EAAE Transactions on Architectural Education no 45

ARCHITECTURAL DESIGN & CONSTRUCTION EDUCATION

experimentation towards integration

Editors: Constantin Spiridonidis and Maria Voyatzaki

european network
enhsa
of heads of schools of architecture

Lifelong Learning Programme

EUROPEAN ASSOCIATION FOR ARCHITECTURAL EDUCATION

ENHSA-EAAE Architectural Design Teachers' and Construction Teachers' Networks

Architectural Design and Construction Education

Experimentation towards Integration

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Despite the attempt to transcribe with accuracy the debates from the workshop, the editors wish to apologise in advance for any inaccuracies of the interventions of individuals that could be attributed to the quality of recording.

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Experimentations towards Integration: An attempt to gather good-practice examples

Architecture as manifestation of our culture in space emerges through a creative synergy of artistic expertise, technical intelligence and scientific knowledge guiding the act of designing buildings and structures. The process of design through which architectural forms are produced is primarily driven by values, principles, ethics and objectives directing the creative manipulation of mass, space, volumes, materials, textures, light and pragmatic elements such as cost, construction techniques and technology, in order to achieve an aesthetic, functional and meaningful end.

Architects are involved in the creation of the built environment by translating into built forms and spatial organisations the socially and culturally defined demands of persons, groups or bodies. As agents who transform through the architectural design practice the citizens' needs into designed proposals of physical space to be constructed, architects should be able to operate within a variety of client, architect, management and builder relationships in an effective and professional way, within the constraints imposed by the building and construction industry, the project budget and the brief. This is why architects must possess a systematic and broad body of knowledge, skills, and theory developed through education, graduate and post-graduate training, and experience. Architectural education should be structured to assure clients that architects are engaged to perform professional services, meeting acceptable standards and enabling proper performance of these services.

It is more than 25 years that architectural education worldwide experiences a progressively growing modularization of the studies offered by schools of architecture. As the number of offered modules is growing, the links between them become increasingly weak and unable to assure continuity in the taught contents. The fragmentation of the teaching contents renders architectural knowledge to be offered a set of disconnected smaller entities with no clear directions for students to make the necessary connections in their effort to develop an understanding of the wholeness of architecture and thereafter to form a competent profile for practising architecture. The central question that this workshop raises is if contemporary architectural educators as well as the educational system as a whole have developed the necessary teaching methods, techniques and tools for integrating the fragmented and progressively isolated taught parts into a complete and coherent body of knowledge.

In the last few years we are experiencing significant changes in all aspects of contemporary architectural practice accompanied by new approaches in architectural theory and contemplation. All these changes in the way we understand, think and create architecture run parallel with the extremely fast development of advanced information technologies and digital tools supporting architectural design in the process of generation, representation and simulation of architectural forms. In parallel, the construction industry, responds to the new orientations of the formal and technical aspects of architecture, uses the same technology and even more the same or compatible digital infrastructure, in order to produce new materials, depended upon new construction techniques requiring specific technical knowledge. All these radical changes affect the education of the architect since the demand for integration becomes now imperative. New competences emerging from the need for integration are now of vital importance; new knowledge is necessary and new concepts and conceptions are definitely affecting the profile of the contemporary architect. The request of this new profile influences not only the contents of the subject areas taught in architectural curricula but also the whole system of studies, as it is responsible for the coherence of the education offered and the integrity of competences to be fulfilled.

One of the main characteristics of this new profile is the ability of the architect to experiment and to create innovative architectural forms by using new materials, by implementing new construction techniques, and by applying new forms of structures depending upon new sets of standards and constraints. In this new condition, the creation of architectural forms is not any more based upon a standardized construction process, upon well-known techniques and well-established materials able to materialize a broad spectrum of conventional architectural forms. The design of form must be anticipated alongside the construction logics, integrating all the constraints of the emerging new materiality. The growing demand for professionals able to collaborate in interdisciplinary teams with a global understanding of the interconnection and associations of all the elements that comprise architecture renders integration one of the key issues of contemporary architectural education.

There is a clear paradox between the objectives of contemporary architectural education and those of contemporary architectural practice, the former being about fragmentation, the latter being about integration. The question arising is how we can organize architectural education and deliver our architectural design and construction courses in a way that will enable us to incorporate in our teaching the inseparable active presence of a way to think about the form with a way to think of its materiality. We all accept the design studio as the melting pot of architectural knowledge but is it really the place where all the fundamental knowledge has easy access? How will the traditionally separate courses of architectural design and construction be redefined in order to assure the ability of graduates not to design forms that another specialist will know how to construct but to create forms conceived on the basis of their unconventional materiality? How can we teach architectural design and construction assuring the creative synthesis of the designed forms with the aspects of their materiality? How can we offer integrated knowledge where structures, materials and forms are one unique and inseparable question-issue? Does architectural education need to re-consider or even invent new teaching methods, techniques and tools in order to achieve this goal? How is integration taught? What are the necessary assignments to teach integration? Is it a bottom-up or a top-down process?

The fifty-eight contributions of this volume give us the possibility to feel the spectrum of the approaches to the contemporary perception of the integration as teachers in forty schools of architecture from eighteen European Countries practice them. We have had the possibility to follow how architectural design teachers of these schools understand integration and what innovative approaches they have developed in their architectural design teaching in order to assure to their students the capacity to think of form through its technical and material aspects. To investigate how they teach their students to find poetry not only in their formal propositions but also in their tectonics. To explore how they introduce students to think of form, construction, material and structure simultaneously and in integration as a coherent whole rather than a sum of independent parts. To examine how they introduce their students to define strong concepts through studying the materiality of their forms.

We have also had the possibility to follow construction teachers in the respective schools of architecture to present their understanding of integration and the innovative approaches they have developed in their construction teaching in order to assure their students the capacity to encompass the tectonic aspect in the forms they imagine. To survey how they introduce their students to envisage the technological implications of formal decisions in their design practices. To be able to turn the material and technical limitations to the advantage of their designed forms. To think of form, construction, material and structure simultaneously and in integration as a coherent whole; to re-define and re-assess the profound content that the materiality their forms can offer to strengthen the quality of their architectural propositions.

The volume expects to formulate the conditions for an interesting academic input on the basis of which a constructive debate can be formulated on the issue of integration aiming at bridging the most outstanding but artificial separations in our educational systems, that between architectural design modules and construction modules. We also expect that the innovative approaches presented in the volume constitute a collection of good practice examples able to inspire more teachers and to influence changes in our educational approaches.

Constantin Spiridonidis
Maria Voyatzaki

Keynote Lectures

Marco Verde

Eng, March | [P]a | Hyperbody
TU Delft

Friction
Experiencing computation, matter and data-driven manufacturing

In order to address a consistent innovation of an ever-increasingly data-driven practice, the designer must become an interdisciplinary specialist. The architectural domain demands a change, to depart from rationalistic approaches to the project practice, and traditional non-efficient building technology, often characterized by artisanal manufacturing and assembly techniques.

Novel generative design strategies can be reformulated through the experimentation and integration of data-driven techniques. The shift towards a process-driven practice requires not only a solid understanding of the computational logic as instrumental to the generative process, but also a compelling demand for an exploration of material performances and computer numerical controlled (CNC) manufacturing processes. Today's designers need to rethink alternative strategies in order to establish a robust connective tissue between disciplines and specializations. Contemporary Information Technology (IT) provides the instruments to approach a cross-disciplinary experimentation. Thus, an aptitude for exploration is needed for the entire design process, from the earliest generative trials until the production phase. Indeed, the materialization of these new digital productions on a real building scale demands a radical innovation in non-standardized building solutions as well. The paradigm shift implies rethinking buildings as integral systems rather than the juxtaposition of optimized and monofunctional layers.

One of the main challenges of data-driven architectural practice is maintaining consistency from design to materialization. Thus, by pursuing a holistic nonlinear approach and an interdisciplinary methodology, designers can move away from a traditional linear production workflow based on a succession of fragmented processes. Through the pursuit of integral design strategies, the boundaries between the specializations of the architect, engineer, materials engineer and builder become blurred.

This article is rooted in a personal research initiative called *Performative Design Processes for Architecture* ([P]a) founded in early 2007. [P]a is currently under development at Hyperbody, the research group guided by Prof. Ir. Kas Oosterhuis at the University of Technology in Delft. [P]a research practice focuses on the development of innovative strategies to integrate computer-based design, data-driven manufacturing processes, and material performances.

Design Intelligence

At the beginning of 1970s, Frey Otto and his project team developed the net structures for the Olympic Stadium in Munich. The entire structural system had to be prefabricated, assembled in the ground and later fixed in the final position on pylons. In cable net structures there is a strict relationship between the form and the loads working on the given system. One of the biggest challenges was the calculation of the length and the thickness of each single cable and the development of the pattern of these in order to achieve the expected shape.

Otto's team sought to employ a computational system to process the complex calculation. The technology employed at that time to provide computers with data-storage space was called magnetic core memory. This was a magnetic circuit of several cm in area and each magnetic core measured several millimetres in diameter and storage capacity was limited to a few kilobytes. In general those early machines, compared with current systems, required a long time to process data. Therefore, although Otto's team used the most powerful computer available at the time (the Control Data Corporation CDC-6600), only part of the structural calculation could be solved with computer aid.

However, the empirical experimentation was at the core of Otto's team project practice. During the entire development of the structures for the Olympic Stadium the team built accurate physical prototypes which drove the Form-Finding process and provided the necessary information to study the behaviour of the system. (Figure 1).

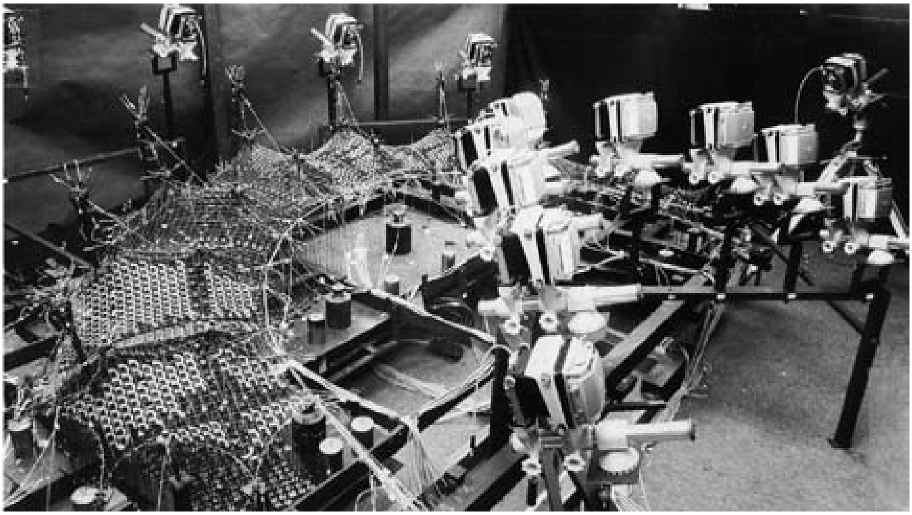

Fig. 1

Munich Olympic Games. Frei Otto. Final pattern model tests of the stadium structure: asymmetrical loading case. (1967-72)

It can be said that a robust methodology informed the design strategy and the integration of disciplines was critical to the success of the project. Biologists, architects and engineers, palaeontologists, mathematicians and ecologists; even philosophers and sociologists were used to combine their expertise in the research projects developed at the Institute for Lightweight Structures in the University of Stuttgart directed by Otto. A method rooted in the integration of discipline and the interaction of specialists could cover for the low performance of computational systems.

By means of the ever-increasing calculation performances, contemporary IT fosters a data-driven interdisciplinary practice while providing instruments to link the knowledge of different specializations. Indeed, the new instruments demands alternative methods to explore the new potentialities.

In this scenario, there are several questions and assumptions which foster the research on Performative Design Processes for Architecture, such as: What disciplines and specializations are contributing to shape new intellectual framework motivating design innovation? As the move towards mass-customization of production systems hosts the potential for a decisive break in materializing novel design processes and efficient production techniques, what effect does this have on architectural praxis? The challenge for today's designers lies in the shaping of a new design intelligence, whereby the process of development by experimentation through every stage of the design process becomes significant to the success of the final result. How can computation, matter, and data-driven manufacturing combine to form a new cross-disciplinary framework?

Ubiquitous Computing

"Computational thinking is influencing research in nearly all disciplines, both in the sciences and the humanities. [..]Computing has enabled researchers to ask new kinds of questions and to accept new kinds of answers, for instance, questions that require the processing of huge amounts of data. [..]Computational concepts provide a new language for describing hypotheses and theories. Computers provide an extension to our cognitive faculties. If you want to understand the 21st then you must first understand computation".
Alan Bundy (2007)

All products of contemporary society are processed through information systems. Furthermore, these provide new possibilities of interaction and production while altering our society, economy and way of thinking. The Internet, for example, is one of the biggest phenomena of the information era. This is a machine (only 6000 days old) but the logic of the "network" is becoming pervasive. Contemporary IT connects goods and consumers through continuous non linear flows of information.

The friction with computer-based technologies, information systems and computerized production techniques contributes to change the designer's practice as well. Computation, using exponentially increasing calculating performance, allows many fields of industrial production, like Aeronautics, the Automobile industry, as well as Product design industry, to work with a degree of complexity far greater than was previously possible. Thus, computational systems contribute to the development of products which were seemingly inaccessible before.

The presentation of the Turing Machine in 1937 has been crucial to the development of modern computational thinking. The Turing Machine was an "abstract machine", an operative model designed to process mathematical functions through a set of mechanical processes. The new approach to mathematics suggested that all processes suitable to be executed through a sequence of mechanical operations are computable. Such a relationship among mechanical and computational processes is described by Stephen Wolfram in the formulation of the Principle of Computational equivalence: "All processes, whether they are produced by human effort or occur spontaneously in nature, can be viewed as computation" (Wolfram 2002).

The exploration of the linkage between computational and material processes is crucial. The evolution of the Spline tool, for example, is an interesting case to discuss this relationship. In the 1960s, before the advent of CAD, draftsmen employed the Spline device with weights to draft on paper the smooth shapes of aircraft and ship. The tool consisted of a flexible plastic or wooden pipe and some weights connected to the pipe. (Figure 2).

The Spline curve was described in the 1950s as a precise mathematical (thus computable) function. After the advent of computers, the move from the physical system to the computerized solution set the basis for a radical innovation in design. This gave birth to a new kind of geometry called Nurbs. Nurbs are today ubiquitous in CAD, CAM and CAE systems and are largely employed in the design industry.

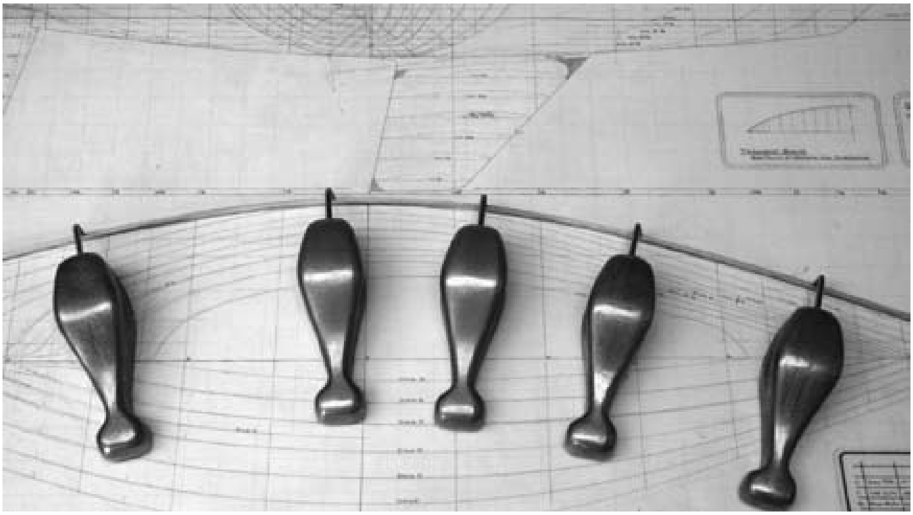

Fig. 2

The Spline tool with weights. Draftsmen could find the desired smooth curves by manipulating the position of the weights to bend the strip as needed. The devise was used in aircraft and ship-hull design.

The architectural domain, engaged with this move, partially adopted contemporary IT such as CAD and CAM processes, but these often pointed towards developing technical upgrade of routines instead of defining novel strategies. Indeed, the move towards an innovative practice demands the understanding of the generative capacities fostered by the computational logic and implies establishing new relationships with material processes to address the physical qualities of the designs.

Materials revenge

Product design industry is exposed to continuous innovation in material technology. Smart materials, advanced polymers, shape memory polymers, and composites materials are only some of the results of this development. In many specializations this evolution already contributes to alter a designer's practices, but it seems that architecture is still not completely geared to this process. Often the practice of architectural design and its materialization are not coupled through a holistic process. Moreover, materials are often abused for the sake of design.

From these considerations, a close view of the research on materials conducted by other disciplines is useful to highlight what parameters affect the designer practice in those specialisations. In mechanical engineering, for example, designers understand that *"Components have mass, they carry loads, they conduct heat and electricity, they are exposed to wear and to corrosion, they are made of one or more materials; they have shape; and they must be manufactured".* (Ashby 2007).

It can be said that developing a "material intelligence" capable of informing the design process is a challenging objective. This implies a solid understanding of the reciprocal relationships among geometry, behaviour of materials, and forces acting on a material system. For example, the capacity to carry loads, to be shaped into particular geometries and perform certain behaviours depends on the intrinsic properties of the material and on the geometric arrangement by which the material is employed. Both intensive and extensive qualities distinguish materials and systems and the way materials can be used.

Aeronautics, which is closely linked to the research on materials, provides many examples of the relationship between design and material performances. The Bomber Northrop Grumman B-2 Spirit, also known as the Stealth Bomber, can be considered a specimen of radical innovation resulting from an integral design approach

B2 designers exploited the latest know-how in material technology and manufacturing process. The integration of those radically altered the design of the aircraft. The unconventional shape of the B-2 is the result of the negotiation among the fabrication method, materials employed, and forces to which the aircraft has to react. The body is produced in moulds by lamination of fibre composites materials. The B-2 Spirit's shell is 80% composite materials. (Figure 3).

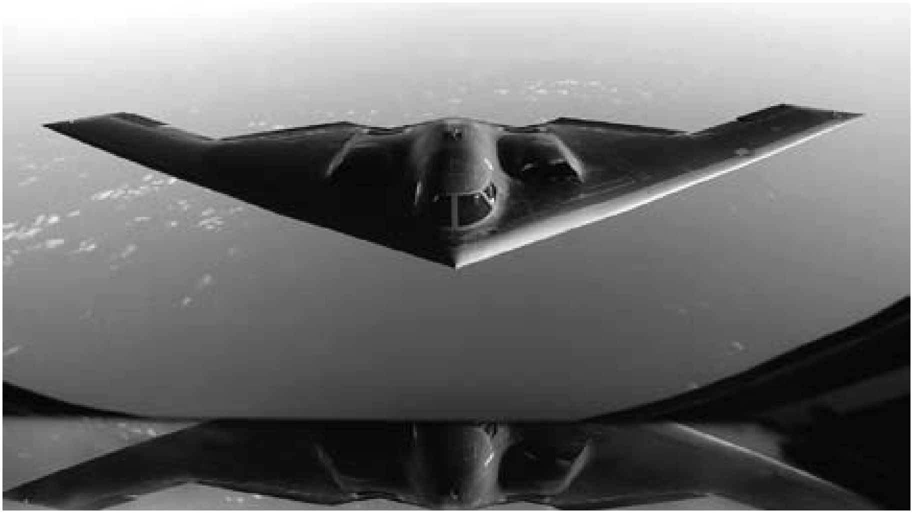

Fig. 3
The Bomber Northrop Grumman B-2. U.S. Air Force, 2007.

Although, in the Aeronautics industry, the design responds to pure functionalistic needs, designers strive to attain a multi-purpose functionalism. Not the mere functionalistic purpose, but the pursuit of multi-performative solutions as well as research into an efficient usage of materials find a place in the research on Performative Design Processes for Architecture.

In the framework of material processes, Nature is the richest field to be explored. In Nature, the processes of morphogenesis and material auto-organization guide the formation of complex systems. Morphogenesis is the biological process by which natural systems produce an organized arrangement of matter in space and over time. Precise physical and mathematical processes drive the growth of an organism. D'Arcy Thompson and Alan Turing wrote some of the earliest ideas about this relationship.

During the process of growth, the production of matter implies a high consumption of energy. Therefore, Nature attains maximum physical qualities like strength, elasticity or adaptability through efficient geometric processes aiming at the minimum expense of matter (energy). "Strength by shape" is a pervasive drive principle. Thus, the variety of forms and the formal articulation that distinguish natural formations is a necessity. (Figure 4)

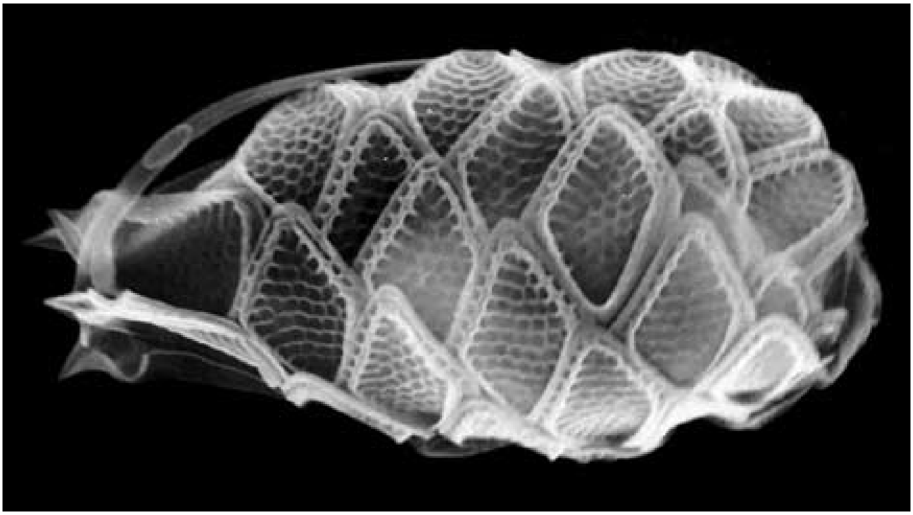

Fig. 4
Scaled Chrysophytes. Silica algae.

In Naturals Systems, matter self-organizes developing emergent patterns. Different mechanisms contribute to the emergence of those patterns, and certain principles can be extracted to understand their generation. An emblematic study case is the Michell Structure. A.G. Michell, in early 1900, prescribed a strain criterion for the members of a minimum volume structure (i.e. a structure having the minimum amount of material) to equilibrate a given force system. The study proposes a structural configuration of minimum weight employing smaller, lighter, and multiple elements organized in a distributed arrangement. Through this criterion it is possible to drastically reduce the total amount of material for a certain structure.

Comparing Michell Structure with the section of a femoral bone, we can recognize the geometric analogy between the two structural patterns. The geometry of both structures is informed by the forces to which they have to react. Both patterns follow a common efficient organizing principle rooted in the criteria of multiplicity, distribution and differentiation. (Figure 5)

The observation, abstraction and reformulation of those principles of auto-organization, adaptation, and differentiation, at the core of natural morphogenesis, can provide robust criteria to inform the design logic.

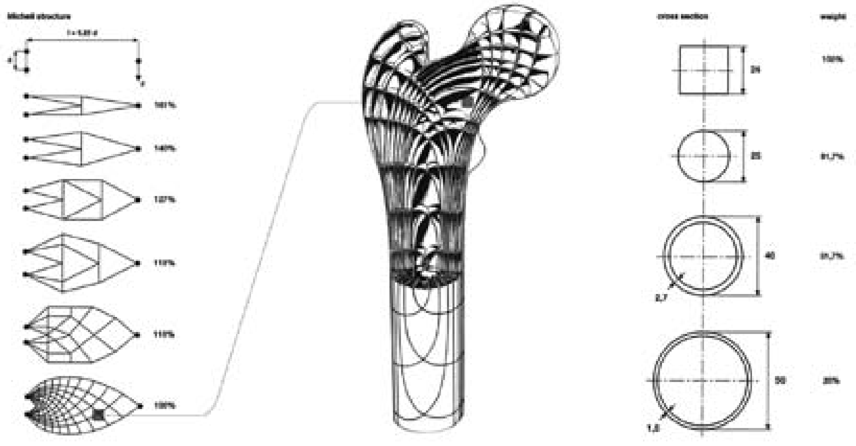

Fig. 5

Michell structure compared with femoral bone. On the side: the bending-stiffness of a thin-walled pipe twice as a square bar is the same, but its weight is 80% less. From Lightness: the inevitable renaissance of minimum energy structures.

Manufacturing diversity

There is a reciprocal relationship between evolution in technology and evolution in technique. In Aeronautics, the Automobile industry, as well as in Product Design industry, a mutual exchange of knowledge pushes the innovation in product design. Contemporary production systems are witnessing a paradigm shift: the drift towards customization of industrial production. Called mass-customization, the new manufacturing logic seeks a flexible production capacity to increase the variety of production without increasing the costs of the process. Mass-customization systems provide the potentialities for a decisive break in materializing novel design processes and efficient production techniques. Establishing a new paradigm, mass-customization radically diverges from the logic of mass-production constrained and regulated by principles of standardization and serial repetition (Figure 6).

CNC production systems have a critical role in the innovation of the contemporary production industry. For instance, "Digital factory" is the next target of the Automobile industry. The entire life cycle of the car of the future, its design, its manufacturing as well as its functionality will be digitally simulated before assembly. The Digital Factory challenges a manufacturing process that is quick, flexible, economic, and responsive to new demands. The new logic allows the designer to manipulate and customize the design directly during its manufacturing.

Once more Aeronautics provides an interesting study case. The latest achievement in commercial aviation is the Boeing 787 Dreamliner. The 787 is a full-size commercial aircraft with composite wings and fuselage. The 787 is manufactured through extensive application of CNC technologies. The fuselage sections are produced by CNC laydown of composite tape on a cylinder-shaped mould. After the fuselage is cured, CNC Waterjet cutters cut out windows and doors. The new production method implies a

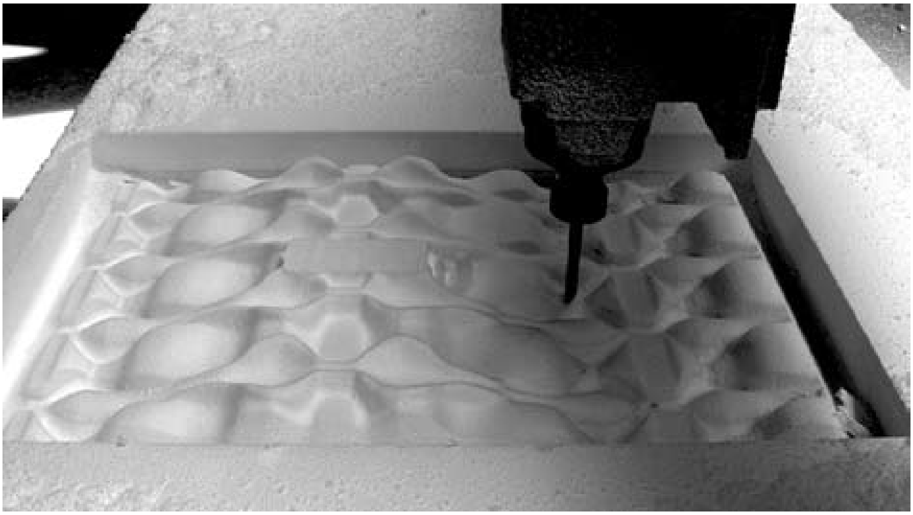

Fig. 6

CNC prototyping. Marco Verde and Simona Assiero Bra', Excitable membranes Design Studio (Evan Douglis and Jordi Truco), EsArq-Uic Graduate school, 2005.

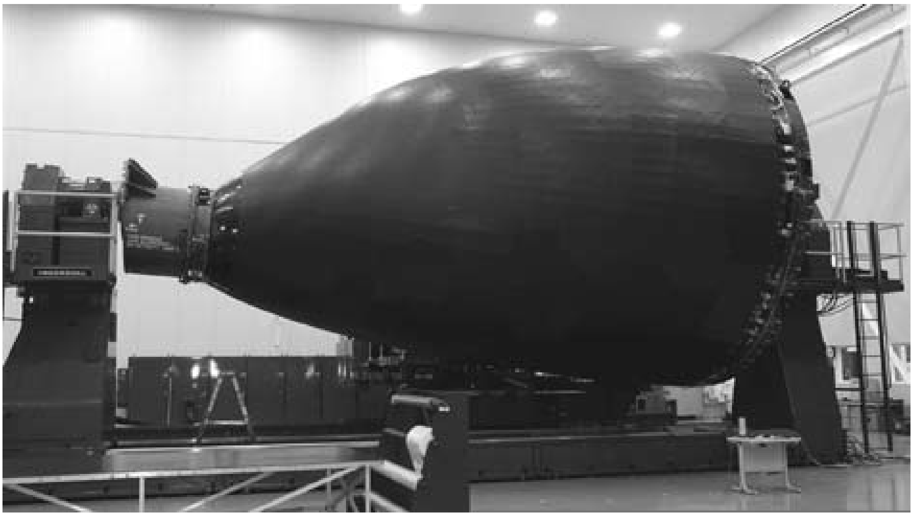

Fig. 7

Boeing 787 Dreamliner. Fibre composite fuselage section. Boeing, 2009.

substantial change in the design. By manufacturing a one-piece fuselage section, Boeing reduces the number of parts on the airplane eliminating 1,500 aluminium sheets and 40,000-50,000 fasteners. (Figure 7)

It is tangible that the understanding of material performances is crucial in order to maximize the possibilities of CNC manufacturing processes.

The nature of computer-driven production systems implies that the manufacturing of a series of one-off pieces has the same technical implications as the production of identical parts. Thus, in the domain of architecture, the drift to data-driven production systems has a critical effect on designers' practices. Through a new way of thinking, architectural practice can diverge from the acquired tradition of inefficient homogeneous repetition of standardized elements. Digital production discloses new design, and the logic of customization/differentiation lays the ground work to discover unprecedented qualities in the architectural productions.

Geared with those new criteria, [P]a challenges novel design and production techniques while developing a solid and responsible critical position: despite the extreme freedom in materializing certain designs, it needs to be considered that materials cannot be manufactured without regard for their qualities and energy consumption.

The debate

The progress of a number of scientific fields is strongly influenced by the development of complex systems theory. A recurring oscillation exists between the approaches taken to the study of complexity. The Mechanistic tradition emphasizes the relevance of the unit whilst the Holistic tradition concentrates on the whole.

It can be said that a system is a group of interrelated, interdependent, and organized units forming a complex behaving whole. The Mechanistic perspective understands and explains a given system by its component parts and studies these as simple independent entities. According to a reductionist model the whole is understood as a simple mechanical assemblage of its components. In contrast, the Holistic (from ὅλος holos, a Greek word meaning all, entire, total) model, diverging from the Cartesian analytic thinking, considers the properties of the parts as depending on the interrelationships existing in the context of a larger whole. Under a systemic view, it can be recognized that systems exhibit certain properties according to the level global organization and interaction of the constituents unit. These properties are called emergent properties and disappear when the interaction between system's components terminates.

Biology, Physics and Psychology are some of the fields historically involved in the debate between the two currents. The prominence of one position respect to the other drastically influences those disciplines and steers their studies in contradictory directions.

Starting from the nineteenth century, the process of mechanization of the handwork has been a pervasive phenomenon. This gave birth to the concepts of mass production, standardization, and optimization which at first drove early designers' practices, but later have transformed into rigid constraints to production in many industrial fields. For instance, it can be said that the modernistic discourse adopted and instrumentalized these principles to the architectural practice; the firm rationalization, homogenization, and standardization of design and production determined the incapacity to deal with complexity.

Many products coming from human efforts are subjected to a process of optimization so as to make them optimal for single functions. In the practice of architecture such procedure is especially explicit. In conventional practice, all parts of a building are thought as separated mono-functional elements. Often, there is a clear physical and conceptual distinction between primary structure, secondary structure, exterior envelope or technical systems. Furthermore, designers approach many features of the project development as a phase of post-design optimization. Manufacturing, and energetic efficiency or sustainability-related issues are only some of the features commonly not integrated in the design process.

Innovation implies a radical change in the way of thinking and doing. The shift towards mass customization fosters a radical change in architectural practice. It encourages the move from homogeneous non-efficient repetitions of elements towards a differentiated and efficient production. This change implies a different design practice which needs to be cross-disciplinary to grasp the new potentialities. Driven by an integral systemic approach, a holistic understanding and development of building can lay the foundations for a paradigm shift. Thus, the architectural domain as well as the other disciplines dealing with complexity, finds its place in the debate between Reductionism and Holism, between separation and integration, between mono-functional optimization and multiperformative efficiency.

Towards System Thinking

Systems Thinking diverges from Reductionism and recognizes systems behaviour as a phenomenon not explainable as the simple sum of the constituent parts. System Thinking hosts at its core the concept of heterogeneity intended as the quality of a system which results by the adaptation of its constituent parts. Adaptation itself is one of the true organizing principles that Kevin Kelly (1994) points to as intrinsic to the development of systems:

In heterogeneity is creation of the world. A uniform entity must adapt to the world by occasional earth-shattering revolutions, one of which is sure to kill it. A diverse heterogeneous entity, on the other hand, can adapt to the world in a thousand daily minirevolutions, staying in a state of permanent, but never fatal, churning.

A paradigm shift implies 'replacing the former way of thinking or organizing with a radically different way of thinking or organizing'. Adopting Systems Thinking in the architectural domain implies rethinking buildings as systems: heterogeneous formations driven by the logic of modulation and adaptation of their physical pattern. In such formation shape is not imposed on matter, but arises from a synergetic process of morphogenesis. The physical pattern of such formations would present neither mono-functional specialization of parts nor explicit physical distinction among structural frame, environmental threshold or habitable space. The building, while behaving as an integral system, could be an efficient catalyst of multiple architectural, structural and environmental features and qualities. (Figure 8)

Nature provides a variety of examples to understand the processes of systems' formation, growth and behaviour. The eggshell is only one of these. The eggshell is a very complex mineral porous formation which protects the embryo from mechanical damage and regulates gas exchange between the developing embryo and the external environment. It also prevents contamination by bacteria of the organism. Finally it provides a source of nutrients, primarily calcium, to the developing embryo. (Figure 9)

The eggshell can be described as a Biological-Multiperformative-System which, by the qualities of its formation, performs simultaneously as structure, skin and environmental filter. Nature teaches us how energy can be saved by developing efficient differentiated formations simultaneously fulfilling multiple functions.

One of the challenges for today's designers, architects and engineers is the energetic efficiency of their proposal. It can be said that embracing System Thinking implies understanding energetic efficiency as an emergent quality induced by a different architectural praxis. Therefore, it can be argued that the understanding of the processes of growth, adaptation and differentiation intrinsic to natural morphogenesis can foster the abstraction of certain principles which are significant to the development of a new design intelligence. These criteria, if coupled with a data-driven practice and consistent research on material performances, can establish a robust framework for new explorations.

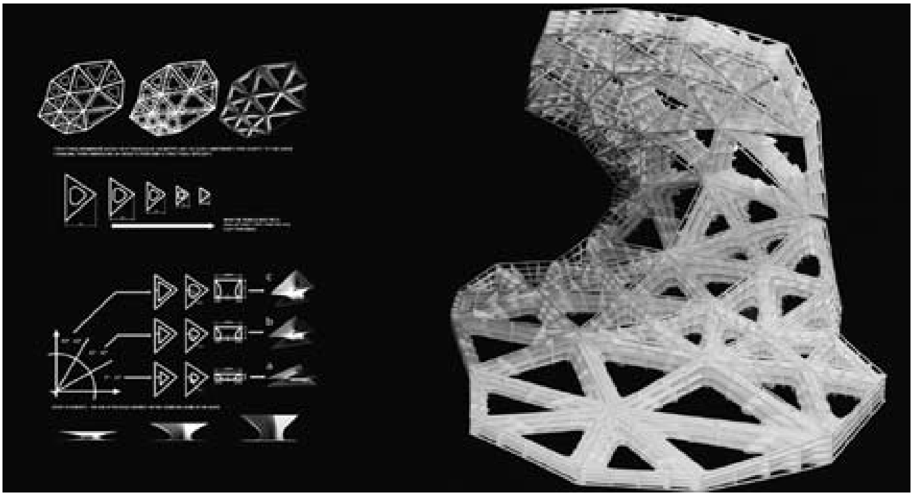

Fig. 8

1/20 CNC prototype. The differentiated system, made of parametrically modulated components, integrates structural, manufacturing and assembly logic. Anna Hartofili, Gabriel Moreno, Daniel Terán, Ma(s) Lab Design Studio (Jordi Truco and Marco Verde), EsArq-UiC Graduate school, 2008.

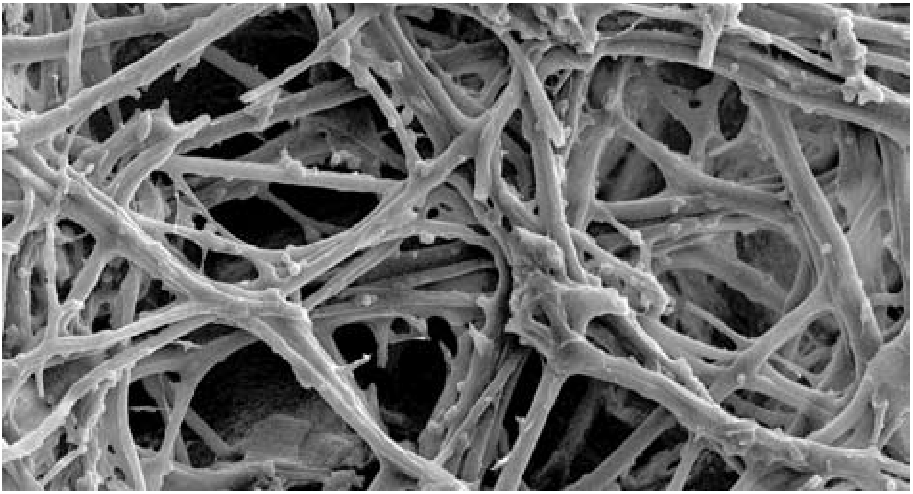

Fig. 9

The eggshell intricate mineral structure (SEM). UMASS, 2009.

Conclusion

The architectural domain seems increasingly to be moving towards empirical methodologies focused on strategies and processes of development rather than on pre-deterministic approaches. An inductive and experimental aptitude is replacing those processes of metaphorization already acquired in the practice of architecture.

It has been illustrated that an approach grounded in System Thinking may lay the foundations for a a consistent innovation of the architectural practice. In this framework, computation, materials science and data-driven manufacturing are complementary resources. If instrumentalized and integrated into the design process, these can be crucial to the success of a new practice.

Under this assumption, the process of design becomes a performative process which creates knowledge while fostering a new interactive relationship between the designers and its practice. Technology has an important role in this move, although it is not the only force shaping the new intellectual framework. Nevertheless, contemporary IT and the computational logic are instrumental to the design process and combine to form a new generative design intelligence.

As discussed, the observation, abstraction, and reformulation of the principles of auto-organization, adaptation, and differentiation, at the core of the process of natural morphogenesis, contribute to the establishment of new criteria for the design logic. From this different perspective, the processes of formation and materialization become integrated features of a unique process.

In this framework, P]a targets exploring integral design strategies while promoting an experimental and interdisciplinary aptitude. Rooted in Systems Thinking, [P]a seeks innovative solutions to full-building-scale architectural applications.

Integration, as a general principle guiding the design process at every scale, can settle a break with the methodological reductionism diffused in conventional architectural practice in favor of different strategies catalyst of the technical, economical and social development of the contemporary society. A radical innovation of architectural praxis can be crucial for the development of efficient solutions to contemporary architectural demands.

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Holger Kehne
Eva Castro
Ulla Hell

Plasma studio, London/Bolzano

Parallel Processing: systems- space- strategies

Holger Kehne

Thank you for the introduction and for the opportunity to be here in these inspiring surroundings. Thank you also for the inspiring paper that truly addressed the issues of our times, in regard to making a real transition from nominal designs that existed for centuries towards this new paradigm which has not quite happened yet. It needs more thought and time; it needs to be properly thought out and developed further. We are here showing you this from the perspective of a globalised design practice. We have a completely international office with members from all around the world sharing ideas. We are working through Skype, through different means of communication, so in that sense certain processes, like making models, are already no longer fast enough; they no longer work as they did in the past. If I want to develop a kind of morphology and then to double-check it with the local office in Italy, it is much easier for me to enter it into the computer and then to send the file over. The file can then be worked on in that location and be sent back to me. Obviously the kind of structure and working processes that we are working with in this way at this time are shaping our work. They present a completely different paradigm. This also gives us the opportunity to be much more adaptive and flexible, which clients appreciate and now actually demand! Particularly working in China, the goalposts are changing all the time. You are aiming for next week and then it is like you almost have to go in the opposite direction. In Italy there is a similar attitude. Sometimes the client changes his mind and wants something completely different. To have worked in that way in the 50s or in the 60s just would not have been possible. But at the moment we are enjoying this much more flexible and dynamic way of producing things. We have three underlying modes of interest that are developed throughout our work for all different scales, so it is a kind of non-scalar approach. One is the index, another is the diagram and there is also a keen interest in the material itself. This project shows how we work these things out together, which then becomes a template for all the subsequent projects that we are showing here. This was an installation for a gallery in London. We were given very thin pieces of metal by British Steel as sponsorship and we had to do something with them. The sheets were so thin that they were not actually structurally stable so their structural properties were all but useless. However, we perforated them with this very regular pattern that went through the whole sheet. Somewhat ironically, as perforating the material actually weakened it further, this suddenly enabled the global shaping of certain structural patterns. The stresses that go through the material inform the formation and the shape of these sheets. It can be used by the designer in a very direct and unpredictable way. The perforation suddenly makes this material load-bearing and structural. The effect of this is the way that suddenly the light flows through the holes. There is an element of unpredictability that we very much enjoy in architecture, the fact that we can never be 100% in control; there is always an element of surprise, an element that you are not quite aware of that you suddenly find. That is what architecture and the world of three dimensions holds for us. We are in charge of these things, but we are also leaving a lot of things out in the open, uncontrolled and letting the work speak for itself.

Ulla Hell

It must be said that in general we like to build on different scales but with the same kind of approach. In this instance, installations for us are always an area of experimentation but we will at least have in mind something which a building will then have later on. Thus in this way we can make it with much more freedom, in a playful way of doing something, but we want them to then bring the same attitude to building projects and not to loose the quality that these installations have.

Holger Kehne

The dichotomy is that you usually find is that somebody has done a quite crazy installation but then he builds a boring box. You find the same in academia: people design these strange blobs and then in practice nothing of that gets built. I think that we are trying to overcome that. Through my teaching at the Architectural Association to what we do in practice is fairly seamless; and we do the same things as far as possible. That involves finding out what is culturally relevant at the time and pinpointing it through the different techniques and methods and opportunities that we find. This is an architectural gallery in Chicago that was just formed. For the inaugural installation we were asked to do an installation and we found a space which is very open but which on various levels is quite complex and beautiful. We wanted to emphasize the existing configuration of the space by introducing or remapping it through another system. We ran three strands of cable through the gallery that spiral from the front of the street to the back garden. Then we indexed it: here they are taking the same points that define the existing geometry and that these points are then shared between this Cartesian geometry and the new one. This is a sequence showing how it was done. This is the existing gallery. We located the key points and then we strung three different strings through. We divided every segment by ten and then we combined those three points into single triangles. We adapted the sequence of this kind of triangle; there were some overlaps and this is a process of optimisation that we did with parametric software. With this software we were able to pull the global points and all the triangles automatically adapted. This is where software proves itself extremely useful. If you had to redraw every single triangle by hand, every time something moves, it would be almost impossible. These are completely new techniques that need a different approach and different competences.

Ulla Hell

For us, in each project, it is a challenge to explore new tools and not to be fixed to one tool which we were used to working with in a previous project. Installations in particular are the field to improve those explorations and then later to refine them in the built examples.

Holger Kehne

As you can see, the aesthetic of this is the renegotiation of relationships between a global shape and the local differential or component that this sets up in a dynamic way. It is a reinterpretation of the existing gallery space through different means. We usually try to project it from very specific points, projections that overlap. This intensifies the experience as well.

Ulla Hell

Now we will talk a little about other more recent projects. These projects show how the experience from another scale is used in the built project and in dialogue with the building industry. This is a project for production facilities in Northern Italy of a local construction company with whom we had built previous projects. It was interesting not only for us to have an immediate dialogue with the construction industry but also for them. The construction company has a lot of confidence in our work and was inspired to go out and build their own headquarters using us, firstly experimenting and then translating the ideas into a real building. This building was based on two different functions - the first is the production itself and the second, a representational aspect of the building which we tried to integrate into this process. First there is the more pragmatic, functional part of production and then the representational part which is more concerned with explaining the space and showing different qualities. Based on the pragmatic instructions from the side of the client, we tried to set up a catalogue of parameters which later should inform the building itself and also its details. We explored different angles of insulation, of views which wanted to be kept which we then not only described using the computer, but also by explaining things using the physical model. However, here in tests we have seen its limitations: it is not flexible enough. Thus almost all the work was based on jumping from one method to the other and not being fixed on following only one particular way. I think this is an important element in the quality of our work. If we see that something is not the right way of continuing, we can very easily and rapidly switch from one method of working to the other. Here we can see something of how the facade was developed depending on the qualities we wanted to have on the inside of the building. The facade is composed of a single lamella which always changed rotation and changing it gives a more open view and then less of a view. In this case, the physical model is not enough either to give answers fast enough or to give enough answers in terms of the number of answers. Here then we had to use parametric software to show different ways of how the demands of the client could be resolved. Not only can these different demands be changed very quickly, we can also explore many more possibilities of how we actually want the building to be. This is the building which will be built in the near future; it will be finished in 2010 in the northern part of Italy. This project was built by the construction company which asked us to design their headquarters. For us this whole process was thus a great experience in the sense that we thought the client would want something unique so we took a chance and designed something. In the beginning we were a little afraid of what it would be like having to deal with a very small local construction firm. We wondered whether they would be able to communicate with us; whether they would be able to build what we had designed. Right from the beginning it was a very positive experience. We were in communication with the construction industry and this was the best way to find solutions which were in the end not a compromise but a learning process for both sides, both for the builders and for us. The building was a roof top extension for the owners of the house. What was very nice was that it involved two generations: the parents and the second generation. The parents were a little conservative but were letting the second generation built what they wanted for themselves. There were no real limitations from the client's side, which is not always good as sometimes limitations help to define the design, but in this case we took the occasion to decide what to design for this family. We took the existing house more from how it was as an abstract. It was a small villa on two different levels. We took those levels and put a covering over it which by its complex form was described as vertical sections through the building itself. This we translated into the structure of this new building which was like a series of steel frames running through the building itself. The shell below was all prefabricated elements. We wondered if it would actually be possible to get a very small construction firm to do them but then everything turned out as we had wanted to do it. I think because we had such early communication with them it worked very easily. It is not often that smaller construction firms can work with the same software we work with and it was a very fluid communication with them. At the end, to define better the feeling which we presented, we added a second layer of timber frames which forms in a more fluid way.

Here you see pictures done before the project was built. What was very important to us was that at the end of the process we achieved those pictures. This is the big challenge in the process: whether you can build this quality based on pictures and promises made beforehand. In this picture you can see the sections running through the building always taking the model of the staircase which was done from the outside. A staircase was brought into the inside through the outside. Here is a picture which best shows the whole project seen from the rooftop. It shows how different spaces connect to each other and there is not any division between the terrace, the roof and the wall so that they become one single object. Here is another project recently built in Italy; in both cases we have used local wood. For us, the wood was the link with the local tradition of building even if we always we tried to use the wood in a new way, to invent new details but not forgetting the qualities the wood actually has. This is an extension of a hotel in the Alps, which has a marvellous view, which already made the site quite promising. It is on a steep hillside so it was important to us to insert it in this context as far as possible. We took the stratification of the topography in order to blend it into the operation of the building itself and to use this technique to define its operation better. This stratification is then taken of the horizontal line of sections which are then brought into the building and then from those bends which run through the volume onto the roof through walls and balconies. What we try to lose is the division between wall, roof and every single element of the building itself. The problem from the construction point of view is quite interesting how we developed these very simple details, the supports of the balcony itself. But we found a way of describing in this right part of the building a double curvature in the surrounding bends instead of inserting another triangulation. For us, achieving such things is a way of developing new details, not just sticking to something we have learnt at school, but using this knowledge to think more about it, to develop something further. It is not just knowledge which you reapply ten times but to use each time in thinking of what is needed, what we want to achieve and how we want it to apply to the building and also whether the people who are constructing the building can actually do it. In this case, we bring in the communication with the construction company.

Holger Kehne

There is also the question of whether it is affordable. In this case there was an average cost throughout the project, nothing extraordinary at all; we were working to quite a tight budget. So here we had to find solutions. For instance the upstands of the balcony were laser cut and folded; we used parametric software to draw them all so we did a lot of work for the metal workers in order that they could actually price it reasonably.

Ulla Hell

This picture shows what the intention of the whole project was: a blending of the natural landscape and the building itself. Here there are the upstands- a very simple detail which was affordable and guaranteed the quality which we wanted to have. Here is an inside view of two walls and the surrounding landscape; here the effect that this very simple detail gave to the balconies. The building has three floors and each floor is divided by a different kind of code. Here we tried again to bring some of the outside qualities into the building itself following the views. This is one of the guest rooms where the local material had to be used to translate the expectations of a guest coming to the Alps.

Holger Kehne

The Italians in particular want to go to the Alps and feel like Heidi did, hence the amount of wood - which personally for me is a little too much - but we had to work with it. We tried not to follow the cliché of cuckoo clocks on the walls that people might expect but to have clean cut, geometrically interesting development but which is totally wooden. This is from an invited competition in Norway for the National Library. It is a project we have just done so it is a good way to show our approach and how our techniques are applied on a larger scale. The use of the diagram is to show how the building becomes part of the ongoing changes next to the harbourside and how the building transmits people and coordinates the flows in the location. It is a huge building. Our circulation system was linked: we had two systems of ramps at either side of it. At the same time we were working with an interesting facade concept. This shows how the different components were put together in three dimensional modelling. This froms an internal system of branching which parametrically developed into a structural system. In this way, whenever the overall geometry changed, whenever somebody wanted to have a wall a little higher then the structure would automatically adapt so it was not necessary to go through all the steps again, which is very useful for this kind of project. Here we see how the different systems interact and connect to each other and the kind of spaces that this creates. It is a building that is similar to the other project; it grows out of its context and has connectivity; it also works very closely with the landscape. Here this fish scale facade system is being developed. As regards a library, the interesting thing is how you connect inside and the outside, how much light you want to let in. In Norway there is obviously very little natural light so you need quite a lot of transparency. At the same time, however, you do not want a kind of glazed box, you want to give a bit of differentiation inside so we started by mapping different programmes (which can be seen at the bottom of the diagram here) onto each facade. We then developed that into a script that translated it into the various fish scale patterns that were made of a combination of natural stone and glass.

Ulla Hell

In competitions in particular the building always undergoes changes until the very last moment so it is very useful to be able to work with software that allows you to make all those changes and not have to start again each time which would mean losing time. It is also important to stop yourself at a certain point and realise there is no more time to do anything else. We generally want to avoid running out of time or to use this as an excuse to stop the process. Having this software allows you to do this.

Holger Kehne

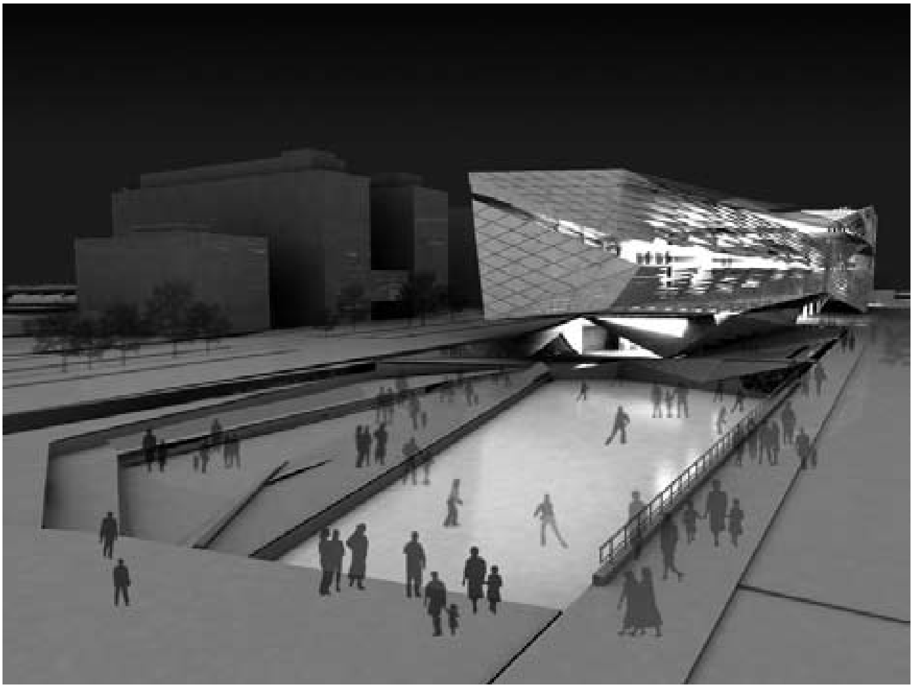
You do not want to end up with a half-baked solution just because you do not have the time or the money. Here you can see how having the single components of the facade system respond to the solar conditions that are found in the different facets of the facade and how the structures are related to that. Here you can see how globally this is organised. This is the look that this would have had. Unfortunately, we did not win; our project was not for them. It would have been quite a nice project though. Concluding, we have a large project in China which is the International Horticultural Fair in Xi'an which is the city of the Terracotta Army. It is a city with a population of 10 million in the centre of China. This is a completely new development where they have created a new and artificial topography with lakes and so forth, all of which is currently under construction. We focussed our entry on a sustainable approach. We worked on the integration of natural and artificial systems, to treat ground water, to reduce the environmental footprint of everything. Unfortunately not all of that is going to be implemented, some parts as showcases, but not the whole thing. This is a further example of changing goalposts that we face all the time. This is an interesting project where we work a lot with landscape. My partner teaches in the AA Graduate School in the landscape urbanism programme; as a result we see buildings and landscape as seamless domains. We are very interested in transgressing the boundaries of these disciplines.

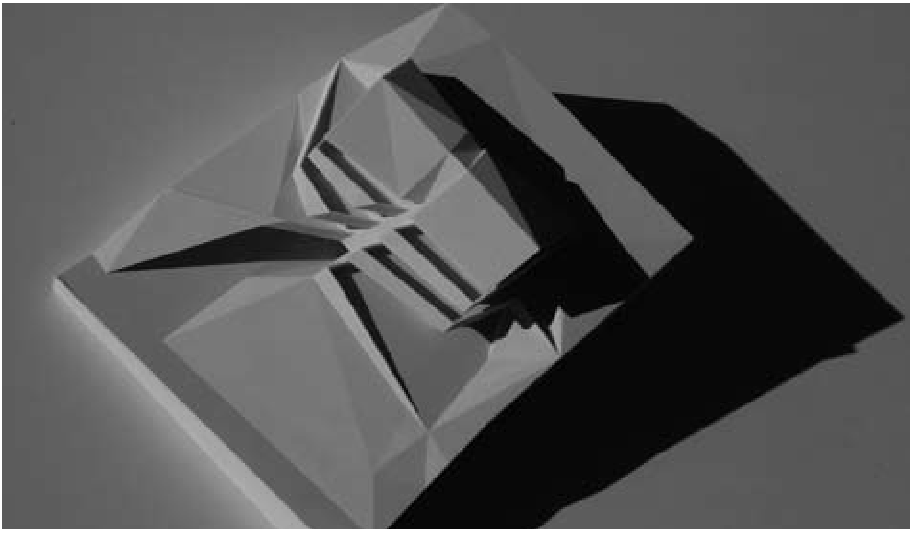
Ulla Hell

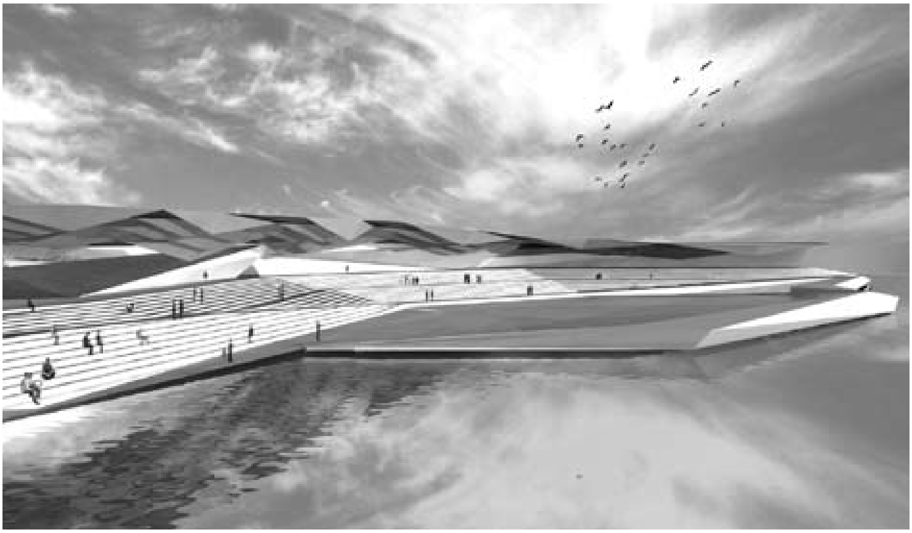
Until now we did not have the opportunity to do that. We could only focus on the buildings themselves; within the scale of the competition we were unable to go beyond. This time we can manage to do both.

Holger Kehne

Hopefully this project will become a showcase of our vision of what we believe in: a holistic experience of architecture within a man-made landscape. Starting from natural patterns, from plants, starting from the dynamics of seasons, of growth, and what kind of materials we would like to use. We would like to orchestrate how people see certain things, what they feel, gravel under their feet for example. To make this work physically, we need to work out how the plants would interact with each other, what conditions they need and how to configure that into something that is not in the tradition of the English landscape of trying to replicate a natural Arcadia that has never







existed before. Here we create one which is completely artificial and proudly so. The client wanted a lot of flowers and colours so this is what was produced for them. It gives the idea of meandering: the path diverges, you have a choice of where to go but it comes back together again. This method has something of the mathematical character that you also find in web browsing, you find different things leading to the same source; nothing is completely predetermined any more in a tree- like fashion. Then there are going to be three buildings. There is going to be a huge motorway so a bridge is needed for people to cross above the motorway. The bridge will have different programmes. This is something we are very interested in: using infrastructure as architecture which is rarely done. There are amazing examples like the bridge in Florence or the Rialto Bridge but it rarely happens. Nowadays these infrastructure constructions do just one thing. There is a segregation that we are having to work against so this will be an example of how we combine and charge these structures with different programmes and a different meaning. This is another building we are going to do. It is a main exhibition building which redefines the way a building goes over the water. A water-land distinction is built through the application of landscape: we are working with thickened ground and then there is the shape of the building. Here it has been developed a little further; it gives the idea of fingers. The building has three fingers and the landscape goes through and on top of them. We are trying to integrate the building and the landscape in a different way, creating a quite contemporary relationship between them. The third building is a greenhouse that will function as a greenhouse for only three months so we do not have to concern ourselves too much about technicalities. After three months it will become something else. These things change all the time. We are given very loose programmes of what they want; it is up to us to properly define it. When we show a design, however, suddenly they realise what they want and say that they want it done slightly differently. We are constantly following their ideas and changing things. For that we need to work using certain methods. We do have something of a problem working with consultants. Often they cannot keep up with us. They do an analysis of the structure, then there are some slight changes and they have to do it again which takes a couple of days. They also only work from nine to five rather than through the evenings. All this creates a slight problem. This is however what has to be done in China; when you show something to the client you have to have these things done. This picture would probably not be in such a beautiful place because of the pollution that you find there. You can see it is a great adventure for us; we are not fully in control out there but we enjoy it very much. I hope you have enjoyed seeing it today. Thank you.

Discussion

Katherine Keane

One thing I was unable to understand from the photographs was how the buildings were actually constructed, the construction system, the building materials. For example, when you were wrapping, I was clear it was wood, the extension on the roof seemed to be a metal and glass frame with wrapping. Moving onto the hotel extension, I would like to know if it was solid concrete. I would just like to know something about the structural systems used.

Ulla Hell

As regards the hotel, the structure itself is concrete; because it is on a steep hillside, it needed to be built into the hill, so very little was exposed. For instance, had we done it in wood, it would have been only the entire last floor and then on the front is totally glazing. The structure which are the dividing walls between the rooms themselves are concrete, and then the back wall which until the last floor is built into the hill is concrete as well. The other building, the small house, is from fabricated, sandwiched panels which already have insulation inside. At that time, the building had much more of a soft shape, we found it very difficult to communicate with the construction firm, so we went back into a triangulation of the shell which was easier in terms of communicating with the construction firm that prepared the prefab panels. With the steel layers and the wooden layers we wanted to define certain lines. It was in the end more than a soft shape.

Unidentified speaker

I would like to ask a quick question regarding the computer. I would like to know whether you have to write your own programmes for certain projects or if you are happy with what is on the market.

Holger Kehne

We do that occasionally but it is necessary to have people who can do this. We have two or three people able to do this but who are often involved with other things, so there is not much time to do this as it takes a lot of time. Sometimes however it does save a lot of time. One of our employees has worked with small scripts which were very useful. It is quite applied stuff, it is not form generative things, it is more for details. If there are, for example, 350 up-rises and they are all slightly different, you can automate that so that it is less work.

Ulla Hell

We also found we cannot fix ourselves to one single program to develop a project. For some parts, one program is used and then we find the tools are not good enough to define what we want to achieve and then we return to another software. This takes time; although we do not have the time to know all the programs, we do try to work through possibilities and not to limit ourselves by using a certain tool. When we have a physical model, we use the computer so we keep all the possibilities open.

Unidentified speaker

The subject of this workshop is integration of structure and teaching structural systems into the system of architectural design. Thinking of this, regarding the fragmentation of the solid and rectangular surfaces into linear elements, linear geometry and not necessarily octagonal but oblique shapes, I would like to know how this practice affects the structural system and the load bearing system of any building. In following this route it is possible to shape the structural elements of the structural system itself? I would like to know what type of effect this has on the structural system regarding aspects such as the geometry, the structural form, the cost and the constructability.

Holger Kehne

We are working to transfer forces through different means; forces do not necessarily have to travel vertically, they can travel sideways which is something we make use of. But it works three dimensionally: if you have a force going diagonally, you have to prevent it from falling over. Despite my complaints about some structural consultants, it is good to work with them because they can do this three dimensional development and analysis. The kind of capabilities that these engineers have nowadays are quite fantastic.

Ulla Hell

It is important to establish good lines of communication right from the beginning of each project with the engineers. In the small projects in Italy we try to find a partner who has the same vision and who is then open to discuss things with us, both in terms of exploring ideas but also in pointing out the limitations. We do not know everything which is why we are open to discussion; I think this is a very important process of each building.

Holger Kehne

We base our work on general structural understanding but we love to challenge. It is not simply putting up a vertical column everywhere but perhaps having a rudder dividing a sheer wall. We wonder how it will work and then the engineer comes up with a possible solution and does a space beam. For this project we made a folded ceiling structure like origami. We enjoy the challenge of using existing structures rather than inventing new ones or using exciting ones, to tease out the spatial quality and also different kinds of spatial arrangements. I think the architecture determines the structural system. We are always surprised at how much is possible. Although we work with the computer, it still does not necessarily give you the feedback that a physical model gives you. It gives you a sense but it is not always enough. You may have a cantilever of 25 metres but then you need to know if you have enough back-span and then you can make it work. However, you also need to consider all the services. These questions of where you put the services and how you integrate them elegantly are almost more important. That is almost more of a challenge nowadays than the structures where many things can be done.

Session 1

(Re)searching Integration

Karl Christiansen
Anders Gammelgaard Nielsen

Denmark

Individual cast concrete elements

A workshop on the workability, optimisation and production of concrete

Preface

As the second in a series of international workshops that studies the physical and aesthetic potential of the material concrete in architecture, a workshop was held at Technische Universität in Berlin in the period 8th – 13th October 2007.

The workshop took place in one of Peter Behren's AEG turbine halls, which now function as a concrete laboratory for the university's Fachgebiet Massivbau. Here 10 students of civil engineering from Technishe Universität in Berlin met with 10 students of architecture from the Aarhus School of Architecture, and cooperated in solving a common assignment.

The metaphorical point of departure for the assignment was a contemporary interpretation of the Brandenburger Tor in an architectural, technical sense. The basic, classical architectural and static principle of the bearing and the borne – columns and beams were to be submitted to existing and future concrete concrete technological and form-related potentials.

It was a hands on experience where the students created architecture by specifically sketching, developing and finally casting concrete elements in full scale.

The result reflects the interdisciplinary effect of the workshop, namely the cooperation between engineers and architects. Static stability and the course of the forces has been expressed as architectural form.

The workshop was arranged and completed in cooperation with Aalborg Portland Group as part of the research into concrete at the Aarhus School of Architecture.

Introduction

This workshop has been embedded into a research program with the title Industrialized Individuality. The research program is currently being carried out at the Aarhus School of Architecture by Professor Karl Christiansen and Associate Professor Anders Gammelgaard Nielsen.

The research program takes its point of departure from the reality of the new production methods of today.

Briefly described, previous production methods were based on craftsmanship. From an architectural perspective this resulted in designs of great variation and individuality. The 'Arts and crafts movement' resounded the essence of this production method (Mackintosh).

With the Industrial Revolution, the production method changed from craftsmanship and individuality to mass production and standardization. For architectural design, this change in technology led to repetition and rationality. The design components were not individually designed, but came out of standardized fabrication. Architecture lost its previous individuality and became standardized (Mies). In contemporary production methods, a shift of paradigm has arisen. Due to the computer and robot technology CAD CAM, it has suddenly become possible to produce objects and building components with individual forms. This technology rapidly developed in the car industry and is today a reality in many areas of the building industry.

In the research program, we are specifically focuses on the technology embedded in pre-cast concrete industry.

Through a preliminary research program, it has become evident that the precast concrete technology lacks the embedment of the new technology. A survey reveals that the industry is still in the era of standardized mass production, and even this does not seem to be the entire truth. What was to be expected today would be a production characterized by a large number of identical elements cast from the 'mother' mould. The reality in numerous concrete industries is, however, that only a few elements are cast from the same mould. This requires a large number of moulds and therefore an extensive degree of craftsmanship in the production. In other words; there is to a large extent an individual production method in the pre-cast concrete industry, it is just not based on industrial techniques but mainly on craftsmanship.

From this reality arises the paradox that a lot of new buildings aesthetically radiate the era of traditional mass production, but their real production is in fact based on craftsmanship.

The aim of our research program is to develop a series of techniques for the embedment of customized mass production in the concrete industry, or to be more specific: to develop moulds that are capable of producing a large number of different elements. This requires a crossover between different technologies, and that is why our aim is primarily to demonstrate that such a technology is plausible.

To embed a workshop in the research program, it necessitates a more broad approach to the subject in order to give the student a basic knowledge and competence. As a result we have decided to broaden the focus in such a way that it is not only concerned with the technologies related to the casting of concrete, but also to the casting of materials in general. This offers the candidates the opportunity to learn about many different casting techniques and at the same time to become familiar with the aesthetic and technical potentials of a large number of materials.

The assignment

The aim of the workshop was to cast a structure consisting of a number of concrete elements.

After the workshop, the achieved knowledge and competence were transferred into building projects that the students programmed themselves. This resulted in student projects with a much higher degree of tectonic understanding and integrity. The study program is therefore consistent in its aim: to emphasize the development of architectural projects that gives an understanding of basic relations between materials, their technical transformation, and the potential of the architectural form.

The intended construction was to relate to the Brandenburger Tor in the sense that it was to be a load bearing system consisting of columns and beams. In terms of design it was also to relate to the Brandenburger Tor in the sense that it captured the historic and symbolic importance of this work of architecture in Berlin.

The construction was to consist of a total of five members three columns and two beams. All the members were to be designed individually, but in a way so they together formed a totality (this is one of the most important purposes of the workshop). Each member had to respond to the overall construction, and at the same time it had to be optimized as a construction member (all unnecessary material had to be "carved away").

The five members was to be designed in five groups of each four students (each group consisting of two engineer students from TU and two architect students from AAA).

The five members were to be cast in five individually designed moulds. These moulds were to consist of an inner core of polyurethane foam and an outer formwork of plywood. The polyurethane foam was to be cut with a hot wire.

All materials and tools necessary for the workshop were supplied and paid for by Aalborg Portland. The only thing Hans Bruun Nissen from Aalborg Portland needed to know is the exact address at TU where the materials and tools had to be delivered. Hans Nissen would also contact you to find out which concrete supplier in Berlin could deliver White concrete (We only needed one truckload 4.5 m^3).

Even though Aalborg Portland supplied the necessary tools, we might have needed to use tools (circular saw etc.) form your workshop.

The students were organized in groups of four and with the assignment to design a separate part of the construction (column, beam). At the same time the overall design of the construction had to be taken in to consideration.

Already at this stage an immediate urge for communication between the groups emerged as even small changes in the design of one component resulted in the need for an open and dynamic design process.

In addition to the need for communication, the design process was strongly influenced by static and constructive demands that was pointed out by the engineers. At the same time the designs had to be adjusted in accordance with the production technique.

Sketching

During a process of sketching by hand, drawing and model making the five groups of students developed a series of design proposals for the structure. These proposals were constantly revisited and elaborated through a number of critiques, at which different design aspects were discussed (context, production techniques, static and stability performances, junctions)

Various design suggestions for structures. Sketches made in polystyrene in scale 1:5.

