically nourish gentle topography variations. The landscape transmits a suspension of time, life here is able to move forward on other rhythms and other rules, we are not in a residual ravine, or in an edge area between two converging urban agglomerations. The campaign is the subject and protagonist of this scenario, everything else is subordinate to it.

It’s important to imagine this place in all its components: the sky contrasts with its cleanness, the aggressive tone of the earth, the fields, at the arrival of the season, just explode in various shades of green, in the shades of the yellow lemon into the most dark, but always intense and alive, colors of the wooded areas. Except for the sound of a few cars that occasionally run through the state, the sounds that populate the campaign of Bure are those of the nature and the work of the fields.

From requirements to design

When the EDF (Electricité de France), the main producer and distributor of electricity in France, a giant with annual sales of around 60 billion Euros, in 2007 launched a design competition for the creation of an archives center in this rural area, the concerns of the inhabitants of the neighbouring towns were not few.

The request made by EDF was explicit and very precise: to obtain a building that meets high levels of energy management, and a deep integration with the landscape. The idea of the client appeared to be so clear that in the initial notice the volume of the future building was already shown: a one-floor building that seems to merge with the horizon line.

The competition was won by the studio LAN Architecture, with a proposal that did not upset the functional program of the archives.

In the new archives the central nodal points were: energy saving, integration and functionality.

Fig. 2
LAN Architecture, west facade, EDF Archivi Centrre, Bure, 2007 - 2008 (photo by Julien Lanoo).
This research brings LAN to question the volume proposed by EDF: in fact, the study of relationships between morphology and performance capabilities allow them to hypothesize a building with 5 levels, to reduce the envelope surface thanks to the increase in the number of exchanges temperature with the outside. Moreover, from a purely functional point of view it reduces by 4 times the number of trips that an operator of the center must do within the system of record. A proposal very far from the idea of a plate to that of a container, which develops the same useful surface on four floors and releases a large amount of floor space, reducing substantially the consumption of the soil.

The problem that arises is that of integration of this object in the landscape despite the new volume, a box approx 18 meters high.

The silence of the landscape contrasts with the dynamism of seasonal changes, which distorts temperature, weather conditions, and the color palette in the territory. The office uses as a metaphor to communicate a chameleon to take the path that makes this great document container.

Metal plates characterize the facades of the stock cube and give rise to a volume that is absorbed by the landscape itself, through their ability to reflect and fade the edges, blur the outline and not to explicit a box that rests heavily on the ground, in the changing landscape of the countryside.

The project also raises the question of what really is sustainable or not. In this period, sustainability is a religion and is almost always translated with a complete mimesis with nature. If you do not see the building it means that it does not hurt. The formalization of the concept of sustainability becomes more important than the deep sense of the term. Green roofs, underground buildings that disappear in landscapes but consume enormous amounts of soil, are just some elements that make a good

Fig. 3
LAN Architecture, energy, morphology evaluation schemes (LAN Archive).
chunk of academia and practitioners not to think on what is really important and be still tied to the concept of image market.

It was crucial to think about the building of a high-performance response to energy consumption, look at the environmental specifications of the site that does not offer other resources than those of the sun and the earth.

The basic requirement was closely linked to the function of the building: to keep a constant temperature throughout the year. The walls absorb the heat and maintain a constant temperature.

With the installation of a geothermal system are used refrigeration units and calories extracted from the ground.

This mix of technologies creates a centre archives consuming less than 30 kWh per m² per year.

A complex and interdisciplinary system

In this project, the choice for a pure form cannot not be read under any symbolic value in itself, the choice is related to the idea to create an object, as generic as possible, which is able to dissolve in the landscape.

On the other hand, it is inherent, in the methodology of the architectural studio, to reject seductive images as generators of the project.

“When we undertake a project we don’t formalize things. There are no sketches, there are no drawings. Much is based on the word that weaves our context, the context of the projecton which a strategy will be applied**1.

Deep study of the proposal convinces EDF, thanks to the ability to have truly understood not only the environmental dynamics, but also the implicit social demands of that place.
“A project has a program has a specific use, has the contextual conditions that give a set of parameters that help us then to develop forms, but all that really makes us say that these elements are variable and not the axioms. Above all, we help to develop a strategy that is quite a sight, or at least a means to cause the scenarios and narratives that somehow go beyond the function itself architecture and design in particular.

At EDF, he sees clearly this approach: a closed object without windows becomes a piece of landscape and develops a look at and in the landscape, transforming the industrial role of the object, almost a sculpture nestled in the agricultural environment of Bure going to be part of local identity. The inhabitants in the evening gather around the center archives to watch the sunset.”