Critique and evaluation of design suggestions. Critiques were handled as "open spaces" for students and teachers, in order to facilitate the optimal situation for new designs.

The designing and making of full scale templates for the cutting of the polystyrene blocks. All templates necessary for the structure are finally displayed on the floor.

Mould making

Mounting the templates on the polystyrene blocks. Cutting the polystyrene blocks with a hotwire using the templates as guides.

Assembling the formwork. Mounting the inside polystyrene moulds in an outside load bearing structure of plywood and rafters.

Casting

Pouring the concrete in the formwork. Top illustration show break down of formwork, due to improper reinforcement of outer load bearing structure.

De-moulding

Opposite page
Removing the formwork, the outer load bearing structure and inner polystyrene mould.

Mounting

Opposite page
Mounting the structural elements.

Summary

The pedagogic aim of the workshop was to focus on the complexity of teamwork in the professional world of today's building and construction.

Secondly, the aim was to give the students the experience of going through a full architectonical process from beginning to end; from the primarily freehand sketches, through the adjustments of the design due to the various design parameters, to the real making of the forms, and finally to the inauguration of the construction. An experience that it is only rarely possible to give students because of economical and practical reasons. Unfortunately, one may say, because it is the only experience that fully opens the eyes of the students towards an understanding of the integrity of the architectural process.

As a conclusion of the workshop it is to be said that the students were fully confronted with the complexity of today's teamwork. The large number of design parameters that were brought into play forced the students to keep the design process open and dynamic. In the beginning this brought about a number of discussions and negotiations between the groups, as well as internally in the groups; discussions that in many ways paralysed the design process. As a result the designs were constantly redesigned, and with a deadline that was rapidly approaching these disagreements became a valuable source for finding architectural solutions. This was perhaps the most valuable experience of the workshop as the students discovered the possibilities in a problem that from the beginning seemed impossible to solve.

Embedment of study programs in research

The advantages are many when study programs are embedded in research.
Some problems may, however, occur due to the differences in the nature of research and teaching. The following text addresses these problems through the descriptions of study programs at the Aarhus School of Architecture, Denmark.
Research has by nature a well defined point of departure – the hypothesis. In opposition to this, it does not have the same predefined results – the conclusion. If the conclusion were known beforehand, there would be no research. In other words, research follows the rule: if we know where we are going, there is no need to go there.

In our opinion, study programs should follow the same rules. In order to stimulate the students' creative and innovative potential, study programs should have no predefined results, nor should they have a predefined road to follow: only an initiating point of departure and the supporting environment. So far research programs and study programs abide by the same rules.


PETER-BEHRENS-HALLE

The differences occur mainly in the way they zoom in on their study object. Where research is free to zoom in anyway it pleases, study programs in general have an obligation of a more broad approach. This is to ensure that the candidate has a general knowledge of the different aspects of architecture, and that he can orient himself in these aspects.

In the course of the study program, the students have constantly been informed about the progresses and results of our research program. At the same time they have had the possibility of contacting the same concrete industries that we have been in contact with. This has given the students access to a lot of knowledge that has been accumulated in these companies.

At the same time the companies have supported the students financially which, in terms of the workshop, has been essential.

In other words, the students have benefited from both our research program and the companies that we have been involved with. At the same time, we have in relation to our own research program benefited from the study program in the way that it has inspired us and uncovered new ways to follow in future research programs.

Channa Vithana

Arts University College at Bournemouth
United Kingdom

Architecture is the Poetic Articulation of Technology

Invocation

Architecture is the **poetic articulation** of **technology.**

Architecture is the...

Poetic	**Articulation**	**of**	**Technology**
Lyrical	Expression	of	Skill
Elegiac	Verbalisation	of	Knowledge
Graceful	Communication	of	Expertise
Rhythmical	Enunciation	of	Know-how
Flowing	Pronunciation	of	Machinery

Introduction

There are numerous ways of teaching architecture. At opposite spectrums some prefer theoretical approaches, where architecture does not necessarily have to be constructed to succeed, while others maintain a corporeal emphasis with the utilisation of materials, physical-site and empirical-space to create buildable projects. Both ends of the spectrum are pertinent to architecture, where sophisticated theories can underpin and explore the reason why a project is designed, rather than a building being a statement of simply how it is made or as a design that can only survive within the conscious realm.

By utilising the definition, "*Architecture is the Poetic Articulation of Technology*", architecture can be realised using many different avenues of creativity but with the accent on integration and optimism. In this regard, Pearce and Toy, et al. (1995, pp. 66-67) state:

> *Architecture is not only about forms or concepts but about their interaction. The way architectural space presents itself to our representation is neither endo-structure nor exo-structure, it is an interface between the two. The way students engage with it is by making and verbally expressing their thoughts. Architecture in this process is not seen as a philosophical pursuit or as a craft. It is placed in an interactive process that relies on the tension between the two poles.*

Architectural Context

There are many instances of poetic articulations of technology in architecture from large to small. Here are three examples...

Jean Nouvel

Constructed during 2001-2005, the Torre Agbar was designated to contain the headquarters of the water company of Barcelona. Made of a concrete core perforated for multiple window openings, then clad in metal, LED panels, glazing and finally glass louvers, the Torre Agbar presents and casts a glistening, somewhat lucid figure in the Barcelona skyline. Similar but not the same as Foster Associates' 30 St. Mary's Axe

(Gherkin) in London - due to its iridescent multiple glazed countenance, Torre Agbar is not as harsh; with the flowing qualities of a gently upwardly gushing fountain, it illustrates less threatening and softer dimensions to many of its similar modern high-rise counterparts. In a brief description, Nouvel (2009) states

> *This is not a tower, a skyscraper, in the American sense. It is more an emergence, rising singularly in the centre of a generally calm city. Unlike slender spires and bell towers that typically pierce the horizons of horizontal cities, this tower is a fluid mass that bursts through the ground like a geyser under permanent, calculated pressure.*
>
> *The surface of the building evokes water: smooth and continuous, shimmering and transparent, its materials reveal themselves in nuanced shades of colour and light. It is architecture of the earth without the heaviness of stone, like a distant echo of old Catalan formal obsessions carried by a mysterious wind off the Montserrat.*
>
> *The ambiguities of material and light make the Agbar tower resonate against Barcelona's skyline day and night, like a distant mirage, marking the entry into the diagonal avenue from the Plaça de les Glorias…*

Indeed, the interior of the Torre Agbar is no less striking as its carved, layered stone and rock-like surfaces wind and twist as you enter the lower structure - it evokes the insides of a water-filled cave or inner sanctum of the geyser that Nouvel mentions. The multilayered and punctuated openings into the centre of the concrete core emit beautifully coloured shafts of light through the coloured glazing and illuminate the dark inner space with control and a sense of wonder.

Image 1
Torre Agbar (Channa Vithana)

Quinlan Terry

On a much smaller scale and utilising a starkly different architectural viewpoint, Quinlan Terry, famed for his grandiose but predominantly well-crafted classical architecture, created a classical hut in 1975. It utilises the apparent precision and order of mainstream classical architecture with columns and structures fully present but instead of using finely graded marble or stone, this tiny project is constructed from timber, albeit with fine craftsmanship and jointing. The result is, in a similar way to the Torre Agbar, a softer, less harsh facsimile of classical architecture that shorn of its traditional materials invites a fresh sense of curiosity and inquisition. This reformatting of materials to represent classical architecture succeeds in creating a different appreciation for an often derided and unfashionable architecture. The poetic articulation of technology here is clear and absorbing in its material currency and evocation of history.

Arts University College at Bournemouth (AUCB)

The undergraduate architecture course at AUCB started in September 2007 with eighteen first year students. In September 2008 there were in the region of thirty-five new first year students and approximately forty-five students in total for both years at the end of June 2009 after intermissions and other changes within cohorts. In September 2009 there will be the first third year cohort of twelve students. After internal validation, Architects Registration Board (ARB) Part 1 accreditation was achieved in February 2009 whilst RIBA accreditation is scheduled after a graduating cohort from June 2010.

The AUCB is located in Dorset, within the southern region of the UK. It has recently changed designation into a University College, from the former Arts Institute at Bournemouth, with new degree-awarding powers. The architecture course is currently one of the smallest in the UK but as a result remains attractive to students due to more individual teaching time, its locale with a large beach nearby and the AUCB's arts-based courses such as Film, Acting, Graphic Design, Animation, Interior Architecture & Design, Modelmaking and Fine Art amongst others all of which have significance to architecture.

Image 2

Theatre Site Plan
(Tatjana Lemega)

Tatjana Lemega: Folding Playhouse
2nd Year Undergraduate BA (Hons) Architecture Student, AUCB

The architectural emphasis for the second year was on urbanism, with urban context as an underlying structure to the design projects. The second year students designed a new arts theatre in the historic old seaside town of Weymouth, Dorset, UK. The site was an open infill between existing buildings, dimensioned at 16x44 M. The location was intriguing, due to the near instantaneous access links via road, sea, train and walking, and along with nearby car parking, the proposed theatre would have a strong viability within the chosen site. The context to this project was the planned redevelopment of Weymouth Town by Weymouth and Portland Borough Council which included new infrastructure for travel, housing, the arts, and the 2012 Olympics, for which Weymouth will host the sailing events.

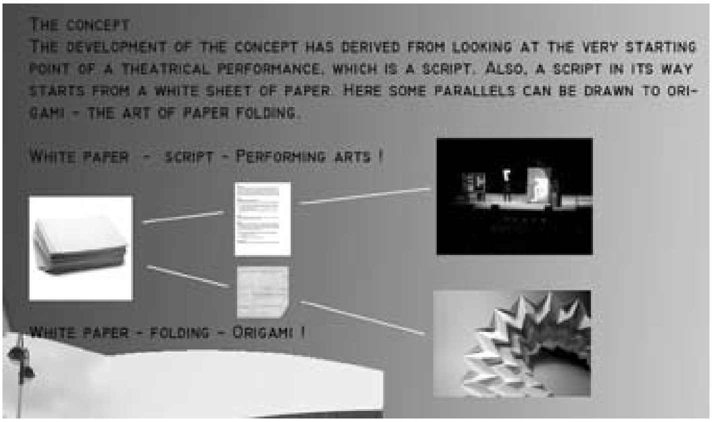


Image 3
Theatre Paper Process
(Tatjana Lemega)

The theatre was to have approximately 300 seats and be inclusive of fire, disabled access and other regulations pertaining to an arts theatre. The students could choose a specific type (or combinations) of theatre to focus their designs upon and this included drama, acoustic unamplified music, amplified music and/or cinema.

Image 4
Copper A
(Tatjana Lemega)

Tatjana chose to focus on drama and looked at the qualities of theatre designs in precedent studies and actual detailed backstage visits to working theatres. Here she arrived at the process of taking the script of a play and understanding its structure; of paper and layers that also describe the narrative or story of the play, also in layers, where the performance unfolds and is revealed to the audience. Then she looked at initial methods of representing this architecturally and here origami and folding paper forms came into prominence for the design work. This was further tested by using scale and urban site context analyses where it was decided that a theatre of contrast to the existing buildings on site would draw attention and therefore create a visual and material architectural identity of its own. This was in combination with the travel and access links to the site where a theatre with a clear identity would attract people, on a direct route via train travel from London Waterloo Station to Weymouth, away from the traditional theatre culture of the bigger city and into a smaller town setting, in Weymouth.

Image 5
Copper B
(Tatjana Lemega)

Soon after, materials and structure became important and Tatjana always maintained a scale model relationship with the design where even the simplest or roughest works could be considered on site. As the design evolved she preferred treated copper in order to maintain the natural brilliance of the metal and thus assisting in creating the clear contrast of design through material on site. Copper is a very versatile material and in this case it is one that provides familiarity to anyone experiencing it, and thus creates layers of intimacy with the relationship between a person on the street and the internals of the theatre. The threshold of the road to pavement to entrance of the theatre was also considered and here layers of copper were wrapped into the building fabric to create continuity of material and identity.

Tatyana worked with Gifford Engineers (structures) and Arup Engineers (Acoustics). The inclusion of a session with Sean Aita, Senior Lecturer in BA Acting at AUCB, was of great benefit whereby he was able to bring in over twenty years' worth of practical theatre experience to enhance insight into how real theatres should work successfully. Detailed technical visits and meetings to the Poole Lighthouse Theatre, Dorset, and The Place Theatre, London, augmented analysis of the Technical Standards for Places of Entertainment 08/09 (Association of British Theatre Technicians) guidelines which provided examples of best practice design, on disabled access, means of escape (fire) and seating as utilised by the two arts theatres studied.

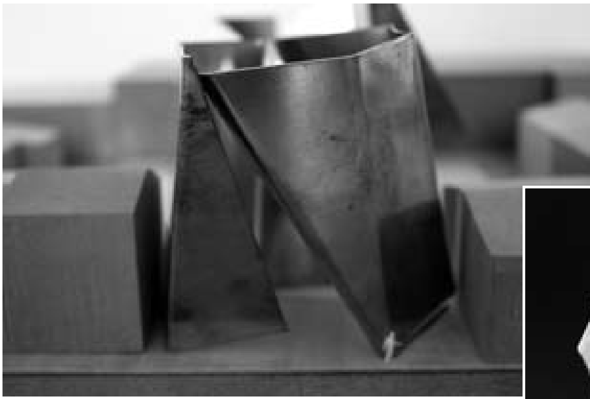


Image 6
Copper C (Tatjana Lemega)

Image 7
Model with People
(Tatjana Lemega)

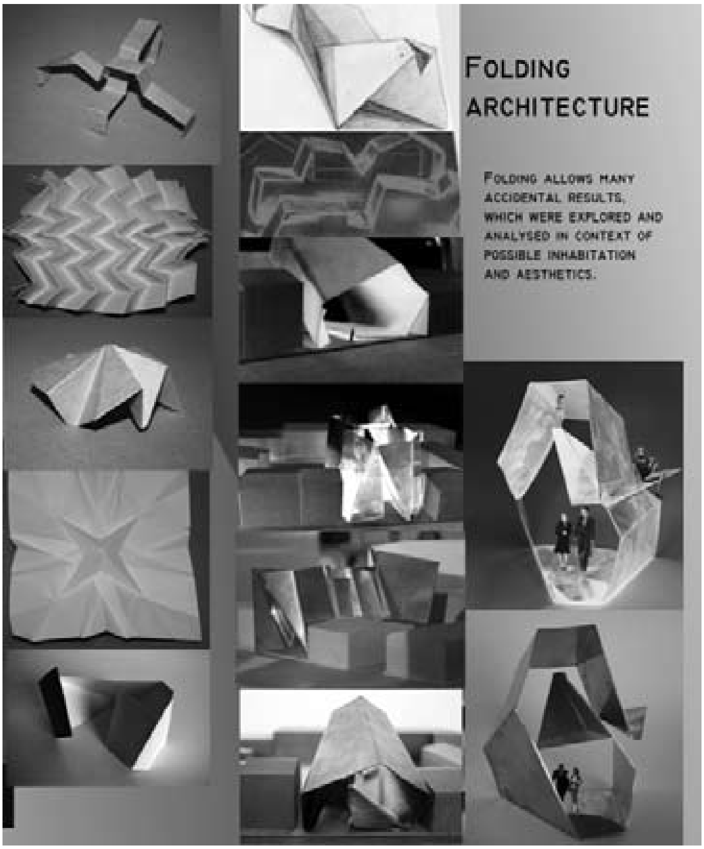


Image 8
Folding Architecture
(Tatjana Lemega)

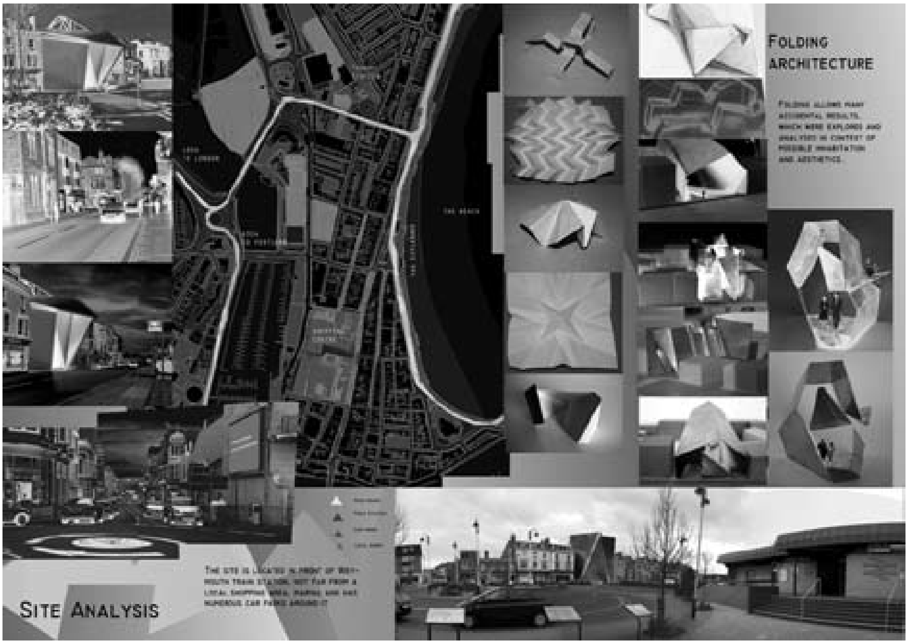


Image 9
Site analysis (Tatjana Lemega)

Weymouth Arts Theatre Project:

AUCB:
Unit Leader: Channa Vithana
Unit Tutors: Simon Beeson, Anthony Holness

Architectural Acoustics:
Rob Harris *Director*
Ove Arup & Partners Ltd

Structural Engineering:
Ben Rowe *Technical Director*
Gifford Engineers

Poole Lighthouse Theatre:
Robin Cave *Programming and Centre Manager*
Lighthouse

The Place:
Graeme McGinty *Technical Manager*
The Place

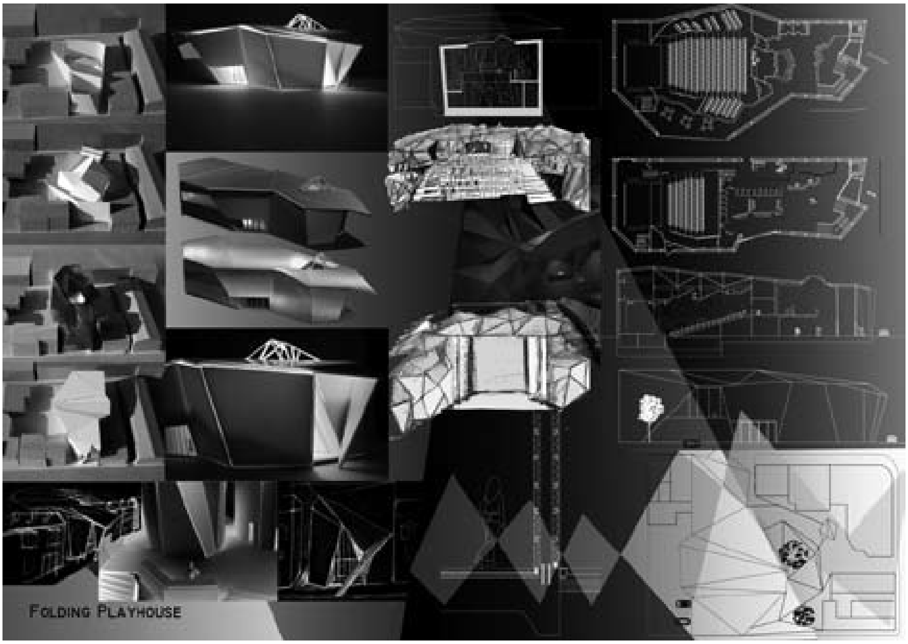


Image 10
Folding Playhouse (Tatjana Lemega)

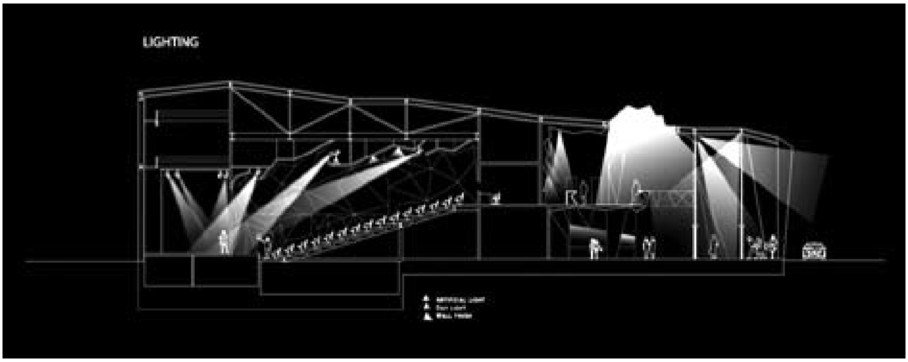


Image 11
Lighting (Tatjana Lemega)

Conclusion

The aim here of exploring the realms of poetics and technology through interaction, tension and translation from one to another, is meant to provide optimism and stimulus when teaching students, where their individual needs and desires can be explored through the realisation of dreams, sketches, drawings and models that are structured and enhanced with the disciplines of architecture in scale, materials, site and specialist expertise from engineers and experienced theatre practitioners and consultants. The realms of poetics in architecture can sometimes be very complex, or conversely, relatively straightforward in the transition into technology as with the projects by Jean Nouvel, Quinlan Terry and AUCB student Tatjana Lemega. What these projects illustrate is that architecture can be inclusive of materiality and creativity, where there is openness to expression and expressiveness without the need for the neurosis that often inhibits the energies and exploration of as many 'types' of architecture as possible. Indeed when contemplating the multitude of techniques/methods/processes/ways to realise architecture, the following sanguinely contextualises so many seemingly divergent 'truths,' where Burroughs (1982, p.13) states:

> *To all the scribes and artists and practitioners of magic…NOTHING IS TRUE. EVERYTHING IS PERMITTED.*

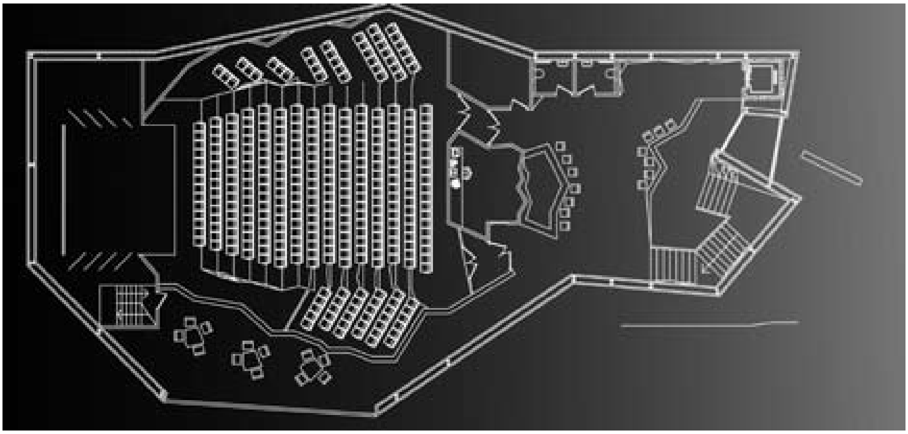


Image 12
Folding Playhouse Plan (Tatjana Lemega)

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Dieter Geissbühler

Lucerne University of Applied Sciences and Arts
School of Engineering and Architecture
Switzerland

Material as Generator for Identity in Architecture

Building as System is the guideline of the Lucerne School of Engineering and Architecture

Material - Structure - Energy are the three foci of the educational concept in architecture, on a more general level in the Bachelor course and on a more focussed level in the Master course.

Focus Material in the Master course

Conception and Experiment

We put the search for the "genetic" fundamental conditions in architecture as the focal point of our examination. What are the determining conditions, what mechanisms of growth define the process of assembling, what is the influence of the parts but also the assembling on the perception of building parts and buildings as a whole?

Therefore we stress the physical approach to materials and techniques of assembling. We take materials in our hands, we treat them with hands and machines, we reassemble and examine their figurative potential. This establishes the basis for the design process that then determines the architectural potential and leads to an architectural project. We examine the influence of the "doing" on the "thinking", against the usual approach which starts with thinking before doing.

From "doing" to "thinking"

We start our design-based research with a Means starting with the phenomena!

Phenomena of the existing, the genesis, the growth, the perception, the assembling.

This means training perception on the existing, starting with handcraft. The work in the workshop is the start, to feel the resistance of the material.

This means the reflection of the process of producing, of the thinking as the reflection of doing. This means putting singular phenomenon before the complexity, breaking the process down into singular phenomenon as a closed approach.

Project

Phase 1 – convertibility and homogeneity – material and effect

The starting point is materials that seem to be upcoming new materials in construction. These materials are examined on their potential of treatment, what media can be used for a transformation? What changes in the appearance are possible?

Phase 2 – combination and segregation – system of assembling and tectonics

The examined material delivers the elementary unit, that becomes the "molecule" of the whole. How can these molecules be assembled to establish a stable component? To fundamental tectonic techniques are examined: casting and layering.

Phase 3 – Reflection

The findings of the manual approach are examined on the potential for a constructive transformation. At the same time the possible forms of appearance are documented. Most important remains the documentation of the influencing factors of the material-based transformations on the process of architectural design.

Christian Drevet

Ecole Nationale Supérieure d’ Architecture de St Etienne
France

Post Civil Culture and Creativity

Architecture is not born directly from the site, nor the program, nor structure, nor materials, nor environmental issues, nor digital fabrication. Architecture is born from a culture as a world vision and, thus, from the values supporting this vision.

This world is in transformation and the architecture which is building its spaces is also in de-composition / re-composition.

The first question in teaching architectural design is consequently the architecture itself, as it were, a critical questioning of the discipline and its contemporary moving values in post civil society.

The ontological singularity, the "sensorial revolution" and phenomenology, the existential landscape, the loss of totality, the fragmentation, the sublimation of everyday life, the "general mobility" of persons, goods, information and knowledge, the plurality of sense, all these stakes and values fabricate, among others, the new architectural figures, which find new balances in fundamental dualities as inside / outside, natural / artificial, micro / macro, local / foreign, abstract / figurative, signifying / significated, and creates new paradigms and tropes as instability, blurred limits, in between, formlessness, faciality and skin, prismatic, fold, morphogenesis, kaleidoscope, bigness, becoming, and so on.

The second question in teaching architectural design is to lead students in situations of creativity in order to "invent the impossible" which is the only thing we can invent and which is also the condition of the continuation of human adventure if we do not want to disappear like dinosaurs.

Thus, the new architectural values and figures play the music of their creative dance and the vectors forces for morphing.

Teaching Strategies

What teaching and which research of contemporary pedagogy theory strategies do we have to develop to "stay alive"?

The teaching strategies in Master cycle I am working on in the St Etienne architecture school follow 3 interfering tracks in Master 2:

1. The pragmatic observation of yet created contemporary architectural objects analyzing their sources, tools and process. That's bottom up track.
2. The theoretical research of creative process starting from the 3 manners for think the word, as it were: art, sciences and philosophy. That's top down track.
3. The experimental confrontation between this "listen in" of the word and each student creative personality. That's upside down track.

These teaching strategies produce 3 pedagogic interacting spaces times:

1. **Art and architectural lectures** in which, investigating works and authors, we explain for example:

- How Delaunay uses "relativity theory" to create light figures independent from objects.
- How Jean Luc Goddard creates, in his pictures, connections between fragments using the theory of geometric space of Riemann.
- How Toyo Ito uses the mathematic curves of Bezier to create unfinished forms and explore the duality between "resemblance and difference".

- How Steven Holl uses fractals to surpass the relation between nature and artifice.
- How UN Studio uses digital fabrication to create "métissage" and new concepts like faciality.
- How Peter Eisenman catches the analogy with material and liquid crystals in particular to express the concept of instability.
- How Alvaro Siza uses Cubism to formalize the plurality of points of view on the same object.

  This space time takes three hours each week.

2. **Transverse seminaries** which are cross-disciplinary approaches of contemporary questions and problems in their true material and social complexity. The outcome is to identify three essential nodes in world shape:

- The forces lines and vectors of the contemporary world like globalization, information, neo industrialism, design thinking.
- The resistances like alter mondialism, neo rurality, patrimony.
- The duties like sustainable development, new civility.

  Another outcome is to revise the historic trends and styles and which are the moments of connection and "correspondences" for thinking and creating the world such as, for example: Art and Craft, Art Nouveau, Secession, De Still, Bauhaus, Modern movement, Nouveau Design, Renaissance.

  This seminar is, in fact, the encounter of philosopher, artist and scientist around merging themes like:

- Form / material in the evolution of hand, tool, machine, device.
- Identity / Universality.
- Image, digital fabrication and creativity.
- Industrial objects system, architecture fabric and place.

  This space time takes a couple of days three times during the semester.

3. **The workshop** which approaches the question of the project in an open way surpassing the traditional dualities like site / program, typology / morphology, sense / sensory.

   The project is the place of creativity, and creativity is exited by investigation of the questioning of the discipline and the search for new experience and value. Each student chooses questions he wants to explore and the epistemological questionning becomes the starter of the architectural design process.

   Epistemological themes can be, for example:

- New balances in fundamental reports as inside /outside, what is a façade today, how is the metropolitan window?
- What produces the association of density and plurality?
- What are the interfaces between fragments, what is composition today?
- Is there interference between biologic life and digital life? In other words, what is the interrelation between atom and pixel?
- What is the relationship between space and information, space and flood?

- Void
- Sense and sensory
- Post Euclidian geometry

  The project on creativity uses tools in the interconnection between image, material, digital such as, for example:

- Diagram, mapping and datascape which condenses information and mixes content and expression, micro detail and macro landscape.
- Accident, games, mathematics of chance.
- Protocols which simulate new experiences.
- Ready made, hybridation, collage, cross breeding, transformation in which two banal things can create a new effect together.
- System, strategy, process can help against cultural inertias and familiarities.
- Foreignness for students working on foreign sites.
- And so on.

  In workshops students are accompanied by creative discipline teachers, architect, artist, designer or digital specialist. They are all also practising professionals.

  This space time takes more than a day each week.

Work on limits to integrate

The essential strategy passes by the implementation all along the cursus of teaching of the discipline that consists in theoretical courses of architecture. The stake in these courses is to make the link between the work, the values socio cultural identified and the knowledge or to know how to make multidisciplinary references, the processes of the project and their tools.

The courses of architecture combine with the other disciplinary knowledge which they activate by associating them with the project. The courses of architecture thus put themselves in correspondence with all the disciplines taught that is three ways of thinking of the world: philosophy, art and science. It follows itself a revision of its disciplines according to relations.

1. Human sciences and the philosophy "in work"

Following the example of all the contemporary practices of conception, creation and objective production, the architecture has to produce the micro/macro human space in a world marked by a change of scale of its "games" (globalization) whereas the unprecedented transformations recompose the anthropological matrices of cultural fields:

- "Plan" of know and production of knowledge (theory, sciences, models).
- "Plan" of the memory and the transmission (trace, heritage, data).
- "Plan" of the communication and the exchanges (signs, information, media).
- "Plan" of imagination (fictions, narratives, utopias, heterotopias).

This "strictly speaking telluric" change affects foundations and thus conditions of the production of the cultural identity via the decomposition / reorganization accelerated by all constituent determiners:

- Determiners intellectual and discursive, formalization, scientific theories, collective axiologies (ideology, morality).
- Determiners sociologic, economic reports (production, exchange, consumption), political structures (distinction private / public, state intervention, legal regulation), family organization (family relationships), games(sets) of spaces ((relationship) city campaign (countryside), urban organization).
- Determiners sensitive (perceptible): affects, games of bodies, devices of pleasures.

  Contemporary mutagen factors (mailmen) are multiple and operate "a difference" for the society in its culture / information relationship. "The information replaces nature" and "couple brain / information replaces the couple body / nature" as Deleuze says and the real question is, "What happens when the strengths of the man compose with those of silicon?"

  The field of human sciences and philosophy must be omnipresent and accompany the education of architecture in the contemporary project. We must understand the world to build its spaces, its supports and its atmospheres.

The control of the key notions of this world passes by the expert exploration of, among others:

- The ontology with the dialectic deterritorialisation / reterritorialisation, immanence / transcendence, identital / universal, nature / subtlety.
- The immediacy, the effect, the sign and the phenomenology.
- The complexity by way of chaos, difference, peculiarity, coexistence, folding, movement.
- The shape, the morphogenesis, the idea.
- The visibility, the image, the glance, the face figure, the landscape, the instability.
- The structure, the system, the game, the fragmentation, collage, the demolition.
- The power, the current and the virtual.
- The post civility.
- etc...

Naturally these maieutics contributions to current transformations cannot be done without the historic bases of the visions of the previous classic or modern world, topiques or hétérotopiques. The role of the professor of architecture is not to be a professor of philosophy but to make the "correspondences" and the connections with the teaching of the architecture and thus to master the knowledge to well enough make them active.

2. Art and the philosophy of art

It is a question of working on the limits and the relationships between art and structures, between aesthetics and philosophy to observe the frictions and the possible articulations between these various disciplinary fields among which headways, changes of paradigms and the falls from one period to another, were able to serve for feeding mutually. At every period does a support of specific inscription of the mimesis corresponds to the digital technology?

It is also a matter of questioning the philosophic and aesthetic status of the image in architecture. The image as the point of articulation between the visible and the invisible, the thought and the material, the intention and the drawing, the sense and the sensation, the subject and the object.

3. Sciences

The approach of the mathematical or physical sciences inevitably bring the descriptive dimension of the space time weather in particular the post-Euclidian mathematics which allow the modeling of the complexity, the fragmentary, the instability, the peculiarity or the unpredictable.

The mathematics also constitute a domain of the specific thought and thus a way of thinking and thus of creating in whole part. They can thus participate directly in the architectural conceptualization through the "functions" which they invented.

Among domains to be revealed we can quote for example:

- The mathematics of fate, probability and complex numbers.
- The space bends, the topology, the spaces of Riemann.
- Quantum mechanics.
- Relativity.
- The theory of chaos.
- Mandelbrot and fractals - the atom and the infinitesimal, crystallization, nanotechnology.
- etc...

Conclusion

As we see, the questions of digital or material or structure are not specific and isolated and take part in architectural design, in different forms among other elements. Sometimes it appears in a question of value like, for example, the debate image / reality for digital, sometimes in a question of new figures of architecture as instability for material, sometimes in a question of creative tool as diagram for structure.

The best way to integrate is not to isolate and never approach specialized knowledge in the front face.

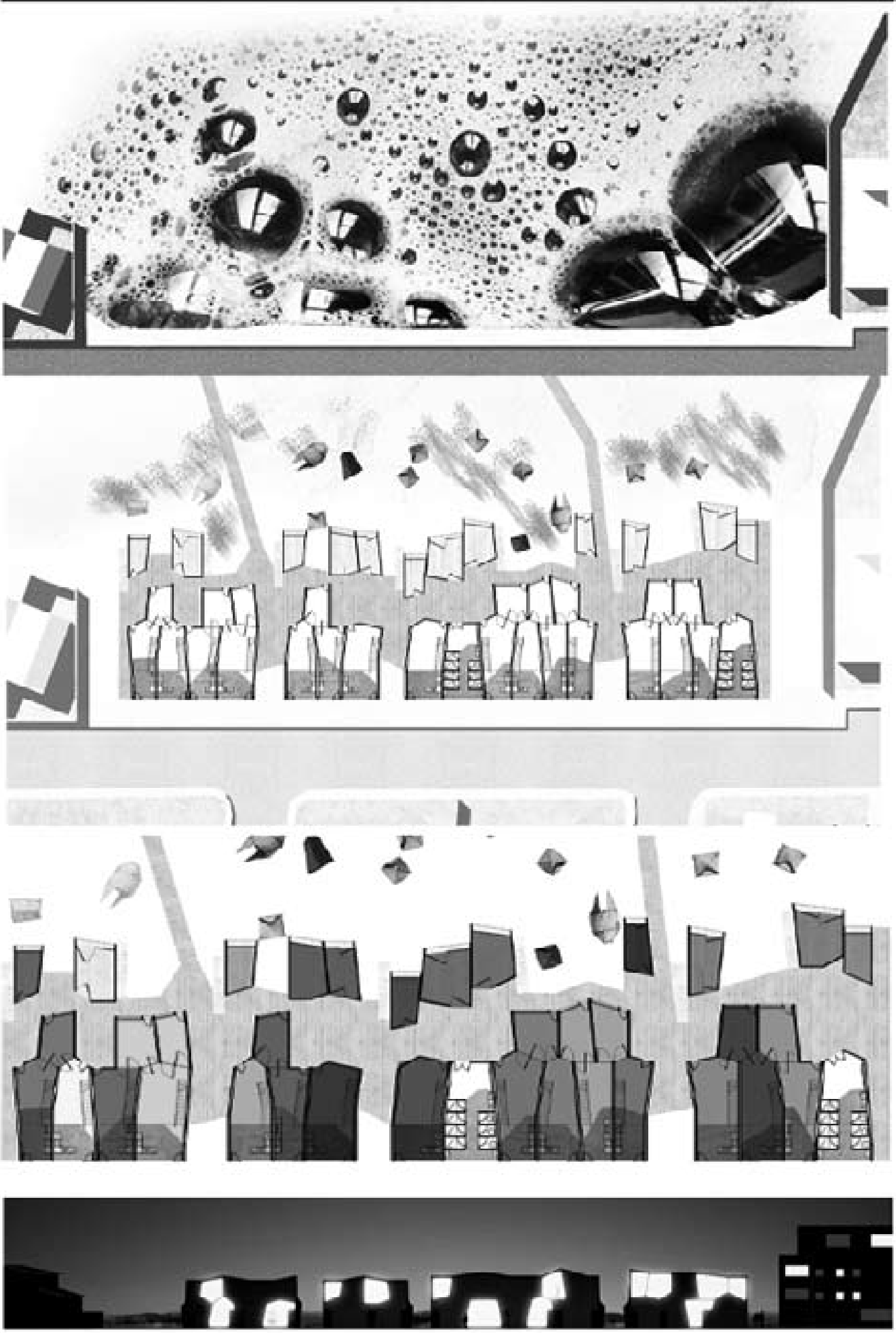
The best question in a changing discipline is to identify what is making a project, what is the matter and the material of the project. So a teaching strategy is becoming a sort of materials library with permanent updating.

These materials of the project appear fragmented, without hierarchy and also moving. Fragmentation is a problem and also a value of this world. Integration is somewhere impossible in the classic sense as well as synthesis. We have to move, like Virilio says: "from one fragment to the other". These moving, interfacing, resonances between elements put in disposition for students in a sort of random and chaotic neo structuralism.

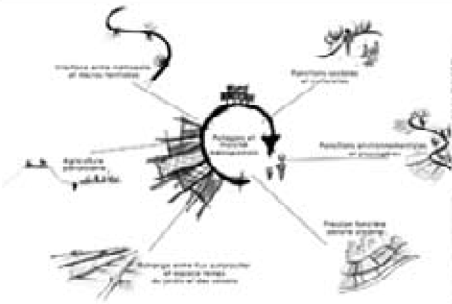
Architectural lectures and transverse seminars act as relay and interface between architecture and other teaching units and a relay between theses other themselves.

This is the correspondences platform. This is an active form of integration.

Thème : instability, semester 10, student: Benjamin Gibert, Porto, 2009

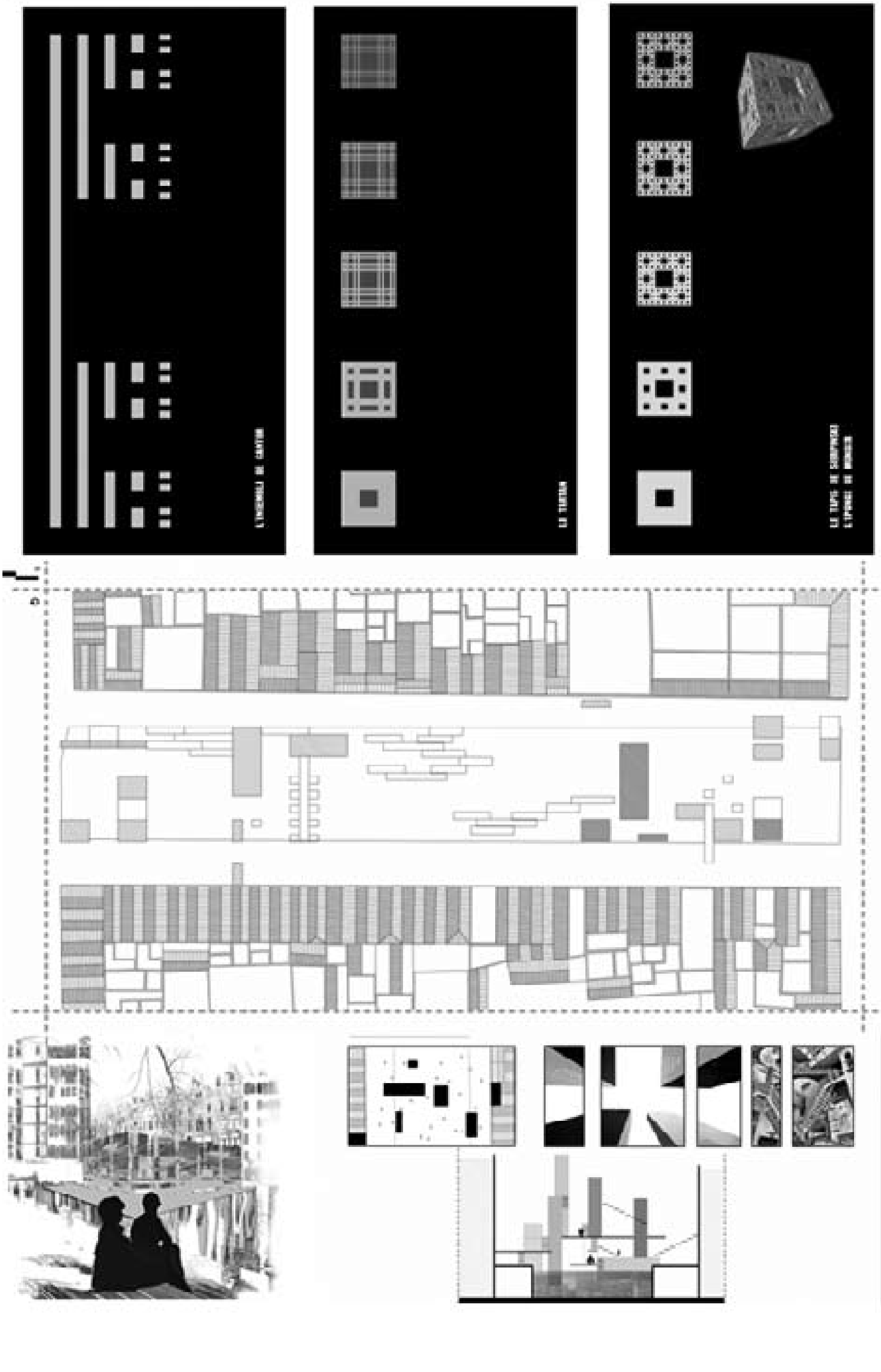


Theme: natural/artificial, semester 10, student: Claire Ogier, Porto, 2009

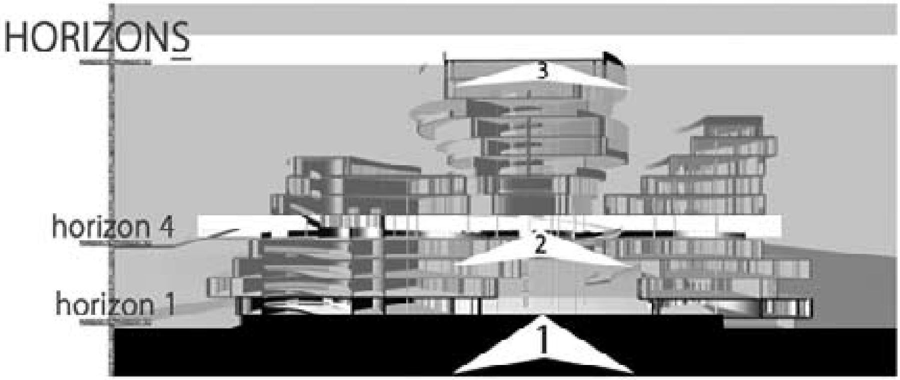


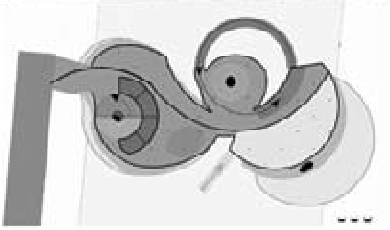
Theme: plurality / cubism, repetition / difference, semester 10, student: Murielle Poncet,Porto 2009

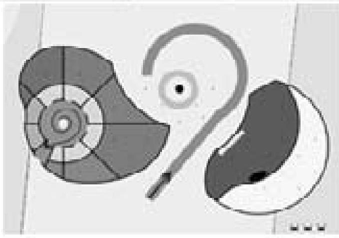
Theme: interstice § fractal, semester 10, student: Audrey Masson, Amsterdam, 2008



Theme: density § hyper building, semester 10, student: Cecile Doron, Dublin, 2008







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Establishing a Digital Fabrication Laboratory and Integrating it with Architectural Design

Introduction

This paper describes some recent developments in setting up a digital design and fabrication laboratory in the Department of Architecture at the University of Nicosia[1] and discusses how this can be effectively integrated with architectural design courses. The paper is divided into four parts:

- The first part is a general description of digital design and a fabrication laboratory.
- The second part discusses the digital design and fabrication courses. In this part, examples taken from students' works attempting to introduce such techniques as part of the design process are demonstrated.
- The third part demonstrates students' works in other courses like architectural design and building technology. In these works similar digital design and fabrication mechanisms are applied and investigated. Then, discussion on how digital fabrication can be integrated with architectural design courses is developed.
- Finally, the fourth part draws some general conclusions.

Establishing a digital design and fabrication laboratory

The department of Architecture at the University of Nicosia is relatively new but is rapidly growing in order to become one of the leading schools of architecture in Cyprus and the region. One of the school's main strategy policies was the organization and establishment of a digital design and fabrication laboratory that will be an important part in the architectural curriculum assisting or integrating with design studio courses in a productive and effective way. Currently the laboratory is used by undergraduate students but in the long term it is expected that it will assist courses at graduate level as well.

The laboratory is equipped with desktop computers using programs such as Allplan (BIM software), AutoCAD, 3DStudioMax and software for image processing. Also, apart from the lab's computers, students may use their own laptops. Additionally, computer programs that are used include Sketch Up, Rhino, etc. Students can print their project in size up to A0 using two plotters available for them any time of the day for free.

Also, the laboratory is equipped with a 3D printer that can print models with dimensions of up to 200mm width, 200mm length, and 250mm height. Finally it is equipped with a CNC (Computer Numerical Control) milling machine (or CNC cutting machine). Its printing size is 600mm length, 1000mm width, and 100mm height.

All undergraduate courses are held in the digital design laboratory that acts as a mini-studio. Students can use computers to practice various digital tools, work on their own projects or use 3D printers. This is an environment where students and lecturers can share their experience in using these techniques. Also, the lab acts as a catalyst for developing architectural studio culture, an important objective for the development of students' knowledge and experience.

Teaching digital design and fabrication

The teaching of digital courses starts in the second year of studies. However, the application of digital tools in studio courses may start earlier depending on students' interest, choice and ability.

Digital design courses aim to provide students with all necessary knowledge in a broader spectrum that will help them to understand how digital tools can be used and applied for their designs. Obviously, the possibilities of such application and use are tremendous and this is something that students will gradually understand through their involvement in digital design processes.

In semester three (ARCH-221), students are introduced to Computer-Aided Design and in particular to 3D modeling. In semester four (ARCH-241), students are asked to investigate digital mechanisms of creation using available software[2].

Analytically, in semester four, the main objectives of the course are as follows (see ARCH-241 course outline):

- To teach the theoretical and practical framework of digital design.
- To introduce and encourage practice in different kind of digital tools.
- To teach students various digital design techniques.
- To teach digital fabrication techniques encouraging students to use the 3D printer and the milling machine.

By the end of the course, students are expected to:

- Critically understand the theoretical principles of digital design.
- Experiment and understand the different principles of 3D modeling such as architectural modeling and free modeler.
- Use and combine various design software according to individual projects and design outcomes.
- Use the 3D printer and the milling machine.

In this last semester (ARCH-241, Spring 2009), students were asked to investigate forms which in the first instance seemed to be quite different. Examples taken from contemporary and traditional architecture were used for the first and the second project respectively.

It is believed that the complexity of forms and structures can be found in different architectural styles, from contemporary and organic like architecture to traditional and ornamental design. Hence, these two examples are quite similar in terms of educational purposes. Common ground in both cases is the process of analyzing and generating forms and structures. Through this procedure students can develop a geometrical understanding. They will be able to understand digital mechanisms of creation and to apply such techniques to their designs.

First project

Analytically the first project (dealing with contemporary architecture) was divided into part A and part B. In part A, students were asked to examine the geometrical evolution of existing forms (a list of contemporary architects was given) through their transformation from an initial situation into the final one and then present their conclusions.

What was examined was the students' ability to perceive, understand, analyze and generate forms that were based on specific digital mechanisms and principles different in each case. It was very interesting to observe that for each student these digital mechanisms were very different even if students had to investigate similar forms.

Figure 1 shows the process of analyzing the form and the structure in Toyo Ito's Serpentine Gallery Pavilion, 2002 [Student: Keravnos, Spring2009].

Figure 2 shows the physical model that has been constructed using the 3D printer. Obviously, in this case the complexity of form allows the use of 3D printer.

Following figures 3 and 4 demonstrate the process of analyzing a part of the building form in Gehry's Guggenheim Museum in Bilbao, 1997 [Student: Kyriakou, Spring 2009].

Figure 5a shows the process of developing a new form, which is in part B of the first project [Student: Kyriakou, Spring 2009]. In part B, conclusions (or geometrical rules) taken from part A were used by students in order to produce their own designs or develop their own concepts. Figure 5b shows the physical model that has been constructed using the 3D printer. Again, the use of a 3D printer helps the designer to capture this form precisely.

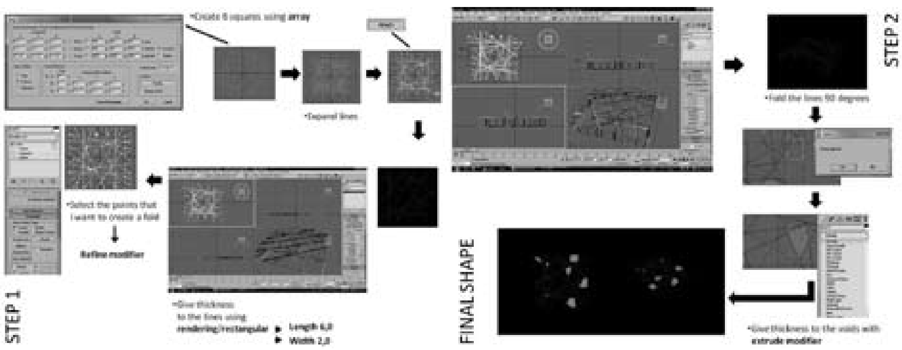

Fig. 1

Analysis of form in Toyo Ito's Serpentine Gallery Pavilion, 2002 [Student: Keravnos, Spring 2009]

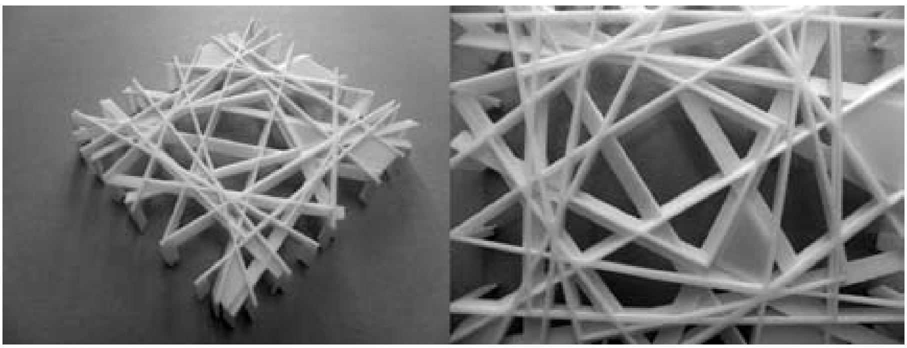

Fig. 2

Physical model [Student: Keravnos, Spring 2009, Digital fabrication: Kontovourkis and Economides, 2009]

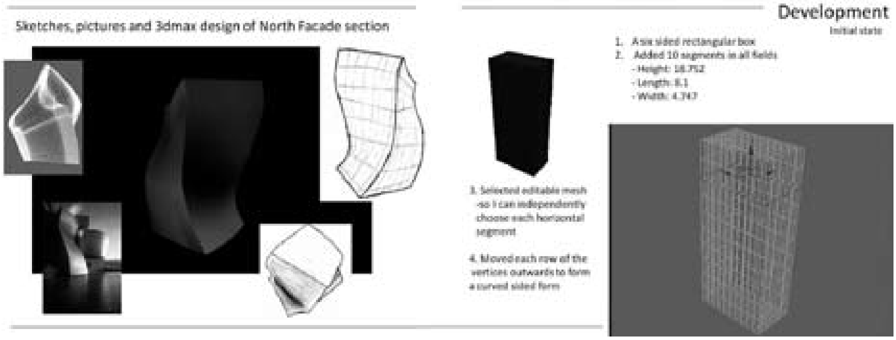

Fig. 3

Analysis of forms in Gehry's Guggenheim Museum in Bilbao, 1997 [Student: Kyriakou, Spring 2009]

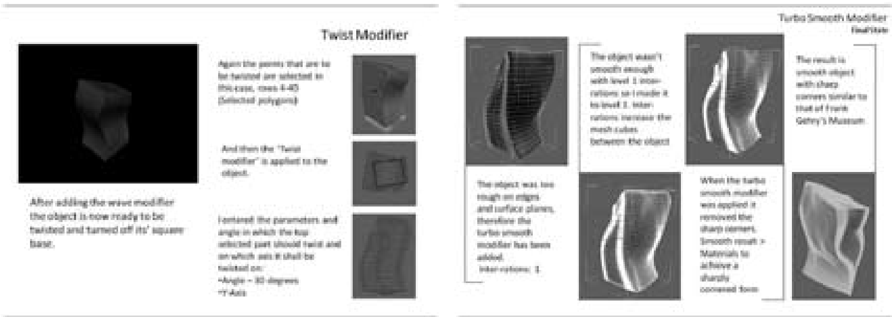

Fig. 4

Analysis of form in Gehry's Guggenheim Museum in Bilbao, 1997 [Student: Kyriakou, Spring 2009]

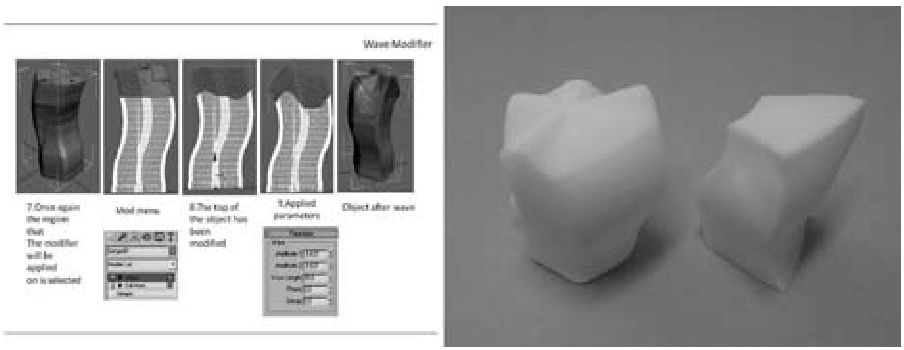

Fig. 5

a. Form creation using the same geometrical rules [Student: Kyriakou, Spring 2009],

b. Physical models [Student: Kyriakou, Spring 2009, Digital fabrication: Kontovourkis and Economides, 2009]

By following this procedure, students were able to understand that any changes in the parameters that control the digital design process (digital rules), can inevitably also change the final outcomes and the design possibilities can be tremendous. It is believed that such an approach will effectively introduce students to the idea of digital thinking since through the examination of different projects various digital approaches are investigated, aiming to capture the concept behind form creation (or form transformation).

Second project

By developing a geometrical understanding, students were asked to use digital mechanisms (this time combining more than one design software) in order to produce 3D models and 2D drawings of façades in the old city of Nicosia[4]. Again emphasis was put on digital thinking. Students were using software as a digital tool for their designs and not only as a presentation skill.

The following figures demonstrate students' examples from the second project. Figure 7 shows the final product of digital design process [Student: Hadjivasiliou, Spring 2009]. Digital tools are investigated and applied in such a way that traditional forms can be generated. Again, a fundamental part of this procedure is to find the appropriate rules of creation. Apart from the final rendering on the left hand side (see figure 6a), on the right hand side the physical model of the door's detail is demonstrated (see figure 6b). Clearly ornamental design can be constructed precisely using the 3D printer.

Figure 7 shows another example of traditional architecture in the old city of Nicosia that has been generated using digital mechanisms [Student: Georgiou, Spring 2009]. Digital fabrication techniques are also applied, in this case showing basic steps of creation.

The following figures 8 and 9 show an attempt to generate the entrance in the municipality of Nicosia (consisting of a series of Ionic columns) [Student: Kyriakou, Spring 2009]. It is interesting to observe that the process of generating the ionic capital of the column is different for each student dealing with this type of form.

Figure 9 shows the final product of the ionic column and the overall design of the municipality's entrance.

By the end of the course, students were expected to understand that various digital mechanisms can help towards the production of any form, providing that appropriate digital processes are applied in the best possible way. The choice of process depends again on the architect's decision.

Integrating it with architectural design courses

This is a workshop following a low-tech, high-volume model of project development. The goal is for students to learn to actively engage with and question the potentials latent in this –for the students- new class of machines.

Already at undergraduate level -in combination with their studio - students are using the digital workshop, creating work models and final models for their reviews. By working individually or in small groups, students develop their abilities in this new

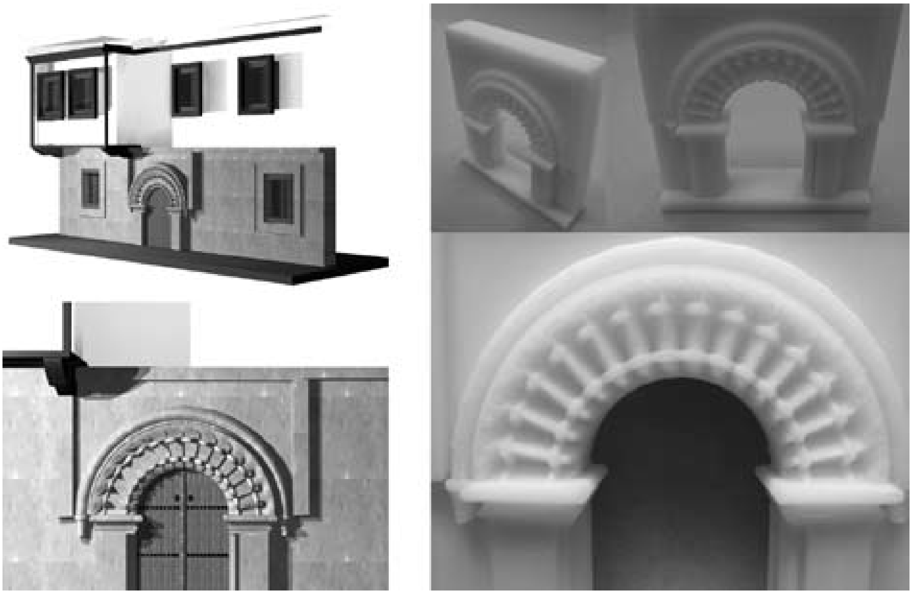

Fig. 6

a. Modeling of traditional architecture in the old city of Nicosia [Students: Hadjivasiliou, Spring 2009],

b. Physical model [Students: Hadjivasiliou, Spring 2009, Digital fabrication: Kontovourkis and Economides, 2009]

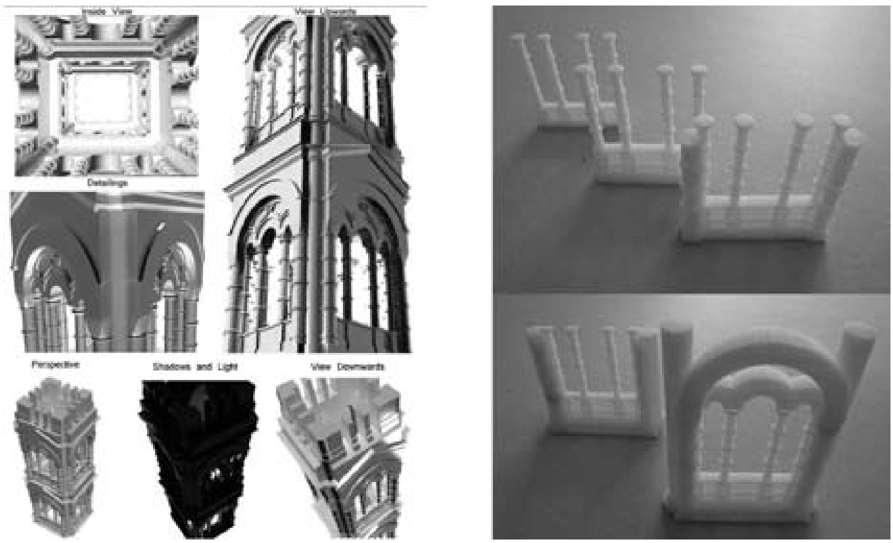

Fig. 7

a. Modeling of traditional architecture in the old city of Nicosia [Student: Georgiou, Spring 2009],

b. Physical model [Student: Georgiou, Spring 2009, Digital fabrication: Kontovourkis and Economides, 2009]

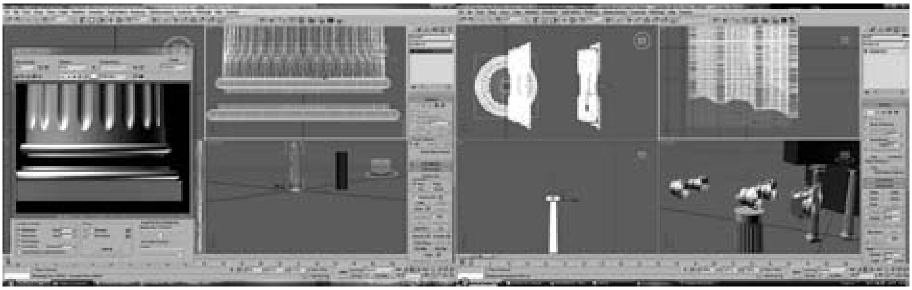

Fig. 8
Screen shots where parts of columns are geometrically investigated [Student: Kyriakou, Spring 2009]

Fig. 9
Modeling of traditional architecture in the old city of Nicosia [Student: Kyriakou, Spring 2009]

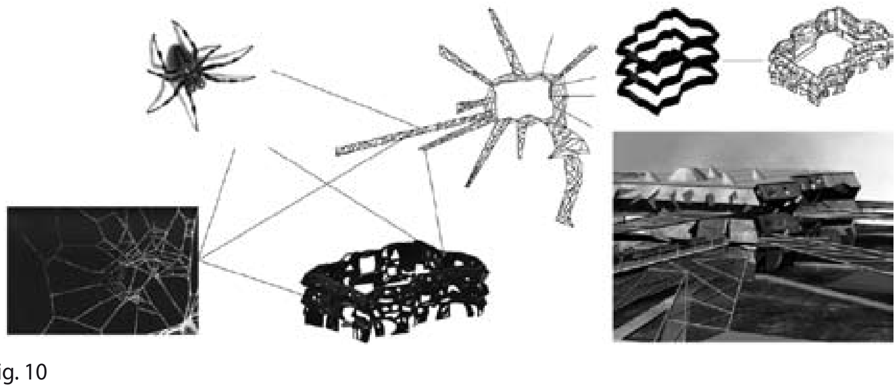

Fig. 10
Investigation of the digital model [Student: Neokleous, Spring 2008]

mode of creation: the presentation for spatial structures, realized as physical objects through the use of digital fabrication technologies.

The use of this technology, based on rapid prototyping and CNC cutting, allows for the direct translation of a digital model into physical form. In this process the students understand forms, structures and investigate design possibilities (see figures 10 and 11).

From the very first concept, students are learning to communicate in 3D. Whenever possible, they use physical models to explore concepts and communicate their vision regarding different elements and scales of design. This may include experimentation in the preliminary design phase up to the construction elements and details development (see figure 12).

Students have found hand-made model-making techniques to be a constrain for two reasons: the time required to make the model is too lengthy, and the process required to extract the necessary data from the computer file for the model makers takes valuable time away from the design.

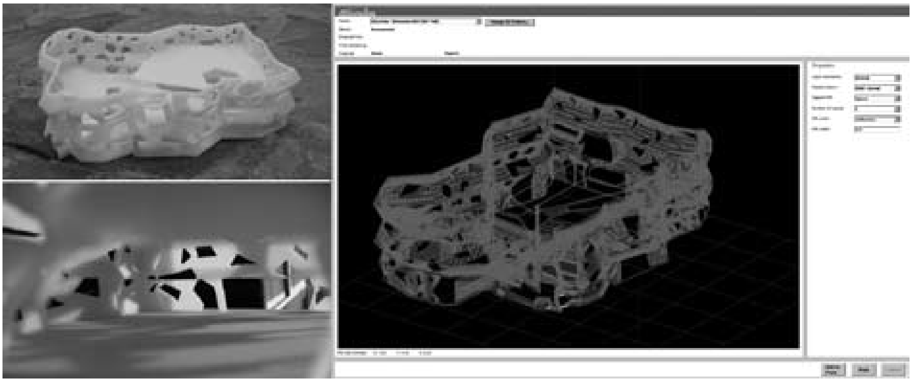

Fig. 11

The translation of digital model into physical form [Student: Neokleous, Spring 2008]

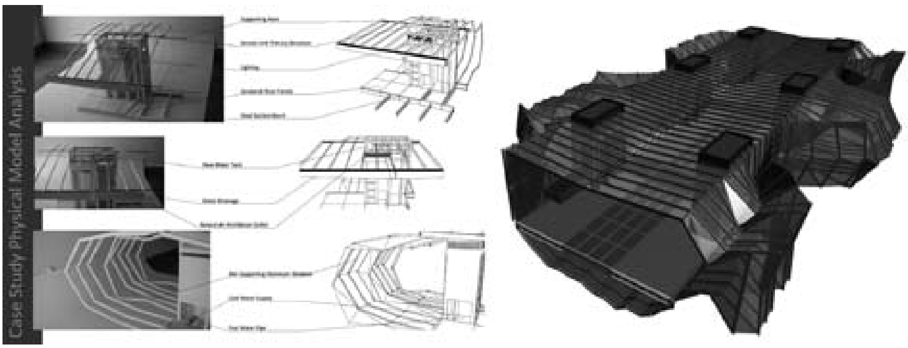

Fig. 12

Multiple models: digital and physical [Student: Postekis, Spring 2009]

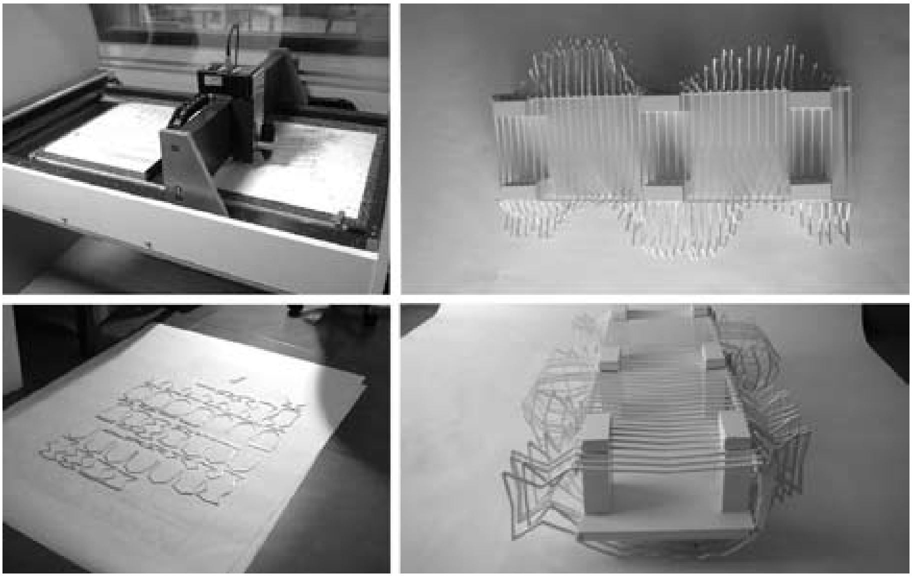

Fig. 13
a. The use of CNC milling machine [Student: Postekis, Spring 2009],
b. Construction of the physical model [Student: Postekis, Spring 2009]

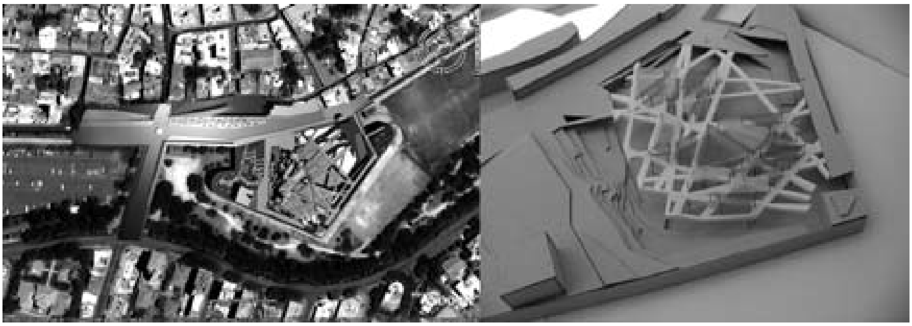

Fig. 14
a. Urban design studio: investigation into different scales of analysis and design,
b. Physical model [Students: Neokleous and Postekis, Fall 2008]

The students, having acquired certain experience in digital fabrication technologies in general, and having realized the advantages and setbacks of each digital tool (3D printer, CNC cutting) in particular, are able to apply the most suitable digital fabrication solution for the respective design process. This becomes more evident in, for example, the case of urban design studios where the development may include different scales of analysis and design (see figure 15a).

For example, under certain circumstances, it is an advantage to be able to print only pieces of the 3D model and for large area model elements, such as landscape sections, to use the CNC milling machine (see figure 15b).

Fig. 15

Physical model and collaborative approaches [Students: Neokleous and Postekis, Fall2008]

The 3D Printer and the CNC milling machine have become a key part of the creative process. The combination of rapid modeling, CNC machine and collaborative approach gives the students a real advantage in synthesis, reviews and in exploring their ideas (see figure 16).

Taking the example of urban studio courses in semester five and digital courses in semester four, it can be observed that even if there is not any direct connection between these two courses, many correlations can be found.

The investigation into the form-making process in course ARCH-241 (for example, see figure 1) can be part of the design process in urban studio courses (see figure 15). The generation of façade models in ARCH-241 can be incorporated into urban studio courses together with animation and other digital mechanisms that will develop further the ability of students to use digital techniques further in order to understand and represent their designs.

Obviously, all these cannot be separated but on the contrary, need to be connected together in order to achieve the integration of digital design and fabrication with design studio courses. In both cases issues under investigation might include: a) analysis and investigation, b) conceptual development, c) design elaboration, d) digital fabrication, e) presentation.

In studio courses, analysis and investigation is an essential part of course requirements. A possible integration with digital design and fabrication mechanisms can offer the potential for alternative design possibilities in different stages of the design process. It is believed that this integration might happen unconsciously since students are trying to apply the knowledge and experience gained from the one course to the other.

Conclusions

Current practice on digital design and fabrication techniques shows that advantages and disadvantages can be found. Briefly described, digital fabrication allows:

- Freedom and flexibility in design creation.
- Complex forms and structures can be easily generated.
- Models can be constructed precisely.

Disadvantages are:

- The expensive materials.
- Models cannot be elaborated on further.
- Alternative solutions cannot be investigated.

In terms of integration, it has been found that:

- Approaches that have been introduced in digital design courses have been separated from architectural design courses.
- Examples show that there is a tendency to integrate digital fabrication with architectural design but it is still at a premature stage.
- In most of the cases digital fabrication has been used in a later stage of the design process.

It is believed that this can be gradually improved when students and lecturers of design studios start to understand the potential of digital design and fabrication as the mechanism of creation. This will allow them to think about new design possibilities by using such techniques.

This paper suggests the use of digital design and fabrication techniques in various stages of the design process, including the early conceptual stage, in order to understand forms and structures and investigate design possibilities. Our goal is to connect the two separated fields in such a way that knowledge and practice gained in digital design courses is effectively applied to architectural design courses.

Notes

1 Similar attempts to establish digital design and fabrication laboratories can be found in various universities. For example, see Pupo, R. et al, 2008. Introducing digital fabrication into the architectural curriculum. Two Similar Experiences in Different Contexts. Proceedings of eCAADe, 2008. Antwerp, pp. 517-524.

2 Availability of software is important since the application of specific software can also influence the design process to a great extent

3 Balmond, C., 2004.Geometry, Algorithm, Pattern. In: N. Leach, D. Turnbull, and C. Williams. *Digital Tectonics*. Chichester: Wiley, pp. 127-135.

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Teaching Architectural Design and Technologies in a Modularised Curriculum

Introduction

The teaching of architecture has changed dramatically in recent years due to the introduction of modularisation. There are probably as many supporters of the process as there are opponents of it, and the question remains: is modularisation to be regarded as a problem that leads to severe fragmentation of the subject, or can the modular system be used to integrate these subjects to enhance the teaching and learning experience?

Before explaining in detail how the teaching of architectural design and technologies in a modularised system was approached at the University College Dublin (UCD), it is useful to look briefly at how the process of fragmentation at third-level education began. According to David Kolb (1984 p162), who developed the experiential learning model

> *The selection of Charles Eliot as president of Harvard in 1869 marked the end of classical education in American colleges whereby all students took the same courses in Greek, Latin, and mathematics. By introducing electives and "majors" in the Harvard curriculum, he began what, considering the rapid growth of knowledge, was the inevitable specialization and fragmentation that characterizes the modern university.*

In other words, the fragmentation of curriculum is celebrating its 140th anniversary. Even though Kolb's book was written 25 years ago (in the 70's traditional education systems were subject to strong criticism from academics), he identified well the problems that we are confronting now. Kolb (ibid.) continues

> *In the system that has emerged in the last 100 years, students have been increasingly free to select their courses and to define programs suited to their needs, interests, and abilities. … In a highly complex and specialized society, the pressures toward specialization in education feed on themselves.*

As architects, we are required to be generalists. However, we need to ask ourselves if we are creating more and more specialists in our architecture schools by allowing students to select majors and minors rather than educating them in one subject called architecture.

To address this question, I would like to refer to the approach to the teaching of architecture in a modularised curriculum taken at University College Dublin, Ireland. The aim of this paper is to provide suggestions for how architectural education can make the most of the modularisation process.

Pedagogical approach at University College Dublin – Architecture

At UCD the modularisation process, which was introduced in September 2005, was used as the opportunity to rethink and improve the architecture course structure. This included, for instance, explicitly connecting the design and technology studios with lectures to let the students understand the importance of architectural technologies in architecture, arranging workshops to explore structural properties of materials, promoting problem solving skills by setting up concrete tasks, and changing the assessment method from the end-of-the-year exam to a combination of methods.

With regard to the area of architectural technologies, the approach adopted by the school has placed emphasis on the following:

- Promoting creativity by promoting problem solving skills and encouraging students to find alternative solutions;
- Using a variety of assessment methods (e.g. exams, project work, lab sessions, technical drawings);
- Promoting independent research as part of the project work submission;
- Emphasising the importance of looking beyond the 'compartmentalised knowledge' approach and helping students realise how different subjects such as history and theory, architectural technologies, ecology etc. constitute one discipline called architecture;
- Promoting an interconnected and interdisciplinary approach in lectures and through workshops which have promoted the idea of 'learning by making';
- Teaching is not to be seen as transmission of knowledge, but rather as facilitation of learning;
- Making the most of knowledge gained through everyday life and facilitating the incorporation thereof into student work through discussions and project work;
- Allowing students to choose their own medium (to a certain extent within given parameters) to express their views (project work and written exams).

Architectural technologies: the course structure

At UCD-Architecture, the subject of architectural technologies is taught to all 3 years of the Part I course with other related subjects such as environmental science and structures. In Part II, design technologies is taught in both semesters in the fourth-year, and in the fifth year, a thesis year, students engage in individual projects.

In the first year, architectural technologies is introduced in its broadest sense, including its principles and applications, in order to provide a foundation for an understanding of the construction methods and performance of a building on a domestic scale.[1]

In the second year, the scale changes from domestic to medium-size framed residential and public buildings with detailed studies of timber, concrete and steel structures and cladding materials.

In the third year, the emphasis is placed on medium-rise complex public buildings. This involves the introduction of modern building components, construction and structural methods as well as related environmental issues and technologies.

In relation to Part II, in semester one students engage in an intensive case study analysis, separate from studio work, which reviews all aspects (regulatory, structural, energy, environmental, technological, material use) of a significant Irish building and proposes critical modifications to improve its sustainability.

The second module runs as a series of options, which are linked to current research projects underway in the school and thus vary year by year. The intention is both to develop students' understanding of research and to help them focus strategically on a particular area of interest in more depth. For instance, in 2008-2009, the following options were made available to students: conservation of building materials; light

Image 1
Course structure

Image 2
First year project

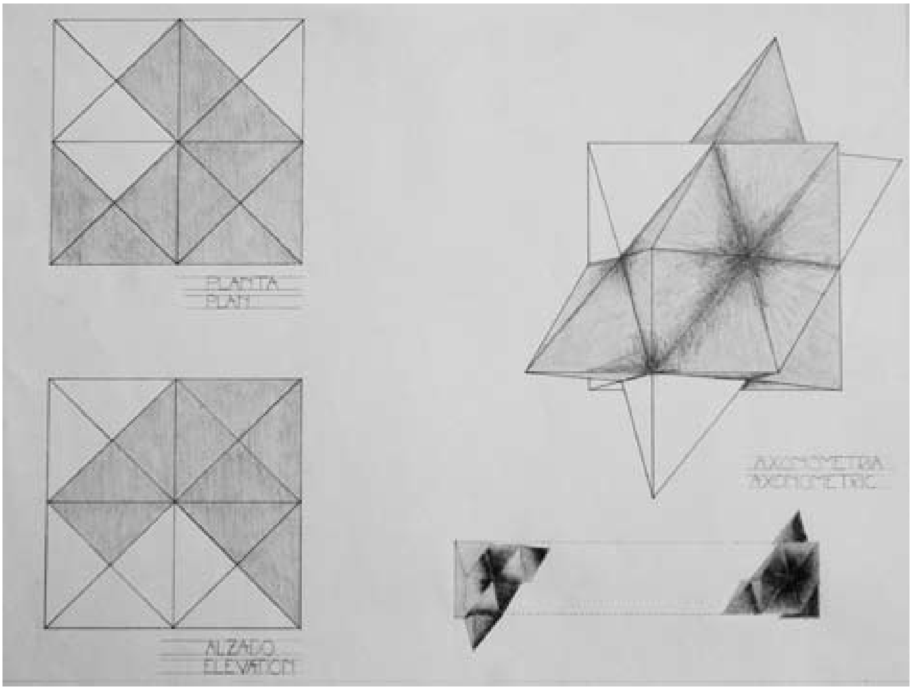

Image 3
Second year project

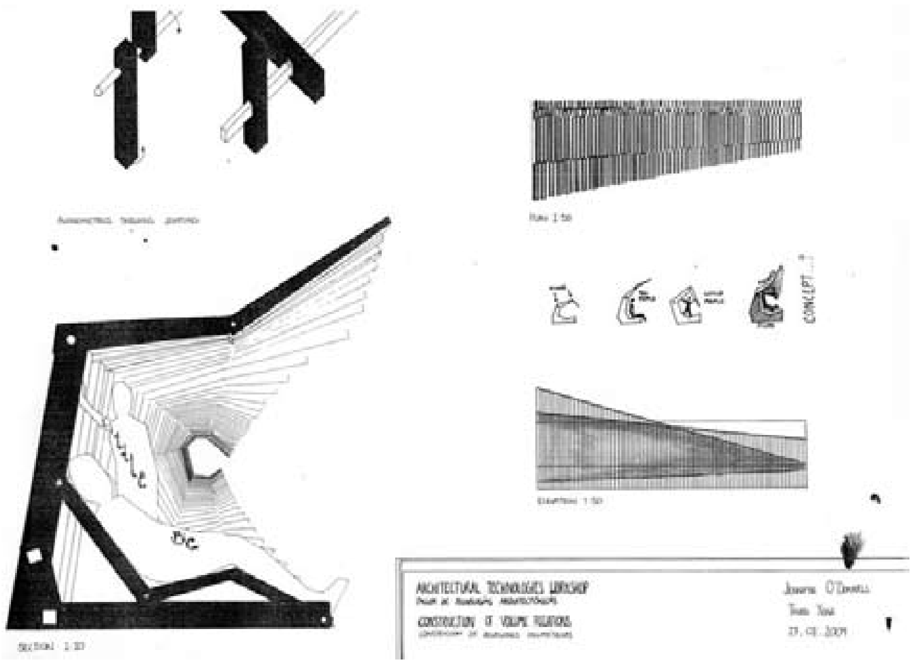

Image 4
Third year project

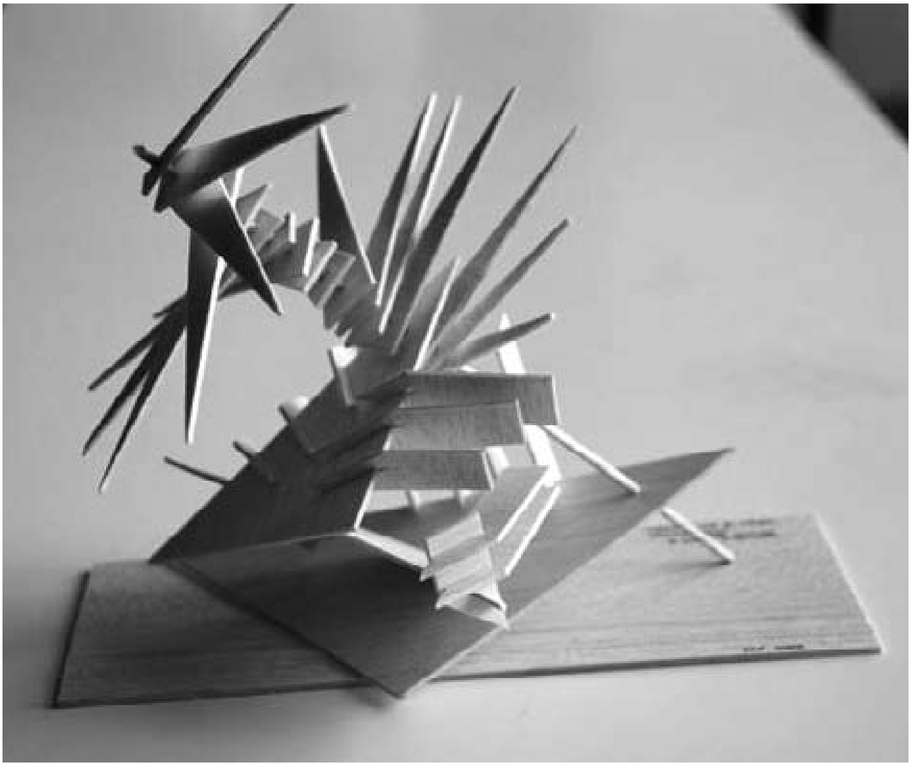

Image 5
Fourth year Irish timber project

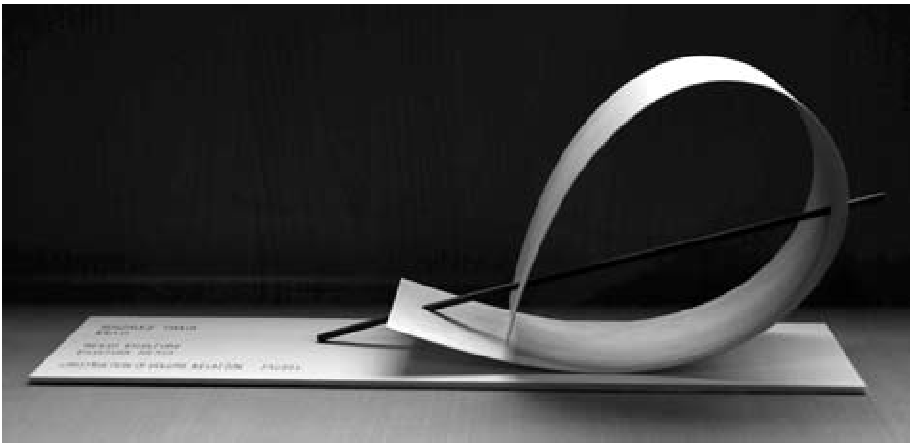

Image 6
Fifth year project

(psychological impact of light and its relationship to scientific standards and measurements); Irish timber and sustainability; and Erasmus summer design build.

The fifth-year design thesis requires each student to pursue a course of independent work focused on a particular issue or theme in architecture. By means of a design project and allied research and experiment, students seek to establish a richer understanding of their position in architecture and of architecture's role and potential in contemporary society. Technology is embedded in their final work.

Impact of modularisation on the subject of architectural technologies

With regard to the technology programme, one of the problems that the UCD - Architecture faced before modularisation took place was the fact that the subject area operated as a stand-alone subject with an independent technology studio and its own exercises. Although this structured placed emphasis on the understanding of technology in certain depth, some students had difficulty in recognising the interconnectedness of technology and design.

In contrast, after modularisation, the subject of architectural technologies is strongly linked to the design studio. In particular, the lectures are connected as far as possible with the design studio topics and needs. The technology studio is used as a tool to develop the detailing skills required for design studio projects. The project work, a 5000-word essay, is an exercise that requires students to explain how to build their design studio projects. The technology studio functions as the link between theory and practice, and design and build. Students are encouraged to study real building materials that they intend to use in their design. The building laboratory plays a major role in facilitating this.

By means of these measures we try to link the technologies subject area with the architectural design studio. We also try to awake students' interest in both through innovative projects and workshops as part of the technology module. We organise small projects, which may run only for a day and focus on a very specific theme, up to week-long projects that are broader in scope.

Examples of workshops

Example 1: The workshop at Les Grands Ateliers in Villefontaine, France

Until this academic year, UCD - Architecture workshop at Les Grands Ateliers was used as a tool in the final (thesis) year to expose students to matters of structure and material at the critical stage of the formation of their thesis. The workshops took place in the context of each student's work conducted on an exploratory basis with the purpose of establishing the ground for his or her thesis.

In contrast, this year's Les Grands Ateliers workshop involved first year students, and its purpose was to: firstly, encourage students to engage with materials and to explore and discover their inherent properties through construction/ making; and to design and make.

Example 2: UCD Architecture – GMIT Furniture Workshop (2nd Yr Joint Project)

In the academic year 2007-08 we introduced an interdisciplinary joint project with Galway-Mayo Institute of Technology Furniture School in Letterfrack. Twenty UCD second-year students went to Letterfrack and worked in groups with twenty second year furniture design students for three days. The aim of the project was to explore the relationship between conceptual consideration of material (and the space that material can create), and the physical act of making. In particular, students were expected to explore the tools for these separate skills and how they could learn more about them through collaboration and shared learning.

Example 3: Erasmus summer design build

The module is offered as an elective technology course for two weeks each summer. It involves 7 architecture schools from across Europe. The workshop is held in a different country each year, and a different material is used each time. For instance: in 2007 the workshop took place in Norway, and students worked with timber, whereas in 2008 it was held in the Netherlands, and the material used was brick. In 2009 students will be working with dry stone in Connemara, Ireland.

Conclusion

In summary, the modularisation process at UCD has been used to facilitate student learning, in particular:

- The understanding of the important role of architectural technologies in the creative process of making architecture;
- The understanding of how to use the technologies students have learned about in their design projects;
- Learning to break the boundaries in students' thought process and be innovative;
- Being open-minded to try out new approaches in technology;
- Being critical to construction methods and materials;
- The understanding of the importance of research and independent study from the very beginning of their third-level education.

Note

1 The information on part I and II structure was taken from the UCD – Architecture programme.

References

Kolb, D. A. 1984. *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

UCD Architecture course details: www.ucd.ie

The author would like to acknowledge the contribution of other UCD – Architecture staff. In particular, Elizabeth Burns, Miriam Delaney, Marcus Donaghy, Tiago Faria, Paul Kenny, Elizabeth Shotton

Session 2.1

Integration as a teaching practice

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Housing Hybrids

Housing Hybrids is an Advanced Design Studio in the Architecture Program at the Boston Architectural College (BAC).

The BAC is a mid-size professional college: students are full-time practitioners who attend school and fulfill professional work at the same time.

The course is one of the Studios and Workshops presented during the "shopping day" at the beginning of the semester. The subject and syllabus of all these courses are developed by their instructors, therefore the idea is that both students and teachers choose and work on what they want, enhancing everyone's motivation[1].

The enrollment is open to both graduate and undergraduate students, and is intended for six to eight students.

The class meets once a week for three hours. In addition, the students are expected to dedicate ten more hours of personal work. Twelve students chose this specific course, thus we adapted its structure to accommodate the excess.

As part of our pedagogic strategy, we focus on both content and class development: what we teach and how we teach it. In this regard, our methodology intertwines three aspects:

1. Students' empowerment. Their active participation is of paramount importance for the dynamics of the course. We want our students to learn in different ways, gaining flexibility and autonomy as designers. We make them play different roles along the course, researchers, developers, designers, teachers, critics and evaluators for themselves and their colleagues.

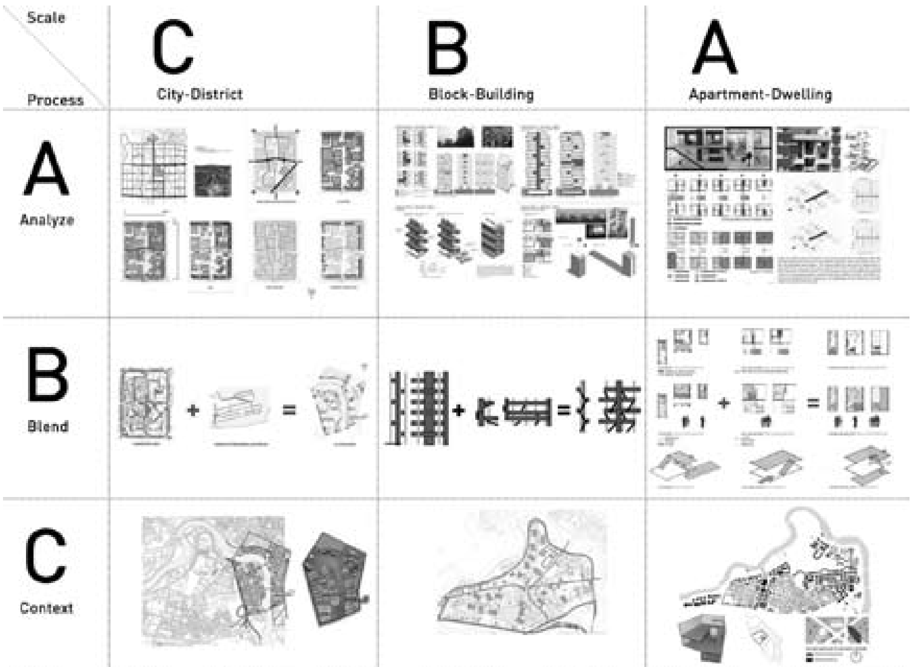

Fig. 1
Introduction: the institution, the course and the class.

2. Challenge the limitations of conventional Studio structures. First, to avoid an excess of hierarchy, students are asked to fulfill some teacher's activities (see above). To avoid passivity, we carefully plan different activities to be performed during the three hours time, lectures, charettes, pinups and presentations, individual desk critics. The class gets more dynamic and everyone gains confidence adopting different roles in front of a demanding audience.
3. Integrate knowledge and practice. This course blends a Workshop with a Studio: students not only learn and present from case studies, but use other designers' strategies to develop their own design strategy.

Fig. 2
Pedagogic goals and their achievement.

Fig. 3

Choose among given samples:
Cities

Choose among given samples:
Buildings

Choose among given samples:
Apartments

Fig. 4

Housing Hybrids Manifiesto:
Integrating multi-scalar residential strategies

Housing Hybrids is a mixture between a Workshop and a Studio that takes the best from both worlds: It provides a theoretical frame based on prototypical residential projects and challenges the student to design through blending them. It first presents an alphabet of fundamental housing examples and then asks students to build their own vocabulary and grammar combining them.

Housing Hybrids deals with the ABCs of residential design –Apartment, Building and City- and delivers a clear and distinct understanding of housing tactics and types at those three different scales.

Housing Hybrids ask students to follow an ABC process in every scale:

A. Analyze two examples of each scale with attention to their design features.
B. Blend those features into a new housing product at the given scale.
C. Combine the new housing item into the context of the previous scale mix.

Housing Hybrids avoids the conventional approach which starts with the Apartment design, follows with the Building project and ends with the City planning. This usually eases the student's approach to complexity, but too often results in the repetition of a perfected housing type over the territory.

Housing Hybrids' students start with the City and end in the Apartment. They learn how a neighborhood can accommodate different blocks and how a block allows for several dwelling types. With every change of scale, students change their previous set of examples to blend. Each student analyzes one sample and then chooses another from a classmate to develop the hybrid either in a group or individually.

Housing Hybrids eases interaction in the class –as students need to understand each other's projects, first to choose wisely and then to use the information - and provokes a way of learning by developing different blending strategies.

Housing Hybrids' aims as an experimental studio are manifold:

- Housing Hybrids provides the students with a library of basic residential examples: they learn about them through exposure, analysis and proposal.
- Housing Hybrids trains the students to find and use other projects' features as references for their own designs: they do so in a flexible way, being able to acknowledge -as well as to overcome- the differences in authorship and scale.
- Housing Hybrids sharpens the students' analytical and conceptual abilities: this specific studio is conceived as an instrumental basis for incoming studios.

Some final comments from and towards the students

Most students enjoyed and learnt along the course; however we shared their main concern, "so many students, so little time". Three hours a week proved not enough for our twelve-people class. Our response involved active e-mailing with feedback on a weekly basis and some off-class meetings with students to help keep the pace of their learning.

Some students found it boring or too much directed to do analysis of different examples in each of the three scales covered.

- Among these, most had imaginative designs but some lacked consistency.

Some students complained about missing information when researching.

- Beware of Analysis Paralysis, students get literal and do not develop concepts.

Some students avoid others' analysis, "you cannot chew someone else's gum".

- When concepts are missing, some students delay work instead of thinking towards their own design.

Some students did not like to act as critics to their own classmates.

- A student suggestion: "start a class blog, so comments get there anytime"

Fig. 5

Note

1 We initially developed a Workshop structure -with more lectures and design analysis- about a selection of prototypical examples of residential developments at different scales, but eventually we were asked to reformat our Workshop into a Design Studio. Part of the course's hybrid condition results from a negotiation between making room for more of students' design, and keeping the housing examples and the lessons they bring with them.

Sandy De Bruycker

Sint Lucas School of Architecture
Belgium

Building Envelopes in a Holistic Perspective: A plea for a Fit-For-Purpose approach and Activating Design

Analysing the design development of existing building envelopes often leads to the conclusion that the roof and the ground slab have been almost excluselively designed from the functional viewpoint while the façade has been designed taking into account architectural aspects. In this context, it was primarily the development in glass technology that was important. Due to the desire for maximized glass surface, the advanced development of the glass technology on the one hand and due to the search for more adequate insulated opaque external components on the other hand (both feed by the need for better comfort) caused a complex quantity of parameters, features, properties, concepts and principles. The emergency grows for verifiable criteria which take all these aspects into account. In this context, Sint Lucas School of Architecture created a research environment called IVOTO *(Instituut Voor Ontwerpmatig Technologisch Onderzoek, Institute For Design Aimed Technological Research).*

In order to optimize the processing of all these verifiable criteria (in the case of designing a building envelope), it can be essential to join different design aspects (expression on the one hand and building technologies on the other hand) through amplifying the position of the building envelope as being not just the outer shell defining the boundary between inside and outside, but as being a selective filter *(Steven V Szokolay, Introduction to Architectural Science)* which enters into dialogue with its surroundings *(Hegger, Fuchs, Stark, Zeumer, Energy Manual Sustainable Architecture)* to exclude aggression or hostiliy and/or to admit supply from the environment. This definition makes the building envelope attractive and accessible for different design viewpoints in an interdisciplinary team. For example, physical parameters can be considered as an expression of dialogue with its physical environment.

As an excercise, students of architecture (first year Master of Architecture) were asked to evaluate or to compare given building envelopes only by means of illustrations and they were asked to list the parameters, features, concepts, properties they used.

Materialisation / Transparency / Sunshade / Airtightness/ Wind load / Fire safety / Fire resistance / Orientation / Accoustic insulation / Thermal insulation / U-value / E-level / Energy Performance Regulation / Comfort / Temperature / Thermal mass / Modulus of elongation / View / Texture / Shaping / Day Night situation / Vandalism / Maintenance / Cost / Burglary / Ecology / Structure / Gravity / Sustainability / Water discharge / Flexibility / Technology / Ventilation / Perforations / Assembly / Roof as fifth façade / Workability / Completion deadline / Transport / Energy / Color / Lighting / Calamity / Buckling lenght / Slenderness / Climate / Accoustics / Watertightness / Vapourtightness / Availability of materials / Function / Programme / Fragileness / Absorption / Reflection / Temporary skin / Advanced skin / Interactivity / Double skin / Renewebility / Replacebility / Prefab / Multifunctionality / Density / Movability / Thickness / Maximum span / Odour / Chemical resistance / Bending Moment / Compression strenght / Tensile strenght

Fig. 1

Student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, February 2009

It is interesting to understand how students or more experienced designers deal with that complexity on the one hand and to find the moment of appearance in the design process to guarantee the satisfactory objectives on the other hand. These questions are a basic search for management. Classifying them in sub-aspects (expression, structure, comfort and energy, construction, prevention, organisation) can be a primary management approach.

EXPRESSION *Materialisation / Transparency / Sunshade / Comfort / View / Texture / Shaping / Day Night situation / Ecology / Structure / Sustainability / Water discharge / Flexibility / Technology / Ventilation / Perforations / Assembly / Roof as fifth façade / Color / Lighting / Slenderness / Function / Programme / Fragileness / Absorption / Reflection / Interactivity / Renewebility / Replacebility / Multifunctionality / Density / Movability / Thickness /*

Fig. 2

Sub-aspect expression of student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, February 2009

STRUCTURE *Materialisation / Transparency / Sunshade / Wind load / Fire resistance / Thermal mass / Modulus of elongation / Shaping / Cost / Ecology / Structure / Gravity / Sustainability / Flexibility / Technology / Perforations / Assembly / Roof as fifth façade / Workability / Completion deadline / Transport / Buckling lenght / Slenderness / Climate / Availability of materials / Fragileness / Temporary skin / Advanced skin / Interactivity / Double skin / Renewebility / Replacebility / Prefab / Multifunctionality / Density / Movability / Thickness / Maximum span / Chemical resistance / Bending Moment / Compression strenght / Tensile strenght /*

Fig. 3

Sub-aspect structure of student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, February 2009

COMFORT AND ENERGY *Materialisation / Transparency / Sunshade / Airtightness/ Wind load / Orientation / Accoustic insulation / Thermal insulation / U-value / E-level / Energy Performance Regulation / Comfort / Temperature / Thermal mass / View / Texture / Shaping / Day Night situation / Maintenance / Cost / Ecology / Sustainability / Flexibility / Technology / Ventilation / Perforations / Roof as fifth façade / / Energy / Color / Lighting / Slenderness / Climate / Accoustics / Watertightness / Vapourtightness / Function / Programme / Absorption / Reflection / Temporary skin / Advanced skin / Interactivity / Double skin / Renewebility / Multifunctionality / Density / Movability / Odour /*

Fig. 4

Sub-aspect comfort and energy of student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, february 2009

CONSTRUCTION
Materialisation / Transparency / Sunshade / Airtightness / Fire safety / Fire resistance / Accoustic insulation / Thermal insulation / U-value / E-level / Thermal mass / Modulus of elongation / Shaping / Day Night situation / Vandalism / Maintenance / Cost / Burglary / Ecology / Structure / Gravity / Sustainability / Water discharge / Flexibility / Technology / Perforations / Assembly / Workability / Completion deadline / Transport / Energy / Calamity / Buckling lenght / Slenderness / Climate / Accoustics / Watertightness / Vapourtightness / Availability of materials / Fragileness / Temporary skin / Advanced skin / Interactivity / Double skin / Renewebility / Replacebility / Prefab / Multifunctionality / Density / Movability / Thickness / Chemical resistance /

Fig. 5

Sub-aspect construction of student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, February 2009

PREVENTION
Materialisation / Transparency / Firee safety / Fire resistance / Shaping / Day Night situation / Vandalism / Maintenance / Burglary / Sustainability / Water discharge / Flexibility / Ventilation / Perforations / Assembly / Calamity / Function / Programme / Temporary skin / Advanced skin / Multifunctionality / Movability / Thickness / Odour / Chemical resistance /

Fig. 6

Sub-aspect prevention of student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, February 2009

ORGANISATION
Energy Performance Regulation / Comfort / Temperature / Shaping / Day Night situation / Vandalism / Maintenance / Cost / Burglary / Flexibility / Ventilation / Workability / Completion deadline / Transport / Calamity / Climate / Accoustics / Function / Programme / Temporary skin / Advanced skin / Interactivity / Double skin / Multifunctionality / Movability / Odour /

Fig. 7

Sub-aspect organisation of student list of parameters, features, concepts, properties to evaluate building envelopes.
1st Master Architecture Sint-Lucas Gent, February 2009

This classification demonstrates that many belong in several sub-aspects. A lot of cross links can be discovered between the sub-aspects.

- Light can be allocated in the sub-aspects' expression (media façades, lightning architecture), comfort and energy, prevention (burglary, vandalism), organisation (function, day night situation).
- Sunshade can be allocated in the sub-aspects' expression (in terms of external look), structure (in terms of being structurally dependent), comfort and energy (to control internal climate), construction (in terms of type, assembling or material).

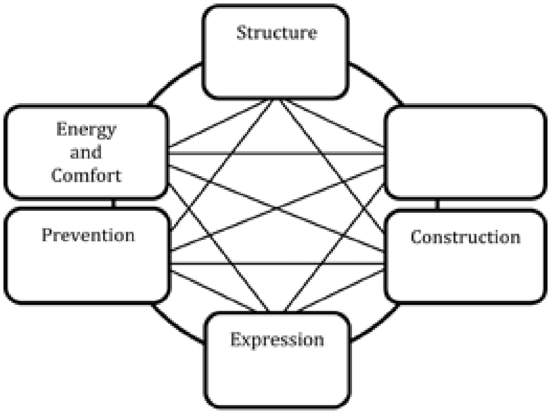

Fig. 8
Cross links between the sub-aspects
(IVOTO_Sandy De Bruycker)

These cross links give aspects as sunshade a plural purpose or surplus value and contributes to the accessibility for the different partners in the interdisciplinary team: the designer can implement sunshade into the design of the building envelope , the structural engineer can anticipate by means of a search for structural integration (load bearing), and the techniques engineer searches to satisfy the comfort inside the building. In this context, a kind of common platform is created in the interdisciplinary team where the building envelope will obtain a plural purpose as a guarantee for a better architectural integration on the one hand and that contributes to the fit-to-communicate approach to convince the client on the other hand.

The uplisted aspects are a cocktail of concepts, parameters, features, requirements and properties: essential and simultaneously hindering the interdisciplinarity. Sharp differences between these aspects could bring some intelligibility. The next questions should be answered:

- What are the differences between parameters, features, concepts, requirements and properties?
- Does clearing up these differences tell us something about the implantation in the design process?
- Are there different implantations?
- Do different implantations cause different architecture?
- Is there a relation between implantation and architectural integration?

Searching for answers can be done from an holistic perspective, the idea that all the properties of a building envelope cannot be explained by its components alone but instead, the building envelope as a whole determines in an important way how the parts behave. Designing a good building envelope is a difficult exercise because of the complex versatility demanded and, in addition, its variable behaviour.

In the previous definition of a building envelope, it became clear that the envelope has as a communicating and filtering task. If the common platform in the interdisciplinay team presumes the filtering requirement as communication with its environment, the potential arises to design a rich building envelope: the envelope can admit supply or stop aggression through which it is automatically communicating with its environment. So from that viewpoint there is no difference between the filtering and the communication requirement. The appearance of the filtering can originate from the demands and wishes of the different stakeholders: the person, the organisation and the society. These demands vary: an employee in a landscape office will perfom more succesfully if his environment satisfies personal conditions such as visual comfort, thermal comfort, acoustic comfort and indoor air quality. A colleague working in other circumstances can have opposite expectations. The office in general (the organisation) has its conditions in terms of presentation towards their clients resulting in more or opposite or several conditions. Finally, the neighbours or the public space (the society) requires more or opposite conditions. This way of thinking strenghtens the idea of the previous definition of the building envelope as being not just the outer shell defining the boundary between inside and outside but on the contrary, areas in terms of the street, the public space, the neighbour and perhaps the complete city are involved when thinking about or designing a building envelope. A building envelope does not exist or does not perform without the inside and outside. Trying to quantify an envelope in terms of a limit, a line as a barrier, is not global and will hinder its objectives.

In order to exceed the chaos of parameters, features, concepts, requirements and properties, it is desirable to formulate as soon as possible the wanted objectives in the interdisciplinay team. The management of these objectives can be situated in a 'Fit-For-Purpose' approach before starting any sketch or drawing. First questions such as 'what is expected from the building envelopes' are important. These expectations are given by the needs of the different stakeholders (the person, the organisation and society) and will be influenced by economic criteria such as capital cost and future cost. There is an increasing interest in methods expressing sustainable development in economic variables regarding building stock or portfolio management. This research wil focus on requirements related to energy and comfort but these should be considered in the idea that they represent only a part of the whole.

A search for objectives related to the building envelope will lead towards requirements. To fulfil the requirements, performance should be introduced. A matching

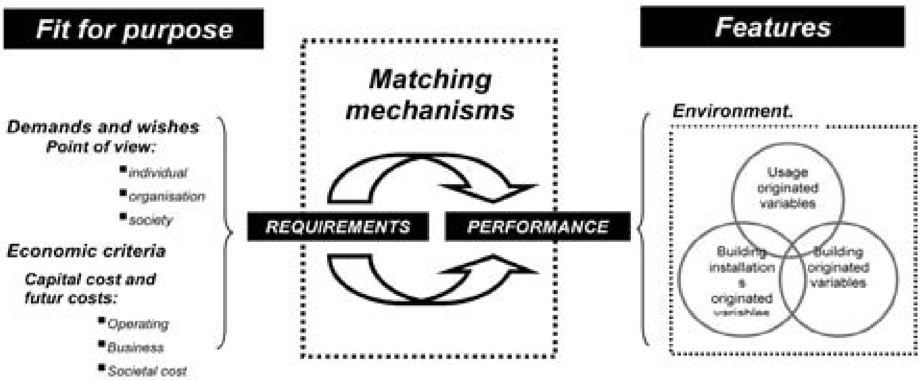

Fig. 9

Matching Mechanism, based on the figures of 'Building Envelopes in a Holistic Perspective, Methodology, Leo Hendriks and Hugo Hens, International Energy Agency' mechanism will occur in the design process to match the requirements posed and the related performance. The interdisciplinay base will promote that occurence and is, simultaneously, conditional due to the complex multi-stratified input of aspects.

Being aware of the fact that the complexity does not disappear but reduced after the determination of the requirements, the management of these requirements is nested in the idea of a target strategy: the main target is the optimisation of the envelope by implementing subtargets related to the filtering and communicating definition:

- Maintaining and gaining heat.
- Avoiding overheating.
- Decentralised ventilation.
- Using daylight.
- Generating energy.

Again, granting the main target does not reduce the complexity but at least it stimulates the very start of the management system, the realization must be located in the subtargets. It is important to adapt these subtargets regarding to the context of the environment. In a more moderate climate it is useful to organise a lot of glass surface pointed to the south west, but in some conditions (sunny winter days and full sunny summer) the great surface increases the overheating issue.

Concepts should be introduced to accomplish the subtargets as a cognitive unit of meaning, a unit of knowledge. These concepts should be controlled by all partners of the interdisciplinary team to guarantee the implementation in the design process. In opposition to of this common knowledge, not all the partners should control the features necessary to define the building envelope properties to generate performance which will be matched with the requiremetens.

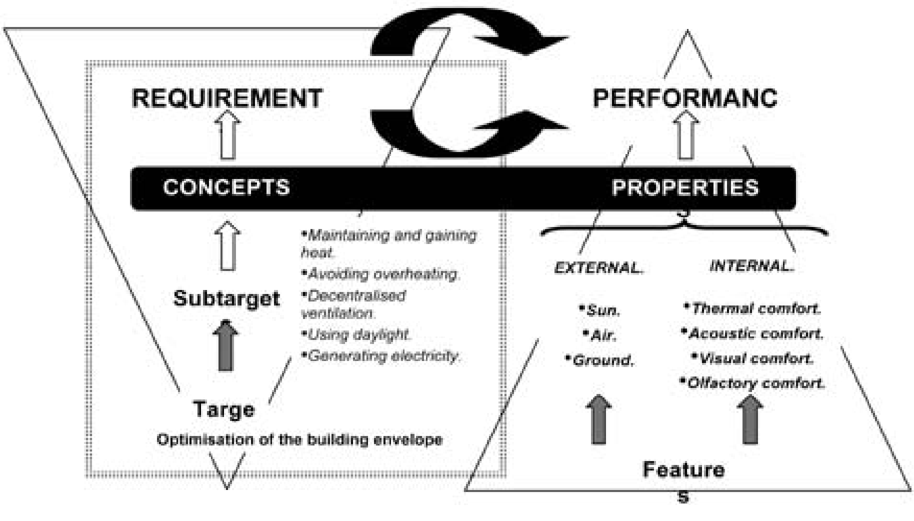

Fig. 10

The body of knowledge in the interdisciplinary team (IVOTO_Sandy De Bruycker).

There can be different concepts to accomplish the subtargets.
Example : Subtarget : Maintaining and gaining heat :

- Concept 1: surface optimalisation and envelope geometry.
- Concept 2: thermal insulation of transparant components.
- Concept 3: Therma insulation of opaque components.
- Concept 4: Passive use of solar radiation.
- Concept 5: Minimising ventilation heat losses.
- Concept 6: Active solar thermal energy gains.

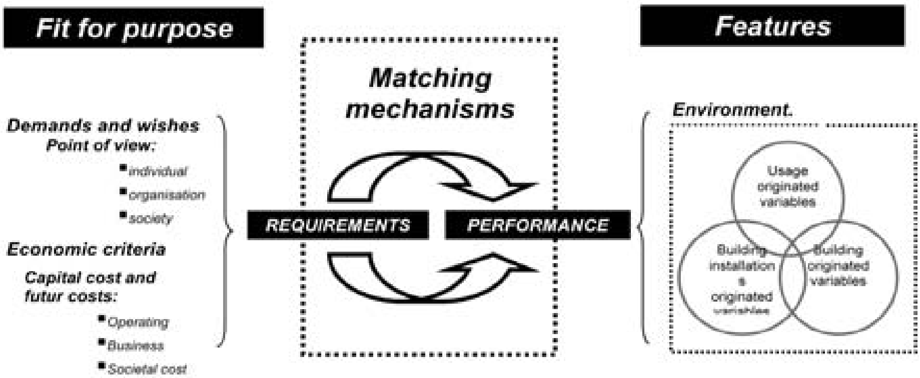

Fig. 11
The Building Envelope Interface (Energy Manual, Sustainable Architecture, Edition Detail).

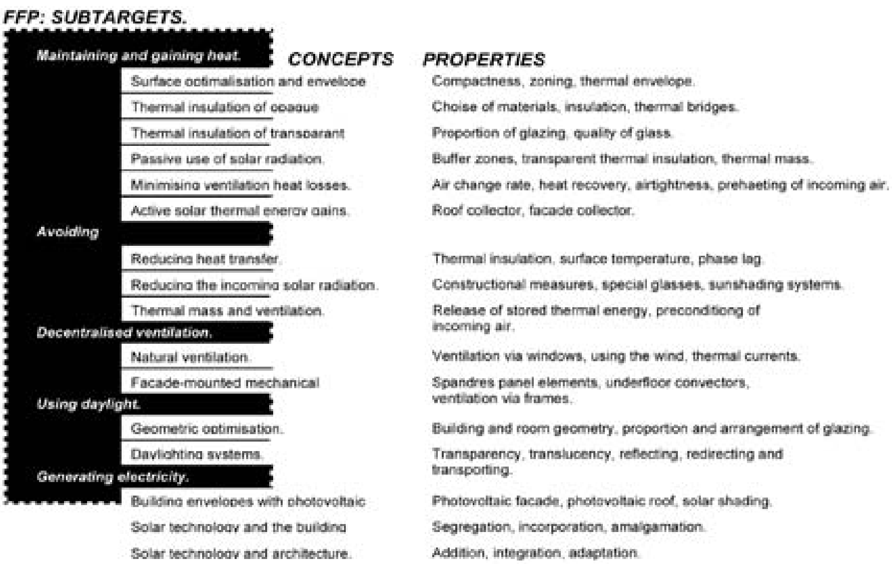

Fig. 12
The matching of concepts and properties in the interdisciplinary team (IVOTO_Sandy De Bruycker).

Properties will be allocated (designed) to the building envelope to realize the matching of the concepts. These properties are a well-considered combined action of external and internal features to generate a performance as an answer to the requirements and they are often the result of experts in the interdisciplinary team.

In terms of building techniques, the education of the designer (architect) should concentrate on generating concepts on the one hand and on evolving them in a creative environment on the other hand as a guarantee for being a full-fledged partner in the interdisciplinary team.

The tool and the language of the designer is mainly graphic. Activating Design can demonstrate the selected concepts as a preparation for the moment in the design process where the matching point occurs between these concepts and their properties. What is more, this activating design can be useful in the 'fit-to-communicate' phase to convince the client or stakeholder.

Fig. 13

Result of a Primary design inspired by references (IVOTO_Seminar Construction an Structure, Sint-Lucas, 2009, students Maarten Gielen and Pieter Lansens).

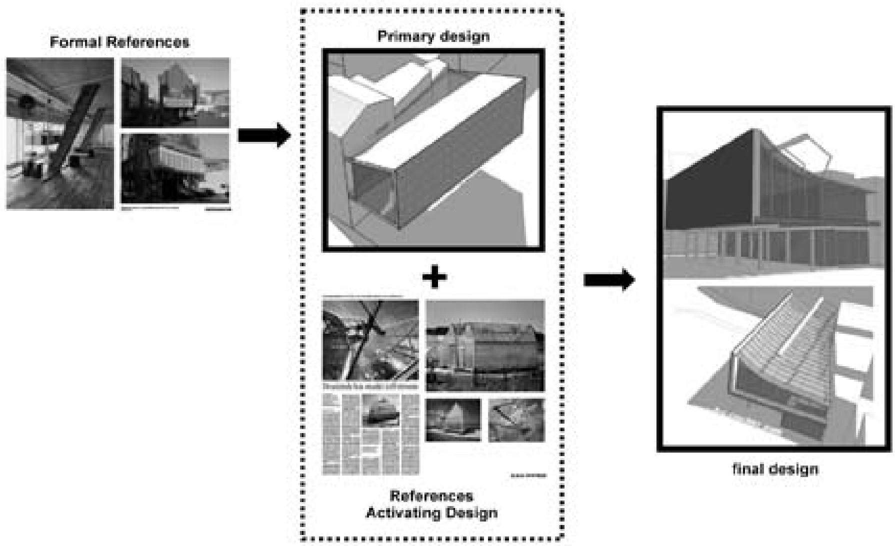

Fig. 14

Input Activating Design into students design (IVOTO_Seminar Construction an Structure, Sint-Lucas, 2009, Sandy De Bruycker).

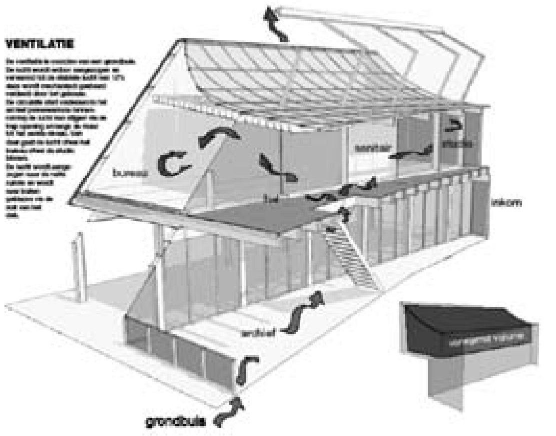

Fig. 15

Evolving the design after introducing Activating Design (IVOTO_Seminar Construction an Structure, Sint-Lucas, 2009, students Maarten Gielen and Pieter Lansens).

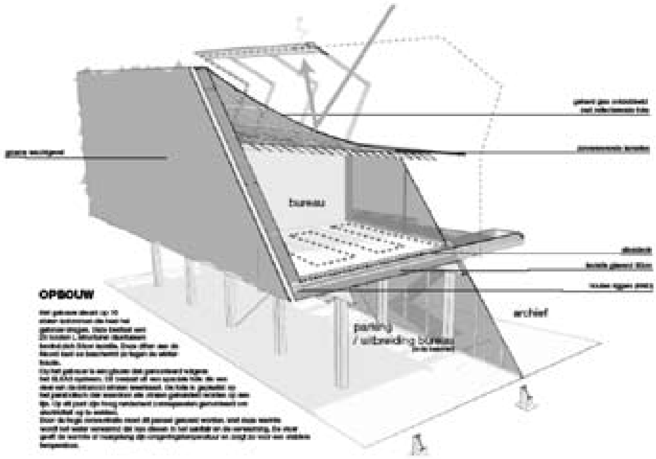

Fig.16

Result of the Research Seminar Construction and Structure (IVOTO_Seminar Construction an Structure, Sint-Lucas, 2009, students Maarten Gielen and Pieter Lansens).

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Perform D[ance]

The course (described in the following text) was written and created as the architecture design studio ARCH-202 for second year, second semester architecture students at the University of Nicosia, Cyprus. The goal of the studio was to challenge students in new ways of thinking throughout the design process from concept development to construction techniques, materiality and structural analysis and thought. Hands on, one to one scale construction or 'making' was emphasized. The students were asked to ultimately design a performance/ dance space (with all necessary associated elements) and a dance studio. They had to both realize and explore architectural conditions or spaces created for performance that were related to a specific site yet were derived from the movement and the exploration of the human body.

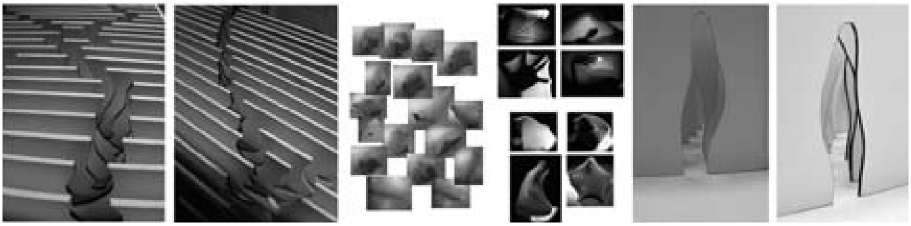

Image 1

As the starting point for the studio we aimed to drive the students directly to what we believe is the origin or generator of a performance space project – the human body. This was done through a series of research and explorative exercises.

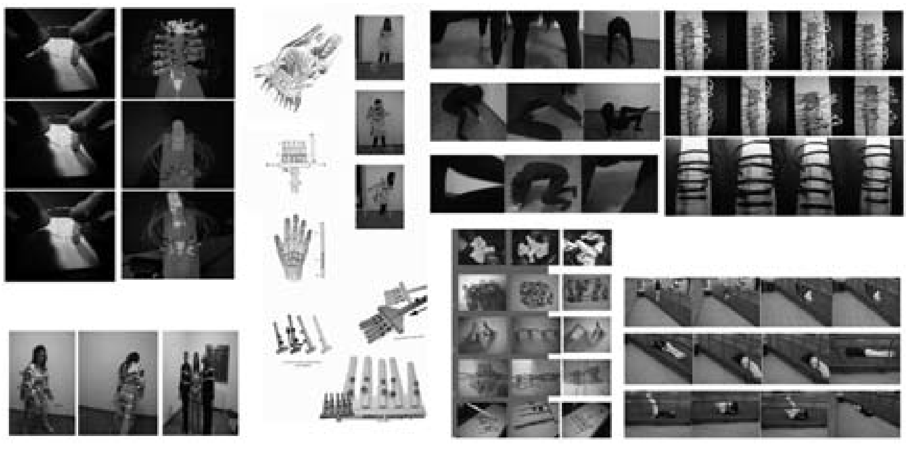

Image 2

We began with the investigation and exploration of the biological and anatomical aspects of the human body - both skeletal and muscular. First, the students had to fully understand how the body moves - so research, analysis and study models were used to conduct in-depth investigations. Students had to understand what allows us to move and what stops us from losing control of our bodies. Students were then asked to choose a joint/link/connection found within the body and relate it to our physical movement. They had to extract it, interpret it, analyze it, take it apart, and re-design it to work in an alternative way. Students were free to pay attention only to the bone joints, or their combination with the muscles, cartridges, or even their function. They were also asked to make connections between the senses and the reaction from the brain, through the muscles to the bones and the junctions/connectors of these elements. Each student was asked to bring a bone to class and dissect it and reconnect it with other materials (metal, plastic, wood) to create a new joint that would enable the body to move or function in a new way.

After introducing the students to notions of explorative- contemporary dance and movements of the body, they were asked to investigate and critically present a series of lectures on ancient, traditional and contemporary performances, performers and performing spaces. These examples questioned the role and the relationship of the spectator and the viewer, re-examining and redefining the performance (and dance) itself and the spaces for performance.

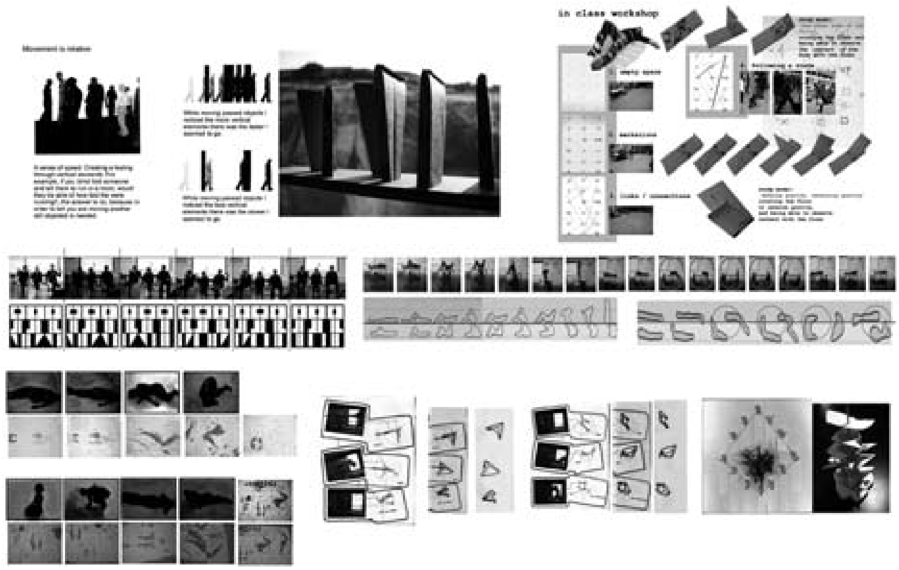

Image 3

For students to fully understand their bodies and the way they could move as well as the way dancers and performers are trained and work and move - we created a series of workshops. Arianna Economou, a contemporary dancer/choreographer worked with the students (in a large renovated exhibition space) in a series of exercises exploring body movements and our ability to create and define space through that movement, and to examine the physical and psychological relationships of the body to space. The exercises pushed the students to investigate: sense the vertical axis of the body, sense someone's position in a space, detect a movement analysis and explore the various joints capabilities, explore negative or empty spaces, find a relative notion of movement (what moves and what stays still) polarizing the space, leave your body's 'ink' or imprint on the floor, mentally trace the memory of the body's movement, pattern the rhythm and grid, freeze time, link systems, flows, groups, and clusters. Students were actively involved in questioning the exercises and discussing with the choreographer as well as filming and sketching the 'performances'. Students also had to create impromptu performances throughout, and sense how the movement can change the space and how a perception of space can change through the movement.

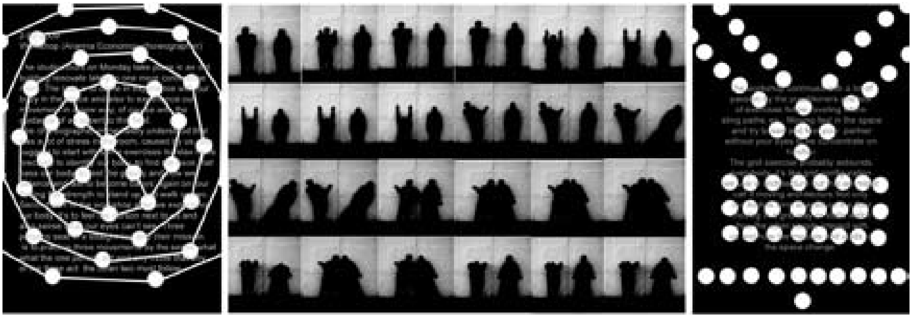

Image 4

Simultaneously the students were asked to 'write' a scripted performance for their body and its relationship to a constructed 'item' (stair, ramp, rail, door, wall). In this exercise they were investigating the space in relationship to their body (they were also allowed to incorporate more bodies) and the 'item', the closeness and openness, the filling of the emptiness, alternative ways of using their joints etc. This was recorded through a series of photographic stills and films spliced with drawings and/or 3d models.

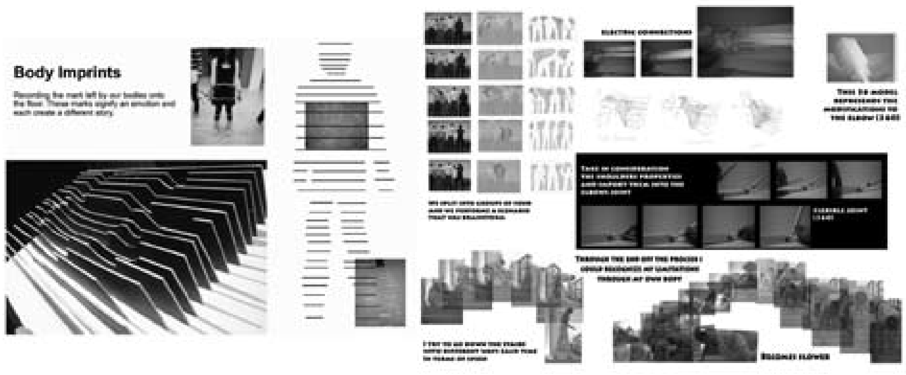

Image 5

A second workshop investigated systems of recording and analyzing body movements through graphic, digital and 3D modeling techniques. After emptying the studio and defining and observing the empty space, they were asked to locate themselves on a point of a grid, created by extending their arms to touch the person next to them. The grid was marked (each student created their own symbol for tracking purposes) as were their subsequent new positions. They then began to create a script of their individual movement and the collisions or relationships made as they came into contact with others.

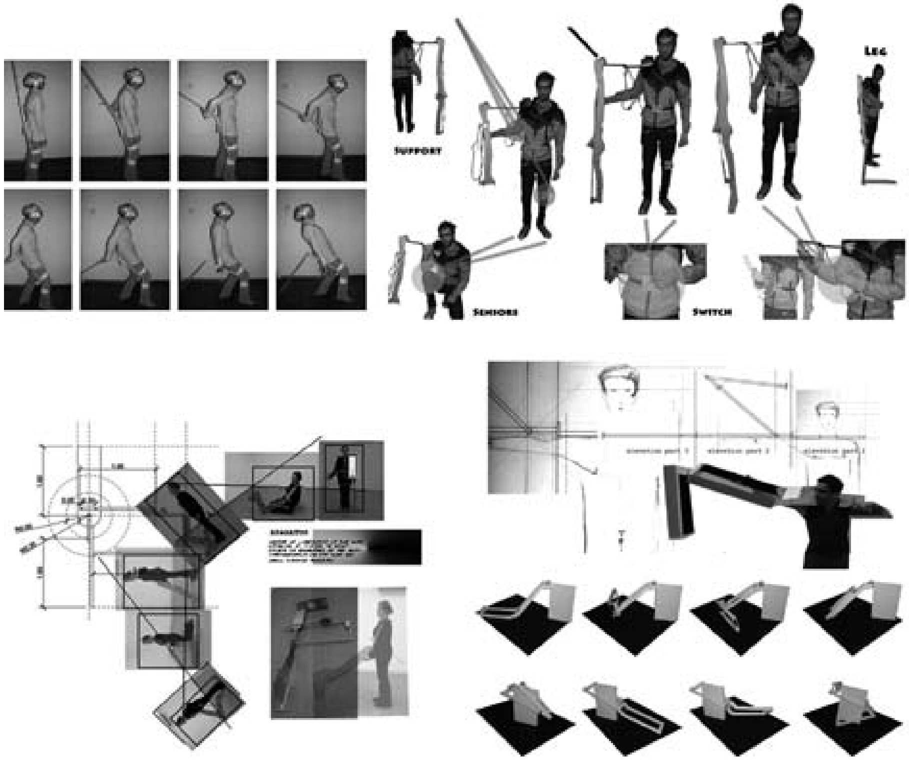

Image 6

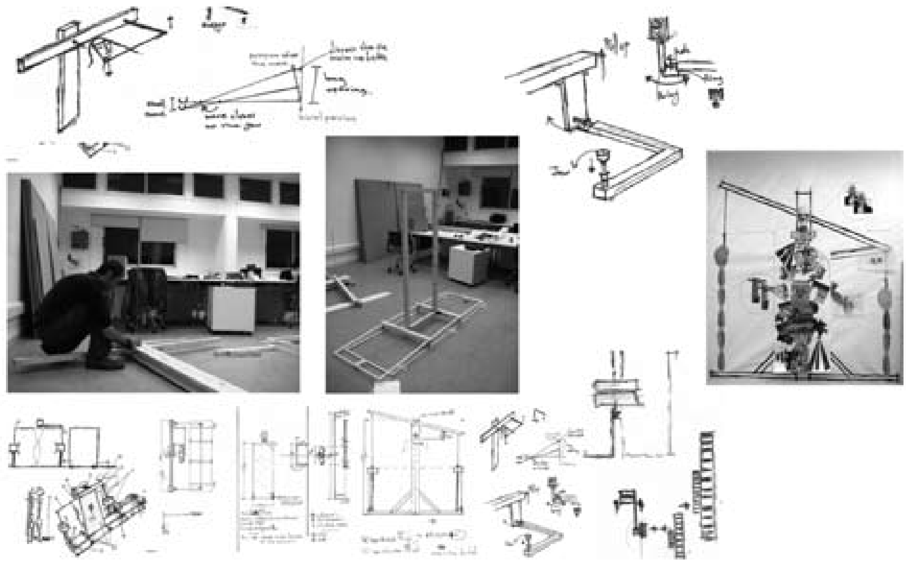

Image 7

For a final project for the mid-term review the students were asked to make a 1:1 scale body apparatus or 'attachment' pushing them to deal with construction issues, mechanisms and materiality. This apparatus had to be used by the students to script or create new forms or creations of new movement. By 'wearing' and 'performing' their apparatus they had to define a new relationship between their bodies and space – these could either be accidental and/or predetermined, pushing the boundaries with a single part of their bodies or possibly extending out from the body to interact with the surrounding space.

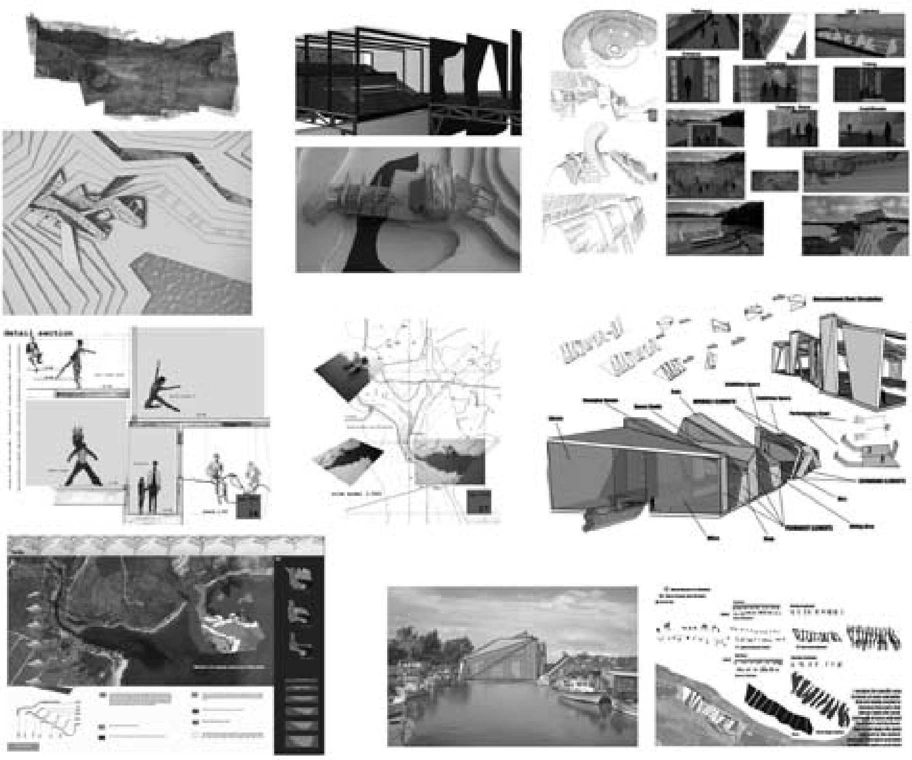

Image 8

At this point in the studio the investigations, results and analysis that had been conducted thus far had to be drawn into the design of the performance/dance space.

Students had to comprehend the diversity of form and spatial solutions and use this knowledge creatively in their own design project to work within a site-specific context.

The students had an option of two sites; a mountain dam and narrow coastal inlet. Both dealt with issues of water, tide and edge conditions, and the relationship of the natural and artificial. The main difference between the two sites was the scale factor. In the coastal inlet the human scale was strongly present as were an interesting variety of artificial materials (the makeshift fisherman's docks). The contrary condition was found at the dam site where the vastness of the mountains and the width of the body of water prevailed and often overwhelmed the students. The students had to tackle the scale issue as they began to reinterpret their previous investigations and link them to their chosen site. The sequences of inhabitable and performance spaces began to generate or push an interaction between the 'spectator' and the 'spectacle'. These subtle or extreme relationships were at times difficult to detect – where visitors and performers or became at times interchangeable.

Students had to record all of their work digitally in a visual diary. All sketches, research, models, analysis and though process and recordings of the workshops had to be transferred into digital format and printed in a small format book/visual diary. Films, sound recordings, 3D renderings and walkthroughs, videos of their apparatus performances had to be interwoven into their visual diaries. The design, layout and construction of a 2D-3D diary of this were a key part of the studio. All work from the later part of the studio also had to be recorded in this visual diary; students had to photograph physical models and incorporate digital or hand drawings. The diary was carefully designed to correspond to the individual student project and concept - many of them were quite elaborate and complex.

Image 9

Through this course we tried to explore ways in which students could merge conceptual thought and creativity with a hands-on approach to construction and materiality. They themselves had to perform and build or construct their apparatus. They had to understand how dancers work and move in order to design a 'building' or space for them to perform in. They had to work with a structural engineer to design their systems and build a large scale sectional model to test those ideas. They had to deal with issues of creating public spaces that had a deep respect for and sensitivity to the natural environment they were placed in, and have an understanding of site and environmental issues. Students had to think about natural and artificial light, orientation, and materiality, senses, boundaries, users, social issues, activities, usage of space, and privacy issues.

Students in fact worked on both directions simultaneously: creating architectural conditions of 1-1 scale structures and solving landscape and general planning issues. Our aim was to have them investigate how the 'inside conditions' affects the whole and how the whole can respectively influence the 'inside conditions'. The investigations and experimentations made by the students were derived from the human body and manipulated to generate a fascinating variety of 'built' relationships, conditions, forms and interactions.

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The Art of Zapping and Switching

The academy of architecture in Amsterdam is a master school. Admittance is based on a combination of the completion of a bachelor school and a portfolio. The programme is based on combining practical work in an architectural firm with studies. To enter this academy a post-graduate education is needed. Most students starting the academy come from a technical school, but a significant smaller group of students have an arts school background. They are former Art Academy students with a bachelor degree in Interior Design. They have a strong developed sense of aesthetics and form, but lack technical knowledge. For this specific group of students the academy developed a special year, a preparatory architecture course.

How do technical knowledge and design teaching meet?

We think our preparatory architectural course is the embodiment of this combination, in which technique meets aesthetics and vice versa. Our method is strongly based on the combination of practical experiment and theoretical learning.

Zapping and switching

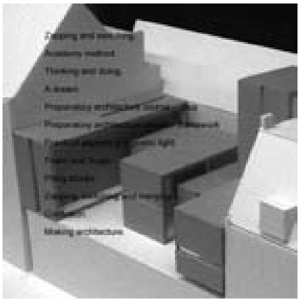
With zapping we address the ability to switch between practical aspects and the poetic idea, the ability to develop simultaneous story lines in design research. Architects think and do, and switch between those two constantly. Architects think about space and aesthetics, about program and cultural values, about tradition and surroundings, but at the same time about physics, construction, materials and installations. Working on architectural projects is working on a dream. Techniques are part of this dream. Physical models and the process of making physical models is therefore essential to be able to research, question and develop this dream.

In the preparatory architectural course technical skills are challenged in the setting of architectural projects and experiment. The framework for the program starts with theoretical courses like construction and physics to slowly transfer to practical research to come to the combination of both. Throughout the year we visit buildings and architectural firms. The excursions to buildings are not guided by the architect, but by the technical project leader of the project. Visiting architectural firms makes the connection with the actual work as an architect. Combining design thinking with practical and technical aspects is confusing. The search is of course to find a balanced symbiosis between the both and to find your personal vision. The latter two: balanced attitude and personal vision is probably something to be developed throughout your life, but the start is made in a preparatory year. In a series of lectures we search for combinations of architectural experience and the craft of making. Themes like 'a brick' or 'light' are explained and talked about by architects with a specific fascination for this theme.

How do you start learning about construction?