Here the design of the panels that make up the elevations of the archives centre becomes an opportunity to produce a patent for a high self-cleaning cement, thanks to the presence of titanium pigments in the compound.

The panels are made by a skin of 8 cm thick (red compound and pad reflective metal) that rests on a layer of reinforced concrete 12 cm thick, for a height of 15.65 meters.

The EDF Archives Centre in Bure is a project that opens up a broad debate on concepts of sustainability and aesthetics in architecture. LAN is part of a new generation of architects who, while not cutting all ties with the past generations, researches new strategies for the landscape, aware of the ever more pressing responsibilities assigned to the role of Architecture.

The project attempts to rediscover sensory aesthetics. Not anymore an image, but a system of profound knowledge involving morphology, material and cross research data without hierarchy of priorities, where landscape and environment go back to being two faces of the same coin.

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Reconfiguring the Ground:
Agile Operations on Public Space
**Natural environments intertwined with urban life**

In 1977, Marina Abramovich (Yugoslav, born 1946) and Ulay (German, born 1943) executed an influential performance (reenacted in 2010). The two performers were completely nude and standing on the only doorway. Anyone entering the event should squeeze between the two of them in order to pass and in doing so choose which one of them to face. ‘Imponderabilia’ had been re-performing continuously, in shifts throughout the exhibition, for a total of over 700 hours. Apart from its historic importance in art, this performance designated imponderable and immeasurable aspects of human responsiveness.

Relating to innovative design, there are emerging concepts on spatial rituals and phenomena, which cannot be recorded in conventional means and have to be observed in their full actuality. Conveying aspects of a redefined environmental agenda, urban operations ultimately suggest a multilayered and unexpected responsiveness to natural elements.

This paper attempts to illustrate emerging concepts for the regeneration of spaces in public realm and the notion of nature intertwined with urban life. The term ‘agile operations’ is used to describe new ways of designing the city, taking advantage of possibilities and potential offered by the use of advanced technology and ultimate consolidation of natural and human activities in contemporary public spaces.

Among other definitions, the notion of ‘agility’ renders the tendency of human environments to change and transform. ‘Agility’ may also relate to reinforced versions of natural planes becoming highly responsive to urban transformations. In contrast to conventional modernistic concepts, natural elements do not simply exist, but perform continuity and discontinuity, reflecting and incorporating changes and transformations in order to arise new urban discourses.

**Reconfiguring the ground**

The notion ‘reconfiguring the ground’ is used to describe innovative design methodologies. Beyond articulated ecological understandings, this paper attempts to illustrate the emerging notion of nature in public realm. New configurations of urban grounds, as presented in this paper, deploy three distinct methodological aspects:

a. Augmentation
b. Relevance
c. Interactivity

The term ‘augmentation’ is not used to describe new tools but new ways of experiencing prefigured elements. It refers to terrains and environments evolving as highly responsive to transformations. The term ‘relevance’ is used to render conceptions of limitless competencies expressed through new urban sequences and dependent upon emerging methodologies capable of lightening urban surfaces. Such lightened surfaces become subject to continuous alterations and incorporate diverse elements. Finally, the term ‘interactivity’ is used to designate channels through which natural elements may act upon urban environments and urban figures may react upon nature.
Four projects

Through such methodological approaches as they have been described above, this paper presents four (04) proposals concerning contemporary urban interventions. More specifically, they are design schemes that have been completed in the cases of architectural competitions, involving a wide array of participating professionals and aiming at new modes of interweaving between urban and natural elements. The four (04) projects are briefly presented in chronological order and concern similar contexts.

‘Interlaced city textile’

The project ‘Interlaced city textile’ is a proposal for downtown Athens, as an entry to a design competition entitled ‘Athens x4’ and announced in 2011. Every team of participants had been responsible for selecting an urban area of four building blocks, providing the starting point for every urban scenario proposed. The competition brief addressed the commonplace of problematic city density and lack of open space. This problematic, defined as the introduction of the competition brief subject to further development, refers to the majority of Greek cities. ‘Interlaced city textile’ suggests the creation of a flexible, responsive urban fabric, generated by a dynamic geometrical rule, capable of accommodating contemporary environmental features and urban needs.

The central location selected for the pilot urban design scheme had already been subject to decay and urban changes in real time, due to social processes and focused on private capital investment. The design approach focused on areas, which are not at risk due to rapid and extreme urban developments, but related to declined rates of green, quality and quantity of the built volume, aspects of sustainability and articulation of public space.

Despite the lack of public space, however, there is a hidden potential, in the selected area. This potential consists of a hidden outdoor public space, a series of hidden

Fig. 1
Schematic distribution of uses and interlacing of functions along the pedestrian route.
open spaces between buildings that make up each block and a continuous series of urban fronts of apartment buildings on the streets, which are interrupted when they give space to the development of blind sides of common walls between buildings of different heights.