By trying, doing, failing and trying again. Based on the theoretical knowledge learned in the course this experimental input is equally important. After an intense period of learning from paper a phase of experiment starts. Constructions the students designed themselves are built with foam and sticks. Tests are done with a package of sugar, one kilo. This playful yet very serious way of testing is effective because you


The art of zapping and switching.
From art to techniques and back
Charles Hueber
Gus Tielens
Academy of Architecture Amsterdam
June 2009


Academy method
Thinking and doing
A dream
Making architecture

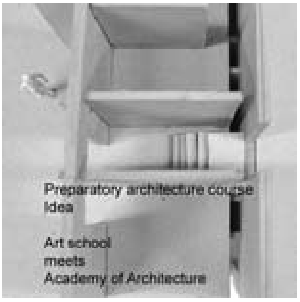

Zapping and switching

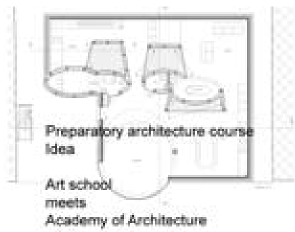

Academy of Architecture
Amsterdam


Academy of Architecture
Amsterdam
Method
Combination of study and
practical experience


Thinking and doing


A dream


Preparatory architecture course
Idea
Art school
meets
Academy of Architecture


Preparatory architecture course
Idea
Art school
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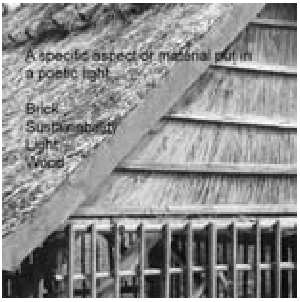
Year framework
construction and physics - theory
excursion
drawing
design workshop - practical
building site
lectures
materials and detail - practical and theory
visiting architectural
firms


A specific aspect or material put in
a poetic light
Brick
Sustainability
Light
Wood

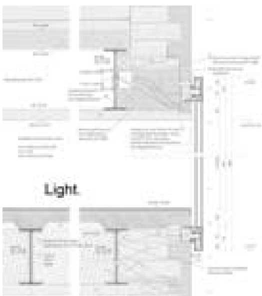

Light
by Serge Schoemaker

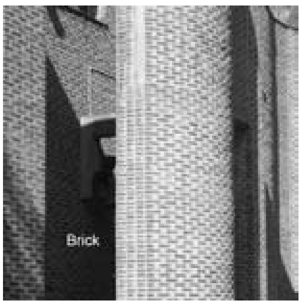
simply see what is happening! Another example is working with smaller parts to learn about the possibilities of piling a wall. With various openings and curved forms piling and the forces inherent to this are tested. Piling pieces of brick or wood makes the connection to our classic examples: How is a bow constructed? What are the dimensions?

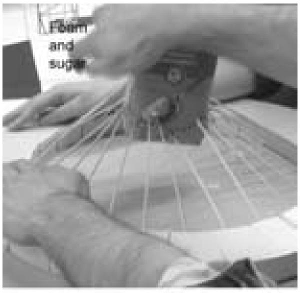
We make students aware of the relation of a project process to the actual building. Therefore we visit construction sites. Students draw and photograph what they see to later analyze what they saw and drew in a practical sense. Again we choose a crafty physical method, the drawing, to make students really see what they are looking at.

The programm starts with theoretical lessons about construction and physics, throughout the year we wander into detailling and materializing of the students design. For some students this is a clash, for some students this is a step by step process. For all of them it is very confusing. We think this confusion is fruitful. For some the awareness of technical and practical aspects will be an obstacle in the design thinking, as if they are two opposite forces. Slowly and for some not so slowly it will change or better enrich their design thinking. We see this progamm as a living document, we try to improve and change it by discussing and evaluating it.

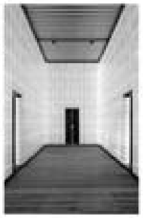
	Number of students
architecture	155
urban design	40
landscape design	40





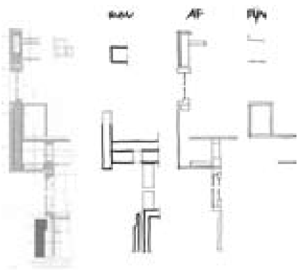




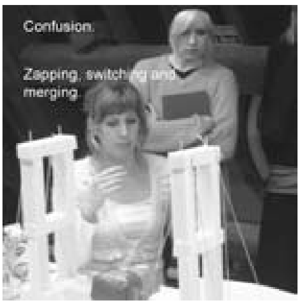



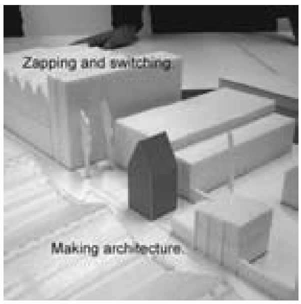
An analyzing eye









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History and Structure within the Design Studio?

Quadrivium Novum: An inter/trans-disciplinary approach for architectural education

This paper forms part of ongoing research covered under the umbrella name of Quadrivium Novum. As a joint educational experiment, the Quadrivium Novum vision conveys the idea of sharing and integration, towards a trans-disciplinary education in a post-specialization era; it proposes flexible and blurred-borders education against the fragmentary education that exists in the curricula of most schools at the present time. The Quadrivium Novum puts forward the hypothesis that simultaneous inter/trans-disciplinary teaching might be the key for a better architectural education in the future, and implements the idea creating a fusion between studio work, structural design and history of architecture, which are the authors' expertise. The article introduces one of the paths of learning coming out of the *Quadrivium Novum* experiment, the creation of a series of 'learning modules' that reconnect fragmentary information acquired in separate disciplines. It presents examples and exercises selected by the authors while teaching architecture students, showing how these modules reconnect concepts and transform them into integrated knowledge to improve the students' architectural design studio work.

Diagnosing the problem

The conveners of this workshop asked for ways to integrate the fragmented and progressively isolated disciplines into a coherent body of knowledge. They also pointed out the need of contemporary architectural educators to re-consider teaching methods and to invent new tools in order to achieve this integration. In an attempt to answer these same central questions the authors founded in 2001 the *Quadrivium Novum*, a research project on effective architectural teaching which was first presented at the former meeting in Venice (Rapaport & Frances, 2006). We are sadly aware that the analytical approach commonly used to teach structures –and borrowed from engineering sciences- creates cryptic and inapplicable knowledge for architecture students; creative structural design in general is left out of most design studios (Frances 2001, Frances 2006). In parallel, History of Architecture -by borrowing academic tools from History of Art- is usually reduced to a parade of masterpieces for the student to memorise (Frances & Rapaport, 2006).

In contrast to Vitruvius' primordial integration of disciplines, we teach architecture in a fragmentary setting (Vitruvius, 1).This fragmentation results in the offering of architectural knowledge as disconnected small units. Therefore it is very difficult –if not impossible- for the students to make the necessary connections in order to take in these separately taught parts and develop without help a true understanding of the wholeness of Architecture. Hence, time seems to be ripe now for reconsideration, befitting an historical moment of post-specialization; time for a revision that would preserve the depth of separate lecture courses but would also recover the former holistic nature of architectural education.

The Quadrivium Novum experiment: The source and the idea

The authors looked for a *new* Quadrivium, choosing the classic medieval higher education scheme of the *Artes Liberales* as model because it evoked the image of a *common meeting space* at the crossroads of courses. Originally, the Liberal Arts consisted of seven disciplines divided into the verbal arts of the *Trivium* -Grammar, Rhetoric, Logic- and the four subjects of the *Quadrivium*: Arithmetic, Geometry, Astronomy and

Music (Fig. 1). This educational scheme became the model for university education over hundreds of years (Frances & Rapaport, 2006).

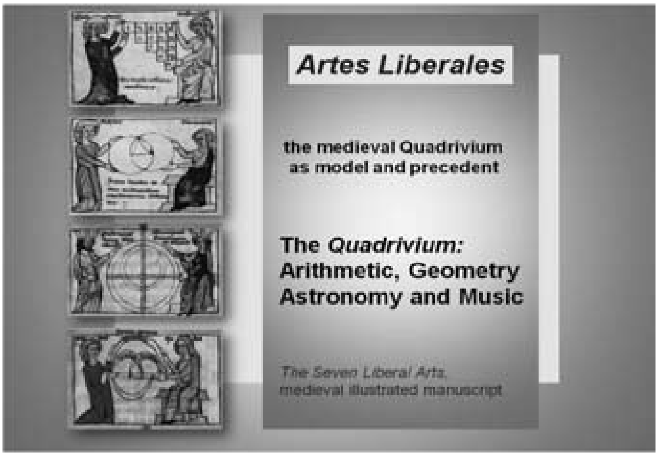

Fig. 1

The authors envisioned a *new* Quadrivium -the word meaning in Latin a four-way crossroads- implying that the paths of knowledge are fundamentally inter-connected while other, unforeseen paths can be found to intersect there as well. Paraphrasing Gaudi's affirmation: "If you wish to be *original*, start at the source –go to the origin", the *Quadrivium Novum* experiment set out to reconsider architectural education starting at the source, that is, at the original categorization of knowledge instituted by the Liberal Arts.

The *Quadrivium Novum* model suggests that simultaneous interdisciplinary learning might be the key to a better architectural education. It conveys the idea of integration and knowledge sharing, of flexible and blurred-borders education. Its vision encourages a crossroads-meeting of the different courses in order to achieve intelligent holistic design. Moreover, the *Quadrivium Novum* model stands for a joining of educators from different areas of learning, teaching together at the same time, learning from each other, while students are encouraged to contribute actively to the process. The main purpose had been to avoid passive reception and to gradually introduce the studio/workshop way of learning, incorporating design exercises to frontal lectures. The authors assumed that the studio pattern of learning would be appropriate for the New Quadrivium vision. The Latin concept of *studium generale* emerged during the Middle-Ages, meaning a universal studying place. The studio then, was a place of studies where people from all parts of the world could come to study any subject (Eco, 2003). The architectural studio provides ideal means for direct interactive training, and many opportunities to implement knowledge learnt in frontal courses. These qualities made the studio/workshop a key *Quadrivium Novum* tool.

Quadrivium Novum: The pedagogical approach

The *Quadrivium Novum* does not intend to make a radical revolution. It starts with minor changes in the syllabi and builds up to serious interventions in the existing curricula, generating new knowledge-fields. Drawing from a long experience as lecturers and tutors, our experiment tackled the Architectural Design studio, and with Structural Design and History of Architecture courses, which have been developed and tested in four different schools of architecture -three in Israel and one in Great Britain. Both bottom-up and top-down processes were adopted. On the one hand, the *bottom-up* process proposes interventions at the level of the separate courses, within the smallest components of the syllabus, creating numerous interconnections, fostering flexibility and blurring the disciplines' borders. On the other hand, a *top-down* process creates interventions at the studio level, promoting integrative design assignments using the courses' topics, encouraging inter-disciplinarity in the architectural design studio and a more comprehensive understanding of the curriculum's components.

Bottom-up process: Linked courses and learning modules

This course of action aims to link the study of History of Architecture with Structural Design and vice versa. Teaching history of architecture stressing structural design issues intends to show how historical buildings offer intelligent answers to universal questions; how technology is a cultural and rational process of choice (Fig. 2). This is easily implemented, for instance, while teaching Gothic architecture or learning from prehistoric and primitive buildings (Rapaport & Frances, 2006).

Fig. 2

The bottom-up process promotes integration and inter-disciplinary thinking through specially prepared modules. Accordingly, the inter-connections between courses as well as the blurring of the disciplines' borders can be enhanced by special short interdisciplinary modules tackling selected topics. These 'learning modules' are short independent study units that can be combined and easily rearranged, replaced, or interchanged to match different studio projects and syllabi. The modules use a studio-oriented methodology, which helps to reconnect the fragmentary information acquired in separate disciplines and convert it into integrated knowledge applicable to the students' own studio work. As they combine issues of structural design together with history of architecture, these modules are devised so as to avoid the former problematic issues and are presented as being part of the art, as well as the science, of architecture. Three such modules have been developed so far: 'Learning from Primitive and Vernacular Buildings' (Fig. 3), 'Gothic: Structure as a Giver of Light' (Kahn, 1991) and 'Structural Masonry: the Forgotten Option' (Figs. 4-7). A fourth module dealing with iron and steel 19th century building technologies (Fig. 8) and a fifth one, on reinforced concrete shell surfaces, are being prepared at present (Fig. 9).

Through these modules students discover that there is no contradiction between vernacular traditions and up-to-date technologies; learning the former can lead the student, future designer, to the latter. For instance, the issue of structural masonry as a forgotten option offered good learning opportunities for the implementation of transdisciplinary educational ideas (Rapaport & Frances, 2008). Students confirm the existence of a far-reaching link between early civilizations and contemporary architecture, discovering that Botta follows Kahn, as Kahn followed the Romans; while Dieste fol-

Fig. 3

Fig. 4

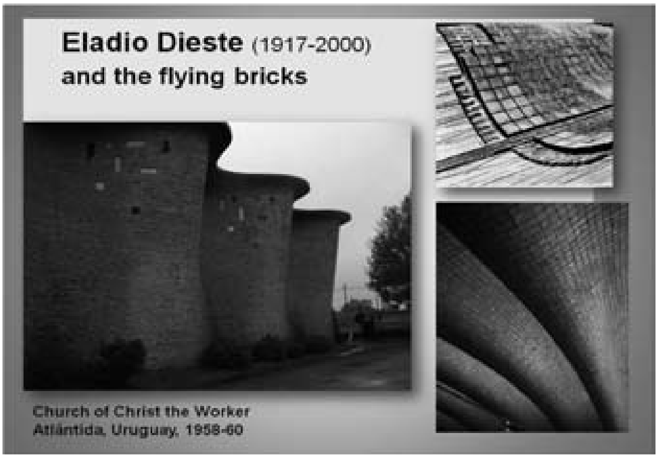

Fig. 5

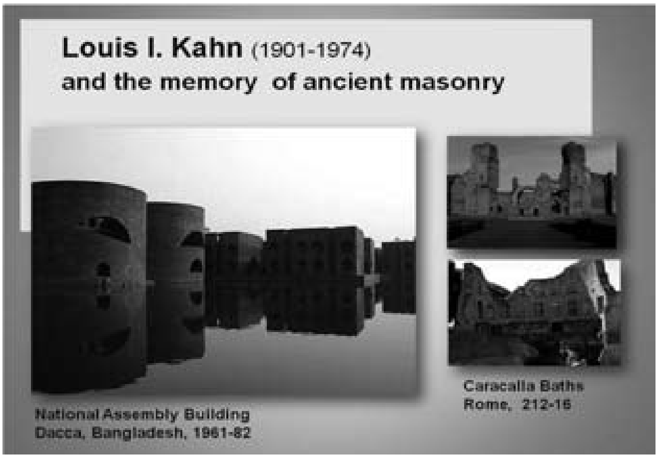

Fig. 6

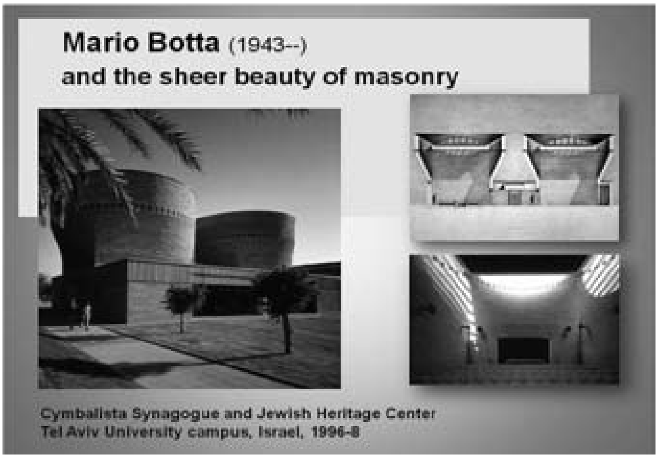

Fig. 7

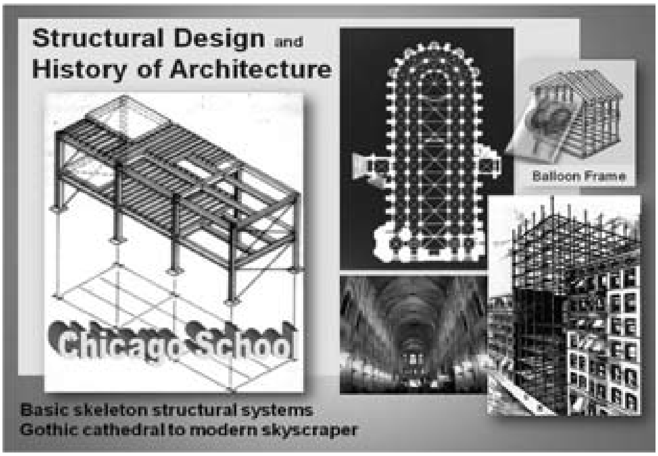

Fig. 8

Fig. 9

lowed Gaudí, as Gaudí followed the vernacular tradition of Catalan masons, which in turn derives from the Romans (Figs. 4–7). Carefully selected examples serve as catalysts for original thinking and stimulate creativity.

Top-down process: Interdisciplinary workshop-modules

One of the main parameters to measure the quality of any school of architecture is the level of excellence coming out of the design studios, achieved throughout the learning process and shown in the final projects. Seeking for ways to keep improving these, then, means advancing the entire status of the school. However, standing back and observing final presentations and graduates' achievements over a period of time, it cannot be denied that a certain part of these achievements are a direct result of the natural talent of the student, what is called *talent-based* excellence. Even if it gathers praise and admiration, this sort of excellence is not dependent on the educational system: its quality emerges unpredictably, not because of and even sometimes despite the school's efforts. Nevertheless, the school pedagogical efforts are reflected in achievements of a different kind, excellence in planning and design that is *home-grown*, based upon knowledge and skills acquired during the years of study, what is called *knowledge & skills-based excellence*. This home-grown brilliance and distinction, being the authentic responsibility of the teaching staff, is what we aim to promote by means of the Quadrivium Novum workshop--modules.

The conveners inquired how the traditionally separate courses of architectural and structural design should be redefined, seeking methods for integrative teaching. It is only natural to turn to the design studio as the melting-pot of architectural knowledge; however, assessing reality as we know it, one question must be considered: is the design studio *truly* the place where all fundamental knowledge merges? Students are rarely able to transform history lessons or construction formulae into design work. Therefore, by excluding or limiting structural and historic issues from the design studio -as it generally happens- students miss precious chances to incorporate cultural values to their work and to understand the significance of structure as a design element; alas, prime opportunities to improve the quality of the student's project through cultural precedents and structural thought are squandered. The *Quadrivium Novum* plan to overcome these difficulties is to prepare interdisciplinary workshop-modules which, consistent with the studio main project theme, provide added theoretical width and depth and work as knowledge connectors. These have proved to be extremely useful to encourage innovation, expressiveness and excellence in design.

Implementing the vision: Within the studio

The first implementation of these workshop-modules was tried at the Department of Architecture of the WIZO School of Design in the fourth year studio of 2003/4, run by former HS B. Baruch and current HS I. Tsaraf-Netanyahu. The authors prepared an inter-disciplinary study unit to come with the studio project, whose subject was Music and Architecture, leading to the design of a music center comprising auditoria (Fig. 10).

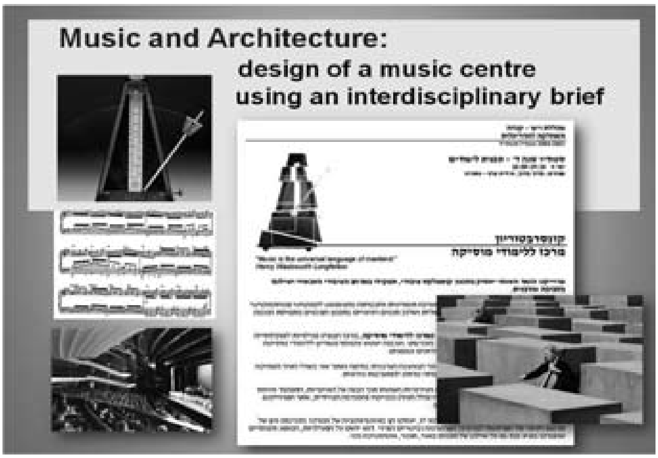

Fig. 10

Instead of individual tutoring, students were offered a conceptual studio for historic precedents and another parallel workshop for structural design, with special activities in joint discussion sessions. First, students were asked to look for interconnections between musical, architectural and engineering basic concepts, such as composition, harmony, rhythm, golden section and space (Fig. 11). In parallel, the association of Le Corbusier and Ianis Xenakis, the Greek compositor pioneer of digital music, was an inspiring precedent: based on mathematical principles, Xenakis connected music and architecture and by doing so, he blurred the boundaries between the two disciplines (Fig. 12). Next, the students analyzed structural design schemes for an auditorium, discussing different alternatives of structural systems, forms and materials (Fig. 13). This shared studio activity provided the means for valuable interactive instruction and offered the students opportunities to integrate and apply knowledge from frontal lectures (Fig. 14). At the last stage, it was hard to tell which discipline, tutor or lecturer had influenced the final design the most: the adoption of the studio pattern of learning avoided passive reception of knowledge, while encouraging the students towards active, enthusiastic participation.

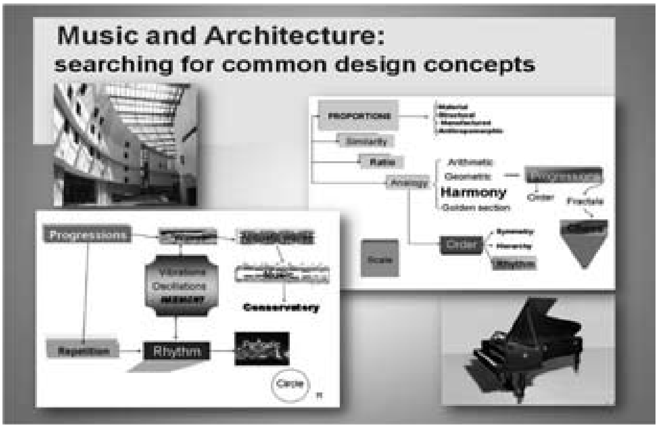

Fig. 11

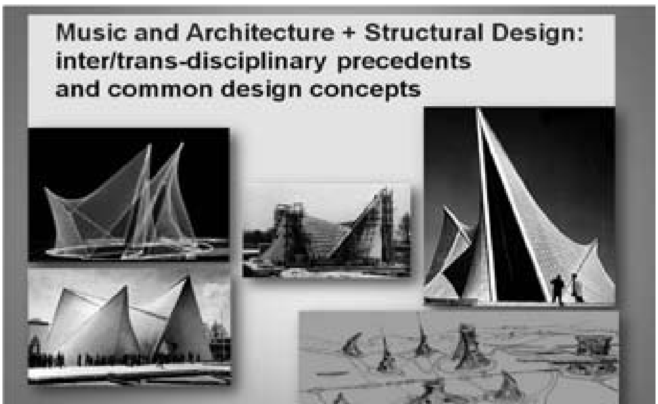

Fig. 12

Fig. 13

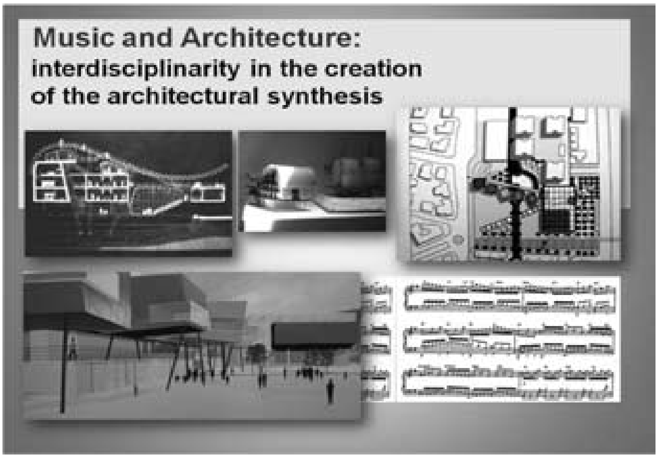

Fig. 14

Fig. 15

Concluding remarks

The *Quadrivium Novum* approach seeks to incorporate historic values to studio work, simultaneously stressing the importance of structure as a design element, in order to develop innovative architectural design. We return to Gaudí's quotation: "If you wish to be *original*, start at the source –go to the origin". *Original* design, in the sense of work which is unique, innovative, creative and imaginative, can be fostered by the knowledge and appreciation of cultural roots. Therefore, looking backwards while going forward, we propose simultaneous inter/trans-disciplinary learning within the design studio, on the one hand to study the wisdom and economy of architectural precedents as the original source, while examining new technologies, with their innovation of pioneer structural ideas on the other. Understanding as tectonics the science -or practice- of building construction and as poetics the poetry of architectural design -the art or technique of imaginative creation, the purpose of the *Quadrivium Novum* has been to convey to our students *the tectonics of history* –how buildings were put together in the past- with *the poetics of structural design* –how engineering achieves artistic qualities, generating an innovative and inspiring interdisciplinary approach for architectural education.

Two questions emerge at this point: should we incorporate history and structure within the design studio? And then, will we have enough resources to fit them in? We believe the answer should be affirmative to both. The pedagogical approach here presented here has the power, we believe, to inspire students to create excellent studio design work that is culturally-based and forward-minded at the same time. We close with the motto of the Quadrivium Novum experiment, "creative, active individuals can only grow up in a society that emphasizes learning instead of teaching" (Alexander, 1977). Indeed, we must keep learning how to train our architecture students to try on their wings ...and fly (Fig. 15).

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Integration of Construction Courses and Design Studio 2 in YTU Department of Architecture

Introduction

In the rapidly changing world, problems of the architectural profession and education are discussed and evaluated in many platforms causing changes in the architectural education plans of institutions.

Yildiz Technical University Faculty of Architecture Department of Architecture has been revising its education plans since its foundation in 1942. In 2001, YTU Faculty of Architecture, Department of Architecture renewed its education program within the context of EKSIP (Project of Continuous Development in the Education Quality) held by the YTU Rectorate. The aim of EKSİP is to institutionalize the genuine, contemporary education model of YTU. Since the academic year 2003-04, the Department has been carrying out the program USIS that was developed as part of EKSIP.

USIS program consists of one year of mandatory English Prep and four years of bachelor degree with a total of 224 hours / 240 ECTS. The distribution of courses are: 18% general issues, 12% history, human behaviors and environment issues, 32% design, 20% technical systems, 3% of application issues and 15% elective courses. The education plan that has 52 compulsory courses (42 architectural and 10 social) and 74 elective courses is based on 2 semesters in an academic year. Each semester the students work on a design project given under the name of design studios, 8 hours per week for 15 weeks. Groups of 10 to 15 students work with a lecturer as the advisor of the group.

This paper focuses on two studios; Design Studio 2 (DS2) and Application Project 1 Studio (AP1) taking place in the second year of architectural education. DS2 is in the first semester of the second year and AP1 is in the second semester of the second year.

Background Courses of DS2 and AP1

Each design studio is the prerequisite of the next design studio. A student can take DS2 only if he / she is successful in DS1. For a student to be able to take AP1 studio, he / she has to be successful in some major construction courses. The prerequisite courses for AP1 are in the second semester of the first year; Building Materials, Construction Elements of Building 1, in the first semester of second year; Construction Elements of Building 2, Architectural Design 2. (Figure 1)

The content of Building Materials is definition and development, general qualifications, timber, natural stone, metals and alloys, soil and clay (ceramic materials), glass, lime, plaster, cement, aggregate, mixtures (mortar and concrete), synthetics, paintings. This course is a three-hour theoretical course per week.

Construction Elements of Building 1 course focuses on structural definitions, classification of buildings, building elements such as foundation, wall, floor systems and staircases, construction of components and solving the problems of these components. These topics are given 6 hours per week.

Construction Elements of Building 2 is also a course of 6 hours per week. Definitions and concepts of roof, sloping and flat roof systems, materials and detail solutions are given in one part of the course. The other part of the course deals with approaches and principles of windows and doors. The design, types, function and problems of doors and windows are evaluated. In these two theoretical courses exercises are given to students each week to solve some given problems. The drawing techniques related to the scale the question is asked in is obligatory.

CODE	COURSE NAME	ECTS	LE	A	L	C	CODE	COURSE NAME	ECTS	LE	A	L	C
0711021	INTRO. TO ARCH. DES.	6	2	4	0	4	0711022	ARCHITECTURAL DESIGN 1	9	4	4	0	6
0711211	BUILD. THE. AND DES. 1	3	1	2	0	2	0711102	INT. TO HIST. OF ART AND ARCH.	2	2	0	0	2
0711251	ARCH. DRAW. TECH.	6	2	4	0	4	0711212	BUILD. THE. AND DES. 2	3	1	2	0	2
0711261	BASIC DESIGN	3	1	2	0	2	0711402	BUILDING MATERIALS	2	1	2	0	2
0711271	DESCRIPTIVE GEOMETRY	2	1	2	0	2	0711482	STAT. AND STRE. OF MATERIALS	4	2	2	0	3
0251621	MATHEMATICS	5	2	2	0	3	0711502	CONSTR. EL. OF BUILD. 1	5	4	2	0	5
9051031	ADVANCED ENGLISH 1	3	3	0	0	3	9051032	ADVANCED ENGLISH 2	3	3	0	0	3
9061011	TURKISH 1	2	2	0	0	2	9061012	TURKISH 2	2	2	0	0	2
		30	14	16	0	22			30	19	12	0	25

2. YEAR / 3. SEMESTER								2. YEAR / 4. SEMESTER					
CODE	COURSE NAME	ECTS	LE	A	L	C	CODE	COURSE NAME	ECTS	LE	A	L	C
0712021	ARCHITECTURAL DESIGN 2	9	4	4	0	6	0712022	ARCHITECTURAL DESIGN 3	9	4	4	0	6
0712111	HISTORY OF ARCH. 1	2	2	0	0	2	0712112	HISTORY OF ARCH. 2	2	2	0	0	2
0712211	BUILD. THE. AND DES. 3	3	1	2	0	2	0712212	BUILD. THE. AND DES. 4	3	1	2	0	2
0712481	STRUCTURAL ANALYSIS	3	3	0	0	3	0712402	APPLICATION PROJECT 1	5	2	2	0	3
0712501	CONSTR. EL. OF BUILD. 2	7	4	2	0	5	0712482	STRUC. SYST. DESIGN 1	4	2	2	0	3
0712611	CAAD-PRESENTATION	3	2	2	0	3	0712522	PROFESSIONAL ENGLISH 1	2	2	0	0	2
9052031	ENGLISH READ. AND WRIT.	3	3	0	0	3	9031140	INTR. TO BASIC COMP. TECH.	4	2	2	0	3
								ELECTIVE COURSE	2	2	0	0	2
		30	19	10	0	24			31	17	12	0	23

Fig. 1
YTU Department of Architecture Education Plan (USIS)

Design Studio 2 and Application Project 1

In USIS the design studios are based on 8 hours/week, 15 weeks/semester. The project a student works on increases in subject, scale and context each semester. The subject of Design Studio 2 (DS2) in second year, semester one is a building design with two functions in a given context. The design problem given in DS2 course is limited with a building that is 200 m^2 in 2 stories which is in a given area / neighborhood in Istanbul. The needs of occupants and environmental factors play an important role in every design. One of the aims of DS2 is trying to recognize one of the characteristic regions of the city, to be able to inquire about the place of this region in the city structure, to comprehend the region' s past, present on the memory traces by different readings. The students should be able to determine the solutions of basic organization for a limited number of occupants and should meet the requirements by suggesting a simple and rational planning. Students work in the context and subject in 1/500, 1/200, 1/100 and 1/50 scales. Before 2003, this studio's subject was a family dwelling (villas) in a given context in Istanbul in which students also had to develop the materials and structures of the project. Drawing the 1/50, 1/20, 1/5 and ½ details of the project started getting dull for the students on the design side of it. Therefore the design studio divided it into two different projects during EKSIP.

With this context in USIS, after being successful in DS2, students continue on a new studio Application Project 1 (AP1) of 4 hours/week for a semester. AP1 course is the details of different scales for the projects of DS2. Students have to attend 80% of studio work led by a lecturer for 10 to 15 students. Students also have to be assessed by submitting their mid-term studies. The content of this studio course is selection of materials, construction details and 1/50, 1/20, 1/10, 1/5 and ½ scaled studies.

The aim of this new proposed studio was the integration of construction courses and design studios. Since 2003 the Building Elements and Materials Unit has been carrying out DS2 and AP1.

Sample Projects of Design Studio 2 and Application Project 1

As the sample for DS2 and AP1, projects of two students are focused on. The first sample project is a children is center, for the children of low income families in Fener, Golden Horn region. Environmental analyses were done individually whereas some students do them as group work. Learning from precedents is used in research and explorations of the present examples. The design is given at 1/200 and 1/100 scale. (Figure 2)

AP1 is carried out with critics each week. Each student works on his / her DS2 project. Individual learning is the technique for this course starting with the foundations, roof plans, 1/50 scaled studies (plans, sections, facades), 1/20 scaled studies (plans and sections of staircases, bathrooms) and 1/5 details of windows, doors, staircases, roofing systems. The project is carried out as the lay-out of the prerequisite courses Construction Elements of Building 1 & 2 as seen in the sample project. (Figure 3, 4, 5) The project starting with DS2 course did lack something between the analysis step and design stage but was very successful in developing DS2 project in AP1 course.

The second sample project was in a neighborhood near Bosphorus. Environmental analysis, models in different scales of a specific content design are given. The final design is handed in as a hand drawing. After finalizing the design, the student works on material selection and details of the design. (Figure 6) After a very fruitful semester in DS2, AP1 was also well questioned and worked out through the semester. (Figure 7, 8, 9) The student was very successful in both DS2 and AP1.

Fig. 2
Student project for DS2

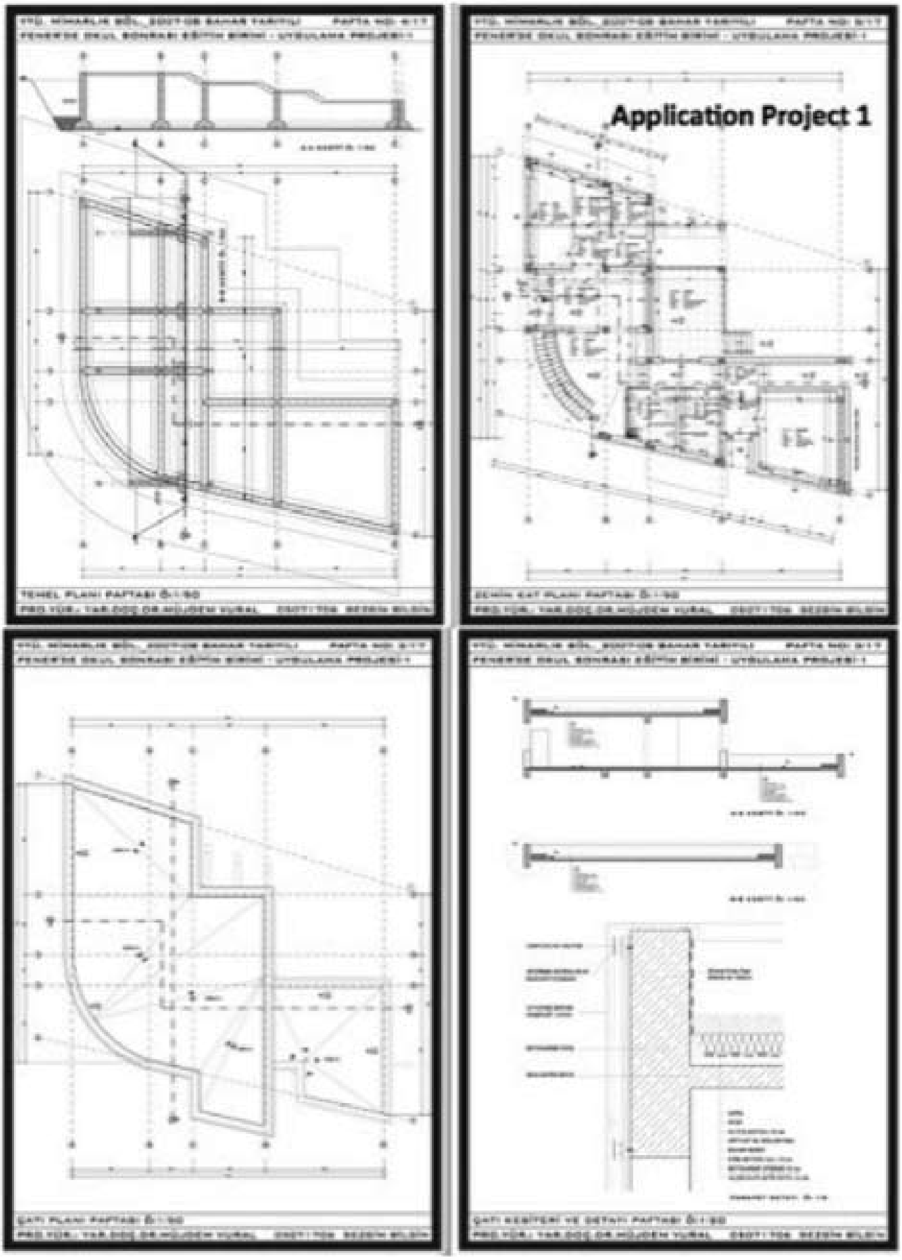

Fig. 3

Student project for AP1 (foundation plan and sections, plan, roof plan and sections in 1/50 scale, detail for the roof system in 1/5 scale)

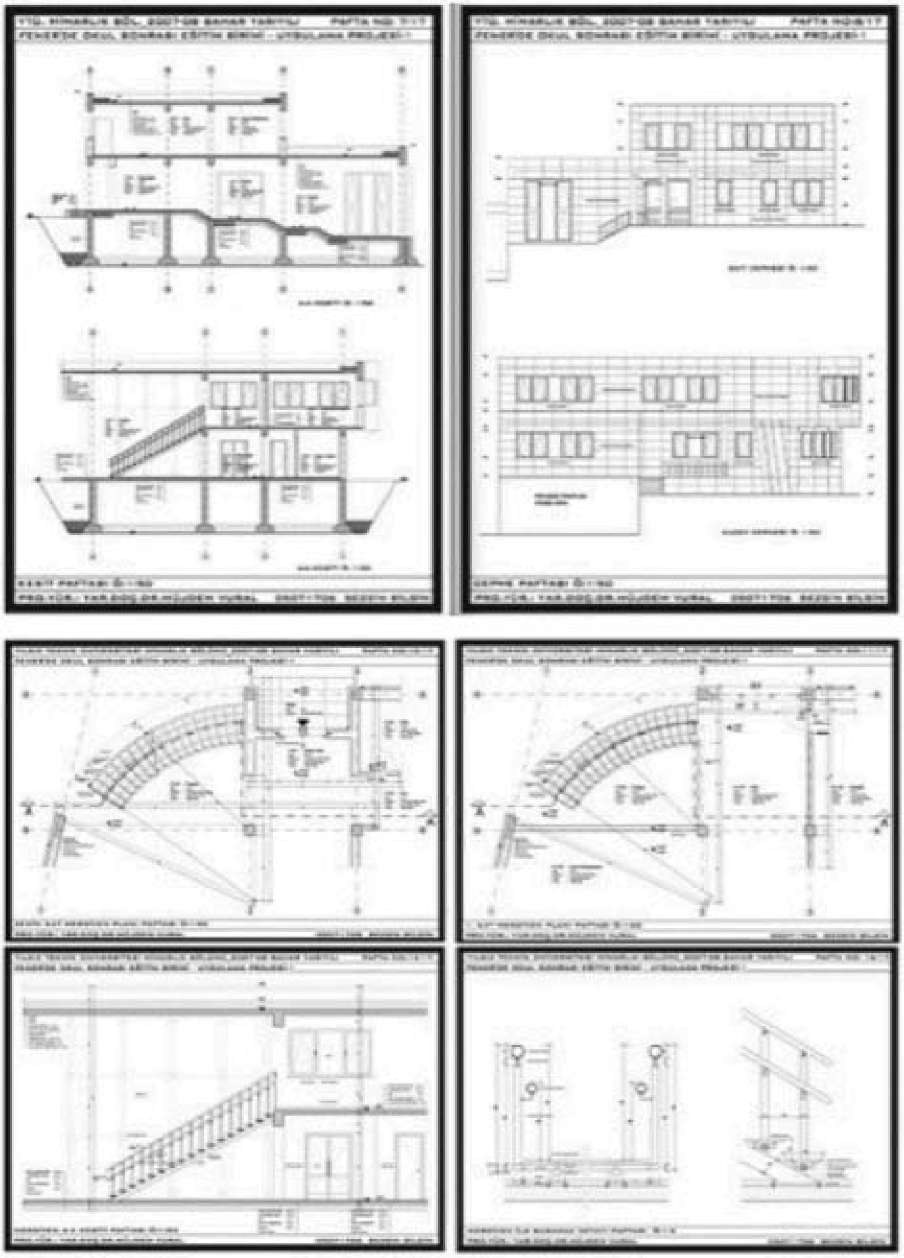

Fig. 4

Student project for AP1 (sections and facades in 1/50 scale, details of staircases in 1/20 and 1/5 scales)

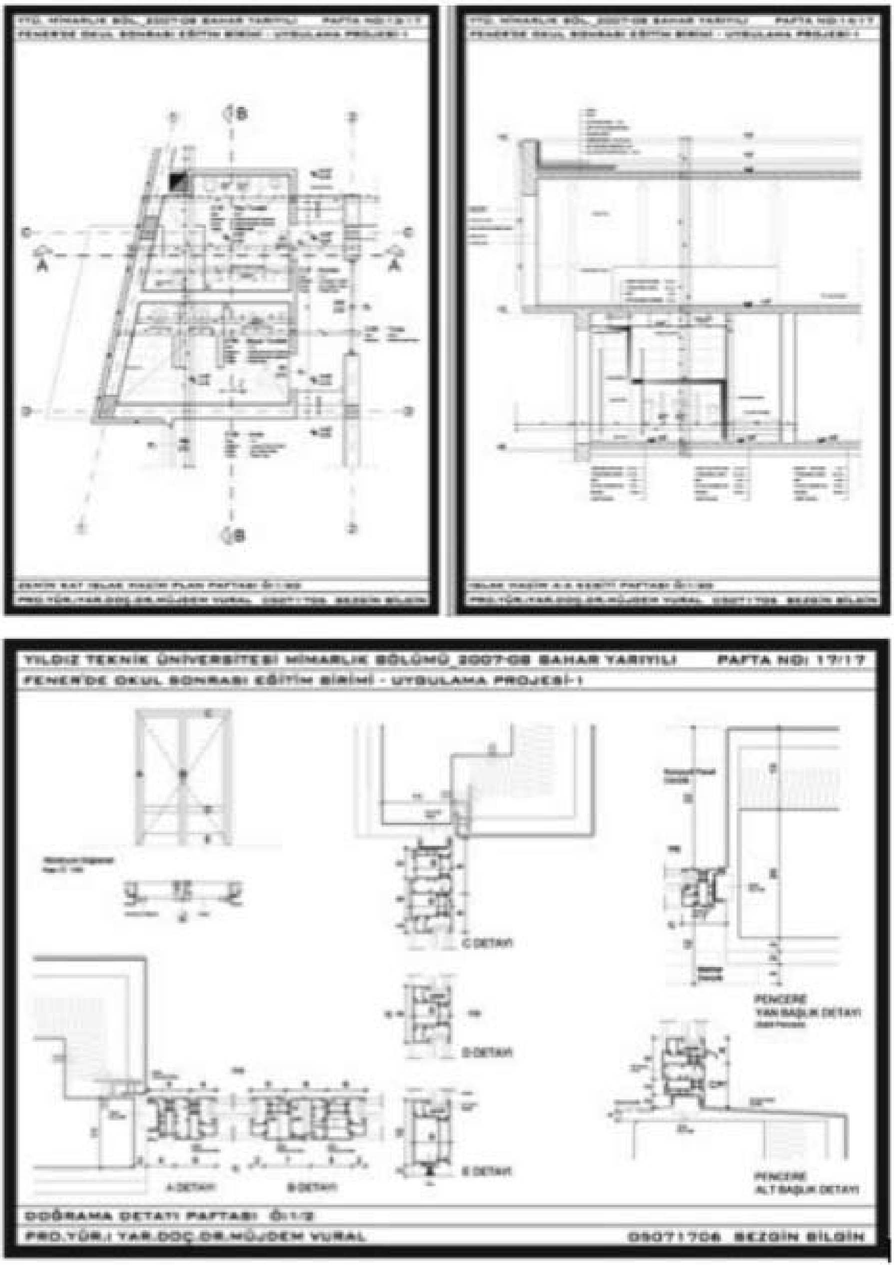

Fig. 5

Student project for AP1 (bathroom plan and section in 1/20 scale, details of window in 1/5 scale)

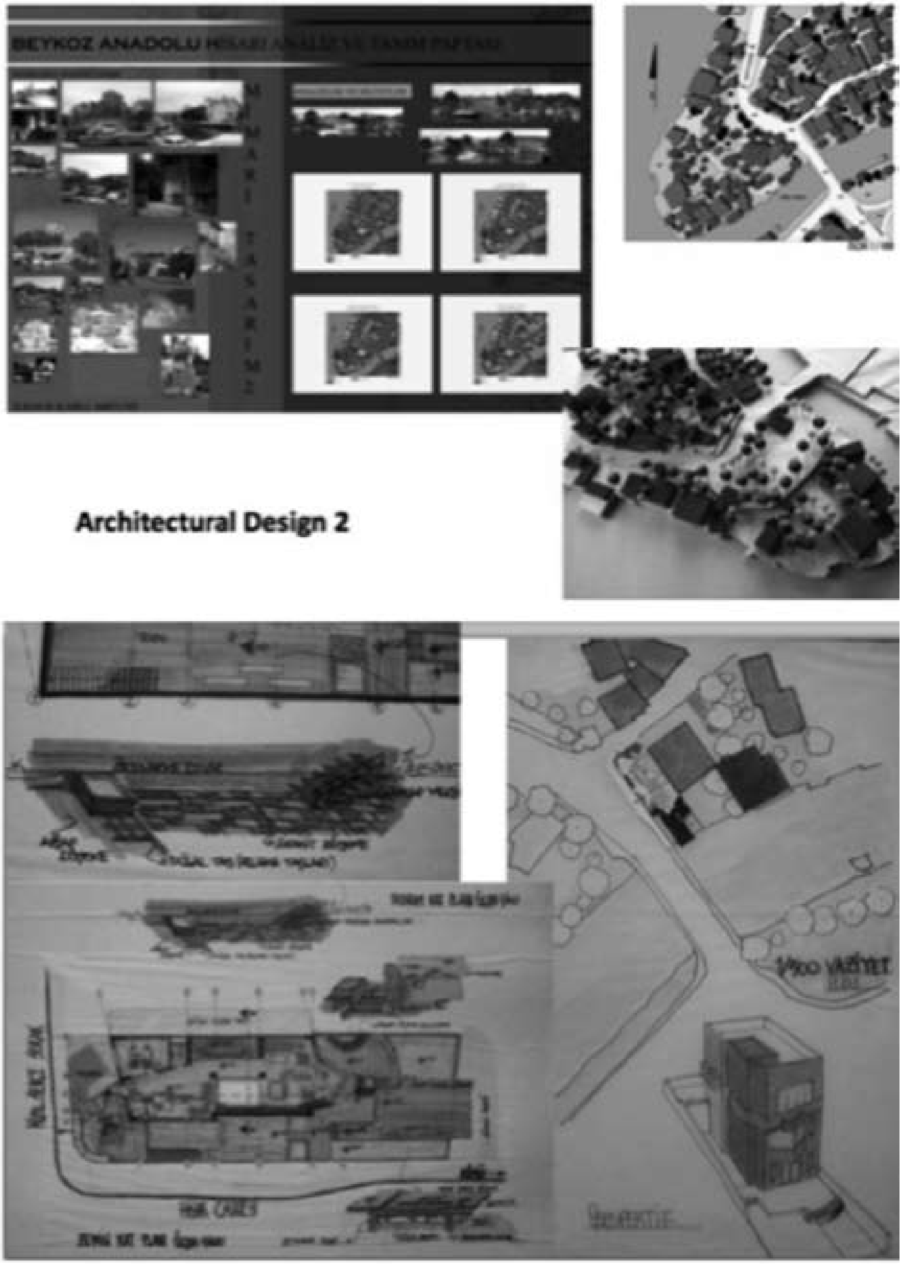

Fig. 6
Student project for DS2

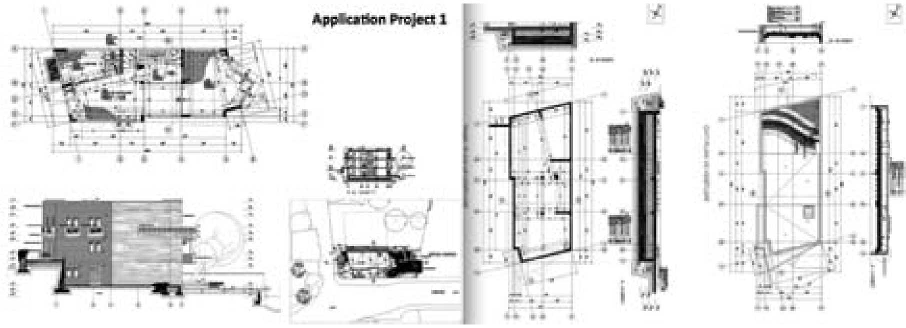

Fig. 7

Student project for AP1 (site plan in 1/200 scale, plan, foundation plan and sections, roof plan and sections in 1/50 scale)

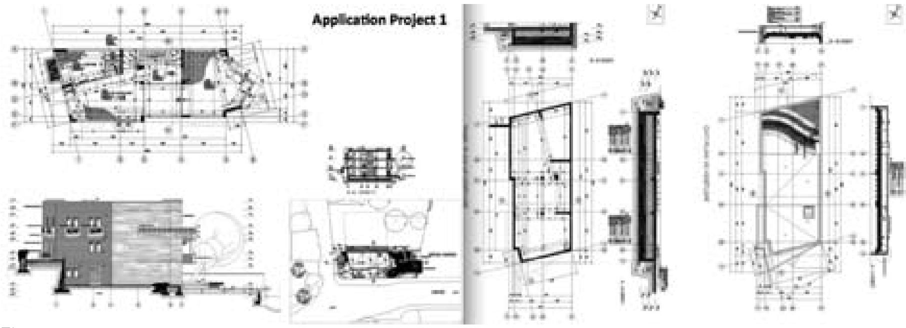

Fig. 8

Student project for AP1 (sections and facade in 1/50 scale)

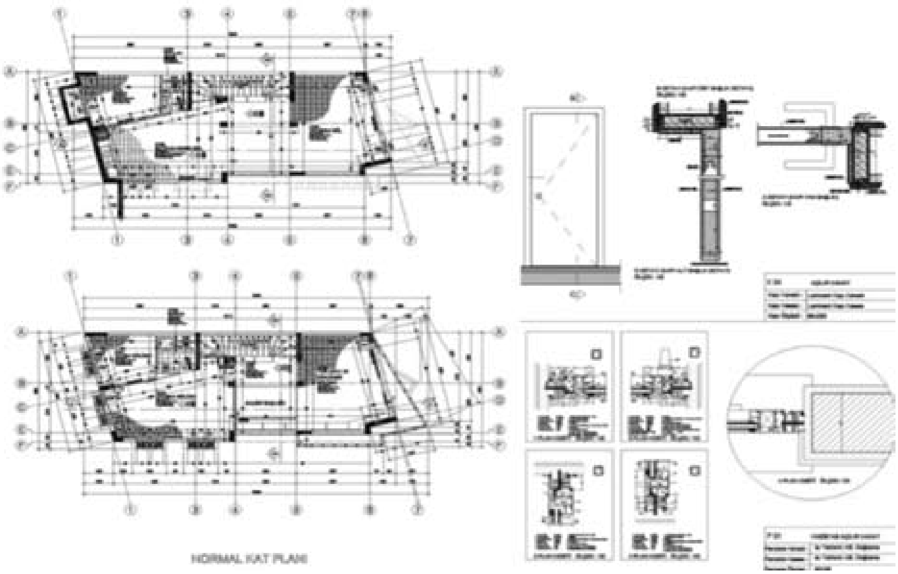

Fig. 9

Student project for AP1 (plans in 1/50 scale, window and door details in 1/5 scale)

Evaluations of Construction Courses

To develop the institution and keep up with the continuous development in education quality, YTU Department of Architecture has questionnaires for each course in the education plan done by the students. At the end of each semester, the students answer a questionnaire with 20 questions for every course they have taken in that semester.

The 8th question in this questionnaire is "The knowledge and skills gained in this course can be used in other courses or during your professional life". The results of this question represent the success of integration of construction courses and the design phase. According to the answers at the end of second year first semester, students do not find the theoretical courses useful. When the results after AP1 are evaluated construction courses are found useful. (Figure 10)

The changes in the results are also recognizable in the 19th question; "The Teaching Staff had a positive communication with students". Students have a prejudice against the construction courses and this prejudice also affects the relationship between the professors and the students. Being old fashioned, conservative, are some of the adjectives with which construction teachers are described by students. After theoretical courses, starting to integrate them with their design studios especially with AP1, the way students see the lectures change. (Figure 11)

Evaluations of Application Project 1

Another evaluation system for AP1 is a self-assessment report written by every student who has taken AP1. Some quotes from these results are:

- Wide ranging research.
- Have strict discipline.
- Leading of the project tutor.
- Continuation of Construction Elements of Building 1 and 2 (are consolidated by drawings of the project).
- The problems students are having can be because of some parts that are not geared towards construction courses.
- Interdisciplinary.
- Blur thinking is coming to a true picture.
- Different scales, recognition of problems, evaluation of problems, gathering information, developing details, selection of materials.
- Steady step in architectural education.
- Visual presentations and site visits could be helpful for understanding.

Conclusion

Two new studios, DS2 and AP1, with the new objective of integrating construction and design without disclaiming a well design are increasing the attention of students and preparing them for their professional life. Outcomes of DS2 and AP1 are getting better each year as the students see the architectural education as a whole rather than seeing it as courses to pass.

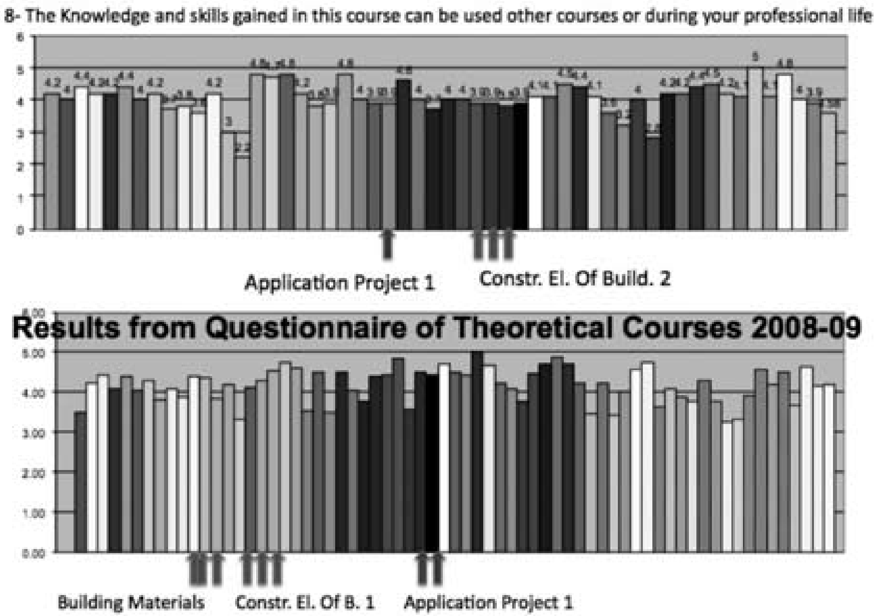

Fig. 10

Results of 8th question from Questionnaire of Theoretical Courses 2008-09

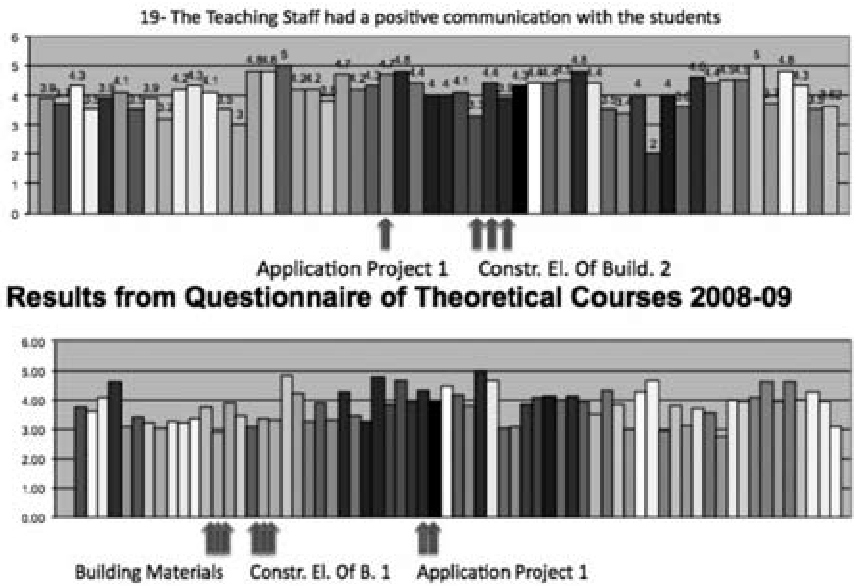

Fig. 11

Results of 19th question from Questionnaire of Theoretical Courses 2008-09

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Teaching Architecture An approach through collaboration of Design and Construction

The *School of Architecture* provides their students that successfully meet all the schools' curriculum requirements after five (5) continuous years of study, with the Diploma of Architect-Engineer, which is equivalent to a Master's degree.

The curriculum of our School has changed during the ninety years of its existence, adding new subjects and remodelling old ones, in a continuous effort to comply with the time's challenge, without dismissing the characteristic qualities that makes every School distinctive, in what they offer as an *Architectural education*.

More specifically, our School's curriculum incorporates subjects such as Design and Construction, History and Urban Design, Painting and Sculpture, and among others, Structural Engineering.

The necessity for integration

After a long period of time, during which *Architectural Design and Construction* were taught separately, which is absolutely necessary in the first years of their studies, we perceive an important complication. Our students had difficulties in connecting these two main subjects and in combining them. In searching for the elements that will help them view their work as a whole we came up against the elementary problem of defining the *central idea.*

All other compositional and technological elements can, up to a point, be rationalized and are amenable to rules, however, the main concept can only be described and its presence ascertained in the building itself.

The structure of every building must be decided at the begining. Without it the building would remain a mere agglomeration of volumes, forms and technological decisions that follow no rule, no basic principle.

Design principles do not differ from case to case. Parameters change, but the procedure remains consistent. This procedure is what we try to teach to our students, the future architects.

The *integration* of the building in its environment and the city life, the solution to functional problems, the enhancement of various units and the building's symbolism, the relationship between closed and open-air spaces, the bearing structure, the choice of the materials and the use of color constitute nothing but basic choices.

Nevertheless, no matter how important the above mentioned appear to be, they are not enough to guide us to the design of a building. The necessity of a *central idea* is imperative. This concept must set up the rules and govern the existence of every proposal.

The implementation of a methodology

In *teaching Architecture*, we are in our School trying to elaborate a methodology through which the students will effectively acknowledge the relation between their ideas and the process of implementing them.

Also the contemporary conditions of crisis to the urban and natural environment impose prudent consideration to the management of resources and energy but also the creation of buildings that are propitious both environmentally and socially.

The project

The projects of the 7th and 8th semester that we would like to present introduce students to more *complex examination* in order to solve functional and building problems, such as the balance between the built and open space, in connection with the character that a specific location gives, as well as the relation between the design and the built structure in a way that this interrelation gives substance to the architectural conception and materialize, under real conditions, the concept of the work.

Consequently, the projects under examination require consideration of complex building programs, function, definitions of the shapes and the volumes into the environment and simultaneously the search of the construction options that support, characterize and legalize the architectural proposal.

In addition it is required to confront the quality issues of the immediately surrounding space and which by definition constitutes one entity with the building. In other words, students are required to find solutions to all the issues that determine a public building.

The *objective* of the course is the infiltration to the substantial issues of synthesis. This is the reason why the projects of the 7th and the 8th semesters are combined to the same *thematic body* but with a different pursuit. The reason for combining the projects of the two semesters is the comprehension of the interrelation of the partial and the whole, space-shell-construction, of the "inside" and the "outside" of the architectural project and the overthrowing of consolidated ideas to the formulation of these relations. Notably, the link between the two semesters is the *central idea*.

The method

During the 7th semester we will deal with the Public building in the *urban environment* and its *development in height*. These two factors outline for the designer specific ways of handling in order for the project to fulfill certain principles of *incorporation of the building* in the urban web as well as the *connection* with the already-built environment.

Also crucial for the project is the making of the space that surrounds the building in the context of the economy of the space and the systematization of the vertical and horizontal movements.

In the 8th semester, the proposal of the previous 7th semester is used as a starting point, but with further infiltration into subjects that deal with the construction, the building of the inner and the open space, the total designing consequence, the rendering of the choices of the synthesis and the *central idea* of the project.

This happens through the elaboration of the phases of the design that lead to the fictitious materialization. In this way it becomes obvious that all these factors are not only an inseparable part of the synthesis of the architectural project, but they also support and enable the architectural creation, often being the motivating force of the procedure of this conception.

The course

For this interdisciplinary course, we present the project for the Academic year 2007-2008 concerning the design of a Municipal-Cultural Centre.

The proposed site is at the corner of an urban block very close to the center of Athens, in a neighborhood which is now changing socially and culturally.

In the first -7th semester students:

- Investigate the relation of proposed building with the wider urban context.
- Formulate basic design-structural choices, which concern functional, constructional and morphological resolutions of the project.

In the second 8th semester, the project of the previous 7th semester is used as a starting point, so that emphasis is given to:

- The building of interior and open air space.
- Architectural-constructional design of the project as a whole and of individual areas.
- Design of architectural-constructional details
- The achievement of a design project, as a sequence of choices in all the architectural constructional scales.

Consequentially in the 8th and final semester, a more detailed analysis and design of the project takes place and emphasis is given to the construction of adequate physical models.

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New Technologies and Materials in Interdisciplinary Architectural Design

Architectural Design and Interdisciplinary Research

While the key importance of the act of design in architectural education and practice is indubitable, based on the contemporary interpretation of architecture, an integrated approach to design may be conducted within the multidisciplinary nature of the area, with one common horizontal connecting element, namely, the architectural design intentions and aim. International applications, based on a timely re-adaptation of intervention of technological parameters and in particular of the significant areas of the structure, construction and environmental systems in the architectural design, have succeeded in a timeless quality of the built-up result through the optimized tuning between the desirability of the building form and functional spaces with the structure, materials and construction. Furthermore, an interrelation of technology with architecture from an early design stage enhances the achievement and application of respective technological innovations, while aiming at the improvement of individual or multiple architectural parameters within the holistic design context. In this respect two independent or interdependent directions may be followed:

- The integration of the design vision, structure, construction and environmental systems to form the architectural design syntax – *design driven technological developments*. Following a holistic design approach, through the synergy of technology with design, advanced interdisciplinary research activities in individual respective areas are initiated.
- The interactive architectural design process through innovative material based structural and construction applications – *technological developments driven design.* Theoretical, design based research and individual technological developments support the integrated context of design.

Based on three architectural studio design examples with emphasis on technology, supervised by the authors at the Program of Architecture of the University of Cyprus, the paper examines the architectural-technological potentialities, made possible by applying the specific design-syntax. The design case studies indicate the way that advanced interdisciplinary research may be required for the realization of the initial architectural aims on one side, leading thus to technological innovations, and the way that the design may be influenced by the proper form and mechanics based applications of new systems and materials on the other side, i.e. technology transfer within architecture.

Integrated Architectural Design

In Schools of Architecture, relevant courses on construction constitute, together with courses on structures and environmental design, the area of architectural technology. Pedagogically, the interrelation of the technology courses with design is implemented in the newly established Program of Architecture at the University of Cyprus through integrated design, with the introduction of the micro-studio concept in all undergraduate courses of construction – construction in timber, r/c and steel – and in the final main architectural design of the three years core of undergraduate studies in architecture with emphasis on technology. The practice of the integrated design approach at the University of Cyprus is based on the belief shared by the authors that design is identical to the construction and construction is always design. In this frame the design refers to all scales of the project: From the urban- to the building-scale, up to the detail.

The integral development and the application of technological parameters in the design are based on the main areas of the morphology that corresponds to the surrounding environment and results from the functionality of the building, the construction, geometrically and structurally directly related to the structure and responsible for the interrelation of the interior spaces, the building envelope, of non minor importance for the skin and of course the external appearance of the building, and the energy efficiency, as regards possible spatial configuration and the integration of the technical supporting systems of the building. The structure supports the framework of design, all areas of the integral development, without constituting a self-aimed component. In addition, a necessary connecting element is the search for and the iterative resisting realization of the architectural aim, the design vision that interconnects the different scales of design and levels of analysis, through construction design.

The schedule of development of the applied design methodology may refer in the first place to the time management of development of the different areas and scales of design, rather than the technology driven direction of design, as described above. In this sense, both directions may be followed: from the development of the building to the construction elements and vice-versa. In all cases, an analysis is conducted initially of the urban and environmental conditions at the site, functional configurations of the building and construction issues. The aim is the formulation of a driving design concept, thus the setting-up of an architectural vision, the development of a general morphology of the building or its elements and a preliminary coordination among form, function and construction. Subsequently the design concept is further developed, in its architectural, structural, construction and energy efficiency sections. This implies:

- The determination of the functional zones, as derived from the construction typology, the users circulation, the functional requirements of the spaces, their natural and technical lighting and ventilation.
- The preliminary design of the structure as regards the system developed and materials applied.
- The construction design of the building elements up to large scale, structure, building envelope and interior elements.
- The preliminary development of an energy efficiency concept, and the incorporation of the technical installation elements of the building.

The clearest examples of the design methodology applied are the results of the main architectural design in the 6th semester, where a holistic development of the designs is conducted. Since the students possess by then fundamental knowledge in the different areas of the integrated approach, these can be considered at equal levels within each stage of an almost linear construction design development, as regards architectural scale, as well as transfer and promotion of the originally design vision set, through means and expression of technology.

In the Spring-Semester 2008 the development of a Centre of the Cyprus Platform for Research and Technology in Building Engineering was required, to be followed the year after by a Platform for Digital Research and Technology, with total area of about 1.500 m^2 each. The brief of the buildings included entrance areas, exhibition, multi-purpose, library, seminar, conference rooms, research spaces and technical supports. In both cases the buildings were expected to comprise symbolically a prototype of technological advancement of contemporary structures, aesthetically and morphologically, as well as through the interactive development of the functions, construction and energy efficiency.

Design driven Technological Developments

The design proposal example for the Centre of the Cyprus Platform for Research and Technology in Building Engineering, Fig. 1, refers to the development of an entirely transparent building, raised from the ground. The building acquires the characteristics of a built up object, an urban exhibit, enabling at the same time continuous visual correlations and an uninterrupted continuum of the external flows of activities and the internal usage and circulation.

Fig. 1

Integrated Design Project 1

The development of an entirely glazed building solution is interconnected with a series of design parameters, Figs. 2-4, such as:

- The spatial organization of the spaces. The circulation zones are placed on the periphery, acting energetically as secondary buffer zones for the interior spaces; the public spaces are left open at the lower floor level; the private spaces are conceived as autonomous closed building units within the building envelope.
- The development of the primary and secondary building structure. The primary system consists of a continuous Vierendeel mega-beam, also supporting the secondary system of the double glass facade. The outer skin transfers the horizontal loads, acting on the building, through a secondary system of compression and tension members, placed within the facade space.

- The preliminary development of an energy efficiency concept. The double glass façade acts energetically as an environmental filter, regulating the natural lighting and ventilation of the interior spaces.

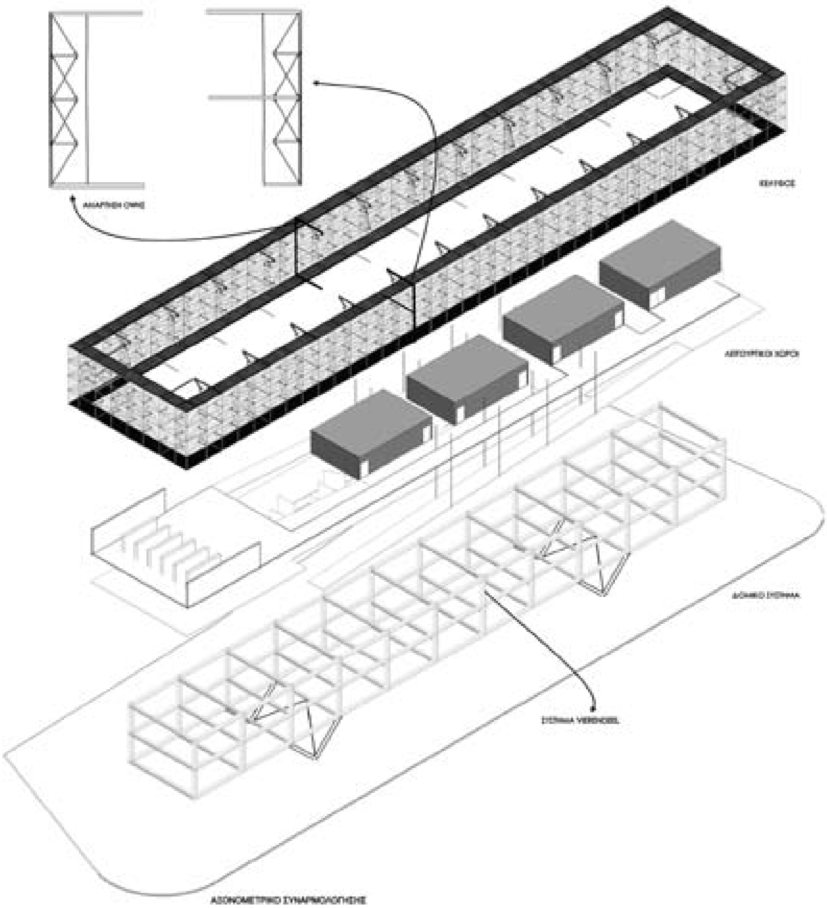

Fig. 2

Building Composition

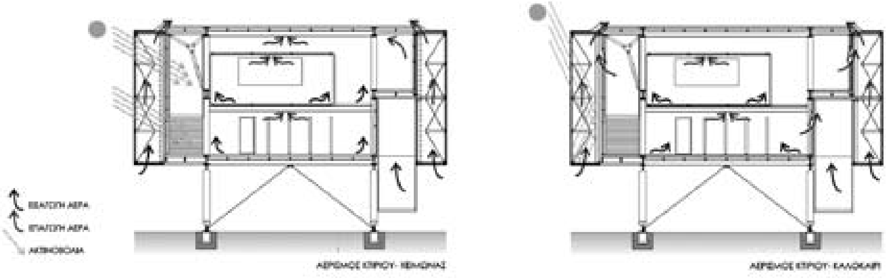

Fig. 3

Bioclimatic Concept; Winter, Summer

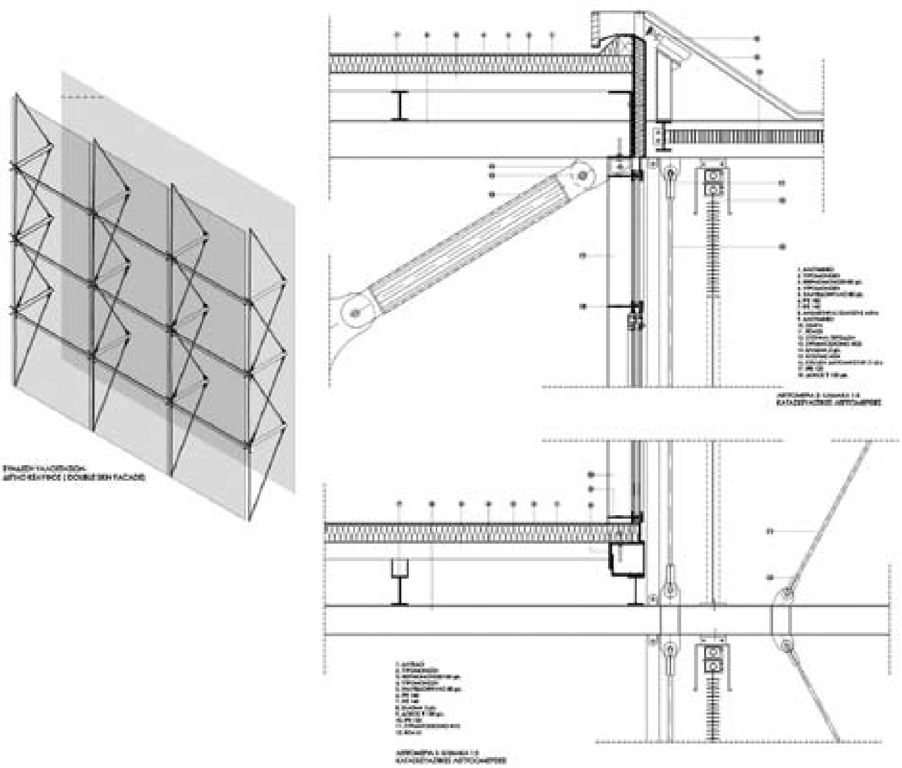

Fig. 4
Double Facade

The particular design underlines the necessity for further interdisciplinary research for the achievement of overall comfort of the users. In the long run a respective substitution of massive materials of high thermal inertia with technologically intelligent facade systems may be validated, when the latter initiate from an integral design context.