The proposal sets a central necessity of providing public and green open space for local residents. Based on the measurements that the design team made, there has been an estimation of about 775 residents in the area of intervention. An attempt to apply EU standards for green spaces (10sq.m. per inhabitant), presents the urgent need to ‘invent’ outdoor green space in the area. It is obvious open place does not really exist between the four building blocks chosen for the competition. That became the starting point of the proposal and the central concept of the team may be described as the invention of a ‘virtual green square’.

The ‘virtual square’ is the assembly of every square meter of available surface area, vertical or horizontal, as mentioned above in the ‘hidden potential’ of dense urban environments. The ‘virtual square’ consists of:

a) Open spaces at the rear of the flats,

b) The ‘cross’ shaped existing open space, formed by the streets and sidewalks of the area and

c) The sides of buildings facing the streets.

Spatial methodological approach for the main axis of movement, on the ‘cross’ shaped existing open space include:

a) optimal ratio of green and open space for users of space,

b) contact with the three basic elements of climate, light, air and water and

c) serve a number of key urban functions and uses.

The pre-existing urban geometry and the complexity of the design proposal implement an axial intensity of the ‘ideal square’. On one hand, there is the necessary of small-scale uses that apply sustainable proportions for residents and users of the site, in relevance to the open space available and the green surfaces that have invented. The idea of urban functional interweaving (interlaced functions) compounds the ur-
ban space available for the ‘virtual square’. On the other hand, there is a parallel process of investigating successive scales of urban space and privacy, as a degree of familiarity that each new element provides.

The design proposal involves the application of a hexagonal grid. The densification and dilutions of such grid intimate the relationship between the user and public space. This relationship is expressed by familiar spatial patterns at each scale. This grid creates an ‘urban fabric’, which is the initial spatial element of the proposed intervention. This ‘fabric’, apart from creating a coherent operational background, achieves the withdrawal of familiar complexity. New urban micro-scale involves subtle references to traditional Greek villages as well as experiential and sensory footprint.

The extensive, outdoor public space extends far beyond the trace of the street. The ‘interlaced city textile’ implements an ideal quantitative and qualitative public open space. It reinvents the relationship between residents and users of the area and proposes a new urban collective.

The overall proposal attempts to reread the urban environment, by attempting to emphasize on the hidden potential of urban density. The proposal strives to enhance the notion of ‘home atmosphere’ and neighborhood life, through manipulations that create new levels of intimacy. Urban and neighborhood life is ‘downloaded’ on the ‘square’ and the ‘street’, uncovering the hidden boundaries of a new large public, green, urban square. The urban habits and daily life are interwoven with unexpected harmony and public uses, as a new pace for the city. Everything is organized and interwoven through an urban material, the ‘fabric’ of the city, the ‘INterlaced Cty Textile: INCITE’.

‘Gradient fields’

The project called ‘Gradient fields’ is a proposal for the regeneration of a former military camp in western Thessaloniki. It is a project that has been completed in the case of an architectural competition that has been announced in 2012.

Flow schemes generate the essential pattern that is used to trace the area and create new topographies. The proposal describes a new, unified network of public and
green spaces. The main objective is to create a new, public, mixed-use park, improving the surrounding urban landscape and the life of the neighborhood. This network is being developed on a new topography, stretching along the area of intervention. This new topography becomes the dynamic, spatial expression of complex flows and movements of the area and incorporates all uses previously installed.

The functional, environmental, aesthetic and economic parameters are integrated into a single, holistic approach, consolidating complex demands of the area as natural. The ‘Agora’, the ‘Plateia’ and the ‘Koilon’ become the spatial and urban reference organization of the new scheme. The area of the ‘Agora’ (open-air market, underground parking space, refectory, etc.) is characterized by a set of uses of public interest. The ‘Plateia’ area (football field, convertible stage) becomes evident both as a generic open-air assembly, as well as an area of sports facilities. Finally, the ‘Koilon’ is a green open space with recreational uses (pathways, bike routes, and green spaces) and public functions (playground, environmental education park, flower beds, etc).

Overall, the proposal seeks gentle operations reorganizing the area without heavy urban interventions and extensive solid, non-environmentally friendly surfaces. Functions are seamlessly adjusted inside the new landscape. An advanced, triangular subdivisioning system is used to provide the micro-geometry of urban space.

The new mixed-use park integrates in the greater urban context and associates with the new network of public spaces in ways that encourage the involvement of nearby residents. This makes the use of new park facilities safer and more attractive, enhancing the quality of life and ultimately improving social and economic aspects of the area.
The project titled ‘Active mosaic’ is a design proposal for the linear urban axis of Agia Sofia St., in Thessaloniki, that initiates from the old city and expands till its meeting point with the seafront, all the way through historical monuments, century old piazzas and modern urban configurations. It is a project that has been submitted at an architectural competition that has been announced in 2012. The scheme suggests a sentimental reading of the city and its innovative materialization in an active, sensitive urban mosaic.

The design proposal sets off a perceptional experience of public space within the limits of Agia Sophia axis. Humans, whether residents of the historic centre or visitors to the city, become the epicenter of the synthetic process. The way that urban qual-
ties and experiences are perceived by people constitutes the key analytic and syntethic mechanism. The initial reading of the city, in the area of the Agia Sophia axis, ‘tints’ an urban tapestry according to emotional impacts and psychological effects of public space. The range of influence to the user is coded on a diagram of four distinctive sections. These sections are:

a. recalling: contains the notion of memory and historic reference
b. exposing: relates to contemporary activities of the city
c. isolating: concerns the personal reading of the city and the need for temporary ‘withdrawal’
d. loving: relates to subtle, emotionally special moments and experiences

Fig. 7
A sentimental reading of the city and its materialization in an active, urban mosaic.

Fig. 8
The designing of the active mosaic in Agia Sofia square.
These four sections appear in different colors within the synthetic process. The way they correspond with existing and proposed urban qualities exceed geometric characteristics of urban space. A new fragmentation of space derives as a result of the application of this new ‘tinted’ topology on urban scales. This continuous self-subdivision of urban tapestry reaches the very personal human scale. The tiniest urban dot becomes the fundamental synthetic and structural element of the design proposal. This tiny urban dot is described as the ‘mosaic’. A number of mixed, hybrid spaces is generated. These spaces bear a distinct functional identity while at the same time they materialize a level of surplus spatial, emotional, psychological and experiential value.

‘When asking the city’

The design proposal sets off capturing an experiential relationship between the urban history of the square, evolving over time through a procedure of scars ‘seeding’ the contemporary urban field. The ‘seeding’ process is providing for two main urban gestures. Firstly, the existing urban square fabric is extended, in order to meet the surrounding streets. In such a way, the designed area of the square delegates to the boundaries of the surrounding buildings and leads to a significant increase of the urban surface from 7 on 11.4 acres. In addition to that, the pedestrianisation of Oplopiou street, aims at better access to and from the pedestrian district of Ladadika, reinforcing the existing pedestrian network of Kalapothaki and Rogoti streets.

Through extensive research on the history of urban transformations in the area, the architectural composition forms in three stages:

a. an urban heuristic mechanism resulting to key surface manipulations,
b. a new topography of urban flows,
c. the seeding of human points and signs.

The urban heuristic mechanism develops as a conceptual integration of historical data and representation of coded signs and urban concentrations. The new topography compresses traces of movement and action on the square, by different people, at different times. A projection of exaggerated sculptural surfaces settles on urban incisions descriptive of imaginary space that forms a system of contours, not referring to a geographical but a historical, human and cultural terrain.

The proposal aims at the reorganization of open public space and performance of a new urban square, consisting of four distinct functional areas. An ‘urban node’ accommodating the ticket office and cultural info points, a ‘linear surface split’, designed as a sloping path leading to a level of 1.20 meters below ground level creating tracing historic references, running parallel to the ancient defensive city wall. Finally, the scheme proposes a ‘gazebo of memory’ emerging from the urban square surface points and a ‘pier to the sea’ negotiating a new threshold between city and water.

The overall design proposal seeks to the mild environmental balance in the historic urban environment. The scheme enhances the quality of life in the city by attempting a reorganization of open public space, without extensive unfriendly, hard surfaces. The restriction of vehicular movement, by allowing temporary parking in selected parts of the square periphery only, gives public space back to pedestrians and delegates green areas. The scheme performs an urban sound management. It also provides for various sunshade areas, both shading by sustained trees and new proposed
species as well as the shading by the new ‘gazebo of memory’, creating conditions of thermal and visual comfort, on the surface of the new urban square. Finally, the collection of rainwater and the utilization of solar energy meet contemporary energy needs.
Conclusions

How ‘natural’ are natural elements in an urban context? If we claim that our cities are growing more and more capable of interweaving with natural elements then we must ask ourselves how natural are ‘natural’ elements that have been incorporated in the dense urban space of Greek cities.

If ‘nature’ is still understood as a limitless relevance of things, expressed via endless sequences of being in space and time, then there are many questions arising that concern the terms of such interweavings.

Design operations presented here, convey aspects of a redefined environmental agenda, which is distant to commercial, technical, ‘green’ solutions. They result in spatial proposals that ultimately suggest an unexpected version of consolidating nature and human activity in contemporary public spaces.

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