Technological Developments driven Design

A second design proposal from the same semester, shown in Fig. 5, addresses the development of a "passage-building" with open circulation and exhibition spaces, enclosed by a uniform building envelope, whereas most private functional spaces are placed underneath the ground level. The development of a transparent building envelope with minimized mass was based on aspects of industrialization and standardization, easy erection and clarity of the connection elements. In this frame of development the structure needed to be defined in its static system and designed as to its appropriate members and connections in the clearest way as to its load-bearing function and readability of form and connections. In the long run the building acquires relevant strong self-identification characteristics, arising from the structure itself.

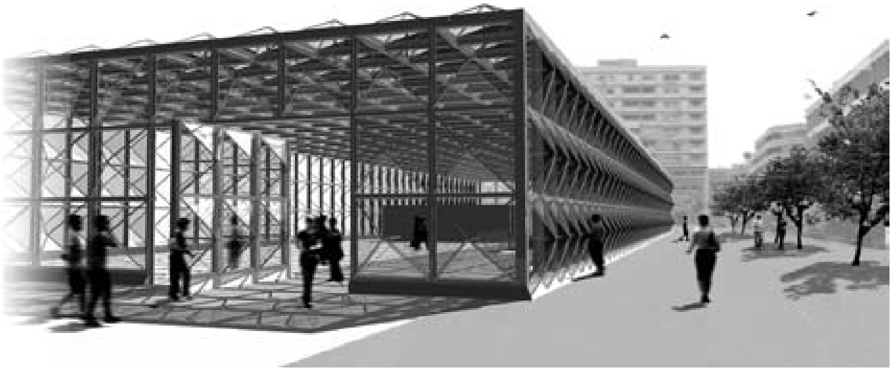

Fig. 5
Integrated Design Project 2

The frame structure of the building and at the same time of its envelope consists of a primary orthogonal grid system of compression and tension members, Fig. 6. All elements are hinge connected, following the principle of tensible structures. The middle free-standing compression elements, respectively connected over eight cables with the primary grid knots, consist of pretensioned glass tubes, Fig. 7. The patented solution by Professor Stefan Behling from the University of Stuttgart served in this case for the enhancement of the design vision set, of a light-weight transparent skin and for the demonstration of applicability of innovative structural elements as to their mechanical properties. The necessity of an additional external sun-protection layer on the roof certainly decreases the effectiveness of the prototype elements application within the holistic design context.

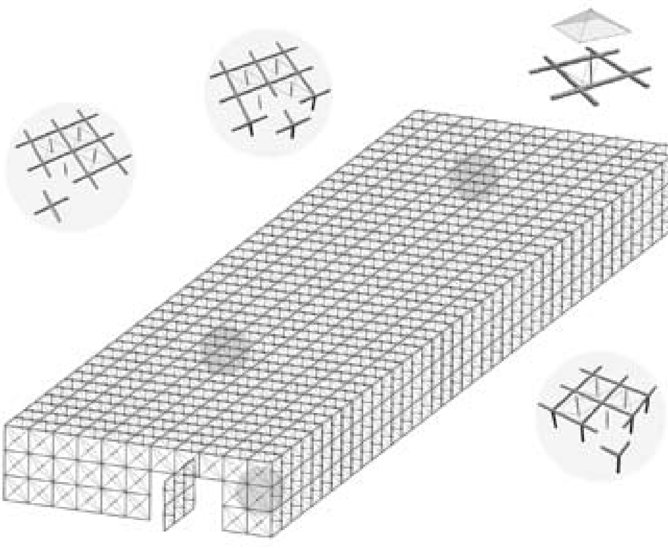

Fig. 6
Building Structure

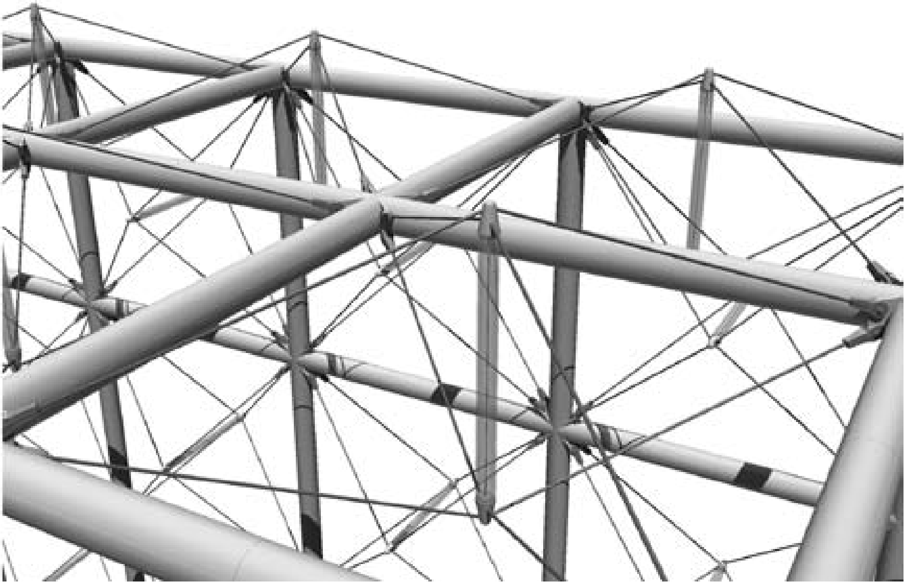

Fig. 7
Structural Elements Design

Technology driven Design

The design proposal for the Platform of Digital Research and Technology, Fig. 8, originated from a theoretical analysis on bionics and architecture. The functional program was translated into a unified built-up organism of private functional units and "public cells", enclosed between two horizontal plates that define the floor and the roof of the building. Within the "open" building volume all private functions are placed on the two longitudinal sides, thus creating a middle open zone with diffused visual boundaries for the activation of respective different public functions, Fig. 9. The project refers to the highest degree to the architectural-technological potentialities offered by glass in its various bundled application forms; in the creation of spatial perceptive coherence and unified identity, vertical layering of transparent spatial divisions and to the interactive structural and construction design process through innovative material based structural applications, Fig. 10.

Fig. 8
Integrated Design Project 3

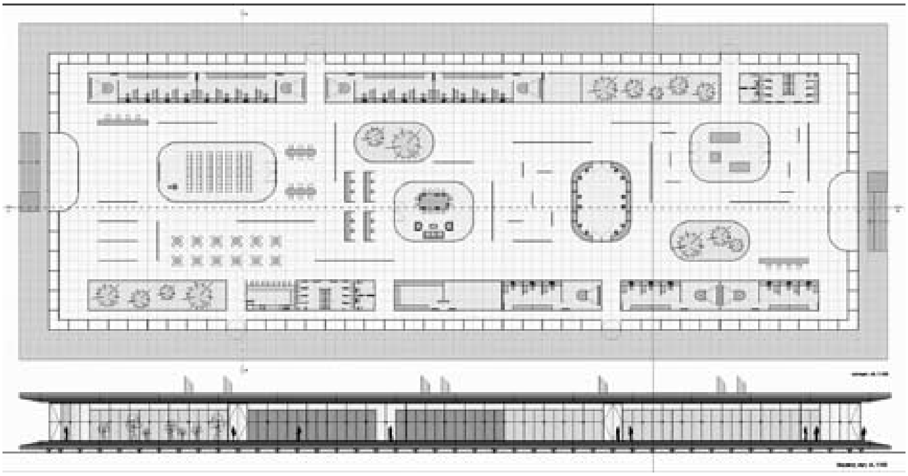

Fig. 9

Ground Floor Plan and Longitudinal Section

Fig. 10

Interior Spaces

The vertical architectural elements are composed of the double glass façade, the interior primary load-bearing glass walls and the structurally and technologically autonomous inner functional units, Figs. 11-12. All elements have multiple functions, as follows:

- The double glass façade acts as the primary load-bearing element, transferring the respective horizontal and vertical loads to the lower horizontal plate. In parallel it enables natural lighting and -ventilation of the inner façade zone.
- The inner glass walls serve as structural linear supports of the upper plate, spatial transparent division elements and projection screens of digital information.
- The inner core elements, equipped with sunlight-reflecting tubes, are vertically composed of a sandwich glass system of load-bearing glass plane pairs that act together over multiple shear connections. The latter consist of adaptable lens mechanisms, originally conceived to form the aperture façade.

Fig. 11
Double Facade

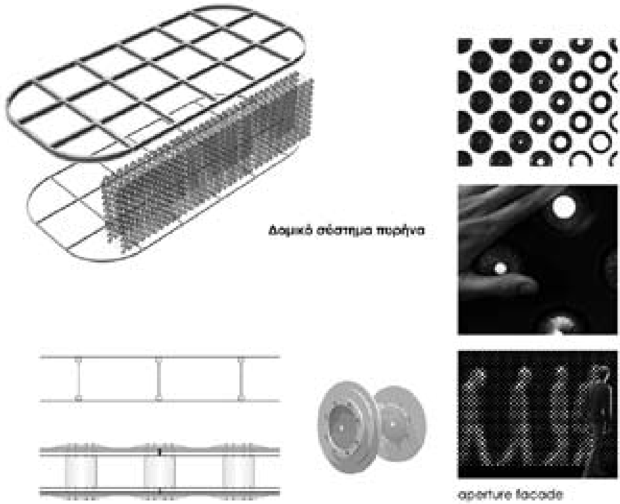

Fig. 12
Cell-Units Structure

The particular design proves that technological developments within the holistic design process refer in parallel to interlacing functions and properties of the materials used as to the architectural, structural, construction and environmental requirements of the spaces created.

Closing Remarks

The application of new technologies and materials in architecture takes place within an integrated design context, whereas morphological and aesthetic issues, functional constraints, the structure and construction of the building elements and environmental issues play a simultaneously significant role. Undoubtedly, such a design approach is most effective when practiced in an interdisciplinary environment. Based on the technology driven design approach followed at the Program of Architecture of the University of Cyprus, two discrete or even interdependent directions towards innovations in architecture on the ground of new systems and materials take place. The first direction refers to the application and further development of technological innovations that arise from the integrated design context, thus satisfying multiple design criteria for providing added architectural value. The second direction refers to the technology transfer within the design process, initiating also the advancement of research activities according to respective design visions and demands.

Session 2.2

Integration as an educational issue

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Design Studio 1st year 2nd Semester
Scale and the Human Body
Materiality and Modularizatio

Introduction

The topic of the second semester first year studio is "*scale - human body – materiality*". The main emphasis of the studio is given to the development of students' understanding of the human body as a generator of their design proposals, both in terms of scale as well as through its engagement with the physicality and the attributes of materials.

The aim of the specific studio was to encourage students to design and analyze spatial conditions instead of formal entities. The human body and materiality were used as constant parameters which informed the process.

The studio was broken down into three parts and was developed as a non linear process. Part one and two (three and two-week projects) were used as a built up knowledge platform in order to prepare students for the third part (seven-week project) that was the main focus of the semester.

Part one

"Autopsies" was an exercise of the mapping of a given space and organization of an event. The first project encouraged the analysis of spatial conditions using the diagram as a tool. Body mapping in the space and understanding of the presence of a body and its scale in this specific environment were the main emphasis.

Part two

"1/1 installation- body interface" was an investigation of materiality in relation to the body, scale and the senses. This fast construction exercise was aimed at getting the students to learn about the above criteria through making.

Part three

"Design of a pavilion" was an investigation of systems. The design process was based on the notion of a module as a generator of an overall structure that was appropriated for the scale and use of the human figure and was also informed by an existing site condition.

Initial Projects: Autopsies / Installation-body interface

The first project, called 'autopsies', was a three-week project, where the students worked in groups. A space in the University was given as a site. Students were required to analyze the way spatial conditions affect colonization by everyday users. Issues of visibility, light, sound etc were considered and taken up as testing criteria. Students were then to design an event they considered appropriate and subsequently to document it while it actually took place. Therefore the spatial analysis was conducted in three different time frames: the existing situation, the design of the event and the actual event.

The project by S. Voskaris illustrates initial spatial analysis through the use of diagrams and the design for the event of an auction to take place. He then used collage as a medium to setup an abstract storyboard in order to document the unfolding of the event.

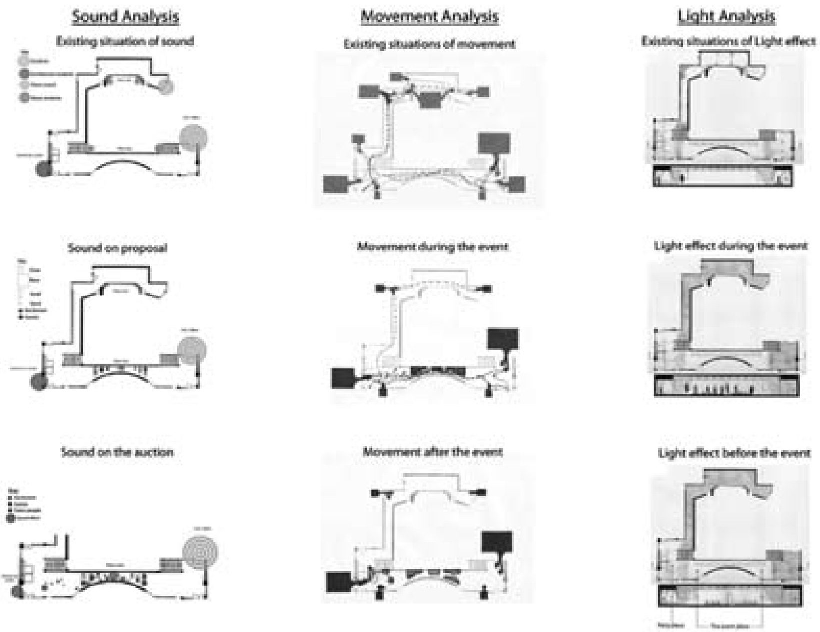

Fig. 1
S. Voskaris

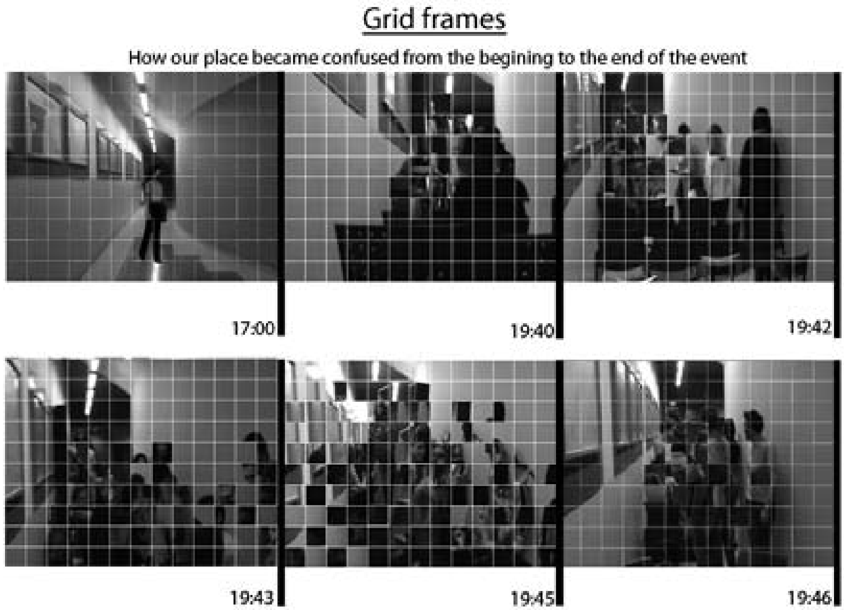

Fig. 2
S. Voskaris

The second project called 'installation/ body interface' lasted for two weeks. It was a quick exercise for students to experiment with everyday materials in order to design and construct mini-systems / installations at 1:1 scale. Students were encouraged to select a material to be used as the module, investigate its qualities and to assemble it in diverse ways producing different morphological manifestations. The installation engaged with the scale of the human body and experimented with an unfamiliar colonization of a familiar existing space.

Quality of the materials in relation to visibility, movement, boundaries, enclosure, sound, initiated a discussion. The notion of a module as a generator of an overall structure was introduced.

Students Projects

Students experimented with diverse materials including plastic balloons, paper tubes, plastic cups etc and chose to place installations in passage areas like corridors and in doorways. In one of the projects K. Nicolaou constructed metal circles encased in timber frames in different sizes and placed them in an outdoor passage; M. Patatas, working in an indoor corridor, used pierced foam board panels to redirect movement and light as well as redefine the perspective view of a person walking through the installation. In two other projects S. Kadem used string to modify an existing corridor, while R. Tollefson stretched elastic ropes diagonally, at the intersection of two adjoining doorways. Both projects challenged the passage of the body through the 'extended threshold' of the door. Passing though was possible only if the body was constantly changing posture.

In a quite different project S. Gharehgoozli used paper tubes to create a flexible piece of furniture which could deform to accommodate different uses. This project used the idea of inhabitation fully.

As mentioned earlier, these initial exercises attempted to develop the background and prepare students for the main project which was the design of a pavilion. Mapping, inhabitation, organization, materiality and scale were issues discussed in the first two parts of the semester and were taken forward in the third part.

Third project: Design of a Pavilion

The focus of the studio, and particularly of this project, was the creation of systems instead of formal entities. Under the general area of the topic of the studio: scale /human body/materiality, we had the chance to question the role of the traditional architect, and interpret it as the creator of systems. The exercises remained abstract so that the students were not able to jump to familiar forms of structures or known combinations of materials. Therefore preconceived ideas of what creates or what is architecture were limited and excluded from the process because they were not under the framework of the investigation of this studio.

An important reference in this approach was the commentary of Inaki Abalos on the work of Alejandro de la Sota's work in "The Architecture of Imperfection":

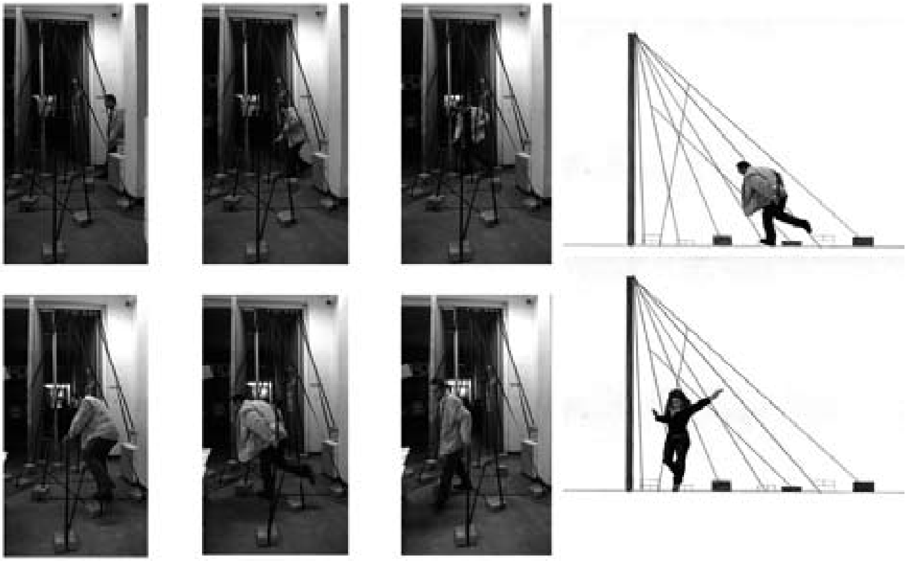

Fig. 3
R. Tollefson

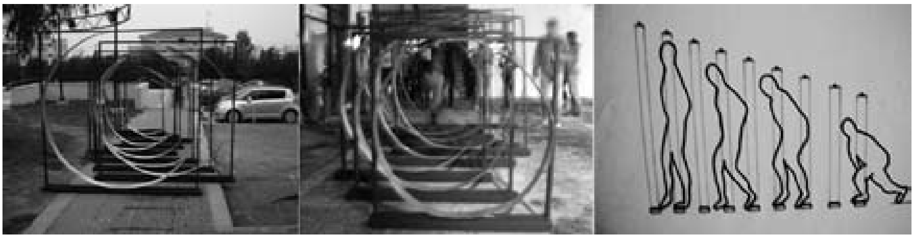

Fig. 4
K. Nicolaou

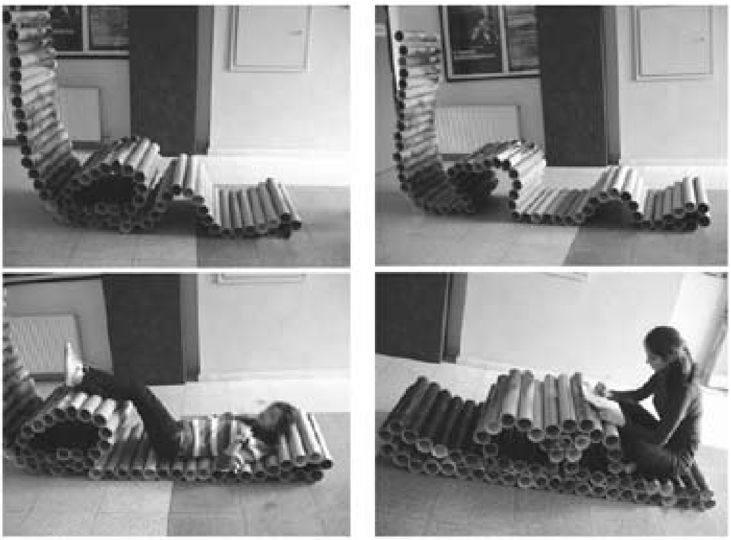

Fig. 5
S. Gharehgoozli

"... the traditional idea of the builder is replaced by the idea of the creator of systems, of groups of elements that are capable of establishing a logical internal order but also of keeping this order sufficiently open to accommodate surprise and contradiction."

In the initial stage of this project model making was the main tool used. Students were asked to explore a variety of systems through fast abstract model exercises in class. Understanding of the notion of vertical, horizontal and curved surfaces were some of the spatial conditions that were initiated at the end of this exercise. Voids as generators of public space, linear, central, and cluster organizational principles were introduced in the discussions we had in class. These group discussions on the possibilities or limitations of different examples presented put the framework for the investigation of the system. At the same time a common background of knowledge for all the students was established (Fig. 6).

Students were then asked to take one system forward, develop, explore and use it as the main design principle of their pavilion. The human body, its potential activities and inhabitation informed the scale and purpose of their design. Students produced sections and collages in order to test and show the potentials of use, and the relation of the body in their system.

The beginning of the design was based on in-depth investigation of "*the part*" in order to go "*the whole*". The generation of holistic forms was not the goal of our studio. The "*system*", its potentials, flexibility, adjustability, materiality always in relation to the human body was our aim.

Each system was generated by the multiplication of a '*module*'. The idea of a module as a unit that is the generator of the overall structure was introduced and was the question for every student to answer. This module had to be determined from an analysis of the relation it had to the human scale, its materiality and its capacity to produce coherent spatiality with flexibility and multiplicity (Fig. 7).

The system set the rules for the design. Students were not acting as creators of form, but as inventors of systems, systems that integraded issues of materiality, modularization, components, repetition of units. That created diverse discussions about adding, subtracting, repeating, bending, order and disorder about principals that you the system needed to be based upon, in order to have rules and restrictions as well as spatial quality and diversity in the final outcome.

The definition of a clear system was addressed at the same time as the necessity to test it in a real site condition. This site had to be chosen on the appropriateness of its spatial conditions in relation to their system's potentials and scenario. Each student had to decide on an existing site in Cyprus, map it and insert his or her system inside. In this way the system stopped acting as an object detached of its environment but became a generator of a real condition. Parallel to that students had to analyse the site in terms of scale, public and private use, movement and circulation, inhabitation, understand its urban conditions. All these issues could inform the creation and development of the initial scheme of their system. This was important in order to make students understand from the early beginning of their education that the conditions of the site can act as generators of the design process parallel to other issues of investigation (in our case the module) (Fig. 6, 8).

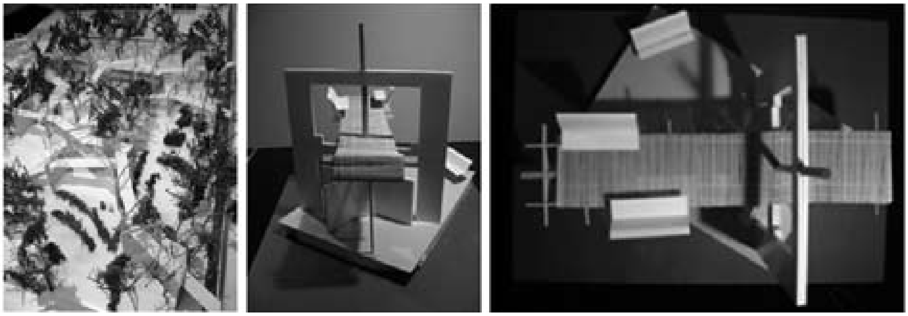

Fig. 6
M. Patatas

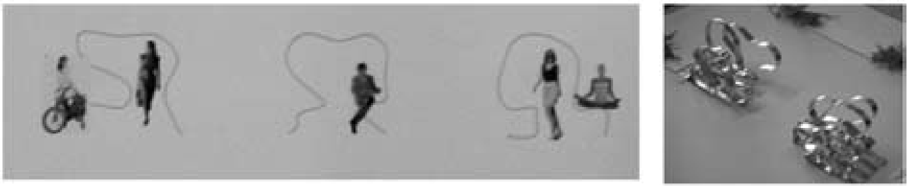

Fig. 7
C. Vasiliadou

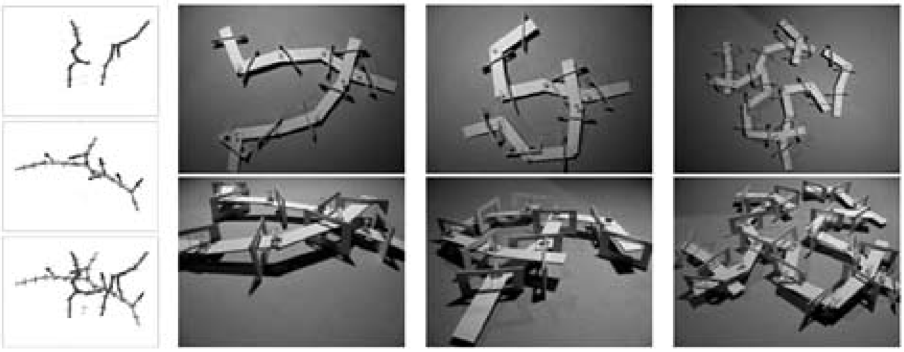

Fig. 8
M. Patatas

Diversity of form in the final outcome of the projects was a positive finding of this approach of a studio methodology. Some systems were based more on a structural principle and others on repetition of smaller units that came together to create space either through addition or through subtraction.

Students that applied and tested their system in a specific site early in the process achieved a better integration as well as a more elaborated and complete module and overall system. One of the projects by S. Voskatis produced a system of wooden ramps which folded and unfolded horizontally and vertically according to conditions

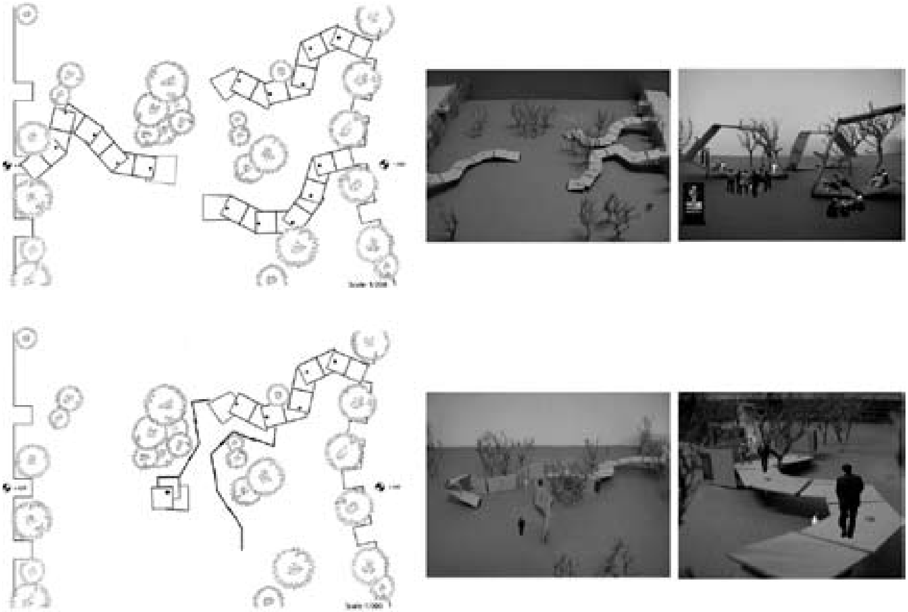

Fig. 9
S. Voskatis

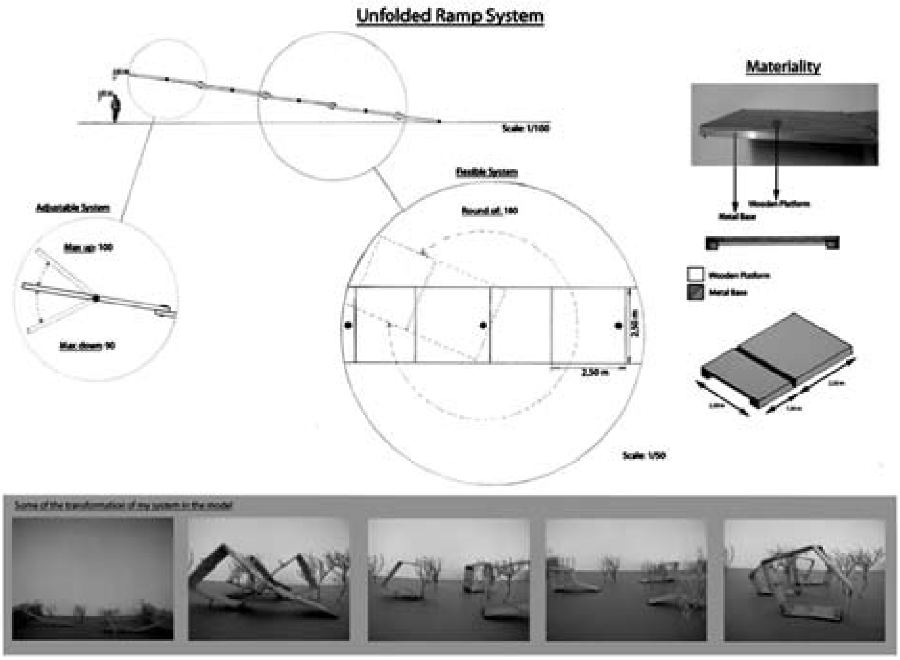

Fig. 10
S. Voskatis

of accommodation and site. To achieve greater flexibility extended research was made on the joinery. In another project K. Nicolaou worked with subtracting linear pieces of timber producing both extensions and internal openings on an initial cubical form. A variety of spatial conditions were created through this system and the proposals that derived were tested in different locations.

In some other cases the site became part of the system itself. The project by R. Tollefson began as a series of additions of folded surfaces which were appropriated according to specific site conditions, but in the process the integration of the site in the system was achieved.

The spatial conditions which derived, the potential scenarios for accommodation, as well as the potentials and variety of their system were analyzed through diagrams.

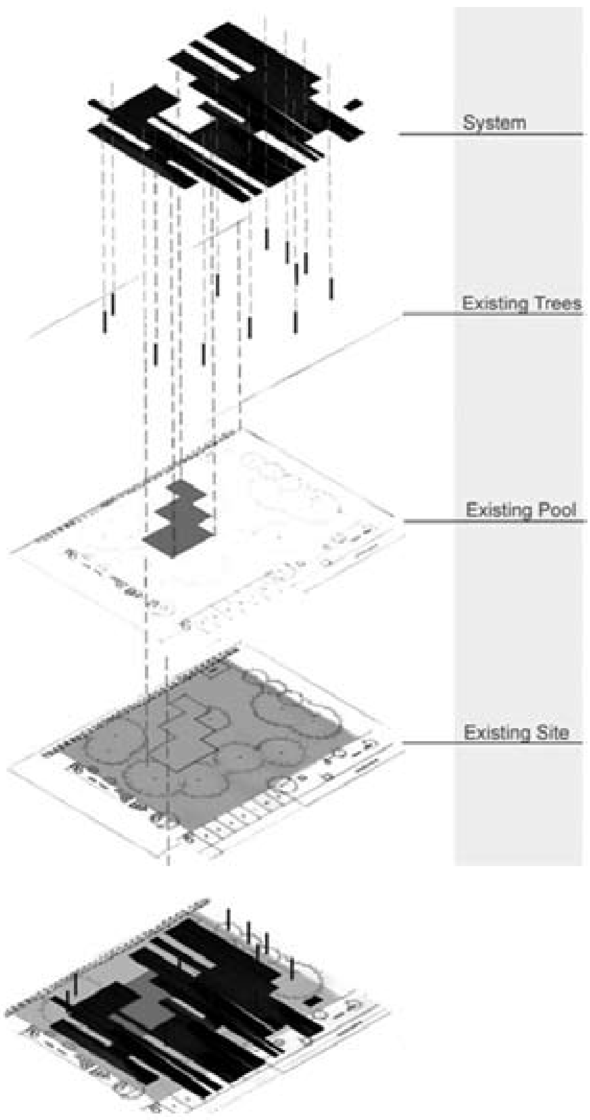

Fig. 11
R. Tollefson

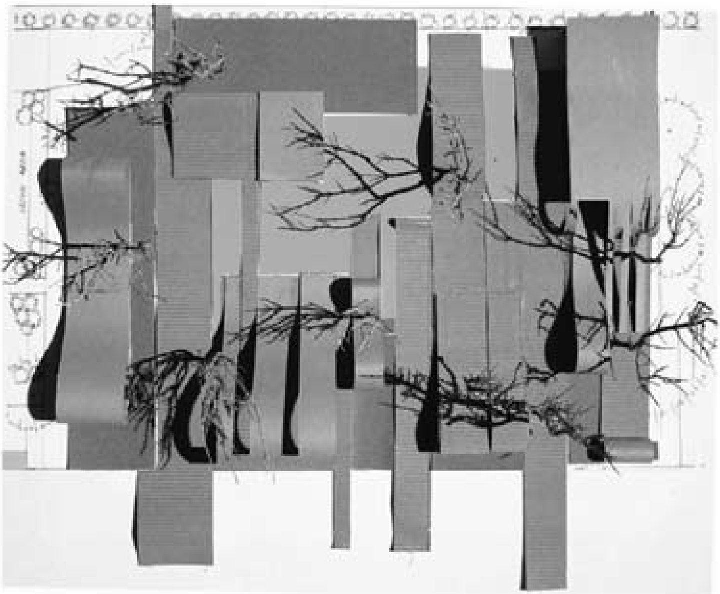

Fig. 12
R. Tollefson

Assessment of the Studio/ Thoughts for Future Studios

This was the first year for this specific structure for the studio. Some of our observations were:

1. The idea of introducing a system-based design approach (which originated from an intuitive idea on behalf of the students about relationships of planes), allowed the students to develop their own structural logic and a rigorous framework for decision making. This also gave us the opportunity to integrate materiality as an inseparable element of the system, and thus question the traditional separation of structure from the design process.
2. Working with a "module" allowed students to experiment with a variety of materials, to explore and investigate their properties, in order to create an overall structure. In this way construction was an integrated element of the design process. The limitations and potentials of the material used were an inseparable parameter of the decision making.
3. The system enabled diverse formal definitions and spatial conditions for the students to experiment with. Nonetheless, some students became very site-specific and did not test many applications of their system. Also some students did not engage enough with the potential accommodation of their proposals. These may need to be emphasized further in future studios.
4. We also consider expanding the idea of the system as not only a formal construct but an organizational one as well. Furthermore, there is a possibility to require students to test their system in 1:1 scale, either in construction or in drawing.

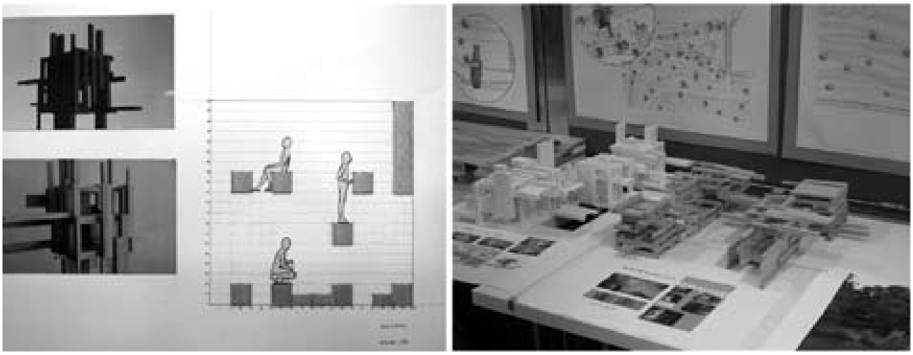

Fig. 13
K. Nicolaou

Fig. 14
K. Nicolaou

Generally we felt that the framework of the structural system and the module was a constructive design tool which was able to be used by students in various ways. In particular, having understood and created their own set of 'ingredients' and clear parameters of design decision making, it allowed students to be creative and confident, alleviating the anxiety of 'right or wrong' decisions.

Reference

Alejandro de la Sota, *The Architecture of Imperfection*, AA Publications

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Integration as a Holistic Approach in the Design Studio

Introduction

Integration in architectural education in general is not something new. Integration has been practiced before, until the progress in science and engineering opened up the possibility for a fractured approach of studying architecture. Now we are back considering integration as something that has worked well. What supports this u-turn is the fact that what we call 'design', and have done for several hundred years, is a form of integrated thinking and doing.

The Mackintosh School of Architecture (MSA) always strongly believed in the concept of integration of architectural technology into the artistic design work. We also believe the design studio is the place where integration works best, for every student throughout the duration of the 5 stages. Focussing in particular on the stage 2 programme (second year of study), this paper discusses concepts of our framework to not only integrate Architectural Design, Architectural Technology and History & Theory within the design studio, but also, from a teaching perspective, the integration of pedagogic theory into the design of teaching strategies and practices.

Why do we see so much potential in the use of pedagogic theory in architectural education, when the original model has delivered successful outcomes for many years?

The motivations displayed by our students for studying architecture in the majority of cases are of a social, achievement or extrinsic nature, which often is reflected in their work that does not display enough depth in thinking and exploring. Pedagogic theory provided us with a framework and methods to enrich learning activities and gave us an understanding of where we could make our teaching more effective to nurture a more intrinsic approach to studying architecture.

Besides increasing in number, our students come from numerous nationalities and various backgrounds, bringing unique and diverse skill sets and knowledge levels into the school. Most of them have just left secondary education and in most cases have also left their home environment for the first time, the place where decisions were made mainly by the parental side. From here they are suddenly thrown into a new world in which they have to make decisions for themselves independently, a new world where they are confronted with strange rituals, i.e. the 'crit', the review, etc. Additionally, students new to architecture face the mystery of the existence of numerous solutions to a design task. They are expected to make critical choices on complex issues right from the start, choices involving decisions based on non-existent or very limited experience and very little knowledge about the topic; and all together time-managed to be handed in before the famous 'deadline'.

My goal as a teacher is that my students are introduced to the world of architecture, and develop a passion and an intrinsic motivation that makes them study and work more independently. Pedagogic theory has allowed us to fine-tune teaching and learning at the MSA. It has broadened and enhanced the experience for the students as the design of the stage 2 programme has been heavily influenced by 'How students learn'.

The main principles we considered in the development of the year content is based on John Biggs' 'constructive alignment' theory, a bottom-up approach, and the advantages of his SOLO taxonomy (Structure of Observed Learning Outcome), a framework for understanding[1]. Furthermore our teaching practice has been informed by theories of active, problem-based learning and the science behind the creation of knowledge. The aim is to motivate every student to take an active role, as activity generates outcome, experience and, therefore, knowledge. Our teaching content does not try to cover everything. We offer a small surface and encourage a deep investigation.

How have we adapted our programme?

Students of stage 2 are not only exposed to subjectivity and speculation, but kept active by testing their ideas and theories through 'making' things, all of which in return is assessed and reflected upon by the students themselves with us teachers facilitating the session. The full cyclic structure of this method allows for a socially amplified feedback from their own peers, and they have learned how to judge certain levels of performance.

MSA's stage 2 programme requires experimentation and the studio is the laboratory for this. It is the centre of thought and creation, a workplace and springboard. We also make use of the advantage from incoming students' different skill levels, ideas and knowledge by supporting communication amongst students and teachers. As an example, over several years, every stage in the undergraduate programme has provided a summer project for the duration of the students' summer pause, of course on a voluntary basis. But surprisingly almost every student has something to show when they come back at the beginning of the new season. The immediately staged first pin-up session provides an excellent opportunity to introduce the year to students and to open up discussion. This idea is strengthened through discussing the principles of learning and the value of analysis and drawing. Taking away anxieties and pressures that hinder creativity and intrinsic learning has helped the development of independent learning.

Integrating Design, History, Art, Culture, and Society

Design begins with an immediate response which is then developed through an iterative process of experimentation, feedback and reflection, leading to a more developed response.

In stage 2 all architecture starts with activity. Students are asked to design a small two-storey public building to accommodate a self-selected group activity and its support spaces. In several seminars and tutorials we start discussing historical, cultural and technical characteristics relating to activity and architecture. By then, students have selected, filmed and recorded their own group activity (i.e. yoga). To trigger experimentation to strengthen analytical skills we introduce watershed moments of visual culture and discuss their potential influence on architecture. To create an architectural response we ask the students to see and analyse their chosen activity through the lens of these watershed moments. In a series of all-day studio workshops students will experiment with these conceptual frameworks and exercise several spatial explorations. Each of these interpretive and objective assessments is followed by design proposals. The workshop simulates a cyclical process based on trial and error, with error being as valuable as success. The series is concluded with peer reviews, again for the reasons of learning how to determine a level of performance.

The workshop itself is a mechanism to ensure students' process results in a product in a given time period. Staged on selected days of the programme, all stage 2 students work from 10 am to 5 pm within the design studio. The sessions are accompanied by at least three members of staff in the morning and four additional part-time staff in the afternoon. The workshops help to provide the resources for immediate feedback. The 'on demand' nature of the tuition suits the students' varying skill levels and work speeds. They can speak to staff when they need to rather than have to. And it gives us teachers the option of having 'everybody there' so we can quickly call a gathering around a particular example. The workshop turns into a laboratory and nurtures the studio culture; the studio becomes a place where architecture is experienced, discussed and reflected on and where students feel supported but not led.

Integrating Design, Structure and Technology

Design, Structure and Technology have a synergetic relationship in the architectural profession; here is how we have programmed our studio teaching accordingly.
Following the weeks of analysis, research and design and equipped with particular knowledge about their chosen activity, the students then start the design of a small two-storey public building. The process is kicked off with a few group discussion rounds about how to implement the acquired knowledge into a design proposal. This method lends itself to students to open up architectural ideas and make them public matter, achieving a transparency of ideas and thoughts and encouraging deep learning. After students have pinned up and received feedback on their interim proposal, we integrate a study of the structure and the principles of building. This is a challenge for a second year student, but from experience this is a good point within the design process to focus on structure and construction.

In Architectural Technology we want students to understand the principles of 'standing up', 'heat in' and 'water out'. We have questioned the rationale of starting with lectures to induce knowledge followed by integration into the course work or seminars to reflect on lectures. Students in lectures are plagued by two things, first to listen and comprehend, followed by writing down the gist of it. We have experimented with doing it the opposite way, the experience coming first so that the lecture can be followed, understood and recorded. So far we have had positive results in greater understanding throughout and better attendance in lectures.

Summary

We as a school believe in the importance of integration. The simulation of a real work place in the studio grounds the students' experience close to reality. The ethos and structure of the school allow collaboration and alignment with the other departments based on the simple principle of taking studio work, including teaching staff, into lectures and bringing lectures into the studio.

We believe the studio is the place where integration works best. The school sees the studio as a 'test bed' for ideas to develop. It has a crucial part in supporting student learning providing a cohort of experiences, knowledge, views and opinions waiting to be exploited. The studio also fulfils an important social function. Out of our experience, students operating within a social network of people who have the same 'destiny', workload and concerns are encouraged to move out of their comfort zone, look beyond the 'cut and dried' and extend their abilities.

The selection of appropriate teaching methods contributes equally to a successful outcome as having clear and transparent objectives, learning outcomes and assessment criteria. Pedagogic theory informed a more effective alignment between students, staff, programme and context, but has also encouraged us as staff to continuously monitor and refine the existing programme within stage 2. Our experiences provided us with a structure or model for integration of the duality of architectural education. The outcomes from this academic season compared with last year's submissions are showing a much broader spectrum and depth in process and analysis, a clear improvement of the levels of the overall cognitive performance and the communication of design and analytical skills.

Note

1 Biggs, J. (2003) *Teaching for Quality Learning at University*. Maidenhead: Open University Press

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Graduation Thesis: Synthesis of an academic path or first step towards the profession?

First, I have to make an introduction.

We're here, in this workshop, to discuss about disciplinary integration; architectural design teachers and construction teachers are invited, so I suppose the first type of integration to discuss is that between these two disciplines, architectural design and construction.

Actually, in the construction group we have different teachers, some are structural engineering teachers, others, like me, technology teachers.

My thought in this short communication is focused on technology teaching and I'm not sure my remarks could refer to other teaching; moreover, it is probably influenced by what the technology teaching is in Italy.

In my opinion, it's impossible to talk about architectural design and technology disciplines separately in architectural work; design doesn't exist without technology, and vice-versa, if we are thinking about the architect as a professional[1]. Maybe we have to decide if we're talking about *disciplines* or about *disciplinary sectors.*

Both disciplinary sectors, in Italy, develop their own research subjects and these are really different, but if we refer directly to the written workshop program probably these two disciplines begin to converge, quoting the program: *"Architectural education shall be structured to assure the public that when an architect is engaged to perform professional services, she or he has met acceptable standards enabling proper performance of those services"* .

This a crucial point: are we speaking about teaching to form professionals or to form architecture graduates? That is: has the architecture graduate to be ready to be a professional? We heard different opinions during the workshop.

Disciplinary integration is, anyway, very important, because architecture as a profession is a multidisciplinary issue.

Anyway, is it always true that didactical activities, managed in separated modules, push students into trouble?

Frequently, if not well guided, it is true that students don't understand the utility of scientific disciplines. But regarding architectural design and technology disciplines, students are often obliged to face the same issue: what is the difference? Maybe it's "only" the approach.

This is why I think collaboration between these two disciplines is very difficult. Collaboration can exist only working as equals, without an ancillary connection.

So, in a University system where the integration of disciplines is not supported frequently, a graduation thesis really could be the only chance to make a synthesis of different knowledge acquired by students.

This, however, can occur in different ways and with different approaches.

Among many frequent topics, in Italian architecture University schools, there's one about how teaching has to be, general or specialist, academic or professional; the question is: who is the architect coming out from Italian University, even if, his/her studies are obviously based on European shared principles?

The graduation thesis is often considered as the last chance to have a *free* design experience, *free* from the reality constraints, *free* from contextual ties, very often considered sad, frustrating, depressing, as to face physical and normative context could cause a loss of *talent*.

Of course, true research architecture composition works are very interesting but they're very rare.

There is, instead, an increasing demand from students to face reality that will be the main part of their future professional life.

Among the more interesting issues certainly there is a preferred link between architecture and the environment in its multifaceted nature: material resources recourse, energy efficiency, interaction between architecture and nature, and so on.

The realistic context in which we work is very important and it becomes the main reference.

How could we, otherwise, talk about the environment without having one?

But this is the focus: how much the thesis will have to be similar to a professional work and what is the degree of freedom to consider?

How to move among multi-disciplinarity and trans-disciplinarity with supervisors coming from other disciplines? Are students able to discuss problems with them, often speaking another language (and we, are we able to too?).

I don't know the answer but I'll show what I mean.

In order for a graduation thesis to be both an academic path synthesis and a first step towards the professional world, there has to be an affirmation of a trans-disciplinary activity into a multi-disciplinary context.

To illustrate my thought I'll refer to three examples of different graduation works, all faced by a homogeneous approach.

There's a debate about the trans-scalarity approach and there are divergences, especially in my disciplinary sector, but sustainable development is a systemic issue and I think it has to be faced at different scales.

The thread running through graduation works is the analysis of the relation between design activity and use of natural sources, that's the main subject I' m concerned with.

There are recurring elements that are fundamental to define graduation work as a transition between the academic world and the professional one:

- definition of a real design context, with realistic limits, coming from the territory transformation observation;
- context analysis, from a physical point of view, that is: climatic, morphological etc. and normative viewpoint that is: technical, of town-planning etc.;
- students are pushed to propose their own vision, their own way to face the cultural context, to propose their personal view, without formal or stylistic suggestion;
- links between analysis results and proposal elements.

These elements, in my experience, aren't as obvious as they seem.

These examples were developed at different intervention scales, from settlement layout to architectural and technological detail, all linked by a strong will to integrate disciplines to get good results, but not acting properly, or not always, in an environment of multiple disciplinary sectors.[2]

In Eva Argenta's work, the theme was how to make settlements in the third millennium, how to control a building layout and its effects on the environment and on local resources consumption, depending on different choices, on equal terms of context and aims. Based on data coming from the new city-plan of a coast municipality, foreseeing a new settlement in a complex location, we discussed having good indicators to control main environmental parameters and we decided how to evaluate them, referring to a sort of brief Strategic Environmental Assessment process.

Of course, this process can't generate architecture automatically, maybe we can say *fortunately*. But why was the project submission examined in the municipality office the worst we could imagine, compared with some others drawn up by the student, in terms of soil consumption, excavations, loss of vegetation and so on? Is the architect responsible for controlling the effects on the environment of building design, or not?

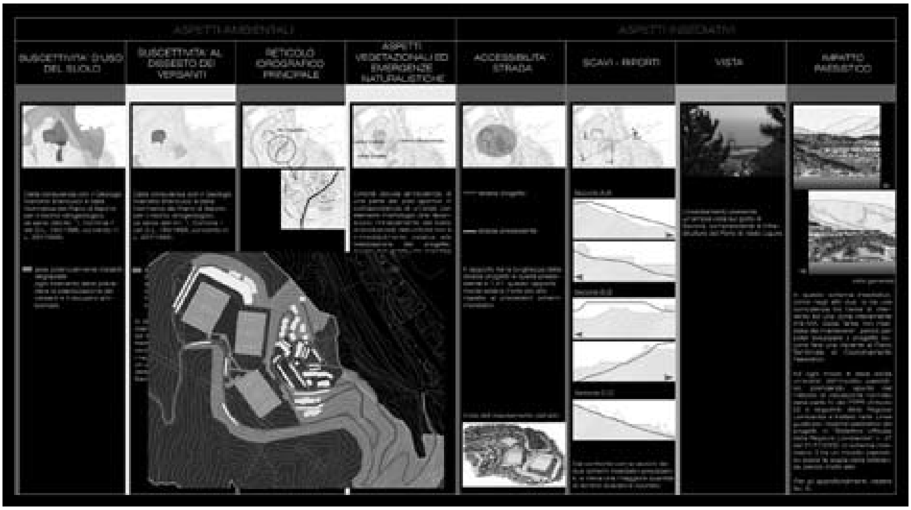

Fig. 1

Professional design, layout evaluation in Eva Argenta's work

Fig. 2

Alternative layouts drawn up by the student

Showing our layouts to the municipality planning office, underlining problems of this area, we did propose thinking about the possibility of reducing the settlement dimension or whether to remove it from the plan.

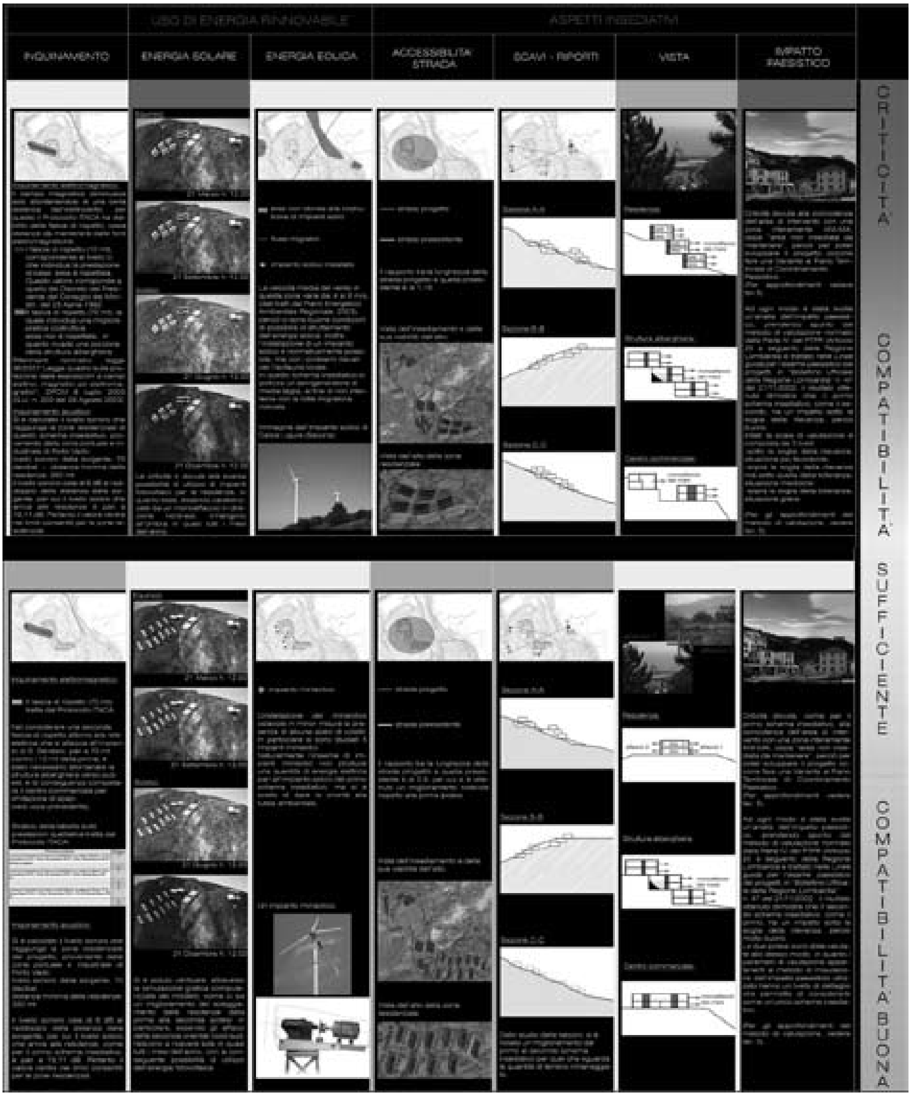

Fig. 3
Evaluation of student's layouts: becoming "greener"

In the second example - the students were Giacomo Cassinelli with Silvia Aresca and Federica De Negri – the analysis process, faced at a different scale, led to drawing up a regulation set to orient as correctly as possible the architectural design and the building phase. Also in this case we begin analyzing local physical and normative data, trying not to criticize administration choices but getting a proper interpretation to have as small an impact as possible on local resources, that is, acting like professionals but with great environmental consciousness. This regulation set led to two different architectural projects, both characterized by a good coherence to analysis results. To manage a hinterland site, almost countryside in this case, means also to be able to control natural values (for instance the presence of vegetal and animal species of scientific interest) and to know when it is necessary to get help from natural scientists.

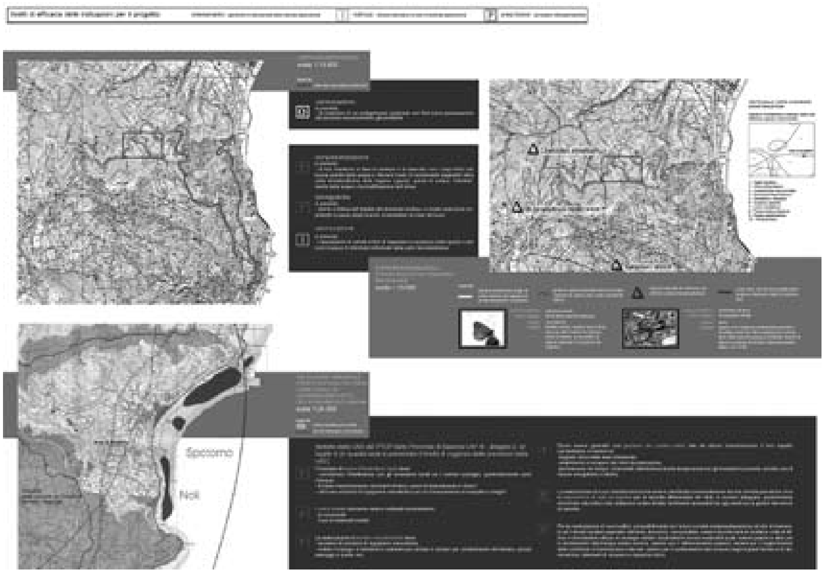

Fig. 4
One of the analysis boards in Cassinelli, Aresca, De Negri work

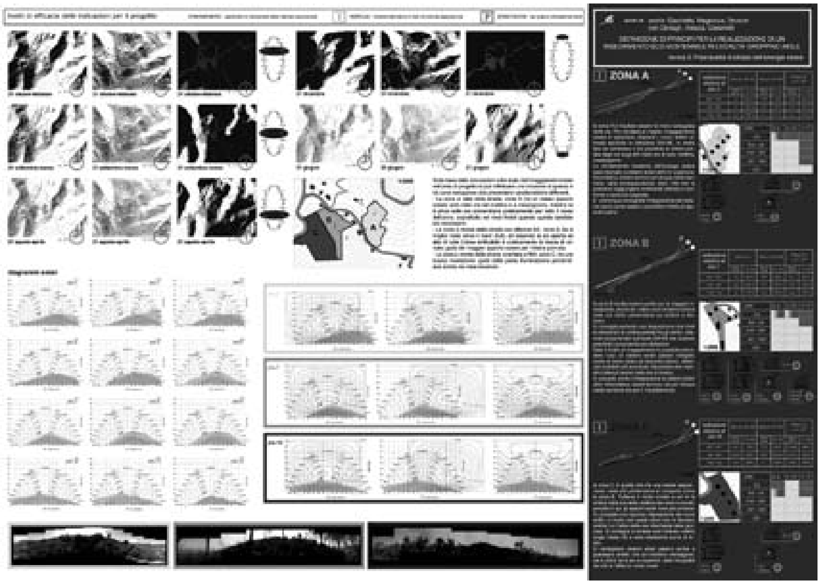

Fig. 5
One of the analysis boards

From an aesthetic point of view, the two projects are completely different, because the two student groups had different ideas about the way to settle in this location, a steep green site with a good view of the sea, towards the north-east orientation, with a problem of harmonizing sun exposure and landscape view. I didn't impose any "poetics", any style, I only acted as a guide among the complex worlds of technology, town-planning, physics and so on, using designer tools to understand better (for instance, software to control hygrothermal performance of building envelope elements and so on), explaining the need to get help from specialists without losing architecture control.

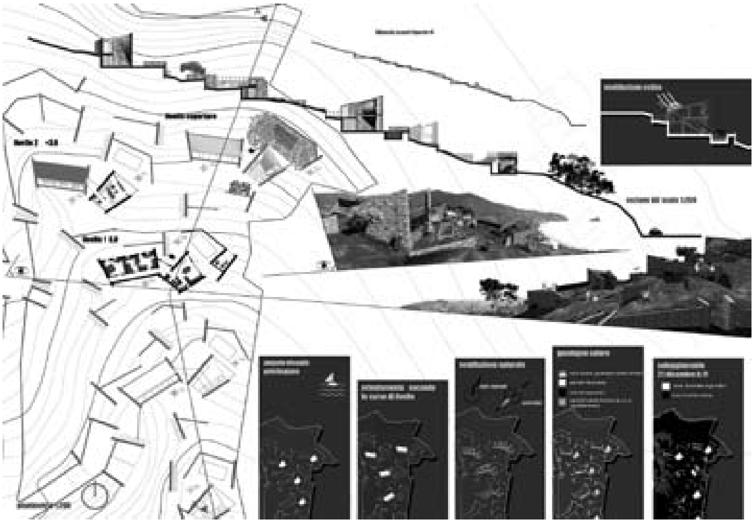

Fig. 6

One of the first students group's architectural design boards

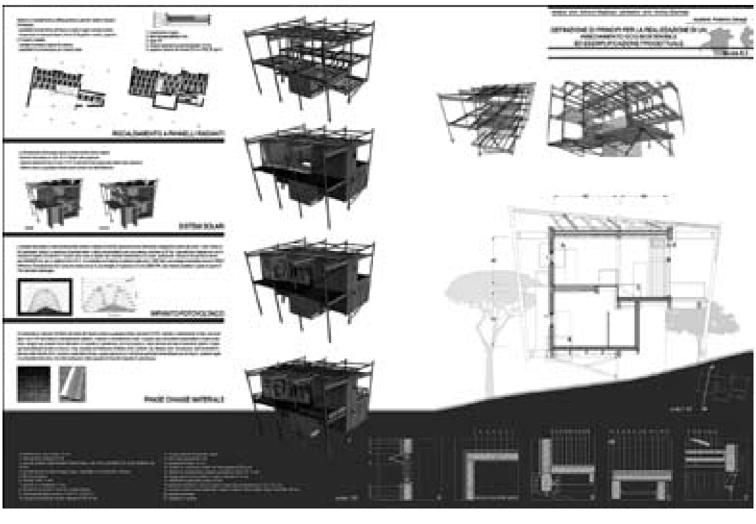

Fig. 7

One of the second students group's architectural design boards

The third work by Valeria Arena is a research centre with dwellings for the staff, in an old abandoned quarry. This area is part of a site protected by the European Directive Habitat (there are some particular amphibians) and it is declared as a building-plot only for this goal. The student was incited by the particular natural and geological values of the site, acquired through the analysis of specialists documents. Both location and use were a great challenge, and the project was divided into two, with a part I call the "earthy" part, strictly linked to the ground, and the other part I call the "airy" part, organized as a sort of forest of tree houses, but with the aim of scientific comparison among different technological packs on a recurrent simple shape. I think this is a good way to marry technology and design composition concepts.

Fig. 8
The forest of "cube-tree-houses" in Valeria Arena's work

I am not a "one-man-band" supervisor. Very often I need specialists to carry on my job. In the graduation work of Francesca Filoramo and Filippo Gulotta, the energetic and functional renewal of a hospital pavilion, for instance, I oversaw the work together with a building health teacher (Prof. P. Orlando) and a renewable energy systems teacher (ing E. Cattaneo), besides the ward manager and the hospital technical office manager, because of the complexity of the activities and special competences to be hosted in the building.

I'm only explaining how I try to show students how deep the control on the architectural design could be. I think each of these graduation works has been a great effort to get architectural design to be an expression of disciplinary interaction, even sometimes in the absence of a co-tutor from other disciplines.

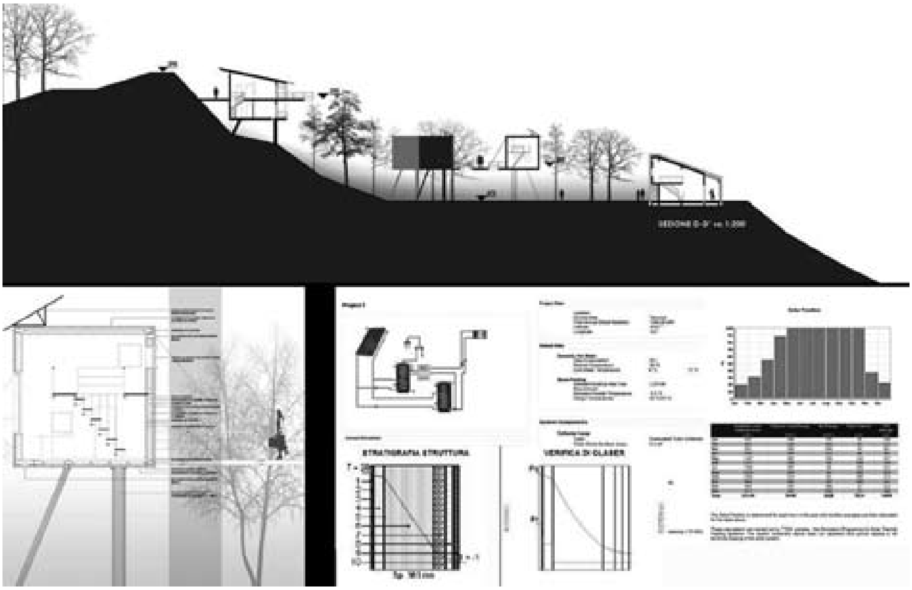

Fig. 9
One of 6 different technology-packs

Specialist contributions are required, yet students have to be the main cultural values bearers expressed in the formal design definition: the integration of disciplines happens in design.

Notes

1 But this does not mean that an architecture graduate is a professional.

2 All theses were supervised, by me, and by my friend Andrea Giachetta, lecturer in Bioclimatic Design, in Genoa Architecture Faculty.

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The Influence of Learning Methodologies on the Understanding of Architectural Technologies

Introduction

This work began as some kind of assessment of how construction should be learned and why. Thus, the exercise described is directly related to this assessment, and its relevance should be understood only within it. We think construction should be integrated in architectural studies as part of a whole, and therefore we played with the idea of using a particular material to convey the student's volumetric intentions. The focus was put not simply on using the student's knowledge on a material and its assembly to express a conceptual intention, but mainly on the tools used to explore and convey this intention. Our main concern was the relationship between a learning tool and the understanding of technologies, more accurately, the understanding of assembly.

Over the course of two weeks during the academic year 2008/09, two groups of students in the technology studio explored the same theme through the same short exercise. In each school, half of the students explored this theme by means of model-making only, and the other half of the students explored it through graphic-expression only. Timber was chosen as the material to use and explore: this material being easy to work with, timber allows the students to sense materiality and establish a close relationship with it. In order to draw valid conclusions from the study, the students completed a multiple-choice test prior to commencing the workshop [Table 1]. Answers to this questionnaire helped in determining knowledge or awareness of the student on the material, experience of the student of different means of expression, etc. The students were also asked to complete a second multiple-choice test after finishing the workshop [Table 2]. This questionnaire offered information on the students' responses to the exercise.

Methodologies applied to Architectural Technologies.

Two groups of students

The exercise was carried out within the third year Technology Studio, which is a compulsory subject of the degree. In both Schools the Technology Studio runs parallel to the studio projects. The duration of the exercise was fourteen hours plus self-study and it was carried out with a staff/student ratio of 2/30. The bibliography included the syllabus, Internet and general library reference literature.

In UCD Architecture's third year programme the emphasis is placed on medium-rise complex public buildings. This includes the introduction to modern building components, construction and structural methods as well as related environmental issues and technologies. In addition, the implications of industrialisation, mass production and design intentions, and the processes of assembly are examined. In the Technology Studio, which is fully integrated with the Architectural Design Studio, exercises are used to facilitate the understanding of the connection between designing and making in the field of architecture. In the third year Architectural Technologies IV and V run for twelve weeks each in the first and second semester respectively. Each week's programme includes a two-hour lecture and four-hour technology studio session. In relation to this particular exercise, in the first year the students were introduced to timber assembly methods and in the second year they were introduced to timber frame construction. [Figure 1]

Table 1

Pre-workshop questionnaire's results

	CESUGA students (%)	UCD students (%)
Students that considered themselves to have a sound knowledge of timber technology, including assembly methods.	3.57	36.66
Students that considered themselves to have a very basic knowledge of timber as a material, and not know much about construction and assembly.	96.43	63.33
Students that considered themselves not to know much about timber	0	0
Students that acknowledged they were very experienced making models, because they found them useful.	28.57	73.33
Students that acknowledged they knew how to make models despite not using them as a tool.	71.43	26.66
Students that acknowledged they made models if they had to although they didn't find them useful.	0	0
Students that acknowledged they knew how to do 3D drawings and found them useful for the design development	57.14	43.33
Students that acknowledged they were able to draw in 3D, but who tend to do it for presentations only.	32.14	53.33
Students that acknowledged they cannot do 3D drawings.	10.71	3.33
Students with some pre-experience in model making before studying Architecture	21.43	30
Students without any pre-experience in model making before studying Architecture	78.57	70
Students with 1 to 2 years of pre-experience in model making.	7.14	16.66
Students with 2 to 3 years of pre-experience in model making.	3.57	10
Students with 3 to 4 years of pre-experience in model making.	3.57	0
Students with more than 4 years pre-experience in model making.	7.14	3.33
Students that considered 2D drawings to be the main design tool and rarely used other means of expression.	0	3.33
Students that considered 2D drawings to be a design tool that needs to be complemented with others, such as models or 3D drawings.	100	93.33
Students that considered 2D drawings not to be the most useful tool, and considered that design could be done without using them.	0	3.33

Table 2

Post-workshop questionnaire's results

	CESUGA students (%)		UCD students (%)	
	G	M	G	M
Students who considered themselves able to explore the assembly methods of the material and learned from it	35.71	71.43	23.08	35.29
Students who thought they had worked with timber assembly, but were not sure about what they had learned	35.71	28.57	23.08	29.41
Students who thought their knowledge on timber assembly was the same as before	28.57	0	53.85	35.29
Students who felt comfortable using the tool they were asked to as a design tool	57.14	64.29	30.77	94.12
Students who felt comfortable using the tool they were asked to, although they would have preferred to use the other group's tool	35.71	35.71	69.23	0
Students who didn't feel comfortable using the tool they were asked to and thought they would have learned more about the material using the other one	7.14	0	0	5.88
Students who believed their model making experience in the last two years helped in the exercise	57.14	100	46.15	94.12
Students who believed their model making experience in the last two years did not help in the exercise	42.86	0	53.85	5.88
Students that rated this help with 1 (high) out of 5	7.14	7.14	0	17.65
Students that rated this help with 2 out of 5	0	42.86	0	29.41
Students that rated this help with 3 out of 5	35.71	21.43	30.77	41.18
Students that rated this help with 4 out of 5	14.28	28.57	15.38	5.88
Students that rated this help with 5 (low) out of 5	0	0	0	0
Students who thought that this exercise could help in the near future to understand materials	85.71	100	92.31	70.59
Students who thought that this exercise would not help in the near future to understand materials	14.29	0	7.69	29.41
Students that rated this help with 1 (high) out of 5	0	0	0	5.88
Students that rated this help with 2 out of 5	0	21.43	7.69	11.76
Students that rated this help with 3 out of 5	42.86	71.43	53.85	23.53
Students that rated this help with 4 out of 5	28.57	7.14	30.77	23.53
Students that rated this help with 5 (low) out of 5	14.29	0	0	5.88

Fig. 1
Students working at UCD. Photo: D. P. Sudhershan

Fig. 2
Students working at CESUGA. Photo: D.P. Sudhershan

The students in CESUGA follow the UCD's Architecture programme of studies with some variations imposed by requirements from the Spanish Government directions. The students in third year have, as a reference lecture course, *Building Technology 3* that runs for twenty-three weeks and includes two-hour weekly lectures plus specific weekly exercises in the studio. *Building Technology 3* looks at concrete, steel and timber structural-constructive systems, but timber systems are looked at in the final part of the lecture series. That means that at the time of this workshop, the Year 3 lecture series on timber technology had not taken place yet. However, in Year 1 they had the chance to learn the basic of timber assembly and timber frame structures in *Building Technology 1*. [Figure 2]

The exercise and its development

The exercise was entitled *Construction of volume relations in wood* and required the students to work with the presence of a material (timber), with its plastic reality, with volumes and with surfaces, finally proposing the composition of volumes that best expressed their intellectual and sensorial relation with the material. All this had to be achieved with the essential prerequisite of not using any other joining material apart from wood. The total number of students in each school was divided by two: half of the students worked individually using only models as a working tool, and the other half worked individually using graphic expression only as a design tool. [Figure 3, 4]

The outcome or output to be delivered by the students depended on the group. If they were working with models [M] they had to submit one model of 30 x 30 x 30 cm maximum. The model had to be made out of wood, but they could choose the type of wood (balsa wood, wood studs, boards…) and they were not to use any other assembly material (glue, nails, screws, etc…). [Figure 5, Figure 6]

If they were using graphic expression only [G] each student would hand in one hand-drawn A3 sheet showing plans, elevations and axonometric of the composition.

Work review and learning outcome

The work was reviewed by the same tutors and following the same criteria [Table 3].

Conclusion

Once the workshop was completed, and the student work produced by the two groups was reviewed, the outcome exposed various issues. First of all, looking at the results of the pre-workshop questionnaire, we find various differences and similarities between both groups. When they were asked to assess their own knowledge of the material, the UCD students felt more confident (36,66% considered themselves to have a sound knowledge as opposed to 3,57% in CESUGA); UCD students acknowledged that they were considerably more experienced making models (73,33% said they were very experienced and found them useful as opposed to 28,57% in CESUGA). On the other hand, CESUGA students were a bit more experienced with three-dimensional drawings (57,14% said they could draw in 3D and found that useful as opposed to 43,33% in UCD). Almost all students agreed that 2D drawings were a design tool that needed to be complemented with others, such as 3D drawings or models.

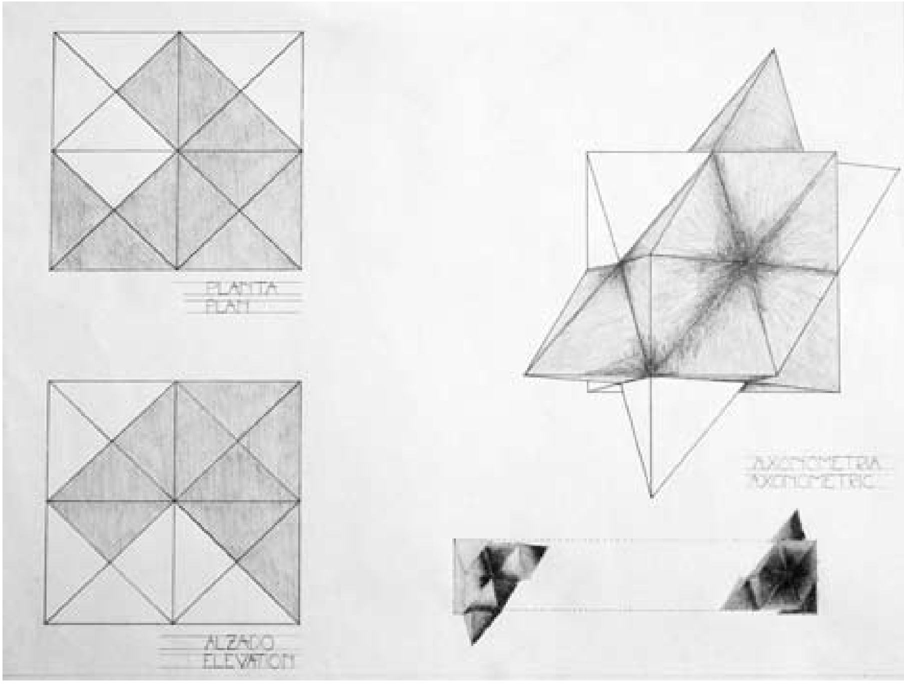

Fig. 3
Pencil study of timber assembly, CESUGA. Photo: D.P. Sudhershan

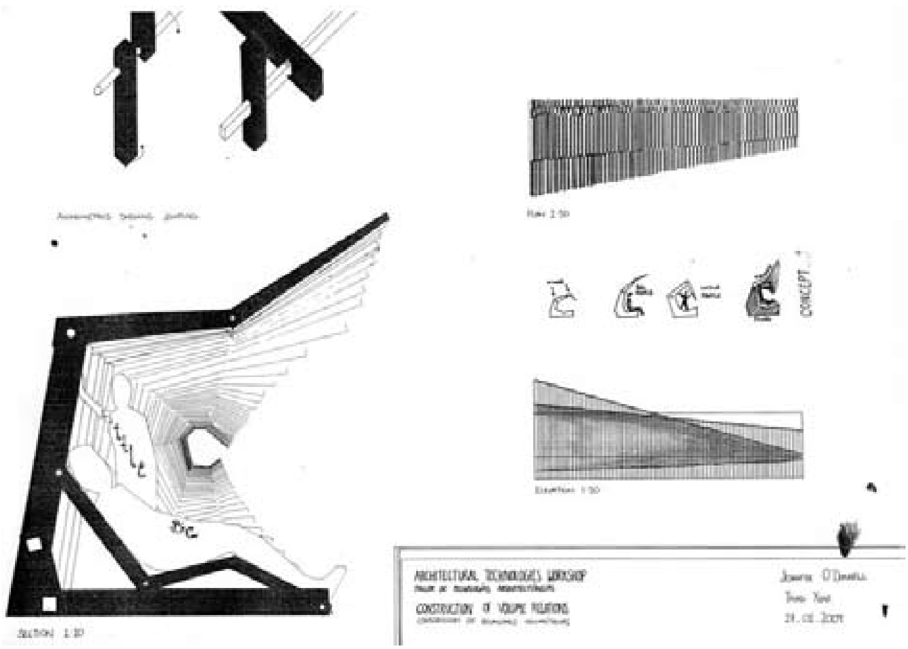

Fig. 4
Pencil study of timber assembly, UCD. Photo: D.P. Sudhershan

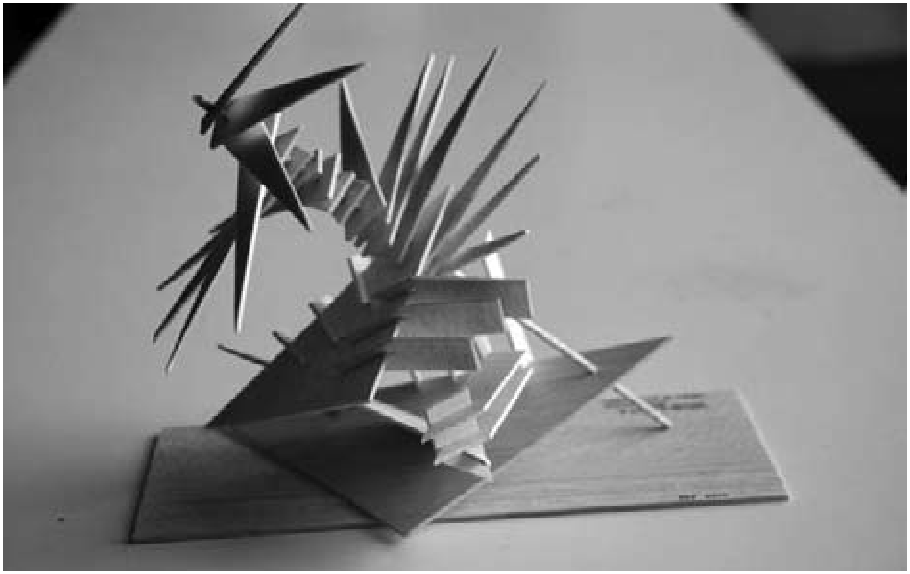

Fig. 5
Assembly model, UCD. Photo: D.P.Sudhershan

Fig. 6
Assembly model, UCD. Photo: D.P.Sudhershan

The post-workshop questionnaire helped to know the students' own perceptions of the achieved result. A high 71,43% of the students working with models [M] in CESUGA thought they were able to explore the assembly and learned from the exercise, as opposed to 35,29% in UCD. However, we find a very different scenario between the students working with graphic tools [G] in both groups: only 35,71% of the students in this group in CESUGA and 23,08% of the students in UCD thought they had learned from the exercise. The students in UCD working with models felt confortable with this tool, since none of them said they would have preferred to use graphic means, in CESUGA however this result was quite different: the same percentage (35,71%) of stu-

Table 3

Work assessment results

	CESUGA students (%)		UCD students (%)	
	G	M	G	M
Students that showed understanding of assembly in their work	85,71	100	61,54	88,24
Students that didn't show understanding of assembly in their work	14,29	0	38,46	11,76
Students that showed a HIGH degree of understanding/complexity of assembly in their work	14,29	28,57	0	23,53
Students that showed a MID degree of understanding/complexity of assembly in their work	42,86	71,43	15,38	41,18
Students that showed a LOW degree of understanding/complexity of assembly in their work	28,57	0	46,15	23,53

dents working with both tools would have changed. Interestingly also, the students in CESUGA that thought the exercise would be more helpful to understand materials in the future were the ones using models (100%), and in UCD they were the ones using graphic means (92,31%)

After looking at the final work we were in a position to draw the following conclusions:

- The students more experienced in making models (UCD) had a slightly lower percentage of success studying assembly through modelling. Therefore we could not draw the conclusion that a higher expertise in model-making will make this methodology more successful as a learning tool.
- The students more experienced in 3D drawings (CESUGA) also had a slightly higher percentage of success studying assembly through modelling.
- All students have a clearly higher level of satisfaction with their own work when using models, although the assessed final work doesn't show such a clear difference with the results achieved through graphic means.
- The students more experienced in using models (UCD) thought they had learned more using graphic means, and the students more experienced in using 3D drawings thought they had learned more using models.
- The workshop showed that students have a higher level of satisfaction and sense of achievement when learning through making (i.e. models as opposed to drawings), although the level of satisfaction does not necessarily relate to the results achieved. Thus, modelling appears to be a teaching method that may increase motivation in applied technologies.
- Also, the exercise showed that when students are asked to use more challenging learning tools, they believe they have achieved a better understanding of the subject of study.

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Architectural Design and Construction - Integration in the Design Studio

The issue of the integration of different fields of knowledge in the design studio is one of the most complex problems facing architectural education today. In relation to construction aspects, this problem is further exacerbated for various reasons. In the current situation, ensuring that construction aspects, like other aspects such as social, cultural, economic, and others, become an integral part of the design process is essential. This article focuses on the development of a methodological approach in order to improve the level of integration of different aspects and especially the construction aspects in the design studio. It includes an introduction about design studio and construction, later a general model for the design process is introduced and later an application of this model in relation to construction is introduced.

Architectural studies, design studio and construction

Architectural studies through out the world have different versions and features. Many schools of architecture have their specific way of teaching and each one of them has a unique identity. In spite of this worldwide diversity, it is possible to distinguish that most, if not all, architectural schools have a structure in which the design studio is located at the core of the studies. Surrounding this core there are usually specific courses which, in general, have to be integrated in the design studio. But in reality, in many cases, there are difficulties which prevent the existence of a high level of integration of different aspects in the design process, especially construction aspects. It is possible to say that this problem has a world wide scale.

Because of this complexity, the integration of construction aspects in the design studio cannot be a one-step process. A multi-dimensional action, which includes different steps as part of a comprehensive and holistic approach, is required. These steps are comprised of different actions, such as the creation of a positive climate for construction studies and the improvement of teaching skills (Mosseri, 2005 (1),(2)) and other actions which have been proposed in the last years in relation to the improvement of teaching construction (for example, Fritz, 2006, Suutaria, 2006. De Bruycker et al. 2008). In this context, one of the most important actions to be undertaken is the improvement of teaching methodologies in the design studio in order to obtain a better integration of construction aspects in the design process.

Dealing with methodologies of the design process in the studio, in relation to the integration problem, requires first noting that one of the main points in the design studio is the diversity of configurations that the design process can get. Different reasons for this can be identified. The design studio includes various kinds of students, where each student has his own way of thinking. There are students who have a more rational and logical approach while others have a more intuitive and emotional one. The same can be said about other polar ways of thinking – deductive versus inductive, scientific versus artistic, bottom – up versus top-down and others.

In addition to this variety of students' ways of thinking, there are cases where it is essential to work with different ways of thinking (without any connection to the student's personal way of thinking). In many cases the specific context of the project, or the site, requires a specific way of design. In few cases there can be even a need to

work in parallel as a design strategy – a fact that can amplify the non-uniform character of the design process.
Moreover, in many cases there can be different opening points at the beginning of the design process. There are students who begin with the site and the place while others can begin with a specific issue, not necessarily connected to specific site or place.

In these ill-defined, flexible and non systematic circumstances, with so many ways of design, in addition to other circumstances like: difficulties to relate to a large gamut of aspects, the complexity of the design process, bias and cognitive dissonance, lack of awareness and other reasons, there can be cases where relevant aspects, including the construction aspects, will be neglected. Thus, in this situation there is a necessity for a more systematic means to ensure that all the relevant aspects, including the construction aspects, will not be neglected. Dealing with these aspects requires first to characterize a general model for the design process, which is proposed in the next paragraphs.

A general model for design process in the design studio

The general model is based on the assumption that the design process in the studio must ensure a flexible and open process that can allow students to express themselves and act according to their own way of thinking (using various tools, both traditional and more advanced). In addition to this, the design process has to ensure the exposure of every student to other, alternative methods of design.

On the other hand, in spite of the freedom and flexibility that have to be in the process, it is necessary to ensure that students will really relate to different aspects, including the construction aspects and their implications, which can be neglected.

Accordingly, the suggested model has two main elements:

a. A flexible and multi tracks design.
b. A control points system.

These two main elements of the suggested design process are introduced largely in the next paragraphs.

Flexible and multi tracks design

In spite of the fact that the design process can have many configurations, it is possible to identify different typical phases which can act as milestones in the design process:

a. design problem or starting point
b. analysis
c. synthesis
d. evaluation
e. final design
f. manufacturing

According to the assumption that the design process has to be flexible, these stages do not necessarily have to appear in one way or in a linear manner. Feedbacks and loops can appear in a cyclic pattern to allow checking assumptions, improvements and upgrading of the architectural creation during a dynamic and evolutionary design process. It is also possible that the design process will not have a rigid sequence. For example, the analysis phase does not necessarily have to appear before the synthesis phase. It is possible to have synthetic thoughts and later to make an analysis. Moreover, the whole process can take place in parallel. For example, it is possible to deal with synthesis in parallel to analysis, but the main important point is that all the phases of the design exist at the end of the process.

During the different stages of the design process it is important to allow the student to use different methods. There can be many classifications of these methods but in this case they are classified into two main groups (in spite of the fact that the borders between these two groups are not always clear): a) rational methods, b) intuitive and emotional methods.

These methods can appear in each one of the stages of the design process in a large gamut of possibilities.

Rational methods

The rational methods are, in general, more logical, well organized, systematic, and they can appear in each one of the design phases. In the analysis phase, which in general is more analytical and mainly oriented towards investigation and studies of relevant aspects, usually organized as a set of different parameters, the use of the rational methods can be done mainly in relation to the site or in relation to the subject of the project. It can include systematic site analysis, future forecasting methods (for the analysis of the future environments) etc. In the synthesis phase which is more creative, imaginative and with an open-ended character, it is also possible to use freely different rational methods. Between the synthetic methods it is possible to find digital form generation tools, conceptual tools, strategic planning methods (vision of the future), targets as an outcome of problem analysis. In the evaluation phase the rational methods can include a set of parameters, when each one of the parameters can get a value after evaluation.

Intuitive and emotional methods

The intuitive and emotional methods use mainly the non rational thinking in the design process. In parallel to the rational methods they can enrich them and add more options and possibilities to the design process. As for the rational methods, the intuitive methods can also be used in the different phases of the design. In the analysis phase they can include emotional mapping and other methods which can be useful mainly for site analysis and subject analysis. In the synthesis phase these methods can include brain storming methods, synthetic free-hand sketches, analogies, etc. In the evaluation process the intuitive and emotional mapping can use holistic evaluation – gestalt- in contrary to systematic and parametric evaluation which is more analytical and rational.

A control points system

In parallel to the flexible and free design process, using intuitive and rational methods, it is important to ensure that different relevant aspects are not neglected in this process. For this reason a control points system - CPS - is suggested. This mechanism is a set of systematic and obligatory points that each student has to pass through, and check his attitude in relation to different aspects – social, environmental, economical and construction aspects. This mechanism can get different configurations including the configuration of an organized and systematic checklist. This checklist can be an outcome of mapping the different fields of knowledge in architecture, when each field can be divided into subfields. The relation to each one of the fields can be on the functional level or on the aesthetic and visual level. Normally the different control points will be located in correlation with the design phases, which were mentioned above. This control point system can verify that different aspects, including the construction aspects, will actually be included in the design process.

At each control point a set of relevant systematic questions or criteria can be prepared to be answered by each student. It is important to stress that the set of questions or criteria is a dynamic and evolutionary body that can be updated and reexamined along the design process. It is also possible to fix the control points to a time schedule – a fact that can improve the time management of the design process.

In the design problem phase or at the starting point the questions have to identify the strategic targets and the relevant issues that have to be analyzed in the analysis stage. In this stage the main efforts have to focus on checking if all the issues which were identified at the starting point have been covered and if the analysis gives the necessary knowledge for the next stage. Also at this stage there is a necessity to determine the methods which will be used in the next stage. At the synthesis stage the target is to check if all the relevant methods and tools, rational and intuitive, were used and if it was done in a proper way. In the evaluation stage the main issue is to evaluate the outcome of the design process.

The construction aspects and the design process

The construction aspects have to be included as an integral issue along all the design process which was introduced above. The attitude towards these aspects can get many configurations. From a configuration in which the construction aspects are the form generators and the leading forces of the architectural creation to a situation in which these aspects are relatively less effective and even neglected. The role of the control points mechanism is to ensure that the free process truly relates to these aspects, as part of other aspects. In order to have a systematic control of the construction aspects in the control points mechanism, a division of the construction field into the following main subfields is suggested: structural design, environmental control (climatic design, acoustics, lighting etc.), technology (materials, construction methods, building details), morphology-geometry and others. For each subfield a checklist can be written as a part of the control points system. In the next paragraphs an example of the control points system in relation to construction is brought.

Design problem stage – starting point

In this stage, which, in most cases, can be considered as the starting point of the design process, the attention can be focused on the connection between the design problem and different construction aspects. The main task is to provoke questions and issues which are relevant to the connection between construction aspects and the subject of the project, the site or any other issue. For example: what are the structural targets of the project? What are the climatic design aspects? What are the relevant structural aspects?, and other relevant questions.

Analysis stage

In this stage, which has to deal with profound research and studies, the main focus in relation to construction has to check if the analysis really relates to the construction aspects or if they were neglected. Did the issues or the questions which were identified really take place and what knowledge was achieved? For example: is there enough knowledge about the structural characteristics of the project (high building, wide span etc.), about the climatic design, acoustics and other aspects. Are there profound conclusions and reasoning about the implications of this information about the project or the site?

Synthesis stage

In this stage, which is creative, imaginative and usually concentrates on strategic vision, targets, design guidelines etc., the relation to the construction aspects has to ensure that all the relevant methods and tools, rational and intuitive, were used in a proper way. For example: were the construction aspects indicted in relation to their visual expression? Or to their functional expression? Were all the construction variables or the construction options used?

Evaluation stage

In this stage the focus in relation to the construction aspects is on their implication and influence on the final solution. For example: what is the level of integration of the construction aspects, in parallel to other aspects, in the final result? Were the construction targets achieved or not?

Conclusions and future directions

The design methodology which was introduced in the above paragraphs includes mainly two elements which can complete each other – flexibility in the design process versus control and balances which have to ensure the awareness to and integration of construction aspects. This methodology is part of larger efforts which are aimed at improving the integration of the construction aspects in the design process. This methodology has to be investigated further on and developed using empirical tests. It is important to note that these efforts have to be continued in parallel to other efforts in other issues of the integration problem.

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The Moleskine Notebook and the Ugly "Studentling"

This is a tale of an architecture student, *The Ugly Studentling* I will call him. A student that lived in a Hans Christian Andersen tale (*The Ugly Duckling*) and like that little "duck" was ostracized by those around him with bad grades and harsh critiques. I have followed his footprints and written the tale that follows.

It was a sunny September morning when he entered the university with blank books under his arm. Architecture students were never mistaken by those of other courses. Artists they were called, as if it was a diminishing term. Artists they felt. It was an art course, as much as it was a technical one. But at the university, something contrasted with the outside world. Analogical thought ruled the teaching of architecture. Teachers required students to draw and to think with the pen, not the mouse.

While he was learning how to control space, teachers were encouraging him to make them bi-dimensional drawings of them on blank pages. Drawings on the screen and models in digital space reproved. But he tried to learn about the new tool available but teachers looked down at him from above, reproving his attitude and he soon felt different from the others. He was regarded as an *Ugly Studentling*, and while those that did what teachers demanded were in front of the class, he was always in that back seat. The *Studentling* tried to fit in, drawing and building models from cardboard.

There were for him two paths, one he wanted to take and one that he *had* to take. Students were supposed to take the path of the Moleskine Notebook.

But Notebooks were now digital and with *touch screen* technology. Everyone had iPhones and iPods. But architecture was to be designed in the white sheets of the Moleskine.

As time passed the *Studentling* tried to follow both paths, one in school, the other at home, alone. Teachers seemed oblivious to this other path, they only knew the Moleskine path. The other path was made of tools the *Studentling* didn't know nor controlled and there was nobody to teach him. In school he was supposed to take the path that would take him to where the teachers were, not where he needed to go. The other path would take him somewhere he didn't know, but where all other professions were going. While it seemed all professions were following a new path, architecture was still following the old one. Everything was becoming technologically advanced, but still architecture teaching didn't move, didn't evolve. At the beginning of the 21st century he found an article by Le Corbusier written in 1921 that explained what he was witnessing.

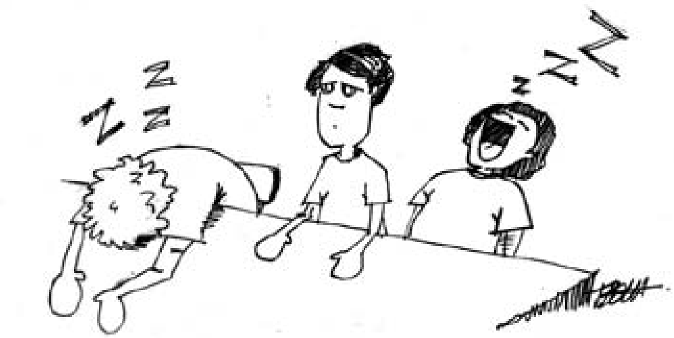
> *"There is one profession and only one, namely architecture, in which progress is not considered necessary, where laziness is enthroned, and in which the reference is always to yesterday.*
> *Everywhere else, taking thought for the morrow is a fever and brings its inevitable solution: if a man does not move forward he becomes bankrupt."*
> (Corbusier, 1986:109)

He was inspired. It seemed nothing had changed in architecture. While cars had air-conditioning and radios, airplanes were carrying more and more people, Atlantic liners were traveling further and faster, while new infra-structures connected cities and countries, architects were looking back to history and standardizing ancient construction elements. It was surprising how similar his time was to the 1920's when Le Corbusier wrote that:

> *"Engineers have been busy with barrages, with bridges, with Atlantic liners, with mines, with railways. Architects have been asleep."*
> (Corbusier, 1986:113)

Teachers were also asleep, but the *Studentling* wanted to wake up. It wasn't until he attended a conference by Peter Eisenman that he understood that this problem wasn't an exception at his school. Everywhere teachers followed traditional teaching methods to teach students that were all but traditional. In a clear message to teachers, Peter Eisenman said "teachers should stop being arrogant". This arrogance made them teach what they knew, not what students needed to learn in today's world.

This made sense for the *Studentling*. Each one should find his own path, his own identity would result in a particular way of seeing and thinking, resulting in a personal methodology that the student should experiment with during the years. But no experimenting was going on, only replicating. Schools were not making architects, they were

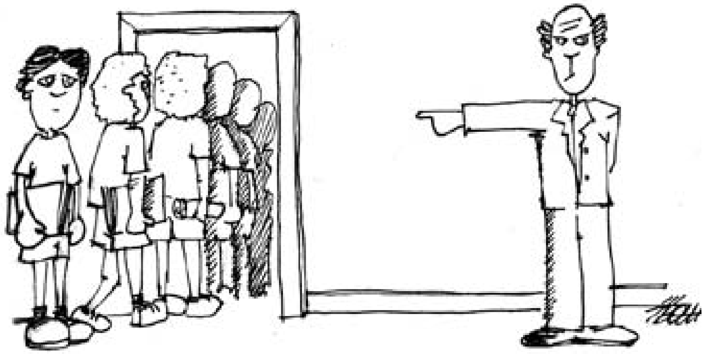


cloning their teachers. He sought his own path and with each step, he seemed further away from the rest of the class. The teacher's vengeance was expressed in grades, but he wasn't afraid. He was searching for his path and no grade would hold him back.

Everyone was following the Mosleskine Notebook path, except him.

Moleskine Notebook Path

The Moleskine Notebook path is here a metaphor for the analogical pursuit of meaning with an intentional alienation of technology and the fear of its alienation of the body. It is used to define a kind of mentality that will not adapt itself, a system that tries to perpetuate itself, considering itself to be the *only way*, in this case, to learn architecture. Although the relation with the pen and paper is surely an important one, it's not the only way to learn about space, but is for sure the *only way* many teachers know how to teach. But it has been said that architecture is never taught, it can only be learned, leaving up to the student the responsibility for what he learns.



It was clear he didn't fit in with the path that was being taken so he tried to find his own. In the classroom technology was banned, while at home it was embraced. He pursued the classic learning methods in school, and alternative ones at home.

Designing in Autocad using lines, arches, circles, was just like drawing by hand, only faster and easier. Accelerating the design process never seemed to be a process approved of by the teachers and this was probably the reason that so many reject the introduction of technology into the teaching system. The *Studentling* felt he was among technophobes, and that these were in charge of preparing him for the future. But a paradox was clear. At the same time his teachers had their own iPhones and iPods, GPS inside their cars, demonstrating their willingness to use technology; inside the classroom their attitude was different. It was like they used that room to free themselves of technology. They were slaves to it everywhere else, inside the classroom they wanted to be free from it. For the *Studentling* the classroom was supposed to be a place where he could feel free but it had an inverse influence, it was a place where he was a slave to the lack of technology. Teachers were obviously in denial, trying to ignore that outside the classroom, technology had transformed every aspect of the social sphere.

But he was not alone. While he read Vitruvius and Alberti's books, he read other books that helped him understand social changes. Architecture is never a quick thing, you mostly design something that will only be used 2, 4, 10 years in the future. It's obvious that architects should always plan for a society that is changing and understand its transformations in order not to build in the Past. This perpetuation of the past in

the classroom contrasted with Virilio's notion of a society in a perpetual present. But the mentality demonstrated inside was expressed on the outside. Hundreds of buildings were as empty as architects and investors spoke of a crisis. But this crisis may not have had its roots in the lack of money, but in the lack of design. Not that buildings were badly designed or built, only that they had been designed for a society that no longer existed.

In some way he had assimilated technology and digital theory, when teachers had advised him against it. Still, they wanted everyone to forget technology and draw by hand. But he wanted to adapt to the Future. He was by definition in a post-modern society, using post-modern tools, trying to design post-modern architecture in a modern school. He was out of place.

Teachers were not only alienating technology, they were alienating him. Just like the Ugly Duckling, the Studentling was ostracized.

Screen Notebook Path

This second Notebook path is also a metaphor but one for the digital pursuit of meaning. It aims to define a mentality that tries to adapt to contemporary methods of communication and work. This is a path that does not consider technology as demonic, but as a new stage of human development and social change. It's the place where technology is understood and used as an extension of the body, as a tool that may improve our adaptation to a fast world. The same way you would not insert a nail into a wall without a hammer, because the hammer exists, this path uses technology as a tool, for the simple reason that it is available. In this path it is understood that we have become technological beings living in a technological world.

The *Studentling* believed that "Technology is always open to poetic appropriation." (Leach, 2000), and counter to what was expressed by teachers, and as Francis Ford Coppola acknowledges, "technology is always an element of creativity, never its source".

If "New conditions breed new ways of thinking" (Leach, 2000) it didn't make sense to impose the Moleskine Path as the only option. Society has always adapted to new tools, and with them, life has evolved to what we now see when we look out the window. Some changes were good, some bad, but if anything has been constant in History is its perpetual *Change*. But at school, the Studentling felt *Change* was in a state of slow motion, never really arriving, always far away. It was something to explore when you left school, not a thing to be taught in school. It was a kind of philosophy that perpetuated what was called "The Cult of the Not Yet" (Coyne, 2002: 45).

But when you say *not yet*, you are really just postponing inevitability. Just as you could not prevent a child from talking while he was interacting with people, you cannot prevent technology becoming a tool in the workplace or the classroom. It's a "join them or leave them" kind of lifestyle that is imposed, only if you leave it, "you go bankrupt", to quote Le Corbusier.

Contemporary digital society has a strong Darwinian expression, either you adapt, or you perish. This was clear for the *Studentling* but didn't seem so for his teachers. The *not yet cult* was clearly developing architects that graduated Not Yet ready for contemporary society. Their lack of readiness was to come as an expression of contemporary society.

Outside the classroom life was different from what the teachers seemed to believe. You'd enter public transport with a chip in your wallet. You no longer needed to take out the card. You'd call to some bank service and you'd talk to machines. GPS in all taxis and mobile phones. Wireless technology, iPhones, iPods, but inside the classroom time stood still. The *Studentling* felt like screaming *iQuit*. Teachers were in some form of *Denial*, intentionally ignoring social changes.

Exploring his Path

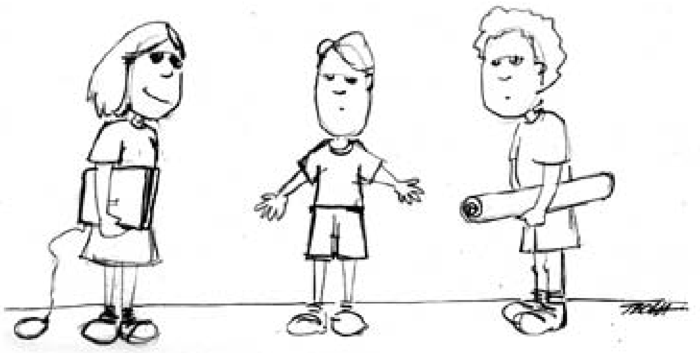
He left for Los Angeles to work with Eric Owen Moss. He found new methodologies, new tools, new methods of thinking, of theorizing space and society. There, geometry as he knew it was dead. Walls were no longer vertical planes, windows were no longer squares, doors were no longer rectangles and architecture was no longer boring. It had been reborn. Space was still space, but involved in a new kind of geometry.

Architecture made sense like that. In contemporary society it didn't make sense to fill the urban landscape with white boxes claiming perfection or purity. Architecture has always been a reflection of its society and contemporary society is anything but pure.

Teachers had been alienating technology at a time when everyone was becoming a technological being. We all were now technological beings, using it as extensions of body and memory. **Alienating technology was in fact a way of alienating everyone.** Teachers were alienating everyone to try and maintain what was once the pure act of architecture. He would not alienate himself. While in the classroom everyone was looking for the *genius loci*, outside the classroom everyone already knew no such thing existed.

Other schools were exploring parametric design, something most teachers wouldn't know anything about. Actually, in many schools, like Sci-arch in Los Angeles, it seemed that students were actually teaching teachers about new technology. How to design using parametric attributes in a way you could interconnect all parts of the building, and connecting them in a way where changing one would change another.

Some schools are on the right path, others are moving away from the objective, to prepare students for their future. The *Studentling* was proud nonetheless. He had not taken the path imposed. He felt free from all ideologies that were dropped on him. He learned architecture, but was not taught about it. He learned how to "Forget Heidegger" (Leach, 2000), forget Keneth Frampton, forget Vitruvius and Bruno Zevi.



Forgetting is just as important as learning; only by cultivating your ignorance can you have a truly original thought. The *Studentling* felt as ignorant as he could be, ready to begin learning everything again.

He looked down at his feet, followed with his gaze the footprints that marked the road he had taken. Proudly, while sitting in front of the screen, he took out his Moleskine Notebook and Using Robert Frost's words wrote:

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a [classroom], and I—
I took the one less traveled by,
And that has made all the difference.[1]

Illustrations by **Tiago Bochecha**

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Flexibility: Architect's Education for the Unknown

Disciplinary integration is like: CONNECTIVE INTELLIGENCE.

Connective Intelligence is *"… an Instrument of exchange which implies the existence of shared context between the one who speaks and the one who listens". The primary and constitutive functions of this intelligence is not to convey alreadi made information but to produce a "common knowledge"* (Silvano Tagliagambe)[1]

You can say, tautologically, that the schools of architecture are designed to educate architects. In a not too far distant past, this statement could have been understood in a quite unequivocal sense.

I believe, on the contrary, that the Faculties of Architecture should not educate architects with a specific professional profile, but should educate persons able to address the "typical" problems in the field of architecture. This approach is quite different.

Even if the definition of the term "architect", throughout history, has been defined in many different ways - the emphasis being put from time to time on anyone among his various skills - the main functions of his professional field seemed to find, however, a commonly accepted core, even if in rather vague terms.

Certainly it has always been less problematic to identify the typical skills of a construction engineer, a mechanical engineer, a chemist, a medical doctor rather than those of an architect. This mainly because the field of science and of technology has always evoked problems of definition less difficult and elusive than those evoked by an area which includes also humanistic culture and art.

In a world currently subject to changes that occur at a dizzying speed, with the creation of confusing splits with history and with experiences of an even recent past, the vagueness of the field of activity of the architect has expanded to a point which requires, from time to time, different definitions.

The weakness of the architect's domain of competence, how it could be easily understood, has (or better, should have) devastating consequences on the educational processes which should be finalized in this direction.

Even if the period has not yet completely concluded in which the educational processes have been divided into thousands of different paths, each one of them aimed to a unique specialist preparation program, in a still confused and uncertain way, the awareness that the separations between decision-making domains may be inadequate and misleading is growing.

This is due to three basic reasons:

- the relationships between the decision-making domains are close and complex, due to the increasing complexity of problems that are no longer solvable through the simplification of the disciplinary specialists;
- the rapid mutations of the instruments and apparatus generate rapid obsolescence of methods, rules and instruments which were effective until recently;
- the unlimited (and unverifiable) availability of information concerning the decision-making processes makes the transmission of the basic knowledge much more complex.

All these elements characterize today the issue of education for human activities and of integration into the world of labour. How are these elements reflected in the educational process of the architect?

How do they affect the schools of architecture?

Holistic and Conceptual Approach versus Manuals

A key aspect of the answers lies in the need for a holistic approach to the complexity of issues, breaking the solitude of the "creator architect" even from the earliest design stages. Even when, for lack of resources and for organizational characteristics unsuitable in our schools, we can not have all the necessary skills, we must act as if they were there, with sporadic but well targeted interventions. Often we have "specialists" in our Faculties, but they are not prepared to come out from their enclosures and to change their approach.

Therefore not an instrumental education flattened on the current professional practice of the moment (also because it is indefinable, broken into a thousand different meanings over time and space).

I think that the higher the level of studies, the less professional it should be.

On the other hand, even at high school level the distinction between technical schools and scientific-cultural schools is this: the first ones prepare (or try to prepare) immediately for a "supposed" profession, the latter tend to provide a basic structure, with a different temporal strategy.

It is more and more necessary to turn to specific teaching modules or types of training for a continuous and specific update of the professional practice, depending on the context where one is working at the "moment". The accumulation of experience is much less likely to be acquired autonomously than in the past, as a mean to achieve a self-acquired ability through many years of work in the same field.

In other words, the instrumental and more transitory part of the professional practices, is acquired autonomously on the field or through short and frequent connections with a continuous learning.

The part connected with "its own" nature of problems related to the built and man-made environment must be gained conceptually, like an attitude to the knowledge and creativity in the problem solving of a wide class of problems. The vagueness of the domain to which it refers can, however, be marked out by some key words, on which it would be interesting to discuss.

Some typical aspects, seemingly trivial to say, but with strong implications for education, come from the fact that all topics of this domain have to do with the *material nature* of architecture (I know that not everyone agrees with this statement despite its apparent banality). This is not the place, here, even if it were useful and interesting to do it, to reflect upon the way of conceiving the figure of the architect (which on the other hand has its historical roots) as a pure creator of abstract forms, etc.

I merely underline that these forms are not very abstract, since they are clearly children of the culture of their time and, in particular, children of a technological culture, much more than the supporters of this "independence of the creator of forms" do not want to admit.

Indeed, the more a form appears independent from its materiality, the more so it implies the omnipotence of materiality. But in this case the task of translating forms into matter lies elsewhere.

However, in this statement there is something true: Giuseppe Morabito[2], states that: *"...it is irrelevant to understand and to study how to make a reinforced concrete floor, while it is crucial to deepen all the ups-and-downs of Alvaro Siza to have Cecil Balmond's design of the great sail over the Portuguese exhibitions pavilion".*

The place at the heart of the training and the educational process must be the *conceptualization* and not only the repertory of examples (among other things inevitably less representative of the possible).

Conceptualization implies *complexity* and a *simultaneous* approach of several different disciplines, where the disciplines leave the boundaries of their specific knowledge in a background level, to face to the *common problem* within a *collective* synthesis.

FAMOUS EXAMPLE OF CONCEPTUALIZATION: DO NOT THINK ABOUT THE ROOF: THINK ABOUT THE RAIN (Rules for those Buildings in the Mountains: Adolf Loos, 1913))

But to reach the conceptualization one should alternate abstraction and experimental application in a circular inductive-deductive pattern.

Learning should be directed mainly to *conceptualization* that is "flexible" in its nature: a concept contains within itself the possibility of abstraction, to "embody" itself in a range of "material" forms that are very different and become real when facing specific aspects of reality.

The conceptualization can and should also benefit from a work of abstraction of the experience of doing (in fact, "learning by doing"), according to a continuous circular process.

Relationship with Information

This is also a source of great complexity:

It seems to be impossible to keep up storing comprehensive knowledge about what it is necessary in order to achieve a conscious decision process.

How to navigate?

a) information about the repertory of materials, processes, products, etc.. "information in bulk"
b) knowledge about the "knowledge" (awareness of different points of view – skills - needed). State of the art in continuous change, availability of single-discipline experts, etc..

In the first case (the "bulk"): obviously the CONCEPTUALIZATION is not suspended in a pneumatic vacuum but, in turn, is nourished by the culture of the time, by history, by media, etc.. All this denies the validity of a training by *manuals*, based substantially on *imitation* and on paradigmatic cases.

I have a great distrust for the "text-books" for architecture students dealing with "roofs", or enclosures-walls, etc., because they run the risk that the student may believe that it could be possible to find the "safe" solution for problems not at all corresponding to a concrete product. If the design is conceived as a system of performances that should match with an idea to be developed in phases, it is necessary to throw oneself into the sea of information, in all its forms (magazines, advertising, real cases, examples coming from other fields, the Internet, etc.), having as a compass the objectives to be pursued.

It can happen, then, that students arrive with lots of pages of useless information taken from the Internet, but, step by step, if they are guided through the network, they learn to grasp what is essential, discerning and finalizing it to their purposes.

In the second case (knowledge of "knowledge"), the way the subject of the classwork is defined is very important, both regarding the decision-making domain, and the "background" conditions, that is, all factors that may affect the choices.

We must clearly denounce all the instrumental simplifications and point out which contributions are essential to face the problem (reasoned bibliographies, targeted meetings with experts, lectures, etc..).

Conditions for "Testing": Teaching with Learning by Doing

I will make some considerations and give some examples of what we do in the courses of the first two years, particularly in design (construction) laboratories where students arrive after having attended a theoretical and propaedeutical course in the first year. The method we use today is the fruit of long experience and of many reflections on the basis of the obtained results.

The architectural construction laboratories are distinguished from those of architectural design because they should be centred on BUILDING (or embodiment) of architecture. Even this distinction is quite schizophrenic and schizophrenia-generating in students (but, in the long run, also in the teachers, I'm afraid, since many successful professionals seem to forget completely the "material" aspects when wearing teachers' coats - preferring abstract "visions" - which do not always carry to conceptualisations).

Basic Conditions For Experimentation:

- To create the conditions (and the design themes) in which the complexity of the problem is explicitly reduced, permits, however, *a complex and overall control of the invention process* (conversely, a very complex design theme runs the risk both of introducing *excessive simplifications* in the search of solutions and of a loss of control of its path by the student, who is likely to be driven by the case and by the attempts);

- These exercises require an understanding of the terms and limits. The introduction of limits, or constraints, often expressed in declared and clear gratuitous terms (as will be seen in the examples), is used to develop *creativity*, which is not meant, here, to be a free and uncontrolled (and uncontrollable) fantasy, but to be the capacity to recognize the nature of the problem and, then, to find an (or several) appropriate solution (even in terms of formal expression);
- The development of the design idea is then considered as a solution of a problem defined in its range of existence, with wide margins of discretionary actions available to each group of students, but within fixed given conditions and with the requirement of "to be shown and told" in its intentions, which then will serve for a critical evaluation (including self-evaluation) and for the discussion during the intermediate and final seminars;
- The project must cover the entire design-construction process and the duration (production-assembly, use and life time management and elimination);
- Use of seminar tests of the students (working in small groups) during which "families" of similar concepts are identified for further investigations. The most important among all of them is the final seminar of verification and discussion of the results, compared with the starting conditions (translation of design intentions);
- The classwork is developed in small groups (two or three students as a maximum) since the potential of a workgroup is the place of many creative contributions that are then compared. But groups must change at any new work theme in order to prevent the making of fixed roles;
- The design themes (usually three or four in a year) increase in difficulty. The last one should be a kind of summary of what has been learned in previous stages;
- At the end of the year all the journey done together is evaluated, putting in discussion all the work done from the beginning of the year.

Disciplinary Integration

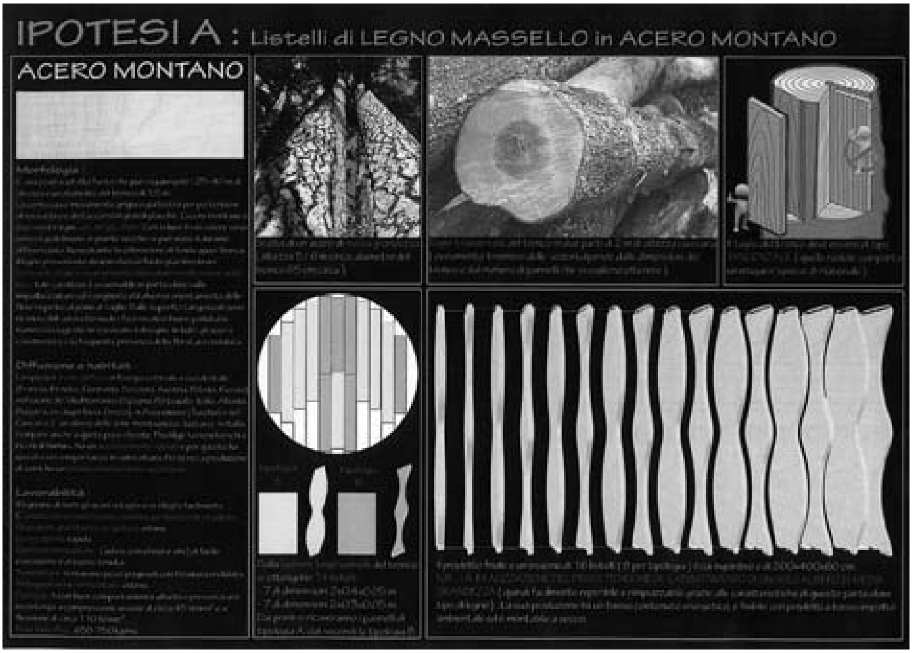
I said that the disciplinary integration is like *connective intelligence*.

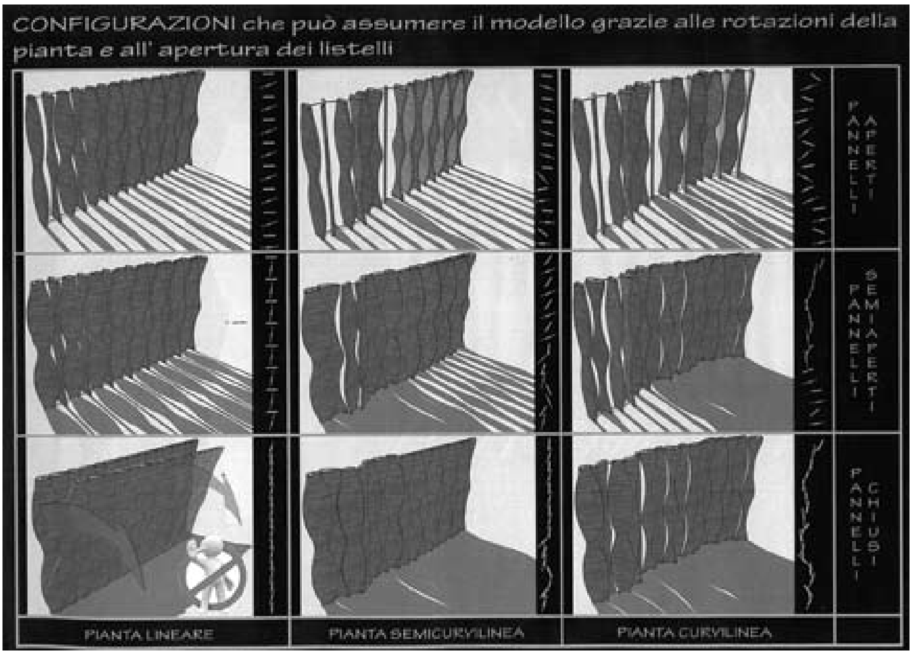
Connective Intelligence is *"… an Instrument of exchange which implies the existence of shared context between the one who speaks and the one who listens. The primary and constitutive functions of this intelligence is not to convey already made information but to produce a Common Knowledge"*

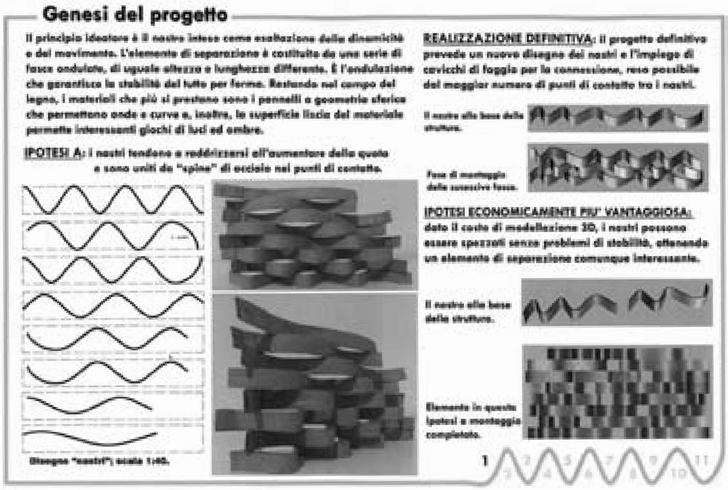
We are interested, in particular, in experiencing the relationship between the area of structural design and the design concept and, moreover, the issue of sustainability extended to the whole life cycle of the object. We then call into question the contributions and skills related to these two particular areas. Other specific contributions depend, more accidentally, on particular choices made by the students in defining their design problems, so that they learn to organize themselves and to build the relationships to be used.

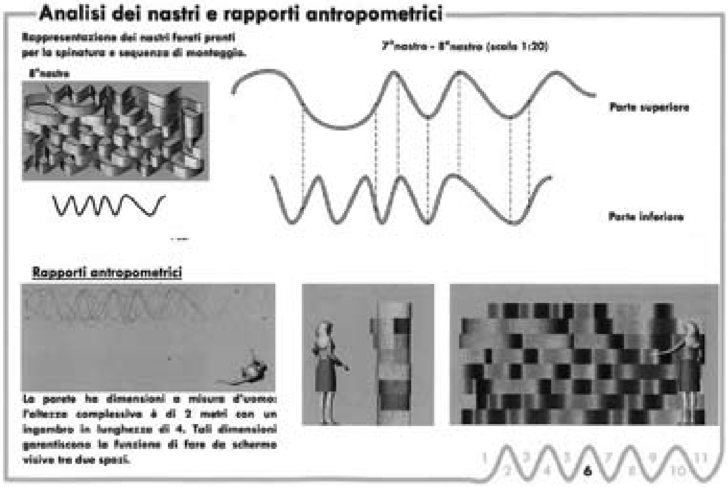
Examples

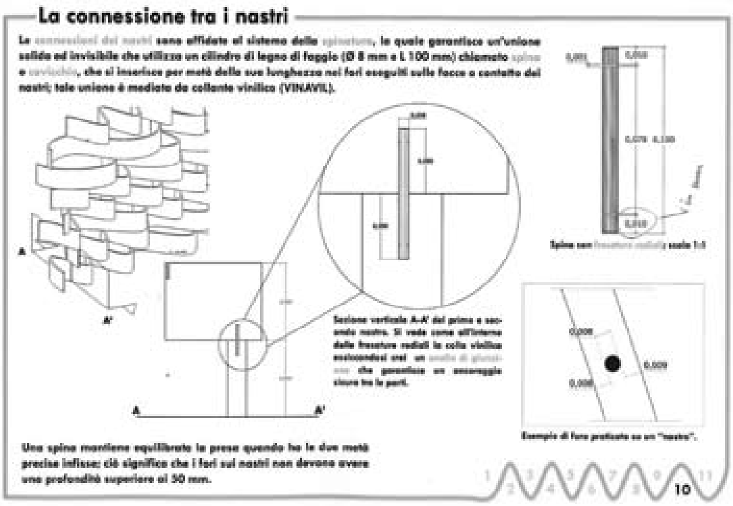
1. Relationship between design concept and vocation of the material.

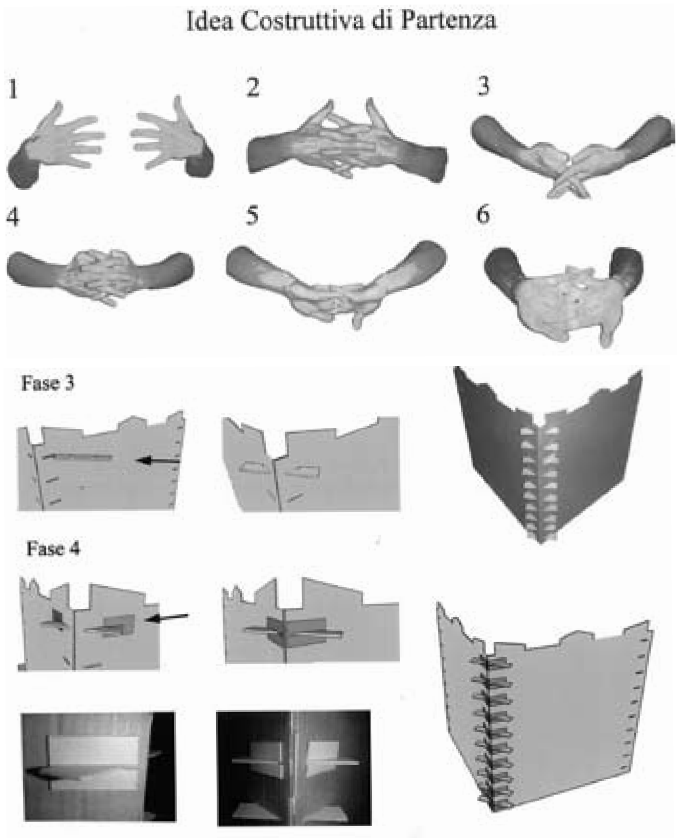


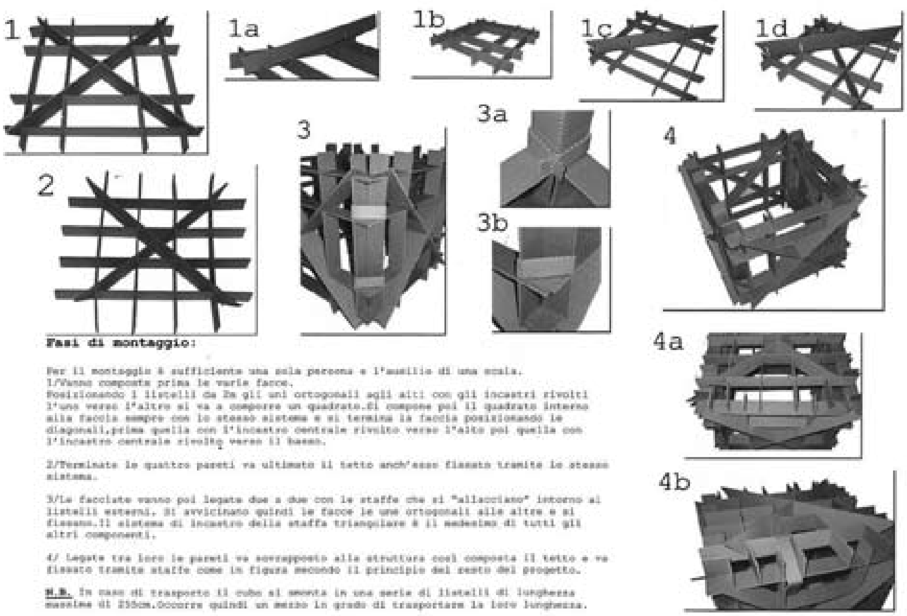



Genesi del progetto
Il principio ideatore è il nastro inteso come esaltazione della dinamicità e del movimento. L'elemento di separazione è costituito da una serie di fasce ondulate, di uguale altezza e lunghezza differente. È l'ondulazione che garantisce la stabilità del tutto per forma. Restando nel campo del legno, i materiali che più si prestano sono i pannelli a geometria sferica che permettono onde e curve e, inoltre, la superficie liscia del materiale permette interessanti giochi di luci ed ombre.
IPOTESI A: i nastri tendono a raddrizzarsi all'aumentare della quota e sono uniti da "spine" di acciaio nei punti di contatto.
Disegno "nastri"; scala 1:40.
REALIZZAZIONE DEFINITIVA: il progetto definitivo prevede un nuovo disegno dei nastri e l'impiego di cavicchi di faggio per la connessione, reso possibile dal maggior numero di punti di contatto tra i nastri.
Il nastro alla base della struttura.
Fase di montaggio delle successive fasce.
IPOTESI ECONOMICAMENTE PIU' VANTAGGIOSA: dato il costo di modellazione 3D, i nastri possono essere spezzati senza problemi di stabilità, ottenendo un elemento di separazione comunque interessante.
Il nastro alla base della struttura.
Elemento in questa ipotesi a montaggio completato.
1
2 3 4 5 6 7 8 9 10 11

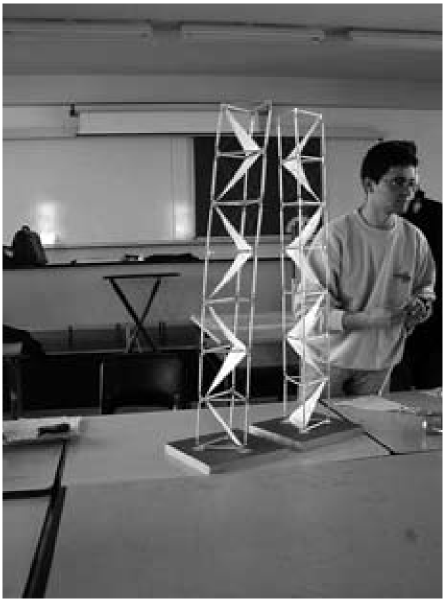

Analisi dei nastri e rapporti antropometrici
Rappresentazione dei nastri forati pronti per la spinatura e sequenza di montaggio.
8°nastro
7°nastro - 8°nastro (scala 1:20)
Parte superiore
Parte inferiore
Rapporti antropometrici
La parete ha dimensioni a misura d'uomo: l'altezza complessiva è di 2 metri con un ingombro in lunghezza di 4. Tali dimensioni garantiscono la funzione di fare da schermo visivo tra due spazi.
1 2 3 4 5 6 7 8 9 10 11

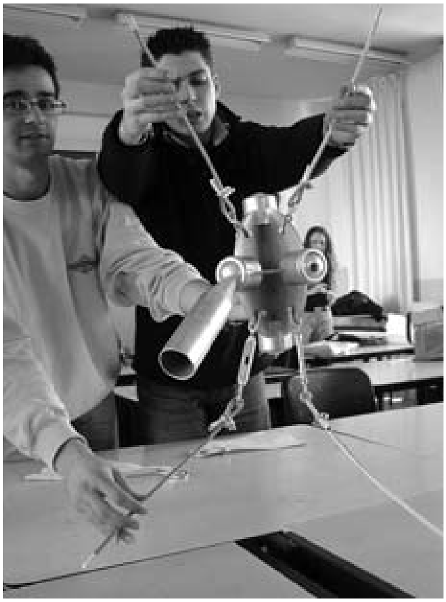

La connessione tra i nastri
Le connessioni dei nastri sono affidate al sistema della spinatura, la quale garantisce un'unione solida ed invisibile che utilizza un cilindro di legno di faggio (Ø 8 mm e L 100 mm) chiamato spina o cavicchio, che si inserisce per metà della sua lunghezza nei fori eseguiti sulle facce a contatto dei nastri; tale unione è mediata da collante vinilico (VINAVIL).
A
A'
Sezione verticale A-A' del primo e secondo nastro. Si vede come all'interno delle fresature radiali la colla vinilica essiccandosi crei un anello di giunzione che garantisce un ancoraggio sicuro tra le parti.
0,001
0,050
0,079
0,100
0,010
Spina con fresature radiali; scala 1:1
0,008
0,009
Esempio di foro praticato su un "nastro".
Una spina mantiene equilibrata la presa quando ha le due metà precise infisse: ciò significa che i fori sui nastri non devono avere una profondità superiore ai 50 mm.
1 2 3 4 5 6 7 8 9 10 11

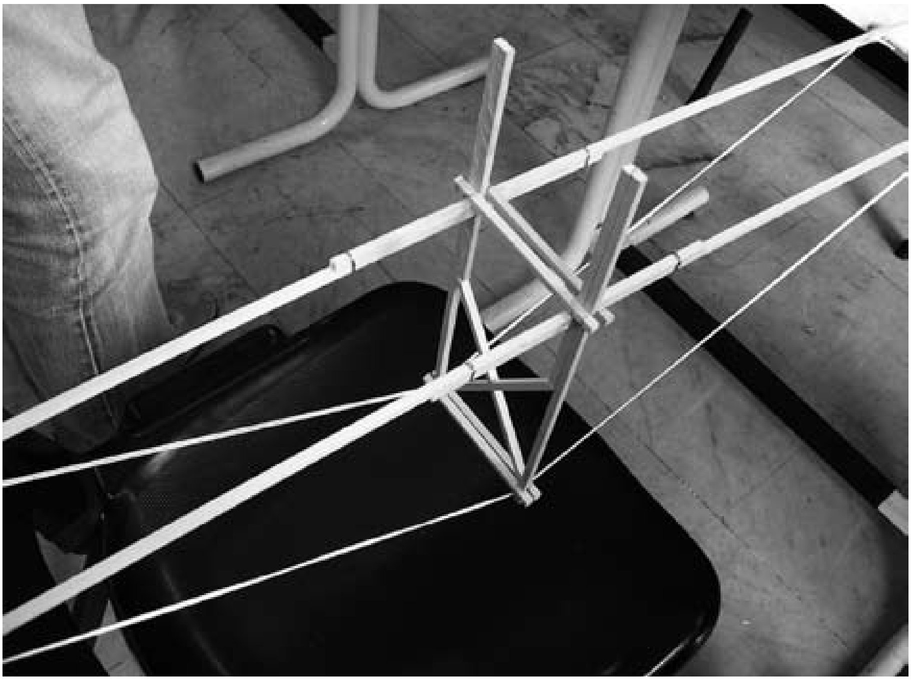

Idea Costruttiva di Partenza
1
2
3
4
5
6
Fase 3
Fase 4


1
1a
1b
1c
1d
2
3
3a
3b
4
4a
4b
Fasi di montaggio:
Per il montaggio è sufficiente una sola persona e l'ausilio di una scala.
1/Vanno composte prima le varie facce.
Posizionando i listelli da 2m gli uni ortogonali agli altri con gli incastri rivolti l'uno verso l'altro si va a comporre un quadrato.Si compone poi il quadrato interno alla faccia sempre con lo stesso sistema e si termina la faccia posizionando le diagonali,prima quella con l'incastro centrale rivolto verso l'alto poi quella con l'incastro centrale rivolto verso il basso.
2/Terminate le quattro pareti va ultimato il tetto anch'esso fissato tramite lo stesso sistema.
3/Le facciate vanno poi legate due a due con le staffe che si "allacciano" intorno ai listelli esterni. Si avvicinano quindi le facce le une ortogonali alle altre e si fissano.Il sistema di incastro della staffa triangolare è il medesimo di tutti gli altri componenti.
4/ Legate tra loro le pareti va sovrapposto alla struttura così composta il tetto e va fissato tramite staffe come in figura secondo il principio del resto del progetto.
N.B. In caso di trasporto il cubo si smonta in una serie di listelli di lunghezza massima di 235cm.Occorre quindi un mezzo in grado di trasportare la loro lunghezza.

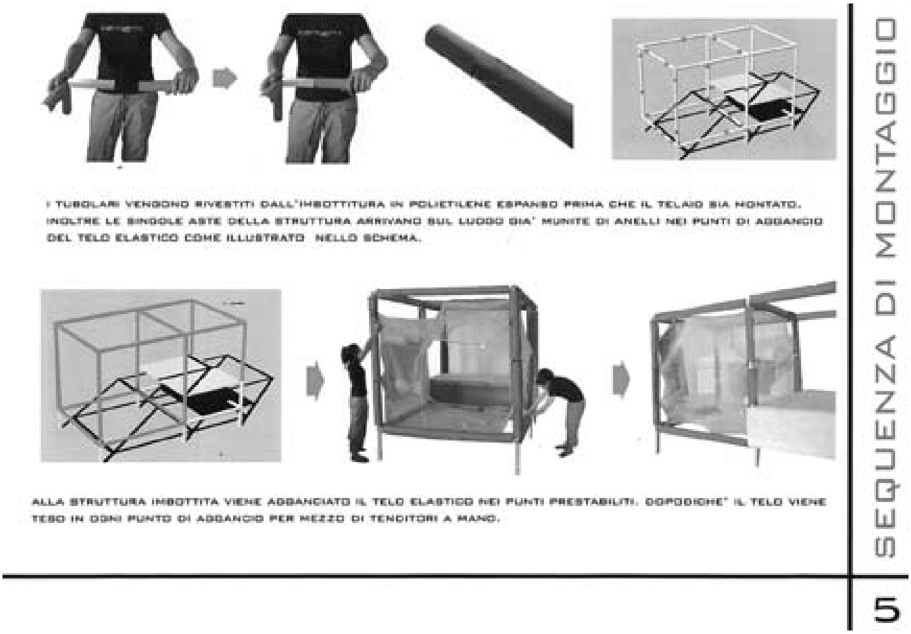
2. Structural awareness and design concept.

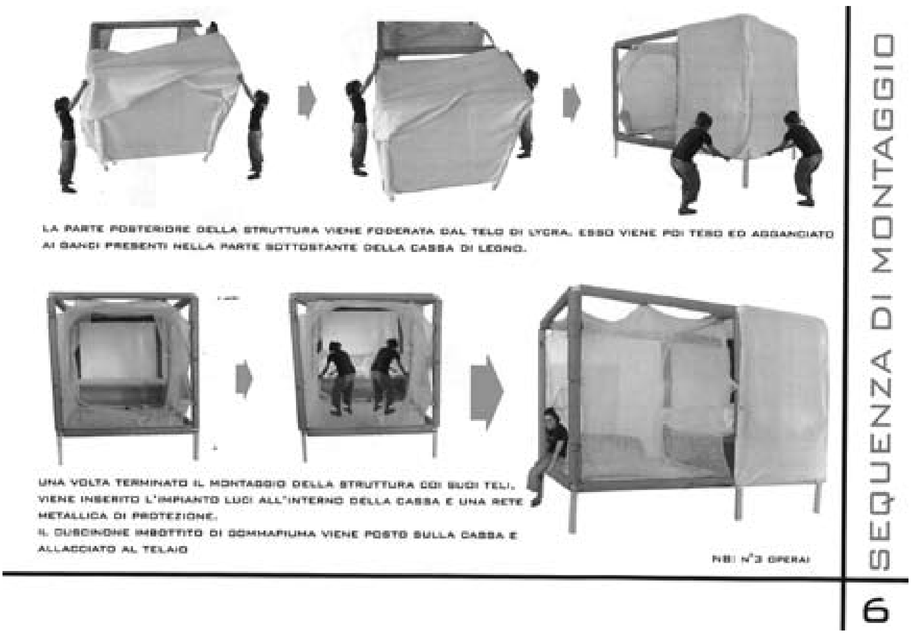






3. Environmental sustainability, climate, context and design concept.






STUDIO CON LA MERIDIANA: L' ANDAMENTO DEL SOLE E LE OMBRE
H: 8 - APRILE/AGOSTO
H: 10 - MARZO/ SETTEMBRE
H: 16 - MARZO/ SETTEMBRE
H: 17 - APRILE / AGOSTO
H: 8 - GIUGNO
H: 12 - APRILE/ AGOSTO
H: 16 - MAGGIO/ LUGLIO
H: 18 - MAGGIO / LUGLIO
H: 10 - GIUGNO
H: 12 - GIUGNO
H: 16 - GIUGNO
H: 18 - GIUGNO

To conclude, I would note, even though it may seem contradictory, since I have insisted so much on the conceptualization and on the abstraction from the specific experience - meant here as instrumental and not bearer of knowledge - that I am convinced that it is important that students should build prototypes or parts of a prototype in a real scale and to handle real materials. The excessive use of virtual reality makes the construction particularly fascinating and increases the possibility of verification and collaboration of several "voices" on the same subject. When we went with the students to the Grands Ateliers de l'Isle d'Abeau to participate in meetings during which a project was really built, there was a real excitement, a veritable "lighting" for students.

Unfortunately, unlike other Italian or European universities, we have in Genova not even the shadow of a laboratory in which groups of students can work with their hands along with other experts.

Notes

1 Silvano Tagliagambe, "Gli aspetti teorici della ricerca scientifica", in "La cultura politecnica" a cura di M.Bertoldini, Bruno Mondadori editore, Milano, 2004

2 in "Quale tecnologia è necessaria agli architetti oggi?" in "Arte, scienza e tecnica del costruire," Gangemi editor, March 2008

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Inconstant Space in Architecture

"Whereas time was once considered to be the fourth dimension, it is now the first."

Ole Bouman

Introduction

Architecture is space. Space that most people perceive as limited and defined by something tangible. Today, in the times of incredible scientific discoveries in fields of materials and telecommunication technologies, we are meeting an inspiring term inconstant space, which was not left unnoticed even by architects. Transposition into architecture logically requires integration of knowledge from different areas of science. Empty space does not exist and everything around us takes place in time. Modern presence and mainly future presumes a transformation and processes that initialise in time and that change status of things in time. Time and movement are dimensions that model tangible, universal but also inconstant architecture.

Discussion

To project universal space is a difficult and mainly unconventional task. The main task is to find meaning of words – universal, flexible, variable – as a starting point of for development and understanding of the theory of unstable space in architecture. The source of inspiration in this tracking and a stepping stone is the theory of relativity and black holes of Albert Einstein. Inconstant space has to be perceived through the optics of space and time integration – space time that the theory of relativity deals with. Then follows the necessity of the integration of different scientific disciplines and theories not only based on tangible architecture (its construction and material solution) but also physics for example. A new theory has to be added to the above-mentioned theories – theory of strings with 10 dimensional space. There are also famous projects of the architects Nox architekten: The Space – with an open unlimited hall space, Glob – blob which is net connected with interactive surroundings with a connection to the web or more particular never-ending house by Kieslera – a living organism where the floor, walls and coat are growing continually from the surrounding nature. The solid ground is waving and becomes a mobiliari or a mono-functional zone or a folding of roofing. [1,2]

On the one hand, the above-mentioned thoughts help in abstract thinking and on the other hand they give a more real shape to the theory of inconstant space in architecture.

Task – problem of inconstant space

We live a dynamic age of transformations and changes maybe more than ever before. The faster we live, the stronger the need for change is and nowadays we are living fast whether we want to admit it or not. We have been dragged into this carousel more or less by force. That is why the reaction of those who form the space of our life – architects – is logical. It is necessary to accommodate architecture to continual changes. Inconstant, flowing, universal, variable – these are attributes of space that can be found nowadays in many works of architects – visionaries and they are finding their place in the teaching of architecture. Inconstant space is not so unreal from the view of nowadays. The intertwisting of man´s life with modern computer technologies brings a different way of work, housing, relaxing from ten years ago. That is the task of the work, the results of which are presented in the report. The task is more interesting because of its application – transposition into the particular city locality that necessarily needs a change to improve all functions in the residential area. There are many anonymous, grey, residential areas (not only in Slovakia) and this gives sense to the introduced work and from the mentioned philosophy a base for a particular model solution of similar problems in all scope of the proposal – from the thought through disposition solution until the architecture – constructional detail [3].

Solution

Objects are results of diagrams that come from a real base – requirements, functions. It is vital to place them in the object and at the same time to express their changes in the time that is passing by. It is suitable to choose three time zones for simplifying the image and visions of a person nowadays. Changes are displayed in two positions – in space and time. The first step is area diagrams and the second step is space diagrams - their base is a ball that is gradually cut in different time. Verifying of diagrams of a particular object and then in the particular locality is the next logical step of the suggestion. Communications – connecting of places, points – is a relatively independent problem. The locating of communications comes from the functions intersection. Another thing that is important is setting the frequency of movement which is different on days off and on working days. This way some maps of a person´s movement are created that help to form the object and its expression. The structure is formed which is changed based on time – from the present, close future up to the distant future. The real shape of functions substance transformed from the diagrams are BOXES that meet the requirements of versatility, variability and functionality with a possibility of change depending on time (Fig.1).

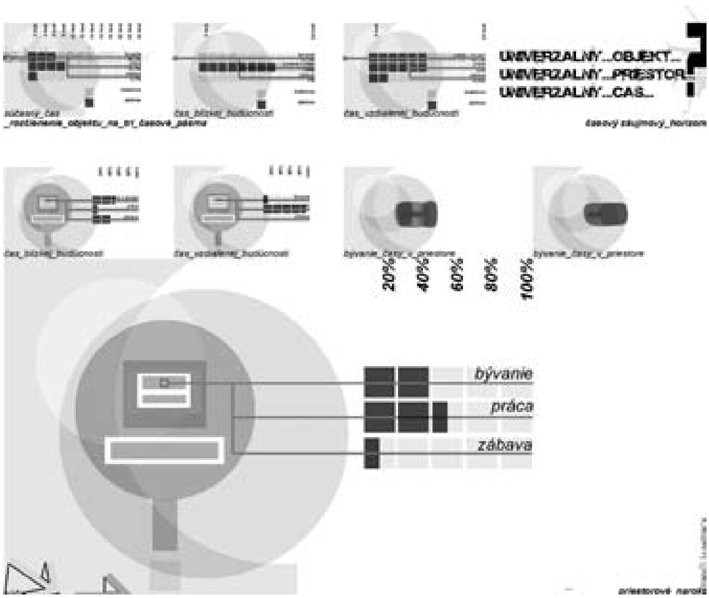

Fig. 1

Vision of transformation of human activities: living, work, relaxing in 3 time horizontal presente, close future, distant future

Viability of an inconstant structure

The extent of the proposal is reality depends on the feasibility of the main technical (constructional) parameters of the proposal. Three levels of inconstancy have been set as an aid.

1st level – solid building constructions and variable space – interior with variable or universal elements.

Function of the structure – maximum assurance of a modern person is demands with a possibility of change in the function of living, work, entertainment as an independent space.

Shape of the structure – there is a block of functions and variability is provided by an internal division of a cell – static variability that does not count with the movement of structure.

Architecture – the look will influence the circuit coating of the object that will coat the maximum degree of a building.

2nd level – we work with the whole cell, its strength and versatility is changed.

Function of the structure – maximum providing of a person´s requirements to the space with a possibility of taking into account particularity. The function of living also takes up the function of work, the function of entertainment is increasing – a form of a multimedia box is created.

Shape of the structure – a partial change of structure is formed, it is provided by movable blocks – static and mobile variability – movement of cells is block.

Architecture – reflects momentary user´s requirements, it respects static elements. The look will be influenced by the change of structure that will be supported by dynamic elements, e.g. LED diodes on the façade that will help to identify space and its change.

3rd level – maximum level of versatility – inconstancy, versatility of communications.

Function of the structure – maximum level of providing the future person´s requirements and its content, with taking into account the supposition that work and entertainment as we understand it will cease and the model focuses on living and work as psycho-relaxing in terms of a cell [4].

Shape of the structure – a maximum level of partiality, singularity. Creation of hyper/structure that allows interconnection by its movement or cell separation – mobile variability, cell movement is module (Fig. 2-5).

Architecture – the look will be influenced by momentary needs of a person that will be displayed in object structurality and at the same time in unification or versatility of expression.

Application – Bratislava, Petržalka

The vacant land is in Bratislava (Slovakia), in the part Petržalka at a Croatian shoulder with an extent of 46 Ha. It presents an opportunity to create "a city in the city". Potential: the most populous part of Bratislava, close accessibility of transport routes and

Fig. 2

Fig. 3

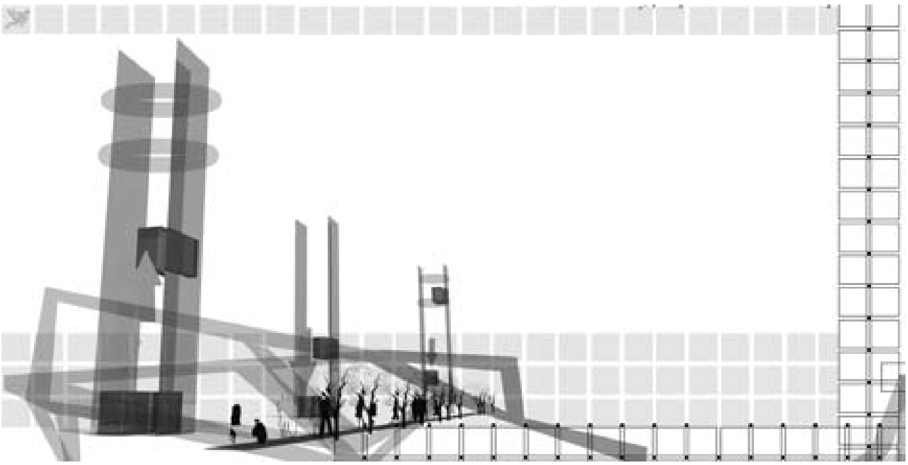

Fig. 4

The course intensity of communication system: Fig. 2 – presence, Fig. 3 – close future, Fig. 4 – distance future

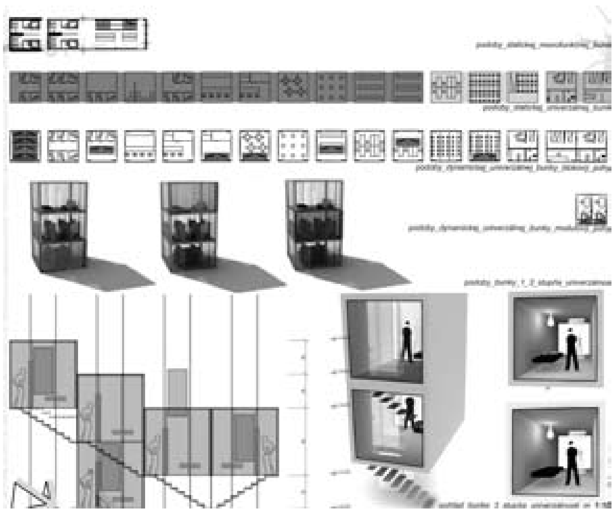

Fig. 5

The form of dynamic universal cell

the historical centre of the town which predetermines the creation of a vigorous centre of the mentioned urban part. The added value of the locality is in the surrounding nature of the Croatian shoulder and in the existence of the space for sport and, the development of relaxing activities.

Solution

The present – mostly monotonous – housing of Petržalka is without appropriate modern civil equipment and also without adequate intimacy and identification of living surroundings. That is why it is required to create a surroundings full of emotions, experience hierarchically divided and at the same time to create quality fully-valued living surroundings complementary to the Old city of Bratislava [4].

Space principles – the proposed "city" is divided by a single segregation into individual countries and at the same time mutually interconnected. Movement takes place in individual countries – corridors that have their own clear beginning and end. There are related functions in one corridor that prevent the interference of operations. Not only is such a division into zones a strong composition motive but it also enables versatility in a poly-functional area. It is a seeming paradox where versatility and inconstancy is realised thanks to keeping a certain level of space structurality by communication or movement routes (Fig. 6-9).

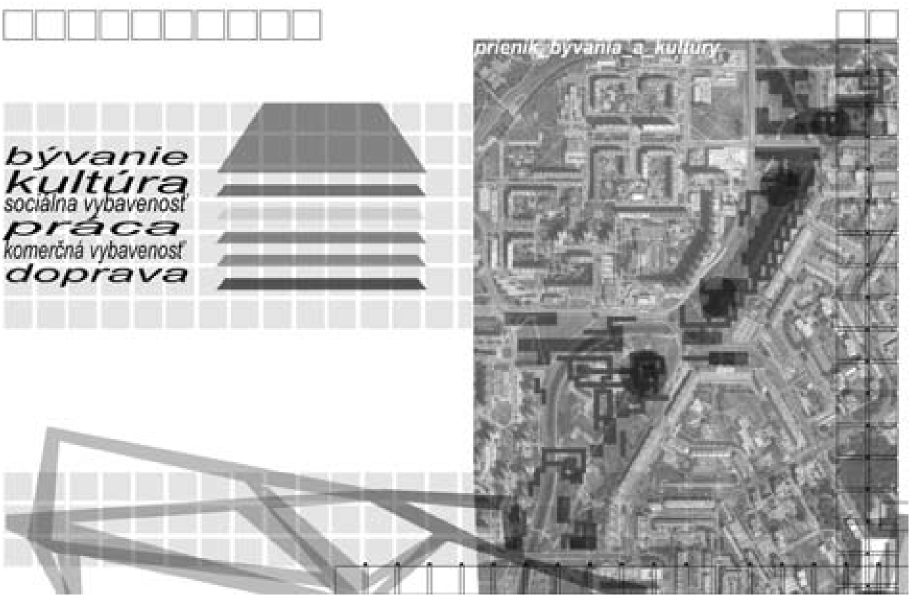

Fig. 6

The projection of a science solution in Bratislava – Petrzalka district

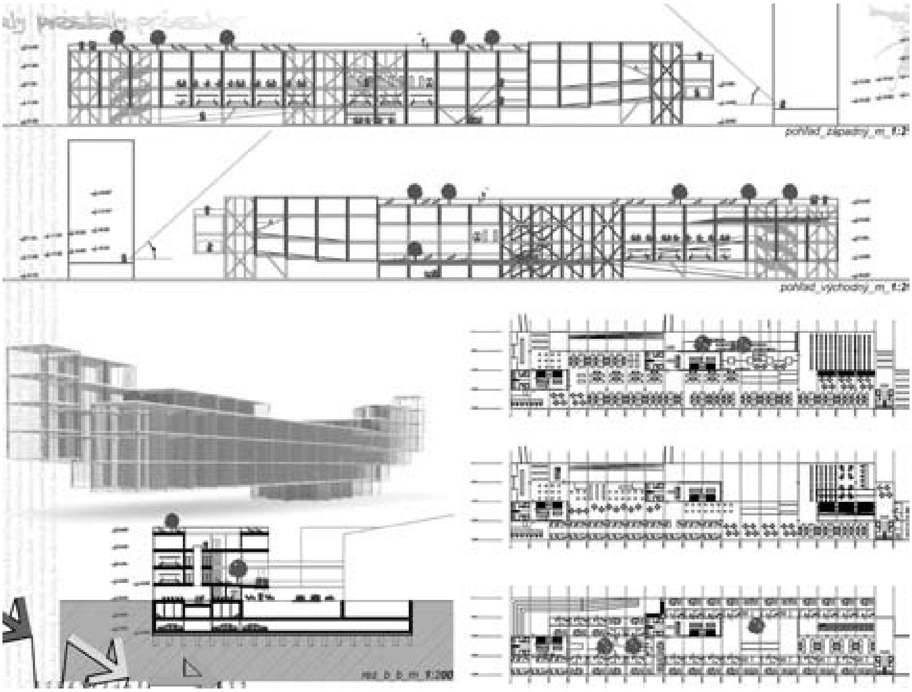

Fig. 7

Transformation of vision to particular architectural and construction structures

Fig. 8

The architectural solution of inconstant and universal spaces in Bratislava – Petrzalka district

Fig. 9

Detail of architectural solution of inconstant and universal spaces in Bratislava – Petrzalka district

Conclusion

"For a long time architecture was thought of as a solid reality and entity: buildings, objects, matter, place, and a set of geometric relationships. But recently, architects have begun to understand their products as liquid, animating their bodies, hyper-surfacing their walls, crossbreeding different locations, experimenting with new geometries. And this is only the beginning." (Ole Bouman, an internationally known critic, author, designer and curator based in Amsterdam). Yes, we are standing as if at the never-ending beginning of architecture, its real dimensions we can imagine only with great difficultiy. However, this uncertainty inspires and pushes scientists to achieve new observations that will ask new questions, raisenew doubts but will also findsolutions in an eternal circulation of scientific research necessary for the movement of civilisation. Real materialisation of the presented future space creation visions will comprise a contextual, scientific and educational frame of academic institutions.

Notes

1 Krejčová, Barbora: Changes of contemporary interior or what happened, when the floor was not floor. In: *Stavba*, 91- 92, 2005

2 Bouman, Ole: Architecture, Liquid, Gas. In: *Architectural Design*, Pages 14- 22, 2006

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Formation of "Minimal Surface"
Case Study I – Educational Training

Team work – construction and design workshops at the Faculty of Architecture of Wrocław University of Technology

The fruitful cooperation of contemporary design teams dealing with complex technical issues has proven the effectiveness of team work. The authors believe that the most important courses for students enrolled in architectural programs are those which enable them to achieve their goals not by competing with each other but in the spirit of teamwork and fun. Competition in this case could serve as an additional driving force to find innovative solutions.

Team-based form-finding may be designed either as an obligatory course or a design workshop, such as the preliminary workshop for the "InStructA '09" conference (http://instructa09.arch.pwr.wroc.pl).

The workshop was divided into two parts, one before, and the second during the conference. Twenty students from the Faculty of Architecture of Wrocław University of Technology participated in the first part. Team work commenced in mid-February 2009 and each meeting dealt with the construction of a special teaching platform designed to find and create architectural forms. The goal of this stage of the workshop was to prepare the participants for their final assignment. Several experts were invited to the meetings to answer any questions and supervise the project. As a result the participants managed to erect a conference tent.

Preliminary training in form-finding

In a preliminary training session the participants played with soap bubbles, which served as an introduction to finding minimal surface forms. Not only was this experience fun but it also acquainted the participants with the functioning of minimal surfaces.

Full-scale project – construction of a membrane for InStructA'09 conference

After a series of meetings, participants were ready to begin a real, full-scale project.

A temporary membrane roof, attached to the building of the Faculty of Architecture, was designed and constructed one week before InStructA'09.

The final modeling of the form was accompanied by design preparations using CAD techniques.

EASY-CAD software package (Technet GmbH) was used to perform the statical calculations as well as the cutting patterns and fabric cutting layouts.

After designing all elements of the conference tent, a specialist company was hired to prepare fabric sheets on a plotter.

When the fabric sheets were ready, the students who participated in the workshop joined all the elements together and, under the supervision of experts, erected a conference tent, which served as the symbol of the conference. After the workshop and the conference the tent was dismantled and given to the conference sponsors.

Fig. 1

Initial training in form-finding: modeling with soap bubbles – a bit of fun to begin with.

Fig. 2

Initial training in form-finding: modeling with soap bubbles – Plateau rules.

Fig. 3

Initial training in form-finding: modeling with soap bubbles – arbitrary minimal surfaces.

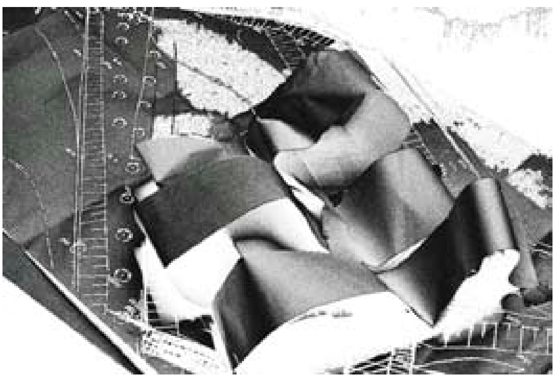

Fig. 4

A temporary membrane roof

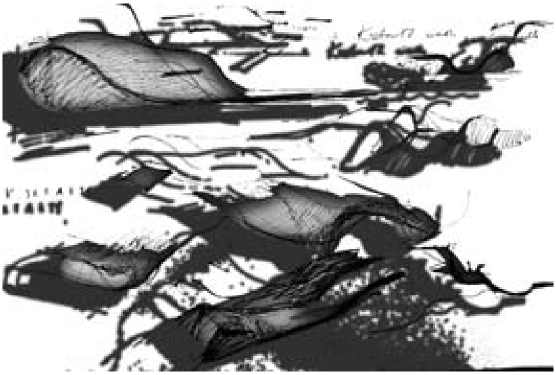

Fig.5

Form-finding of a real membrane structure: modeling with strips of paper

Fig.6

Form-finding of a real membrane structure: modeling with strips of paper

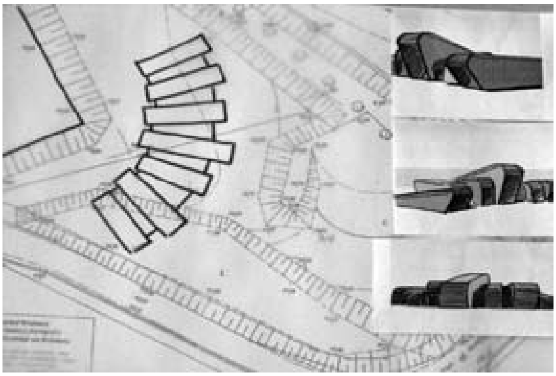

Fig. 7

Designing of a real membrane structure: geometry of the final design

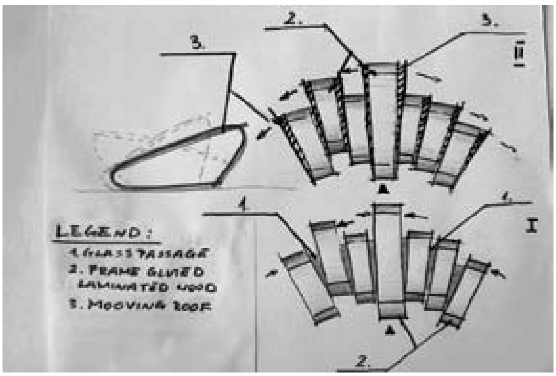

Fig. 8

Designing of a real membrane structure: geometry of the final design

Fig. 9

Designing of a real membrane structure: statical calculations

Fig. 10

Designing of a real membrane structure: cutting pattern

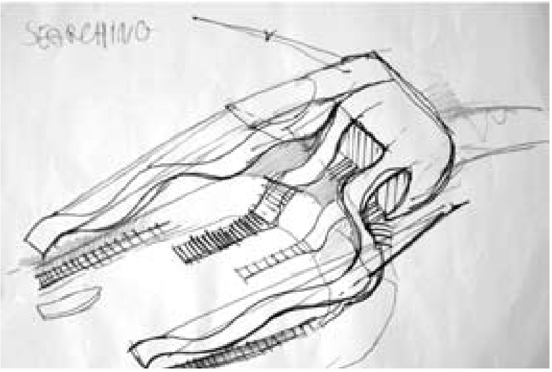

Fig. 11

Construction of a real membrane structure: fabric cutting

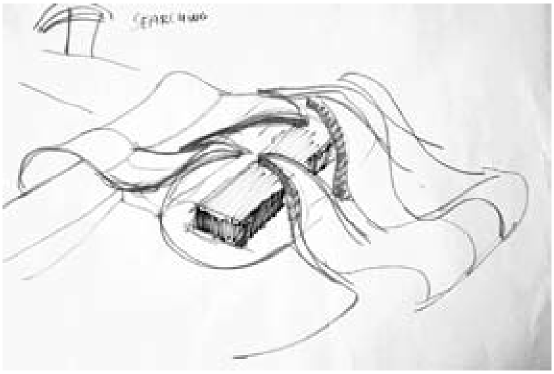

Fig. 12

Construction of a real membrane structure: checking and completing the fabric sheets

Conclusions

Owing to the involvement of students, instructors and team work we managed to fulfill the assumed teaching aims of the first stage of the design workshop. The university authorities, teachers and students hope to carry out similar experiments in the future. Such activities allow them to gain hands-on experience in the shaping of architectural forms.

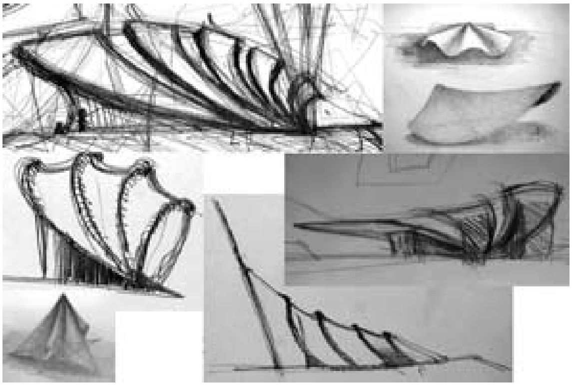

Fig. 13

Construction of a real membrane structure – building site works: footings

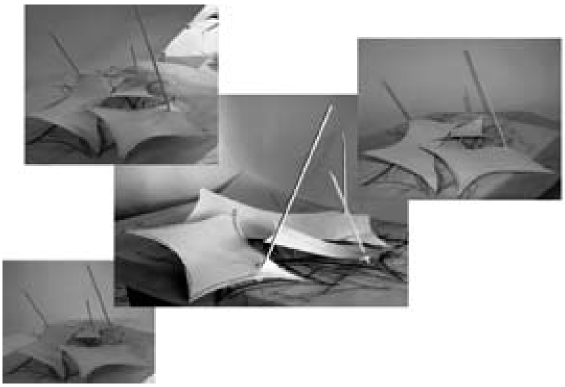

Fig. 14

Construction of a real membrane structure – building site works: erection of the structure.

Fig. 15

Presentation of the constructed membrane to the participants of InStructA'09

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Student Workshops as a Method of Teaching Architectural Designing

Introduction

Every year student workshops of the Institute of Postindustrial Architecture at the Faculty of Architecture of the Silesian University of Technology take place. The workshops have a precise aim: cooperation with local authorities. From approximately 200 students of the 4th year small groups are selected. They are chosen in order to deal with a specific task. The subject of this paper is the experience that was gathered during urban-architectural workshops regarding the transformation of the coast of Gdynia city. The workshops took place in 2008 with close cooperation with local authorities.

Every year, within the framework of a course entitled 'Creating a workplace', students of the 4th year deal with large scale objects. The relationship between the form and the construction of the objects is very crucial for this question. For many students it is often their first attempt to create an object with such large volume. Frequently they have problems with working on the function in a huge 'box'. The form of the building and its long elevations are also causing problems. In the given area they design factories, research institutes, airports, exhibitions halls etc. Students for the first time deal with the problem of landscaping in a form and scale different than downtown. The workshops provide them with the opportunity to develop their skills and lead to deeper reflection on the importance of architecture in an urban landscape. The experience gathered by our group proves that adoption of CAD techniques too early leads to poor project solutions. We stick to the rule that computer support should not be used in the phase of the project's ideas and concepts. Introduction of CAD techniques too early by inexperienced students can lead to:

- simplification of the concept;
- unwillingness to diversify.

As a result we try to make sure that students in our group use a free-hand sketch and a model in the initial phases.

'First intercollegiate urban workshops – Gdynia 2008'

In 2008 thanks to the authorities of Gdynia city the representatives of four leading Polish Universities of Technology (The Silesian Univeristy of Technology, Cracow univeristy of Technology, Wroclaw University of Technology and Warsaw University of Technology) were invited in order to deal jointly with modern urban problems of the city. The port city of Gdynia was built in its basic form before the Second World War. Up till now Gdynia charms with its modernity and the beauty of modernistic architecture. The modernistic architecture of Gdynia city consists of public buildings and middle-class blocks of flats. Even the period of the second half of the 20th century, which was a difficult time for Polish architecture, did not cause much damage to the original beauty of Gdynia. The dynamic development of Gdynia city began in the first decade of the 20th century. Since the decision about building a military port was made less than 25 years ago Gdynia has become one of the fastest developing cities in Poland. Due to the rapid development of the city, the urban structure and the formal expression has stayed very coherent in their modernistic expression. During the workshops it was decided that each University would deal with problems of a particular part of the city. Students of the Silesian University of Technology were assigned to the region of the Presidential Basin. The region of the Presidential Basin consists of two artificially created piers: the Fishing Pier and the Southern Pier are joined with the part of the coast. Both piers were built as an integral part of Gdynia's port in 1920. This region is situated on the main axis of the city that runs from the railway station to the port. The Northern Pier, which is also known as the Fishing Pier, is built up with both port and bankrupt deep-sea catch company buildings. This region is designed to be transformed within urban form and function. The revaluation of this part of the city began with the adjustment of the main route which is parallel to the coast and with the construction of the development of luxurious appartments called 'The Sea Tower'. The Sea Tower is situated at the base of the Fishing Pier. The city council plans this part of the city to be designed for housing and retail. The Southern Pier, which is similar to the former structure of the city, is extending the city promenade. For many years the pier has performed the function of a showroom and a place for walks. The Southern Pier spatially connects the seaside area, green belt and the route of the Seaside Boulevard which are well known tourist attractions.

The method

First intercollegiate urban workshops – Gdynia 2008 enabled the adoption of previous ideas about the methodology of creative work and its application to a specific designing problem. Tomasz Bradecki and Szymon Rendchen, who are currently studying for their Ph.D., supervised the six-person designing group. The attempt to organise the designing problem for this particular question was undertaken. The sequence of solving the designing problem was elaborated for this particular task and it involved:

1. Defining the problem. The identifaction of the planning/designing problem has got two aspects. The first aspect relates to recognising the problem of the urban forming of converting coastal areas known as waterfronts. The first aspect also involves the urban and architectural assosiations connected with the chosen subject. We focused on identifying the problem. It is a theoretical aspect which is dealt with by referring to professional literature or to our own professional experience. Gdynia's location is very unusal for students from Gliwice and it required analysing the association between similar tasks.

   The second aspect of the identifying of the problem relates directly to the designing task we were dealing with. The region of Presidential Basin is associated with the problem of the identity and the 'meaning of a place' in the urban structure of Gdynia city. This problem also relates to the metropolitan layout of Trojmiasto.

   The problem of converting the functional and spacial structure of the embankment is very common, especially in the 20th century. Since the collapse of the sea transport in the late 70s and the recession of the shipbuilding industry rich port cities like Liverpool, Copenhagen, Hamburg, Helsinki, Venice-Maestro, Goteborg etc. have started to carry out programs of converting the regions of ports into new districts.

2. The taken up subject in a spatial context was another question to consider. The designing problem is strictly connected with the existing structure of the city. That

is why we were analysing the structure of spatial layout, the proportion of disticts in an urban buildings, general rules of spacing urban services and planned public spaces, instructions regarding the main axis and comminication routs and the layout of urban greenery. All research indictated the uniqueness and compositional meaning of the designing area within the structure of city management.

3. As result of previous thinking and analysing, the 'idea of the plan' was created. The concept is a big intellectual short-cut. It gives us the general direction to follow. The idea of the plan allows us to define such aspects as the general regional context of the place, the planning idea and the connection with the management plan.

4. The next stage is the 'management concept' which takes into account all previous stages of our designing task. This concept is a summary of our divagations. It is also a graphic presentation of our designing intentions. The result of our work was the concepts of two piers that has given us the opportunity to present two types of municipal. At this stage we introduced the computer support which gave us greater freedom of action and allowed for precision in shaping of the form. Interdisciplinary consultations with the local authorities and trade constructors helped us to achieve satisfactory solutions.

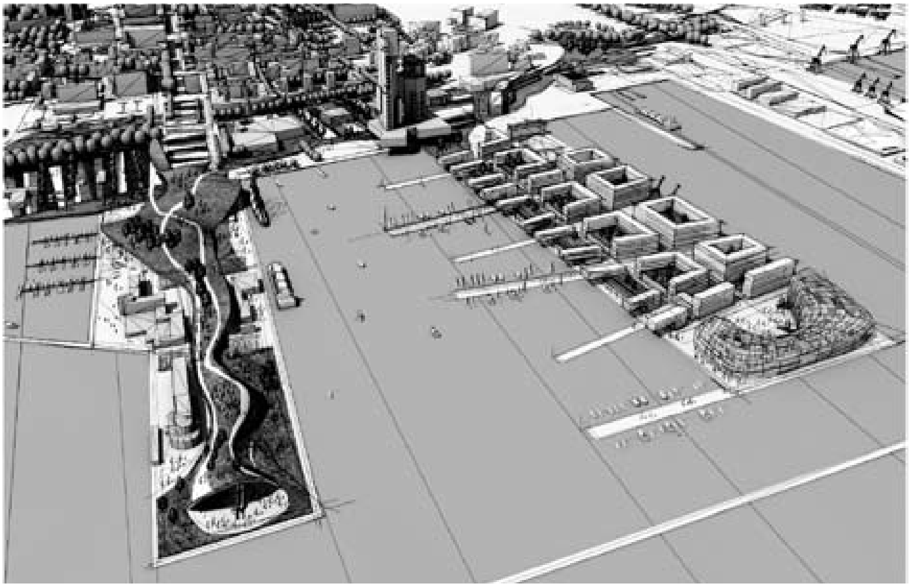

Fig. 1

Areal view of designed Presidential Basin area.

Source: Faculty of Architecture of the Silesian University of Technology archives.

We offered intensive buildings in the mix-use style for the Fishing Pier in order to emphasize its down-town character. We suggested architecture that refers in its form to modernistic buildings in Gdynia city. There is a main artery along the district buildings which is a modern projection of pre-war buildings in Gdynia. The height and the number of the buildings also refers to the pre-war style. Three parallel rows of residential and retail buildings are completed with a culture and recreation centre. The buildings have from four up to six floors.

On the Southern Pier, the urban character of the green belt was emphasized with a waved green structure. This stucture interweaves with the buildings and in its form refers to the nearby hills. The waved green stucture matches other objects such as: Gdynia Aquarium, Gdynia Maritime University, the monuments commemorating the history of the city and the harbour with beautiful moored ships.

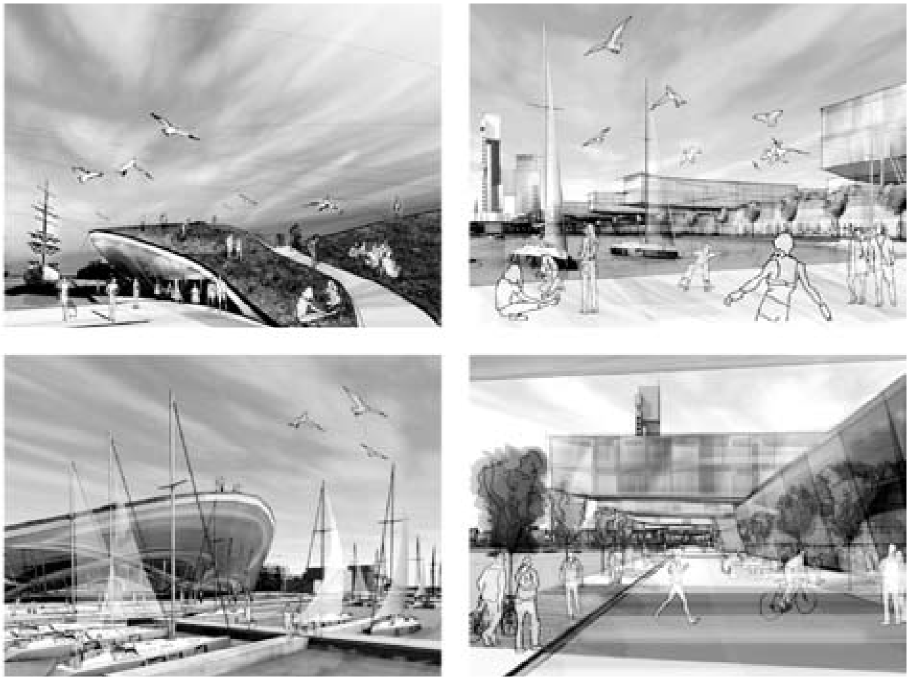

Fig. 2

View of the Southern Pier and Fishing Pier.

Source: Faculty of Architecture of the Silesian University of Technology archives.

The conclusion

Working in groups on a small project gives the lecturers the opportunity to work individually with every student. The teacher-student relationship is very important and used to be the principle in teaching the architectural craft. Traditional classes, where students work in 15-20 person groups, very often do not allow for an individual relationship between teacher and student. Students spend many hours together during the workshops. They discuss things, share opinions and quite often even argue. They can learn a lot from working in a team.

The cooperation with local authorities is a great motivation for the students. They have to deal with the problem in an interdisciplinary way. Student workshops give students a chance to meet civil servants, businessmen and the masters of architecture. It has a great influence on the suggested solutions.

One of the disadvantages of this type of group work is the uneven share of duties. Quite often people in the group share duties according to their specialization. One person is in charge of designing while another is preparing visualizations, description or graphic design. Someone can end up making coffee. This is definitely a question that has to be considered.

Despite the disadvantages student workshops always provide some fresh ideas. It gives students a chance to work in unusal conditions. Both students and lecturers get an opportunity to break away from their routine and common thinking about designing. It is an opportunity for students to get published. Student workshops can give lecturers a new perspective by having their ideas and opinions challenged by a new generation of designers and fresh thinkers.

Session 3.1

Views on integration

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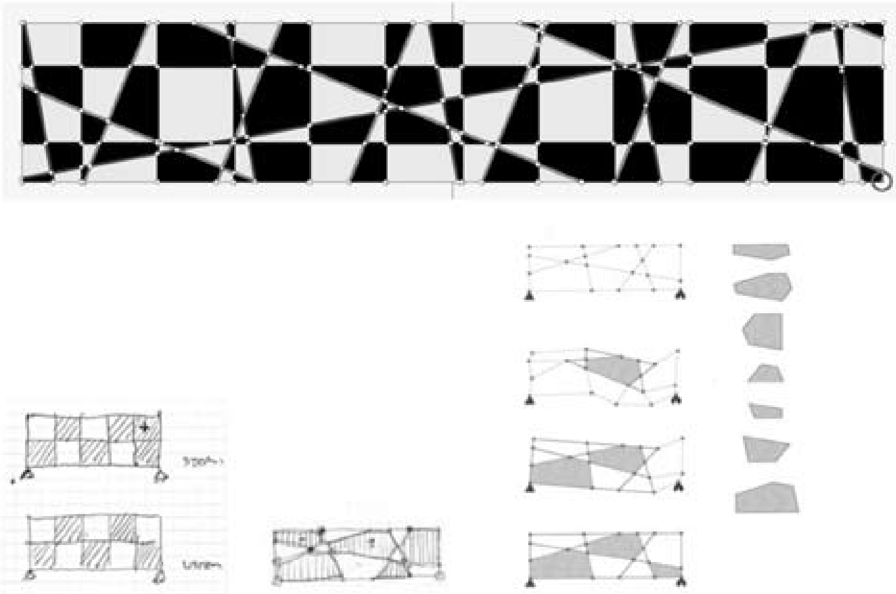
Chaotic Processes in Teaching, Research and Praxis of Architecture

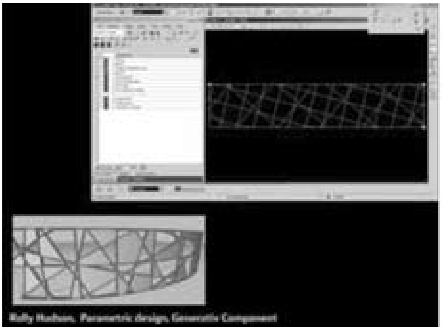
The condition for architecture and the teaching of architecture is an exponentially growing complexity. We can no longer use classical linear or cycloid development strategies. Current development is nonlinear. The rapid development of the information technology is generally used as the cause – but it is rather symptom that materializes the development. We must in our interaction between the scientific/technological and the architectural/artistic approaches to teaching be aware of the great difference between the classical Euclidian approach, and the contemporary view of science. Probability and chaotic process enlarges the description of every aspect of understanding of our surroundings. The architects works in a group of specialists and manufacturers, best described as a dimensionless network. The creative language in such a network is to nourish concepts rather than to search for partial optimal solutions. This is a condition to be learned in praxis as well as in teaching. Built architecture is a physical representation of the complex of ideas which governs the network. The understanding of the roles that govern a complex of ideas, the "ideaplex" or "memplex", helps us to understand the roles for the total building process.

Memes are cultural genes. The term "memes" are cultural heritage originated by the British biologist Richard Darwkins in "The Selfish Gene", 1997. Ideas about architectural structure and materials are memes. Memes develop with a growing complexity performed in a network. The nodal points in the diagram are the memes. The nodes with many and important connections are important memeplexes, so is their growth. They grow until they reach such a complexity that they lose importance as memeplexes in the net, as the complexity kills them. This is one of the reasons why structural development – and particular development of architectural structures have a linear content, as well as having nonlinear interactions with other memeplexes.

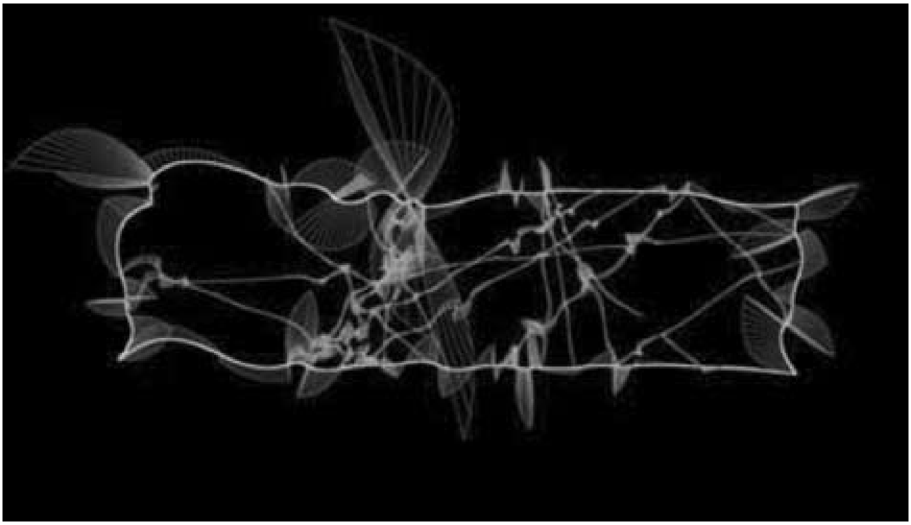


The study and use of chaotic processes in architectural structures can lead to structures with new possibilities: A chaotic framework, generated by overlaying 3 different square patterns, can be filled by plates in some of the polygons left by the pattern. (a) The use of one simple truss with a square grin and plate infill. This can lead to different wall trusses, architecturally very different from the vectorised trusses, but just as efficient. Structurally within our usual methods of design.

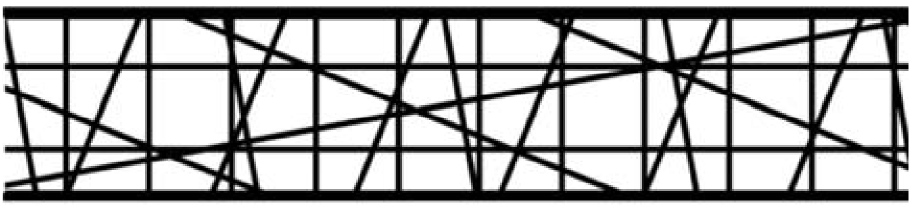
Student application of chaotic plate and grid system used as loadbearing façade panels creating large overhangs and large spans in a very efficient structure.



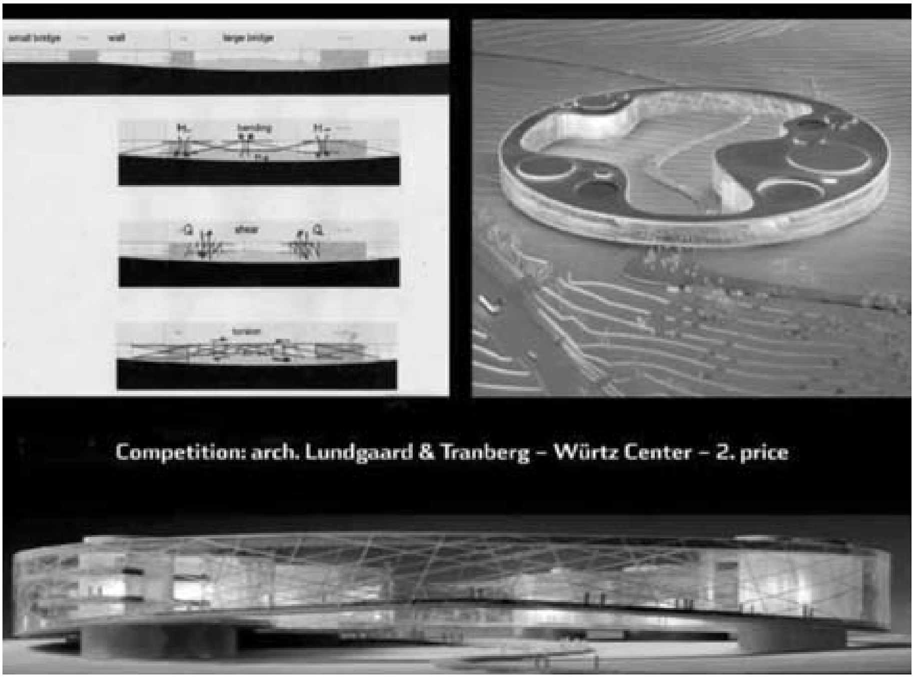
Development of chaotic meme grid using generative components from a workshop with Rolly Hudson, and Chris Williams. Right: student experiment with the principle for a tower.



Structural study with dynamic relaxation of a random chaotic beam done by Chris Williams at a working seminar in Copenhagen.



If the chaotic grid is left open, we have an integrated truss of less efficiency and with bending moments in top and bottom. We have in workshops and in collaborations with architectural practices developed this system further and has been used it in architectural competitions. Architects Lundgaard and Tranberg.

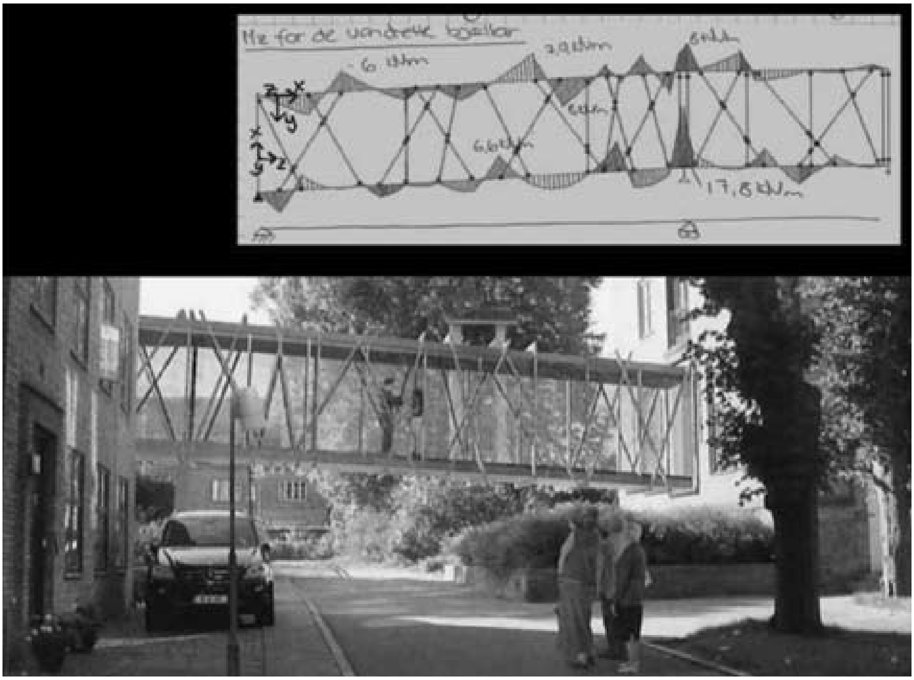


The chaotic frame system generated with reference to the structural action of bending, shear, and torsion in the large spanning building structure. Here 2nd price winning project for a new head office and conference centre for the German company Würtz by architects Lundgaard and Tranberg.

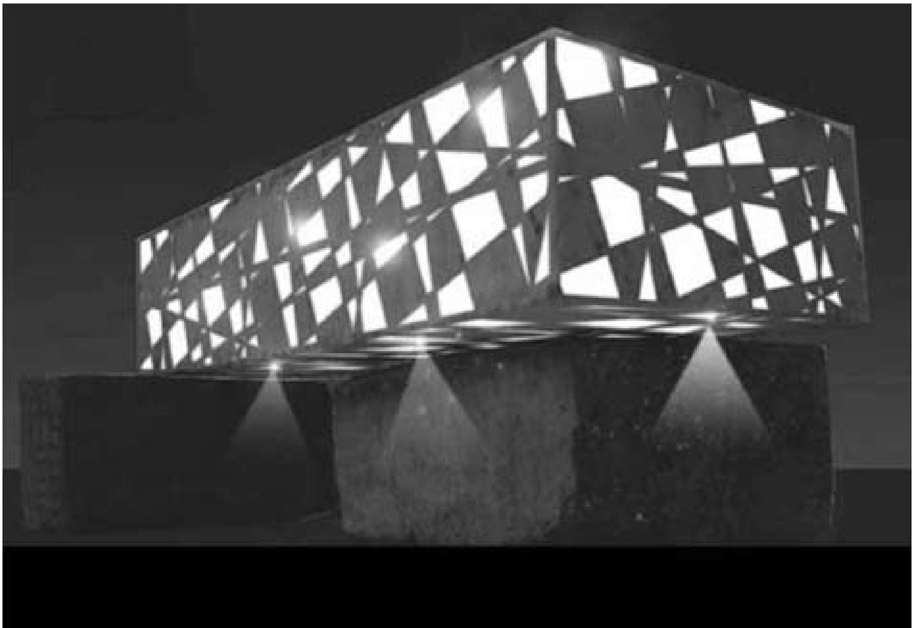
We make these experiences with a course called "Conceptual Structural Design", an integration between specialists and studio teachers. The course describes a contemporary scientific approach to architecture and structures. Discussion of contemporary theories and case studies are natural parts of the course, as well as the projects of the students. The course includes studio workshops, together with research workshops (with Chris Williams as visiting professor), and development together with architectural praxis. Altogether it gives a better understanding, of how to understand memes of contemporary tectonics. It also leads to new architectural structures of traditional materials as steel and composite structures of plates and beams. We call these structures "chaotic structures".

The work is here described with examples from the students' work, theoretical chaotic beam structures, and examples from architectural competition work.

The Conceptual Structural Design course is a collaboration with ass. professor Eskild Pontoppidan, and professor Tage Lyneborg's studio department at the School of Architecture. It is developed in relation to praxis with different architectural offices iclud-ing: Juul and Frost, and Lundgaard and Tranberg from Copenhagen.



A project design for a covered pedestrian connection between two buildings in Copenhagen, in collaboration with architects Juul & Frost and Buro Happold.



Conceptual design for a chaotic structure with structural elemnts of structural brick

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Architectural Design and Construction Education – Experimentation towards Integration

Architectural schools should prepare the graduates for professional life in the future. Graduates may work not only as architectural designers but also in other related fields such as regional and town planning, site management, administration, interior design, and architectural teaching. This is why didactic programs at architectural schools are heterogeneous and consist of various subjects from humanistic ones through art, CAD to technical knowledge with the architectural design studio as the focus point, unlike real designing offices where all participants of the design and building process cooperate at all stages of design. In most schools, the didactic programs consist of separate subjects taught by specialized teachers and placed in the curriculum in various years of the study period. The relation between these subjects is usually logical when the whole program is observed. For students, who see only fragments of this whole curriculum, these relations are not so obvious. This is the reason why students treat some subjects only as "school duties" unaware of their connections with their main task – "creation of architecture". In the school's reality this "creation" means concept designs, with all its limitations, prepared in the architectural design studio. The amount of material and technological aspects in this concept designs depend on the view of the design teachers and may vary from "pure form" to presenting design in working drawing form.

In our school - The Faculty of Architecture (WAPW) within the Warsaw University of Technology - some years ago, five years study which terminated with the Master Degree diploma was changed to two stages – four years Bachelor course and two years Master course. In didactic principles Architecture is understood as a cultural practice involving both speculative intelligence and practical know-how. Students at the WAPW benefit from its relatively small size. In recent years the School has enrolled approximately 180 students annually. Graduate and undergraduate programs in the School share faculty course offerings and facilities, which fosters a close relationship among all students in the School.

The Architecture Design Studio is treated as a focus point of the whole didactic program and offers various architectural issues. These start from the small industrial forms and interior design, residential, public, retail and industrial buildings, landscaping and green areas, sports grounds and facilities, rural and urban planning. Apart from design, students are taught the following range of issues:

- the Theory and History of Architecture, Urban Forms and Fine Arts,
- Mathematics, Structural Mechanics, Design of Structural Elements, Building Techniques, Building Services, Building Physics, Connections to External Power Sources,
- Economics for Architects (Economy of Design, Project Management, Investment Process and Legislation),
- Social and Natural Sciences (Ecology, Sociology, Psychology, Philosophy, Culture, Professional Ethics),
- Fine Arts and Visual Arts (drawing, painting, sculpture, computer visualisations),
- Workshop techniques (technical drawings, modelling, computer aided design),
- Elective foreign languages: English, French, German, Italian, Spanish, Russian and Polish.

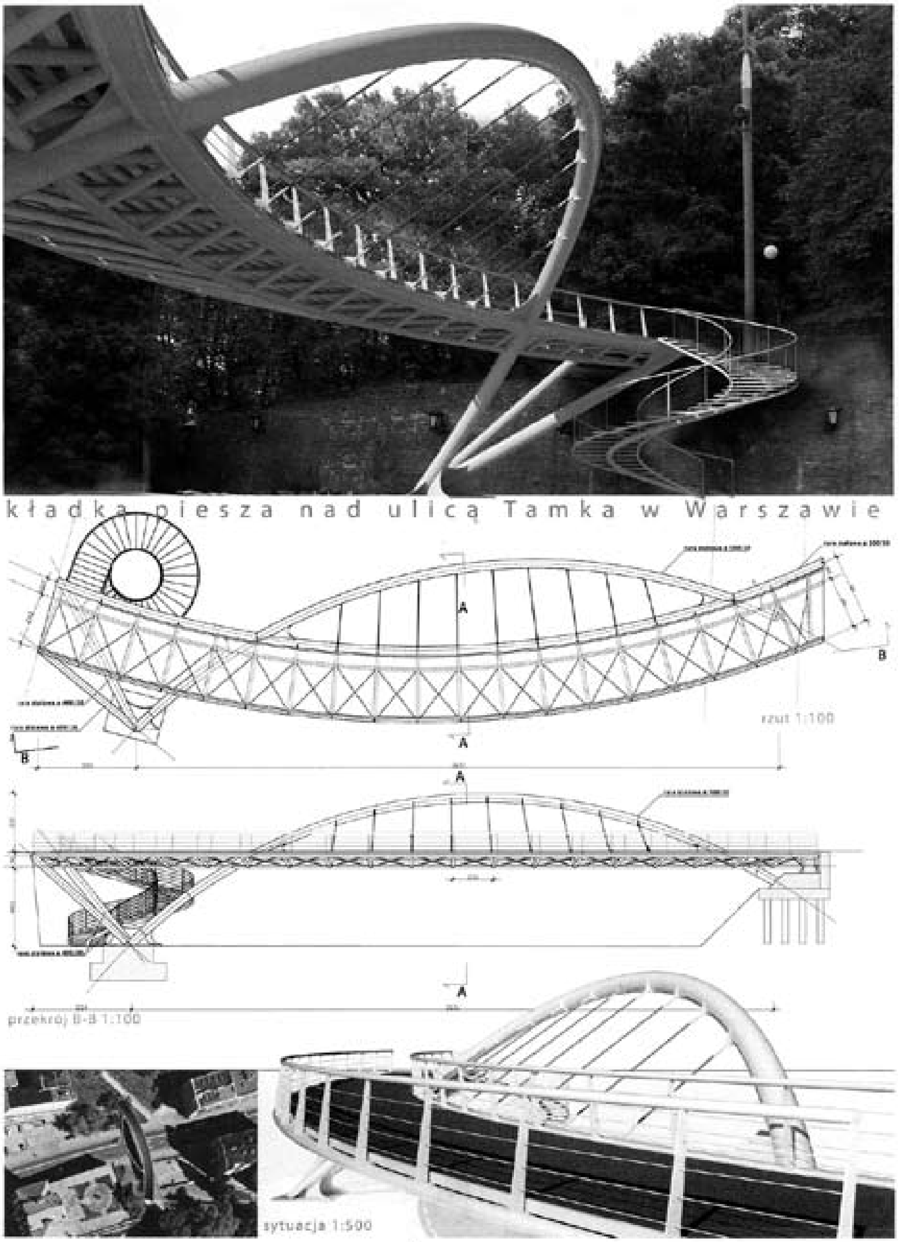

Fig. 1

Structural Design – Footbridge: general view.

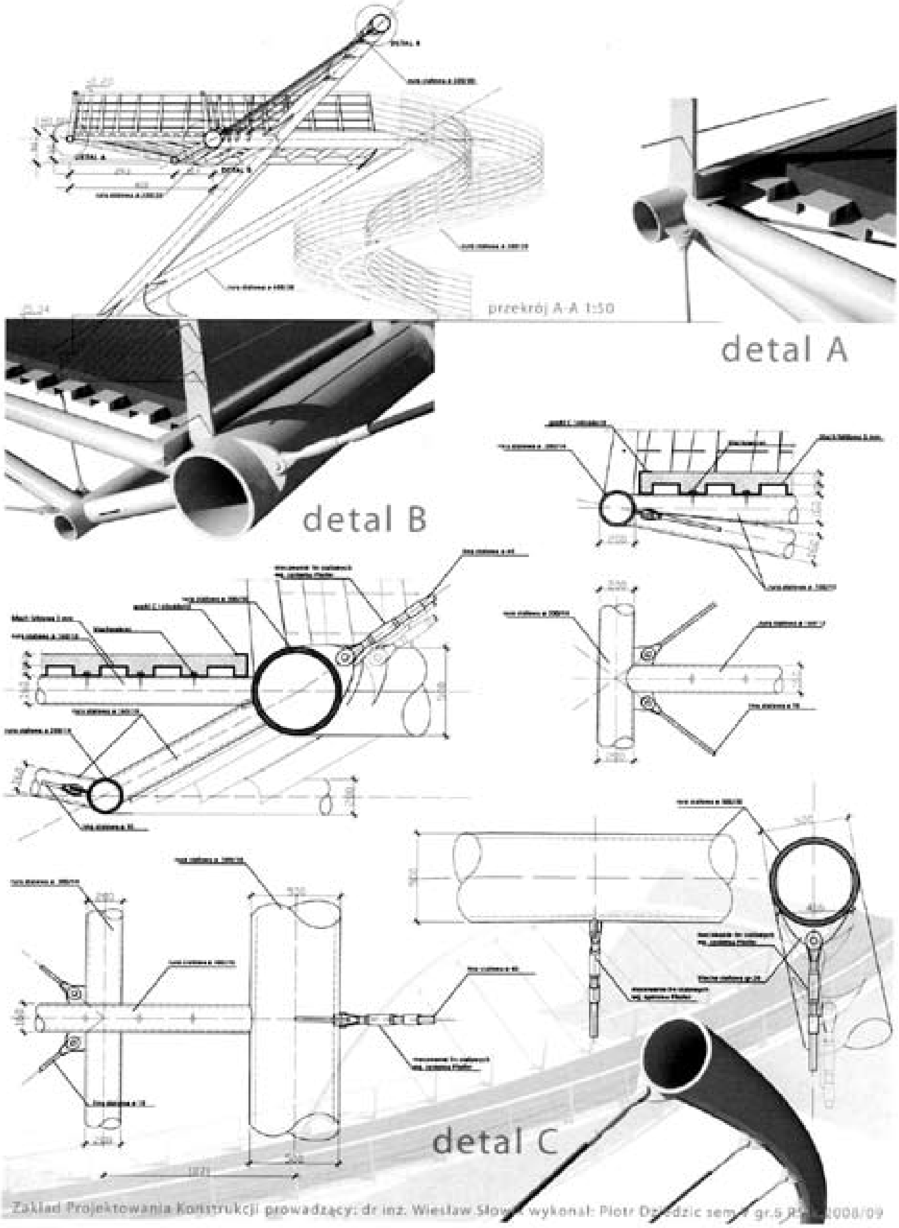

Fig. 2

Structural Design – Footbridge: details (views and working drawings).

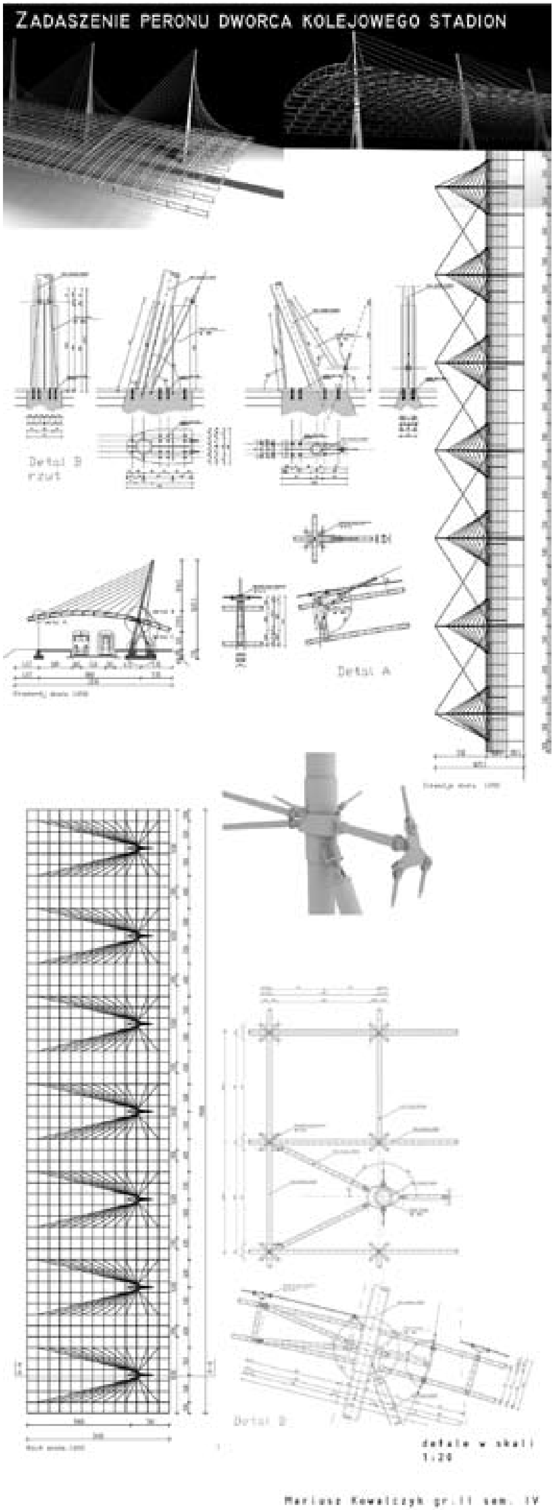

Fig. 3

Structural Design – Canopy over railway platform – general view and details.

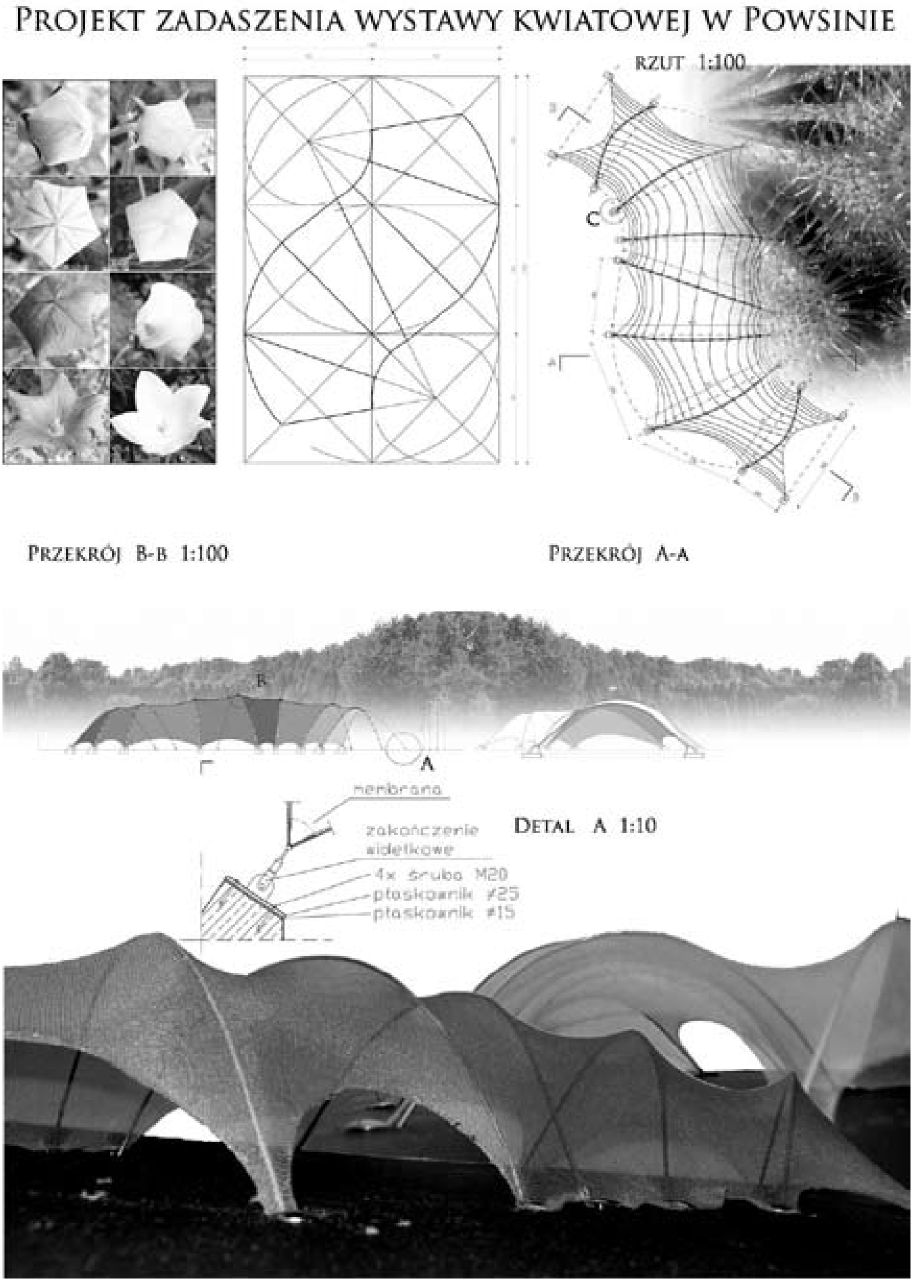

Fig. 4

Structural Design – Textile roof over exhibition area: general arrangements.

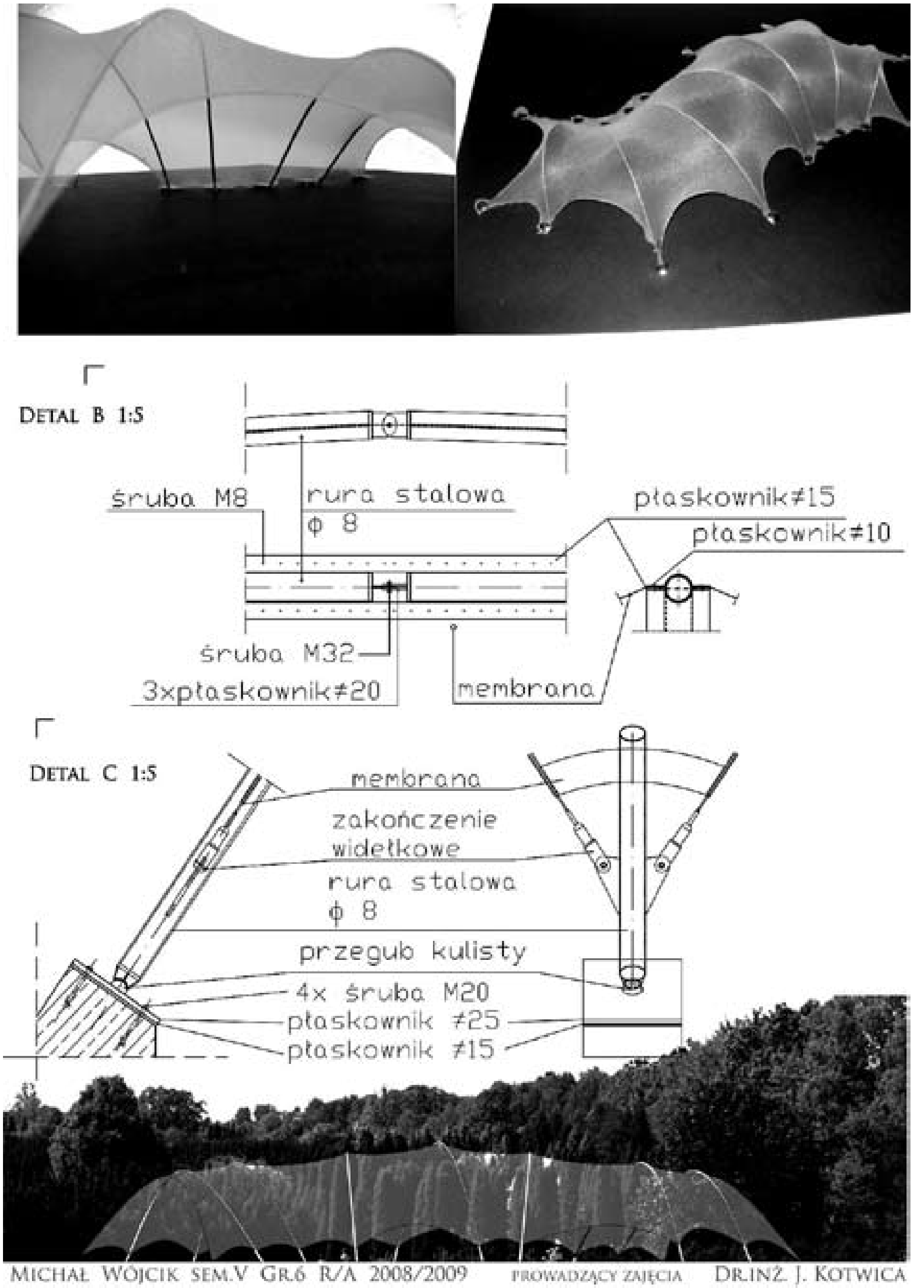

Fig. 5

Structural Design – Textile roof over exhibition area: views and details.

In practice, separate subjects are taught by specialized teachers (though in most cases they are architects, the majority of them having external professional practice) who are grouped in their specialized units. Exchange of detailed information about contents of didactic programs and teaching methods between units is very rare. Due to a large number of specialized subjects and limited study time most of teachers have a feeling of shortage of time for intensive transfer of knowledge to students. As available time cannot be extended, one of the ways to save it is a reduction of transmitting the same information by several units. For example, in the first year construction course we have to submit general information about structural elements or the physical processes so students can comprehend the complex character of the building. Structure and Building Physics courses are in the second and third years and are dedicated to a more comprehesive knowledge of the subject with appropriate calculations etc. It is necessary that the teachers of several units know details of mutual didactic programs. This may help to omit unnecessary repetitions and allow them to refer to information obtained previously. This mutual understanding of what other programs are doing has been insufficient in our school and currently we are working to establish better inter-program understanding. Generally the need for integration is espoused by most teachers from all specializations, but practical realization of this task happens rarely.

Another, possibly more important factor, is the involvement of students in the task of integration. Students have some problems with unaided uniting of different parts of knowledge. Training of such ability should be incorporated into teaching courses. We found that even within the same subject, information given in previous courses are not utilized in later ones. For example, in the Construction course, the knowledge about constructional and material arrangement of main building members (walls, slabs) delivered in the first year are forgotten when the exercises relating to glazed curtain walls and their connection with the main building structure are carried out in the second year.

Substantial integration can be realized in two ways:

a. organizing *joint exercises* with various specialists,
b. stressing interrelations between several aspects of designing and constructing reality *within the specialized subject*.

Joint exercises (usually difficult due to "hours" (money) assigned to particular sub-departments). In our school we organized an architectural design studio of fourth year with direct availability to structures and services specialists. The result was not satisfactory due to the fact that most students did not consult with these technical specialists while they were developing their architectural concepts. They did it at the very end when the introduction of any corrections which would make the design technically more realistic was not possible. In such an arrangement the success depends mostly on design teachers and appropriate timing in the design process. Nevertheless we will try again to introduce this form of cooperation more efficiently as this form most closely resembles the designing process in the professional office.

I am a representative of the Construction Unit and I will present some subjects of our technical department (Construction and Materials, Building Physics, Building Mechanics, Structures, Services).

Fig. 6

Seminar – Developing of architectural and construction details (A): architectural view of small country house with gable walls clad with wooden logs

Fig. 7

Seminar – Developing of architectural and construction details (A): formal inspirations -wooden logs

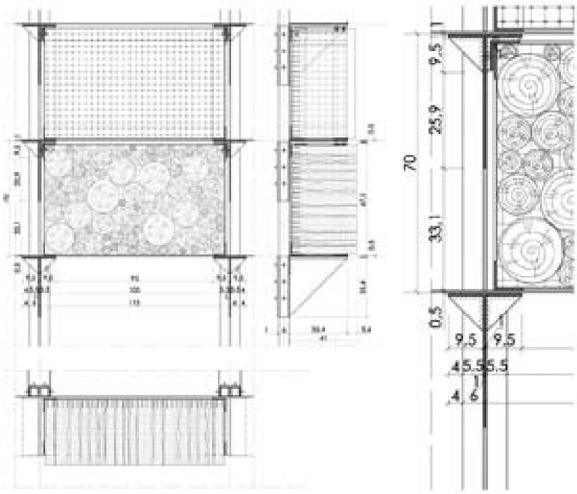

Fig. 8

Structural Design – Developing of architectural and construction details (A): technical details of gable wall cladding

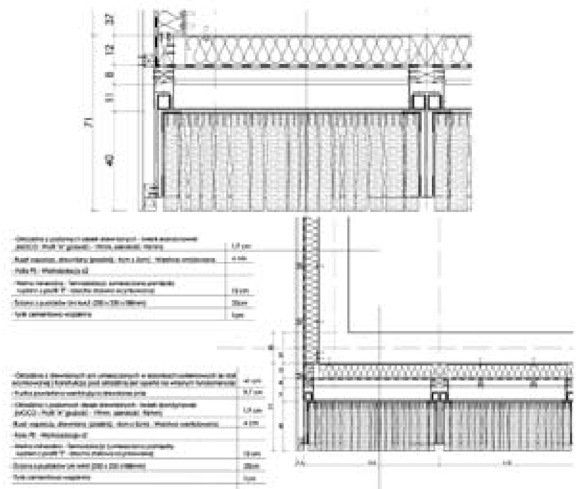

Fig. 9

Seminar – Developing of architectural and construction details (A): technical details of gable wall cladding

Stressing interrelations within the specialized subjects:

Structural Design: executed in Structure Unit, terminating the four semesters course of building mechanics and structures, allowing students to show their abilities in both technical knowledge and developing of architectural form. Students have to design an architectural object in which the structural part is dominant and has an impact on an architectural form such as a footbridge, an exhibition pavilion, the roof of a stadium stand, a mobile structure, an observation tower etc. Preparation of the design during the semester is carried out in some stages:

- lectures and seminars concerning adequate types of structures,
- concept of the structure of the chosen object,
- dimensioning of structure, basic calculations,
- working out of chosen 3-4 details
- presentation and exhibition.

Presentation should include a 3-dimensional view in the form of a visualisation or physical model.

Construction and Materials (four semesters in the two first years): in our teaching, when introducing knowledge of materials and technologies, we try to stress their connection with the architectural form, showing in lectures and seminars many examples of existing buildings photographed in various stages of their realization. Also the physical samples of materials are presented so that characteristics like weight, internal structure, external facture, and colour are experienced. Also the technical drawings done by students in form of plans and sections are supplemented by 3D visions in axonometric or perspective form so students can imagine the architectural result of their technical proposals.

In our view, one of our courses is especially valuable. It is the fourth semester terminating Materials and Construction two years course and concentrating on the translation of the architectural concept to real technical design. Students develop the design at the working drawing stage with necessary technical specification on the basis of their concept architectural design from a previous semester. Thus they have to verify their own primary decisions, analyse the structure, determine materials and make decisions regarding construction solutions. Students prepare a documentation booklet containing drawings and specifications similar to those submitted when applying for a building permit.

Elective seminar in the fourth year – *Developing of individual architectural and construction details*

This exercise force students to find the way from formal concept form to the technical solution taking into account:

- developing of form: proportions, materials, visual effect (in connection with the architectural form of the whole building),
- looking for inspirations in existing architecture,
- working out the technical and material solutions,
- presentation in front of the whole group, discussion.

Fig. 10

Structural Design – Developing of architectural and construction details (B): adaptation of old fortifications for exhibition function – external view

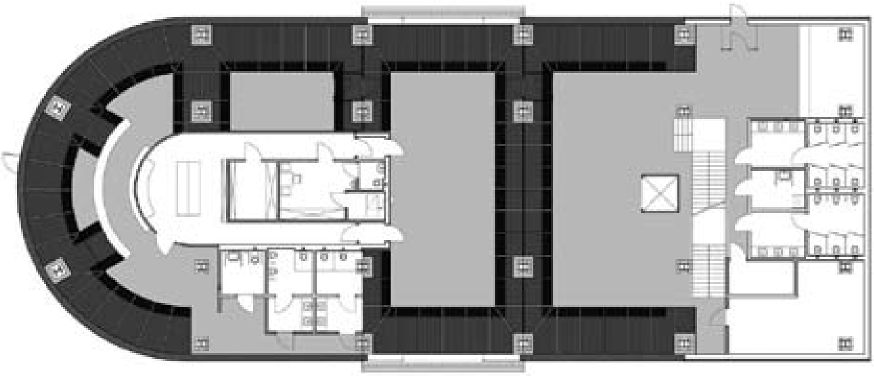

Fig. 11

Structural Design – Developing of architectural and construction details (B): adaptation of old fortifications for exhibition function – plan showing old and new parts

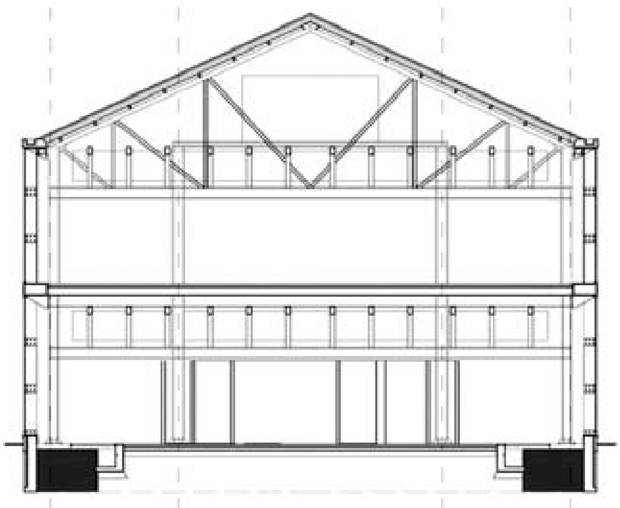

Fig. 12

Seminar – Developing of architectural and construction details (B): section showing old and new parts

Fig. 13

Seminar – Developing of architectural and construction details (B): inspirations (roman thermae in the Archeological Park in Xanten, Germany)

Fig. 14

Seminar – Developing of architectural and construction details (B): inspirations (roman thermae in the Archeological Park in Xanten, Germany)

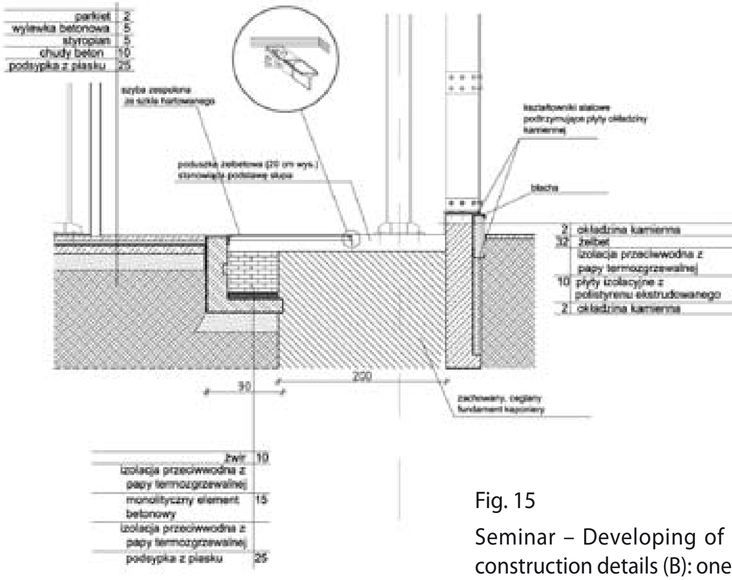

Fig. 15

Seminar – Developing of architectural and construction details (B): one of detail drawings showing technical and material arrangements

Students who took part in this seminar base the development of their details mostly on their diploma design which is being also developed during the same semester.

Similarly, a very useful but time-consuming form of teaching, are the *individual consultations* especially *connected with diploma design*. The objectives of a Bachelor stage diploma (after fourth year) contain elaboration of the material and technological aspect including individual details. The Master stage diploma has a different character with a stronger emphasis on theoretical issues where the designed building, properly constructed, is a sort of material proof for the presented thesis. Students are strongly personally involved in developing their own ideas properly and trying to find the material and technological solutions appropriate to their desired formal concept. I wish, again, to emphasize that ultimately face-to-face consultation with the individual student is necessary. It is my opinion that this is the most effective form of communication with the student.

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Project 'aware'

The management of complex processes and projects is the key to understanding the major issues identified in the field of contemporary building.

Training has a responsibility to turn virtuous processes of experimentation and comparison to answer the need for new skills which can match the formal elements of architectural language fully with the demands of 'practical feasibility' of the project for the scenarios that prefigure today.

Recent reforms of study courses[1] have radically altered educational paths and didactic models, resulting in an experimental state that is still too limited in time to be able to draw any widespread conclusions.

All the same, this phase allows us to study the proposals put forward for educational paths to try and understand the reasons and principles that underpin this new cultural project.

The *European memorandum on teaching and education,* after having recalled the need to modify educational models to satisfy the requirements of our time, indicates a precise way forward, stating that, "What is most important is the capacity to create and use knowledge in an efficient and intelligent manner on foundations that are constantly evolving"[2].

J. Delors' UNESCO White Book deals explicitly with the necessity of being able to move from the concept of ability to that of competences for two fundamental reasons:

- the *immateriality of work*; with the preponderance of technologies it is necessary to know how to apply cognitive and IT resources. Professional ability becomes redundant and increasingly the essential prerequisite will be the possession of personal competence.
- the *dematerialisation of work*; this will require of the individual not only ability, but many other qualities such as socially mature behaviour, the habit of working in a group, and a spirit of interdependence and creativity that are components of individual competence.

For E. Cresson[3] the nature and features of the formation of knowledge in society is defined by the following lines of argument:

- the *obsolescence of knowledge*; cognitive society increasingly confronts the individual with the precocious ageing of his cognitive baggage that, as a result, will constantly turn out to be inadequate for dealing with each individual's life and work situations;
- the *growth of the cognitive potential*; if an individual's cognitive baggage is going to be increasingly inadequate, in the future it will be important to possess an adequate cognitive potential, that is, the capacity to research, transfer and create the necessary knowledge in determined life and work contexts.

Thus, cognitive potential becomes the totality of cognitive procedures, instruments and conduits that allow the individual to achieve knowledge.

The world of today and tomorrow will require of the individual not only *adaptive behaviour*, that is, the application of knowledge and abilities to given contexts, but also and above all *creative behaviour*, that is, the capacity to know how to research constantly, and select with the aim of creating the knowledge that is required to act in a determined context.

In Florence University's Architecture degree the educational project is based on the application of these principles, offering an alternative teaching model to the traditional one for the construction of knowledge, where greater weight was given to preparation and theoretical training.

In the new model, what prevails is the "constructive" concept of knowledge that passes through the reflection of "what to do" to construct the theoretical system and the necessary capacities for facing up to a variety of situations that are often thematically and organisationally highly complex.

1° semestre	2° semestre	3° semestre	4° semestre
LABORATORY OF STRUCTURAL PLANNING *Plan o structures* *Applied mathematics* *Mathematical analysis* **LABORATORY OF TECHNOLOGICAL AND ENVIROMENTAL PLANNING** *Technologies of the plan* *Techniques of the control acclimatize them*	**LABORATORY OF PLANNING FOR THE CITY RECOVERY** *Architectonic planning III* *Architecture of the inner ones* *Technologies of the materials* **LABORATORY OF RESTORATION** *Restoration I*	**LABORATORY OF ARCHITECTONIC PLANNING** *Architectonic planning IV* *Distributive characters of the buildings* *Theories of the structures* **LABORATORY OF URBAN PLANNING** *Urban planning* *Territorial planning*	**PROJECT - FINAL TEST**
History of the contemporary architecture **Economic appraisal of the plan**	**History of the city and the territory**	**City sociology**	**Advance techniques of Rappresentazione** **2 matters to chosen of the student** **Formative Workshop/Stage**

Fig. 1

Architecture degree – Faculty of Architecture, Florence, Italy

In particular it is necessary to prefigure competences that have connotations of predisposition to interdisciplinarity and the communication of information between specialised sectors.

With respect to the vast knowledge that characterises the figure of the "generalist architect", what then prevails is the weight of expected results expressed using the Dublin descriptors[4] system:

- Knowledge and understanding
- Applying knowledge and understanding
- Making judgements
- Communication skills
- Learning skills.

A didactic model that significantly increases the potential of the planning experience of students (2 projects per term), to teach them to "know how to" and above all to enable them to build a theoretical system with different modalities of teaching and learning.

As regards the creation of competences, an important comparison is made between the disciplines that utilise the instrument of the plan as an applied model of interdisciplinarity, using on occasion the different specialist contributions that are involved in the complexity of contemporary planning processes.

Project strategies are increasingly aimed at a system of priorities and indications that call to mind two prevalent tendencies:

- eco-efficiency, as a measure of the conservation of available resources;
- innovation, which utilises the contributions of new technological potentials and proposes different ways of conceiving of the project.

In this, the role of technology is that of contributing to resolve or foresee the problems caused by the application of an inappropriate model of use of resources or space. This does not necessarily imply an exclusive increase in technical efficiency, but it can also put itself forward through the planning definition of systems that can, on the basis of existing resources, produce an improvement in the environmental and social system.

The strategies that shape the Laboratory of Technological and Enviromental Planning (Lab PTA) show the approach of a training method designed to deny the prevailing logic of the "hasty decisions and blind", for food, however, a process of participation of users and clients able to promote greater awareness of the choices on the transformation of land through "realistic solutions, and thought leaders."

The objective is to contribute to the formation of an architect who, in full awareness of the constraints placed on the architectural design by the requirements engineering, functional and safety of the work, has the ability to coordinate and harmonize the contents of the architectural language with the technical-scientific for a complete and correct definition of the project.

The teaching method designed to provide knowledge and skills through experience to real-life project for the development and monitoring of project interventions architectural complex.

The aim is to provide the student with knowledge and methodological tools designed to reach qualified operational capabilities to address the planning process from the survey of needs to reach a constructive response consistent with the environmental and economic resources available.

Integrating the organizational, technological and design skills with technical and physical plants are addressed, with esigenziale-performance approach, the phases of planning, design and management of works, the effects of the specific regulatory decisions on the project, procedures of achievement, the relationship between building materials solutions and products with low environmental impact, technical information, time, cost, mode of custody and execution of the work in relation to the special characteristics of the entrepreneurial and industrial.

The method

The activity of the laboratory is concentrated on the development of the planning theme, utilising various teaching and verification instruments to overcome[5] the limitations of the traditional lesson and to encourage the construction of the theoretical system, pointing the work of the planning experience towards the value of interdisciplinarity applied in the different phases of the project and on various scales.

The didactic methodology proposed in the laboratory foresees:

– *traditional lessons*, utilised to explore the theoretical and operative implications suggested by the planning theme. They deal with the phenomena stemming from the comparison between the various types of knowledge that run alongside the project (planning technologies, environmental control techniques).
– *themed seminars*, to amplify the knowledge of the theoretical and operative implications involved in the project. Meetings are organised with experts who bring the results of their professional experiences to a number of specific areas:
  - *Landscape and the shape of the environment. Florence, its hills and the Arno.*
  - *New agricultural park, shared planning, Via Larga – Bologna.*
  - *Winning project for planning the new stadium in Siena.*
– *the theme* of the project, selected on the basis of its complexity and suitability for representing a current topic in social debate.
  This year (October-Jannuary 2009) the project selected was for A.C. Fiorentina's new stadium since, as well as involving complex planning elements on the urban and construction level, it also possesses a characteristic of social and strategic value for the city. The students were asked to construct the way to a "knowing" answer to the lively debate in the city: "where" and "how" to build the new football stadium
– The briefing for the project, aimed at understanding the role of the "Preliminary Document", required by the law on public tenders, to launch the planning process and render explicit the intentions of the clients as regards the intervention they are going to commission.
  Setting out from a detailed analysis of the current state of affairs, the students identified the needs of the different types of users and articulated alternative planning proposals, with a strong innovative element that might form the basis for the public

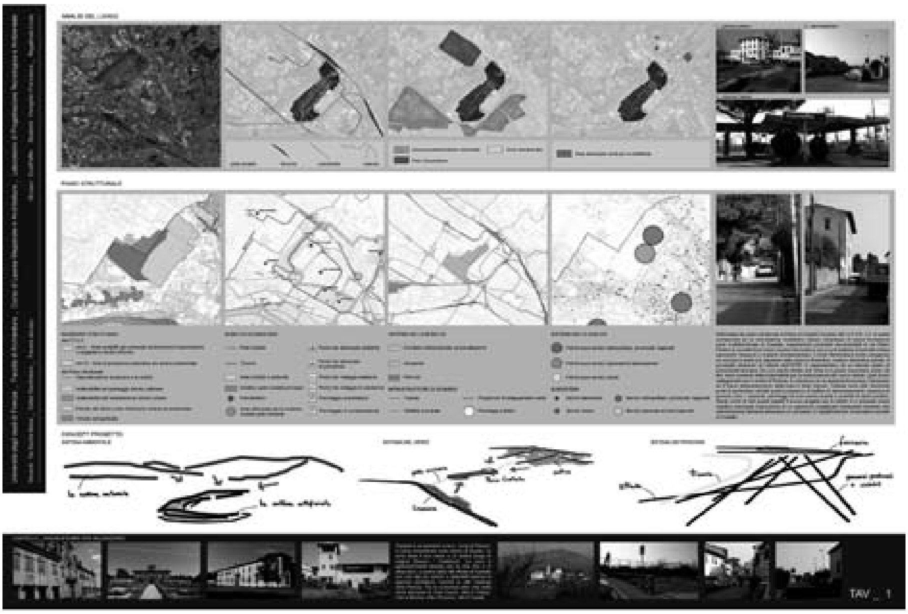

Fig. 2a
Analysis and project concept. (Student: L. Regalbuto, F. Panighini)

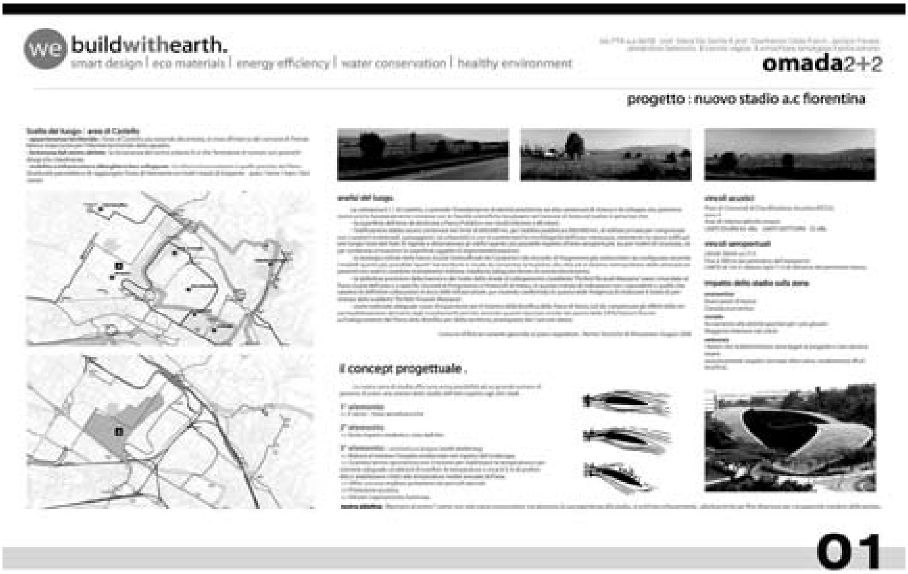

Fig. 2b

Analysis and project concept. (Student: A. Liaskovitis, I. Vagias)

administration's preliminary document. For this reason work was carried out in small groups to elaborate, build and rebuild the shared cognitive maps[6] to activate a shared path of critical analysis with regard to the project.

Each group prepared a presentation to communicate the results of their work and compare them with the judgment of the laboratory.

– *Participation*, using instruments and methods to thoroughly analyse and promote the themes of participation and subsidiarity from the point of view of shared responsibility.

Fig. 3

Participation: "Firenze 1000" The model of the city. October 2009

Understanding the needs of citizens through sample interviews and reading citizens' forums on the topic.

Participation at round tables, organised by the local council on the occasion of the exhibition "Firenze 1000" for the presentation of the plastic model of the city, and critical reporting of the topics debated.

Applying the techniques of brainstorming, problem solving and decision making.

– *the preliminary project*, on the basis of the results of the analysis and the choices made by the group, the project's first formal solutions are proposed, individually.
In this exercise, group planning work in the preliminary phase of the concept is simulated, prefiguring the role of shared participation in the choice of what is considered the most efficient solution. Every student has the responsibility and role in this of communicating their own proposal to the work group and submitting it to the judgment of the whole laboratory.

Fig. 4a
Preliminary project (Student: L. Regalbuto, F. Panighini)

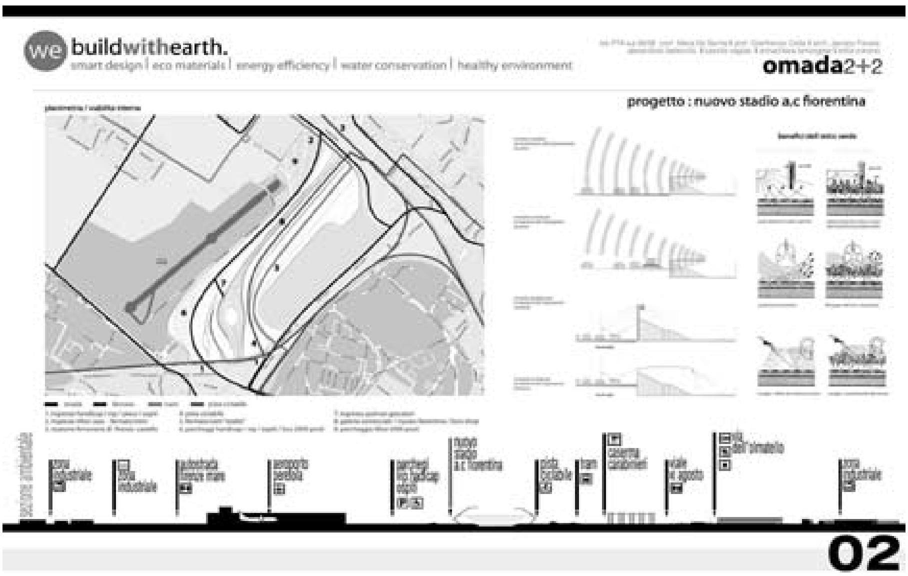

Fig. 4b
Preliminary project (Student: A. Liaskovitis, I. Vagias)

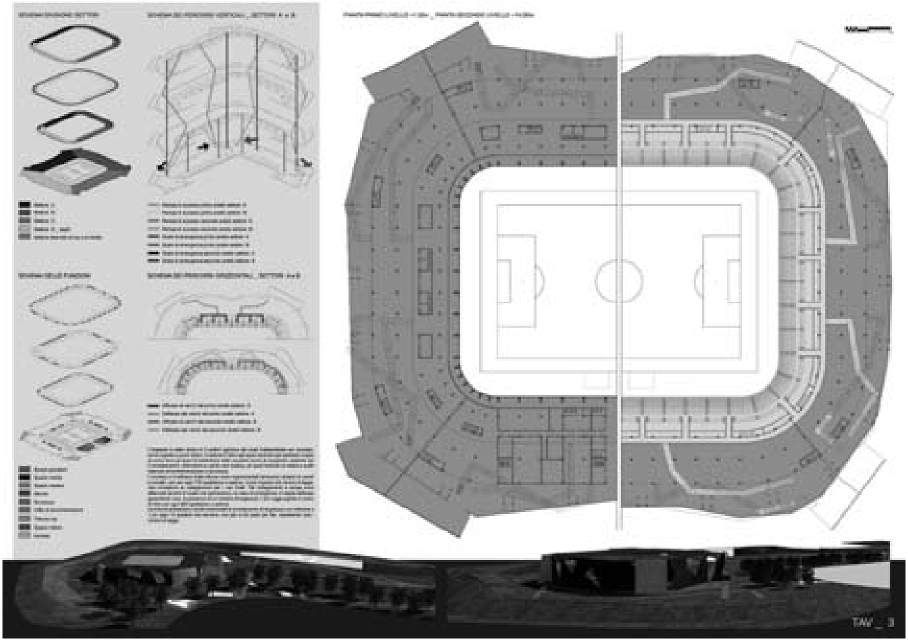

Fig. 5a
Project development (student: L. Regalbuto, F. Panighini)

- *project development*. In this phase the project is developed and checked in all its aspects (functional, distributive, constructive, plant-related, etc.) arriving at the stage of defining the preliminary project including construction choices up to the definition of the structural solution and the details of the shell.
  The introduction of innovative technologies passes through the research and analysis of exemplary projects and in this the student applies the necessary procedures of verification and adaptation to evaluate the efficiency and coherence of the planning choice.
  In this phase, verification instruments are used that go from the application of the regulatory framework in place to methods of calculation and verification of the environmental parameters to the use of software for the preliminary verification of the structural functionality (utilising the instruments supplied by the structural planning laboratory that is taking place at the same time.

The laboratory, which takes places between October and January, concludes with a presentation of the final elaborations from the laboratory and a collective show that takes place at the end of the first semester, a shared occasion for verification and debate between students and teachers on the didactic methods and results obtained by the technological process.

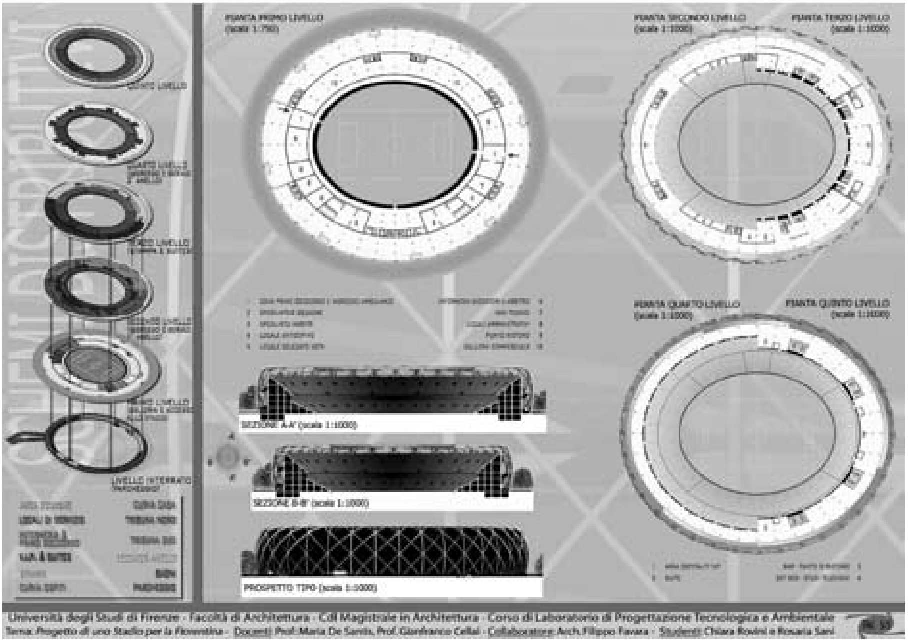

Fig. 5b
Project development (student: C. Rovini, R. Sani)

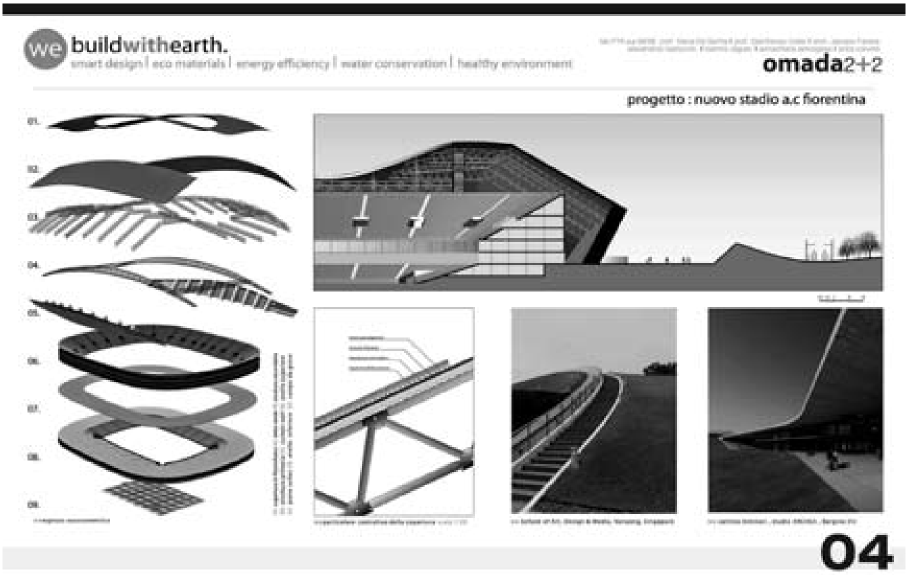

Fig. 6a
Construction (student: A. Liaskovitis, I. Vagias)

Notes

1 Decree 21 December 1999, n.509 – Regulation containing norms concerning the teaching autonomy of the universities. G.U. n.2 of 4 January 2000

Decree 22 October 2004, n.270 – Changes to the regulation containing norms concerning the teaching autonomy of the universities, approved by decree of the Ministry for Universities and Research 3 November 1999, n. 509. G.U. n. 266 of 12 November 2004

2 CCE-30.10.2000, Memorandum on permanent teaching and education, Brussels, SEC(2000) 1832.

3 CCE (E. Cresson), Insegnare e apprendere: verso la società conoscitiva (Teaching and learning: towards a cognitive society), Brussels, 1995

4 Descriptors of study titles adopted in Europe and of EUR-ACE credit model (art. 3, paragraph 7, Decree 16 March 2007, Determining the classification of university degrees. GU n.155 of 6 July 2007 – Ordinary Supplement n.153.

5 G. A. Kelly, *The Psychology of Personal Constructs*, Volume 1, Norton, New York, 1955. According to the pedagogical theory of "constructivism", knowledge is the construction or, more exactly, the reconstruction of knowledge each of us possesses.

6 Tolman E.C. (July 1948). "Cognitive maps in rats and men". *Psychological Review* 55 (4): 189–208

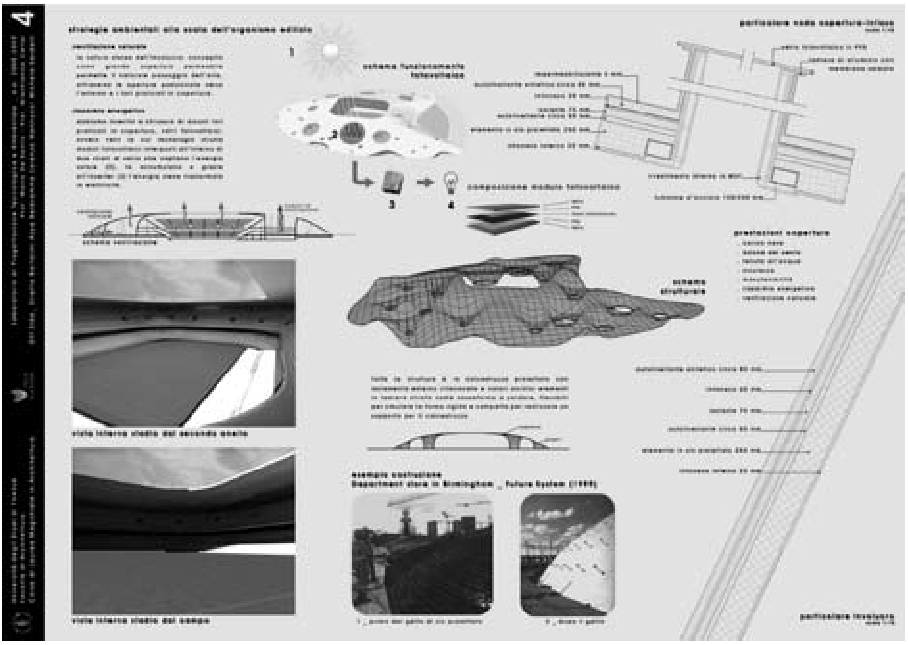

Fig. 6b

Construction (student: D. Bartolini, A. Beltramme, L. Mannucci, M. Sardelli)

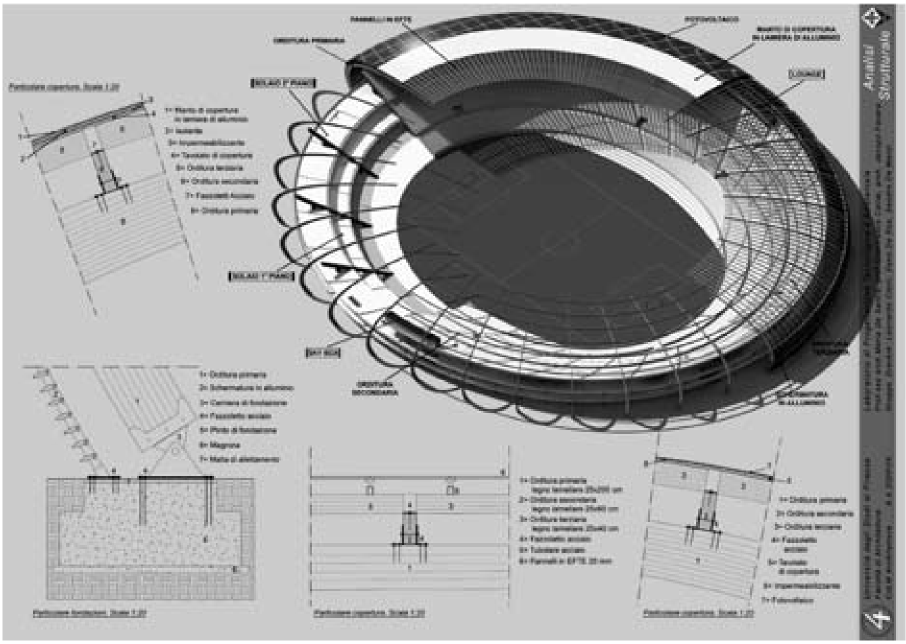

Fig. 6c
Construction (student: L. Cioni, Z. Daros, S. De Marzi)

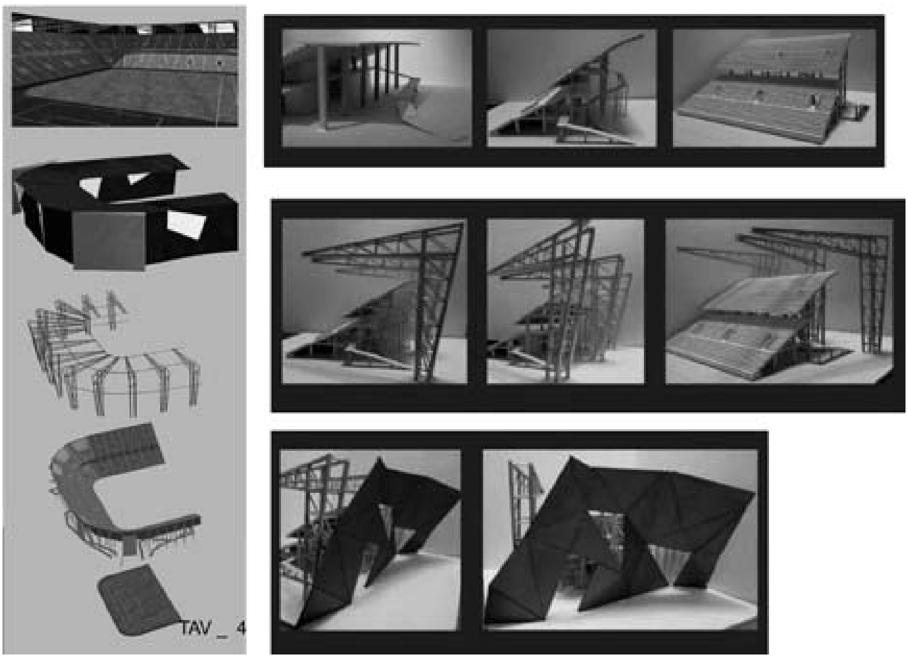

Fig. 6d
Model (Student: L. Regalbuto, F. Panighini)

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Integrating Architectural Design and Construction Modules: From Concept to Structure

The first aim of this paper is to show the role of "integration" in the architectural design and technology teaching at the Aristotle University of Thessaloniki in School of Architecture and especially in the construction and technology courses. This will be attempted by briefly presenting the last five-year experience of our construction team, following different teaching paths. Secondly, it touches upon different approaches for familiarizing students with the complex "synthesis-materiality-construction". Lastly, it proposes the implementation of more innovative and integrative methods and strategies in architectural design and technology teaching.

A1

During the last five years, the primary objective of technology courses at our School of Architecture has been to provide students with the essential knowledge, so that they acquire a firm basis for constructing with regard to specific elements of a simple dwelling. At the same time, there has been an effort to render them familiar with the idea of "materiality" (fig.1) but also they are asked to handle the structure of the building (fig.2). Through plenty of examples, students learn how someone can design different structures by using different materials.

Fig. 1
Photorealistic design of the first years studio

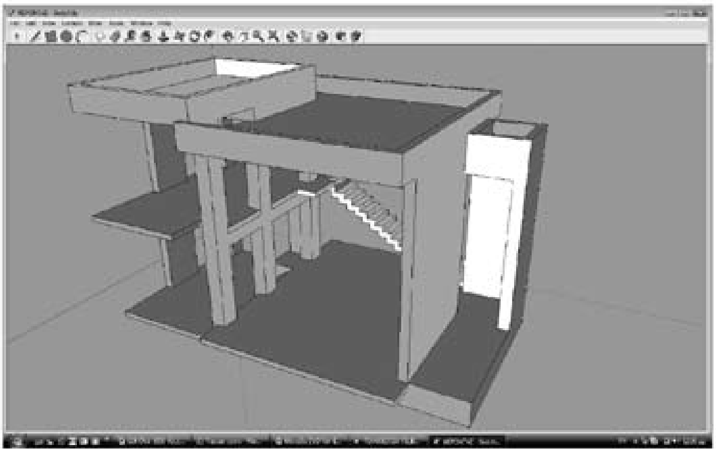

Fig. 2
3D design of the stucture

During the second year of studies, students focus on creating a complete architectural project. In the annual exercise, they have to manage the design of a small dwelling in the first semester (fig. 3-8) and its structural details (fig.9) in the second one. The main features of the external and internal building materials are analyzed in parallel lectures.

Fig. 3
Photorealistic – project A

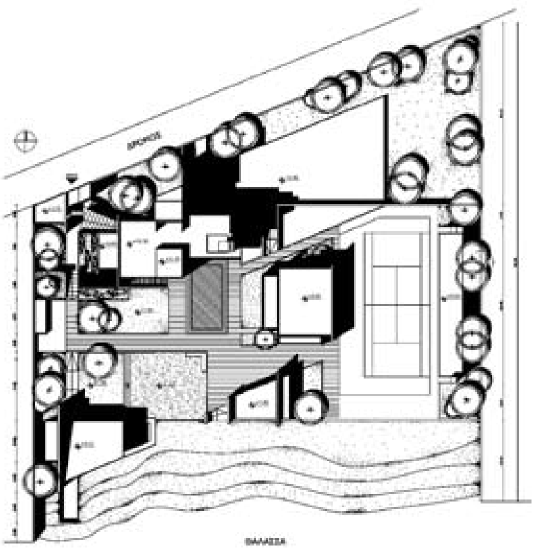

Fig. 4
Ground Plan - project B

Fig. 5
Main building – project B

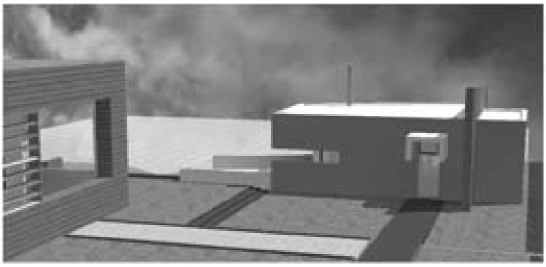

Fig. 6
Office – project B

Fig. 7
Office – project B

Fig. 8
Dwelling – project C

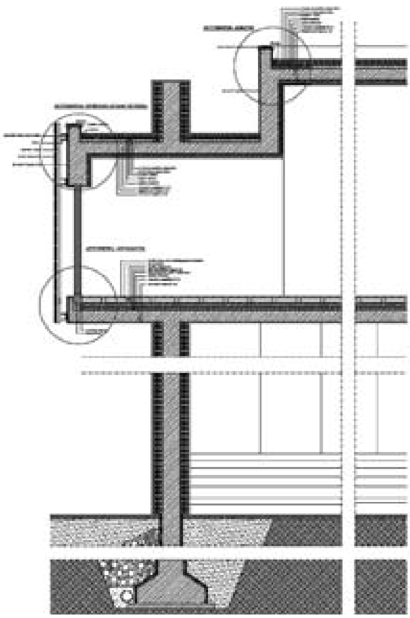

Fig. 9
Construction detail – project C

It has been shown by experience that students feel anxious when they deal with construction details, as they usually hardly realize that they are responsible also for the materialization of their project.

There is no doubt that the Architect's golden standard should be to secure a "balance" between architectural synthesis and construction details, theory and practice. Therefore, this balance should be part of an integrated educational process. The evaluation of this construction teaching method has shown that it was not so effective in creating a link between concept and structure and did not manage to fulfill the evaluation criteria, and more specifically the latest architecture student performance criteria.

A2

In the meantime, more discussions arose within the teaching group which have led to reassessment of the whole concept of technology teaching, including the addition of more courses for the next years. The courses are now aiming at further enhancing the relationship between synthesis and structure details, materiality and technology, by focusing on architectural concepts that can be designed in a highly detailed structural way. The annual studio is still supported by a series of lectures that support the theoretical part of the teaching method. During these lectures, the basic building materials are presented by pointing to their construction details and technical features during the first years, whereas more complicated and smart materials are presented in the following years. Also, emphasis is placed on cultivating the Architect's ability of communication and collaboration through design methods and codes. Finally, a great deal of significance is given not only to technology but also to environmental design and sustainable architecture. The educational aim is for the student to go thoroughly into research, analysis and understanding of the materiality of architecture, while being able to manage construction details. Lectures support the evolution of the studio work.

B1 Modernization of European universities - competitiveness through the worldwide market of knowledge

By adopting a Resolution, the Council of the European Union looks into ways for modernizing Europe's Universities having set three targets: Education, Research and Innovation. The key challenges were identified and indicated in nine sections which compose the agenda of modernization: a) Management of Universities, b) Interchange of Students, Staff and Researchers, c) Independence, d) Reports & Co-operation with Business Community, e) Support to a Program of Proficiency (Distributive Education) and Research, f) Interaction of Knowledge and Academic Community, g) Reward of the Best, h) Study Programs, i) Financial Support.

Within the field of Business and Culture, the E.U. supports initiatives promoting the improvement of the European academic network, as well as those targeting more global interchanges. This is the new initiative field of the Green Paper: "The European Research Area (ERA): New Perspectives Improving Research, Work and Experience". The E.U. Member States will have to draw up a relative report within the framework of the Program "Education and Proficiency 2010".

Lifelong learning programme - European university/business forum 2008-9

A forum has been organized for two years ago, called ''European University/ Business Forum'', based on the idea of a lifelong learning program and supporting the inter-link between Higher Education and Business, no longer promoted as an option but as a "must". In this Forum, everybody welcomed the initiative of the Commission to provide a European-level platform for a structured "dialogue" and interaction between Higher Education and Business stakeholders. So, the question today is not whether there should be cooperation; the question is about HOW to establish such a cooperation. In other words, "implementation" is the issue. There is no doubt that closer and more enhanced cooperation is highly beneficial; it stimulates the exchange and sharing of knowledge in both fields. Knowledge becomes an indispensable part of the teaching, learning and research process in Higher Education while integrating at the same time into the business processes of firms and public organizations. Good cooperation provides the basis for longer term relationships that generate a wider variety of opportunities and returns. The insights arising from working together are valuable for both parties. Exposure to real problems and solutions via relevant curricula and placements enriches student learning and prepares students for future employment. Working together on a regular basis and with a long-term perspective creates mutual trust and can lead to ambitious partnerships and collaborations that benefit both entrepreneurs/ businessmen and academics.

The topics of the last Forum, addressed during the parallel sessions, were:

- Modernizing Governance Structures within Universities
- Curriculum development
- Entrepreneurship
- Continuing Education and Lifelong Learning
- Knowledge Transfer
- Mobility.

B2 Our approach

According to the 2004 National Architectural Accrediting Board Criteria, students must reach a specific performance level in their work. The assessment of this level is related to the achievement of the following leading targets (chosen as more suitable for the local mentality and the studies programme of auth, among a long list that contains others):

1st year of studies:

- Speaking & writing skills
- Fundamental design skills
- Structural systems.

2nd year of studies:

- Site conditions

- Comprehensive design
- Building service systems
- Building systems integration
- Graphic skills.

3rd year of studies:

- Building materials and assemblies
- Technical documentation
- Environmental systems
- Sustainable design
- Construction cost control
- Architectural practice
- Research skills
- Building envelope systems .

4-5th year of studies - Post-Graduate studies:

- Professional development.

B3 Our proposals

Undrergraduate level - 3 Years of studies

In order for our graduates to fulfill the above mentioned criteria and meet the ever increasing demands, it is accepted that changes in education are imperative. So, it is our duty to prepare for the next day at universities.

The undergraduate education should - in our opinion - consist of two stages:

At the first stage, the aim is for the students to gain a baseline knowledge in order to become architects capable enough of corresponding to the minimum demands of the labor market, efficient to design and construct with reference to the minimum aesthetically acceptable criteria. At the same time, they are introduced to the concepts of building materials and environmental design.

The first step of training involves three basic years of education and is carried out through the first basic courses of lessons. Students initially become familiar with all design conventions, using conventional design tools. Later on, as long as they have already maximized the use of design tools of architectural expression, they are given the opportunity to attend more advanced lessons where they deal with synthesis in its complete form, with regard both to its function and volume handling. At the same time, students deal with issues of "materiality", sun-protection, sound-protection, shading, orientation and ventilation, with the use of digital design tools.

This stage of basic training is completed by teaching students how to cope with the bearing structure and construction problems that are going to arise in their future every day practice. By identifying correct construction details, students learn to intervene optimally to the most "crucial" construction details of a common building. They become familiar with new concepts while the synthetic process is determined. Organized visits to construction areas, on-site practice training in design and structural companies and supporting lectures complete the basic training.

Having already come into contact with the international current status of architecture, new forms, modern materials and technologies, having thoroughly understood the interaction between synthesis and construction and having acquired updated and specialized knowledge and qualifications through the educational process, the architect-to-be has become independent enough to enter the wide and highly competitive European labor market.

Postgraduate level – 2 Years of studies

At this postgraduate level, students are faced with deeper problems of design and structure, so that they learn to cope with more complex projects.

Associated lecture courses support the design studio and expose the student to advanced concepts of Architectural Humanities, Technology and Environmental Design, New Materials and High Technology, Management Practice and Law. These are designed to help students elaborate on their professional knowledge, develop their design briefs and technical knowledge. The objectives are further pursued through personal and group investigative study, dissertation, specific subject areas related to the design project work, integrated design, individually appointed design thesis, all supported by study visits, seminars, tutorials and inter-disciplinary teaching. In addition, through an established Virtual Learning Environment, by attending lectures of value by visiting lecturers (architects and other experts) and by being in contact and collaborating with other professionals (civil engineers, electricians, mechanologists, experts in isolation of sound, light, green architecture, etc), students exchange viewpoints, ideas, knowledge, experience and simulate an actual design and construction environment as if the group is preparing for a real project. In the meantime, they have to follow-up a real and quite complicated, construction area, at all levels of structure and give reports and comments on it. Students are required to submit essays and take written examinations in order to provide evidence for the achievement of the course objectives and final outcome. The whole program has to encourage weekly studio workshops (indoor and outdoor study visits), specialization in different fields, integration between architectural design studio and construction, independent life learning. Teaching incorporates Technology, exclusively by means of digital tools. The introduction of new lessons transforms synthesis into a "collage" of building materials as these are chosen from the European market and adjusted to the demands of anti-comformistic shapes. The aim is fully achieved through the laboratory enlargement and involvement of other specialties, thus converting it into an interdisciplinary studio.

Through their digital work in studios, the architects-to-be come also in contact with the art of creating and constructing new materials, learn to collaborate with special craftsmen and transform their synthetic concepts into action, entering the magical world of industrial designing, building materials & architectural elements which, altogether, create and highlight the personal and particular expression style.

Targets

The objectives set are:

- to develop and present a clear, coherent and integrated design based on knowledge, research and analysis;
- to develop an understanding of the creative role played by construction, structures, material grammar and environmental design in the design process;
- to develop an understanding of the major role played by context in the development of design work (i.e. physical, cultural, social, environmental and economic context);
- to increase understanding of the professional components of the Architect's responsibility to clients and the relationship with professional consultants, relevant public authorities, the building industry and the general public;
- to allow a flexible and integrated approach to professional training within the academic framework;
- to encourage independent learning and problem-solving, while also developing the ability to work as part of a team, listening and critically responding to the views of others;
- to support investigation of architectural specialist fields of study which will promote deep knowledge, scholarly methods and the pursuit of lifelong learning.

Outcomes

As a result, students:

- learn the creative role played by construction, structures, material grammar and environmental design in the design process;
- become fully aware of the major role played by context in the development of design work (i.e. physical, cultural, social, environmental and economic context);
- realize the importance of human individual and social needs in architecture;
- discover the integrated nature of comprehensive design solutions, requiring both the application of environmental design principles and the sound knowledge of construction disciplines;
- develop a determined and reasoned individual design position;
- acquire a critical understanding of a specific subject area in relation to design and demonstrate the ability to structure a rigorous argument pertinent to professional needs;
- become self-motivated and architecturally confident, because they fully understand the nature of the designing process and their potential major contribution and leadership within the professional team.

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Design-built Workshops: Simulating the Design Process – Modes of Inter-disciplinarity, Degrees of Integration

Complexity and inter-disciplinarity in the design process

Historically, the creative potential of inter-disciplinarity has been acknowledged in professional practice and academic discourse. Today, as design possibilities increase and the design process becomes more complex and demanding in terms of knowledge, experience and involved disciplines, strategies for building cross-disciplines and developing inter-disciplinary methods, tools AND ATTITUDES are yet to be outlined.

In design studies, the interaction of design disciplines, as well as the integration of knowledge fields, are attempted in various modes (fig. 1). In architecture education, the traditional approach is based on a segregation of concrete knowledge fields (adopted for methodological reasons), while analytic and synthetic competences are developed in separate modules; the student is expected to combine all pieces, in design assignments (at school) or professional projects (in practice). In a more integrated approach[1], subjects usually taught individually are now merged in the design studio. This approach is evidenced either by outlining tasks and defining elements of the outcome in specific scales or by bringing together a team of instructors and visiting critics with various professional backgrounds or technical expertise.

Nevertheless, as multi-disciplinary as these counteractions may be, the distance between the theoretical exercise and the practical experiment remains and the gap between the institutional approach and the on-site experience is rarely overcome. The paradox between fragmentation in education vs integration in practice persists.

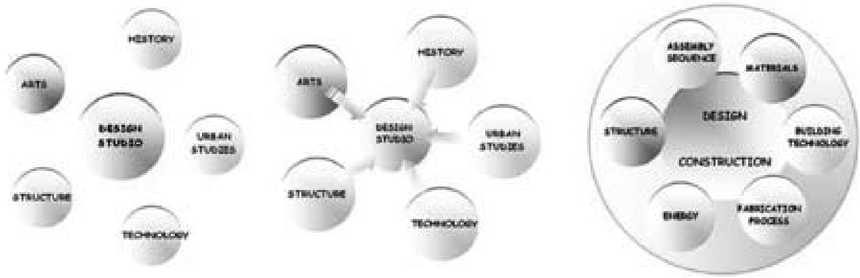

Fig. 1

Varying integration of knowledge fields in the design studio and interaction of technological parameters within the design-built workshop.

The design-built workshop: an efficient training module

The design-built workshop is a module intended to bridge the gap between theory and practice by bringing the conditions of professional practice within an educational framework. Either as part of an academic curriculum (ETH[2], ENPC[3], Buffalo[4]) or in the form of a stand-alone educational unit (Grands Ateliers[5]), it gives the student a unique chance to experience the whole design series from concept to implementation, thus providing the ideal 'place' for interaction and integration. While the challenges and constraints of professional practice are integrated within the process, parameters mostly related to architectural technology, usually theoretically or marginally treated in courses or the design studio, now interact in the design development (fig. 1).

The design-built workshop is an on-site experience to familiarize students with materials, construction and manufacturing techniques and working methods, and to introduce the relationship between the virtual and the physical, the design table and the site. Furthermore, it is a working 'place' to appreciate teamwork, to value multi-disciplinary input, to apprehend the abilities of improvisation and decision-making and to develop differentiated competences. It is a *training module* - the first (?), the only (?) - efficient and effective in developing skills and delivering projects in an environment that is close to reality. For this very reason, the design-built workshop as an educational structure has produced diverse responds[6] ranging from enthusiastic appraisals to skeptical reviews or even attitudes of condescension. While the indisputable power of making explains the first and the final results are open to critical assessment, the actual process and methodologies need to be justified from a pedagogic standpoint in order to resist the latter.

This article presents three workshops as case studies of varying characteristics in terms of project specifics (scale, endurance, complexity), budget and timeframe, student background and teaching support. Pragmatic goals and final results, constraints and challenges, methodology and educational objectives are presented from a pedagogic perspective in an effort to discuss different models of approaching the process, applying inter-disciplinarity and integrating tasks, yet with a common attitude towards experimentation.

Tensegrities workshop: simulating inter-disciplinarity

The first example is a workshop[7] on tensegrity systems conducted at the Department of Architecture at the University of Thessaly in Greece in March 2007. The brief called for the design and full-scale construction of several tensegrity structures. Materials, use and character of installations were open to proposals. Available budget, time and means, along with knowledge background and technical know-how of the students defined the final amount and scale of the installations, as well as the design and construction methods. Twenty-three senior architecture students supervised by one instructor (architect) produced seven pieces in a fifteen-day period (fig. 2) ranging from typical tensegrity forms to industrial design and small-scale architecture structures[8]. Participation was voluntary and there were no credits earned for it.

The immediate goal of the workshop was to provide an insight into these types of structures. While the captivating first impact of tensegrity systems is often confronted with practical limitations, usually restricting applications to physical in-scale models, the actual challenge was to develop a trial-and-error attitude and introduce students to investigating technical aspects through full-scale implementation. In terms of methodology, a 3D-model based approach was suggested, enhancing a non-linear process, encouraging an experimentation-friendly attitude, *simulating inter-disciplinarity* by allocating tasks, yet promoting integration based on 'collective' expertise.

Fig. 2

The five discrete design proposals ranging from art to industrial design and small-scale architecture structures: tower, bench, coffee table, sculpture, bus station.

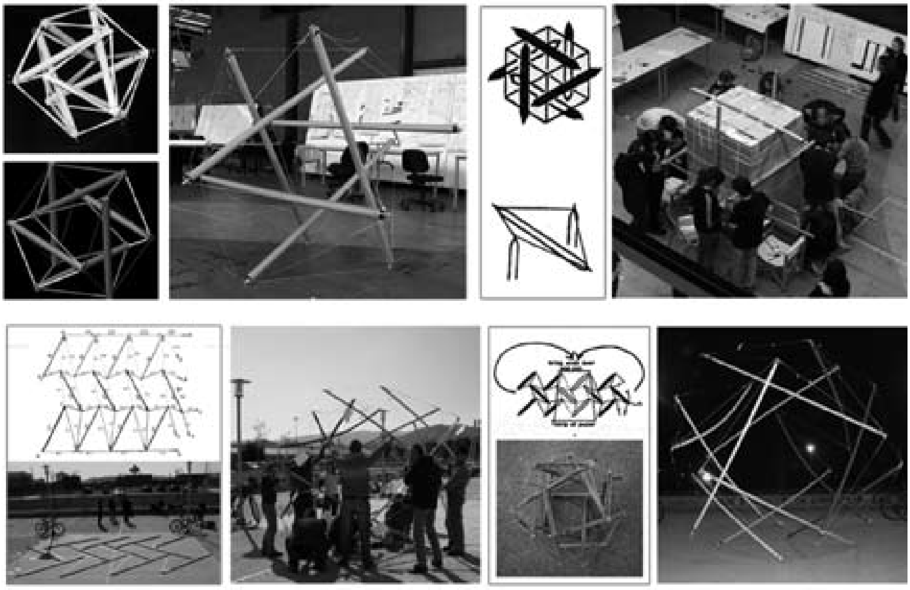

Fig. 3

The two pilot projects (icosahedron, sphere) exploring the implementation process, design and construction methods (with supporting system or layout diagram).

Construction methods were explored in two pilot structures (fig. 3), the so-called team projects, involving almost all students while five discrete design proposals, based on typical tensegrity geometries or well-known precedents (namely sculptures chosen from K.Snelson's work), were developed in groups. In the group projects, the working method (based on the common characteristics of all projects and the recurring nature of concerns) was based on a model of allocating tasks, yet building a 'collective' knowledge. Each group member was assigned a specific task, each group concentrating on a specific project. Thus, every student was engaged in a double interaction (fig. 4); contributing specific input to the design development of a specific project within a group, exchanging information about a specific aspect of the process with the other students assigned the same task. Expertise was adding up as construction was progressing from the smaller to the larger structures; so was self-confidence and team-spirit. For the actual mounting, all students worked together, engaging in a third level of interaction: alternation of degree of responsibility, ranging from full construction management, when it concerned their own design, to simple assembling tasks for the rest of the projects. However, allocation of time, means, people and effort in each project, as well as within the whole workshop, was centrally controlled by the instructor (fig. 5), providing a 'safety-net' to avoid large deviations in time, reduce material waste and secure safety issues.

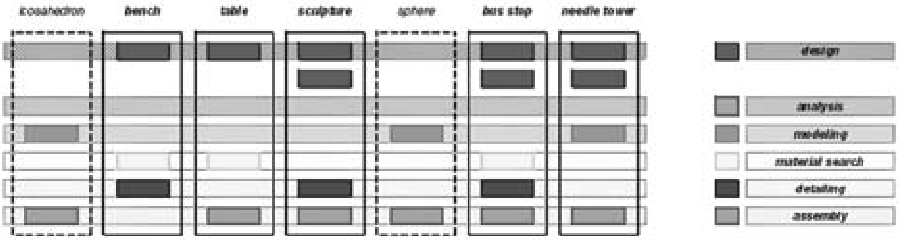

Fig. 4

'Simulated inter-disciplinarity': teamwork and allocation of tasks – double interaction: within the project group and within the task force.

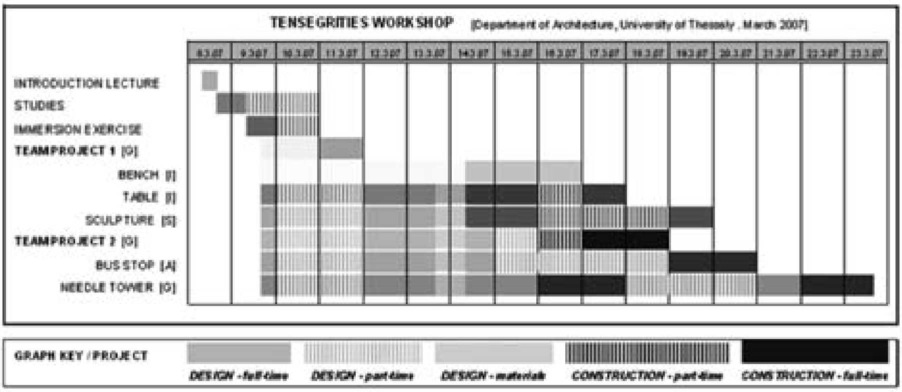

Fig. 5

Tensegrity workshop timeframe: team projects proceeding group projects, construction progressing according project scale.

From an educational standpoint, a workshop on tensegrity systems offers a unique opportunity in design education to explore methods and tools and experiment with the design and construction process itself. The intrinsic characteristics of the structures allow and call for a non-linear design process, while the limited scale of the installations allows the designer to keep control of all aspects. Besides, in this particular case, the initial decision to bypass design explorations by using precedents as a design basis, shifted the commitment of the students towards the problem-solving process of understanding given geometries and finding ways to reproduce them, as well as designing the actual implementation process, yet without losing enthusiasm.

‘Artificial sky’ project: supported inter-disciplinarity

The second example discusses the design and construction of a full-scale experimental ‘artificial sky’ lighting installation, performed in a form of a workshop[9] at the Department of Architecture at the University of Thessaly in Greece in winter 2008. This project was the response to the Department’s decision to add an ‘artificial sky’ facility to its resources. Once the initial feasibility study, in terms of cost, time, means and technical know-how, revealed the possibilities, the final challenge was to develop a custom-design structure as an in-house project by a student team. Real constraints, client and objective related (including limited budget, short timeframe, need for high safety and easy assembly, as well as demand for considerable flexibility and high precision) were defining parameters.

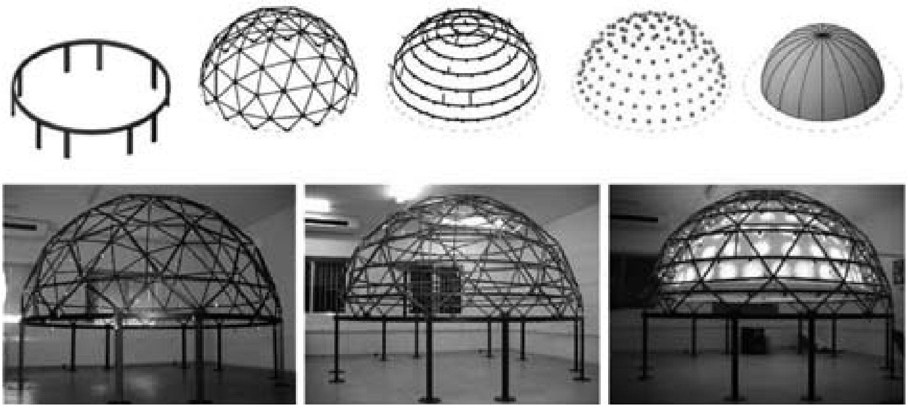

Fig. 6

The elements of the custom ‘artificial sky’ installation: base, geodesic dome, ring-dome, lighting installation, inner fabric dome.

The final installation[10] is a 2.90 m high free-standing steel structure consisting of a primary bearing 4 m diameter hemispheric geodesic dome with pin-joined custom elements combined with a secondary inner ring-dome structure for the lighting installation (fig. 6). In this case, the initial goal served as a motivation for the study of geodesic structures and a semester-long workshop was conducted in multiple steps (fig. 7). Participation was voluntary and there were no associated credits or any other form of compensation.

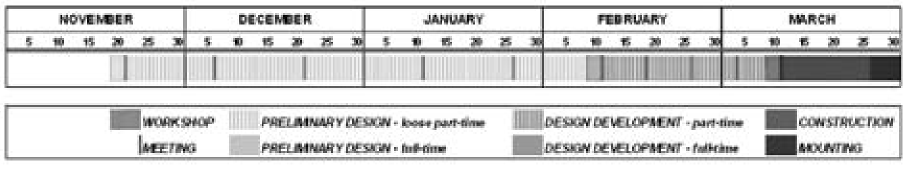

Fig. 7

Artificial sky workshop timeframe: different tasks, varying work intensity and people involvement in each phase.

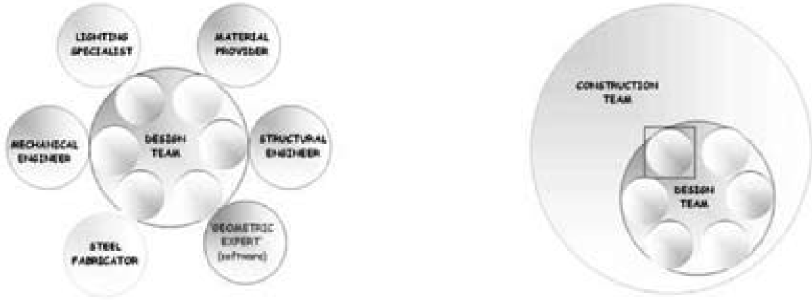

Fig. 8

'Supported inter-disciplinarity': allocation of tasks and expert support – integration: feedback from the professional specialist, input to the design table.

In terms of methodological approach, the programmatic requirements defined the need for a thorough linear process, yet meticulous cross-checking of all parameters, relying on digital technology as much as on applied experimentation, and outlined a model of *'supported' inter-disciplinarity* based on allocation of tasks and assisted growing expertise.

While a larger number of students (thirty) was involved at different phases of the workshop (geodesic studies, material research, preliminary estimates, final design, detailing, fabrication, assembly), the actual designing team[11] was narrowed down to a core group of six senior architecture students assisted by professional specialists and supervised by the instructor (architect) in charge (fig. 8). Students simulated all players in a multi-disciplinary team, each one dealing with and accountable for a specific design or construction issue (geometry, modeling, structure, lighting, construction, assembly). Engaged in a double interaction, students were communicating with the corresponding expert and translating to the team the acquired knowledge. In a rather slow process, centrally controlled, yet allowing for improvisation and adjustments, team members were gradually taking on more responsibilities and control of the project, as specific knowledge was adding up, each one additionally overseeing the corresponding part of the construction process.

The successful implementation of this project (fig. 9), initially confirmed in the actual mounting of the structure (the highlight of the workshop), which was smoothly completed in four consecutive days (fig. 10), and then demonstrated in the first trials of the artificial sky installation, provides a positive evidence about the skills and competences that can be nurtured in an educational framework.

In this case, the key element was the flexible time schedule, which allowed for design and construction interaction and experimentation. A file-to-factory approach was explored, giving the opportunity to experiment with digital technology and manufacturing processes. Digital tools proved to be indispensable for the design of such a complex geometry, while the 1:1 scale mock-ups were necessary for detailing and assembly purposes substituting for lack of experience; both tools proving the importance of experimentation to the design development.

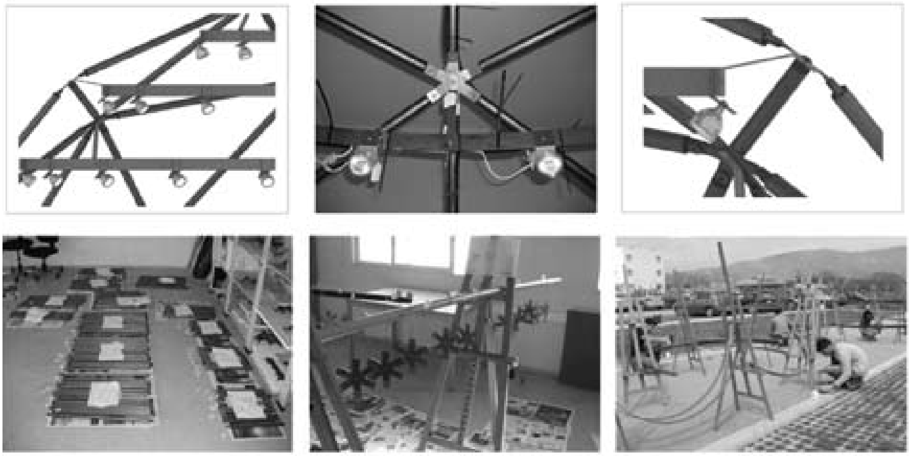

Fig. 9
Construction details and implementation process.

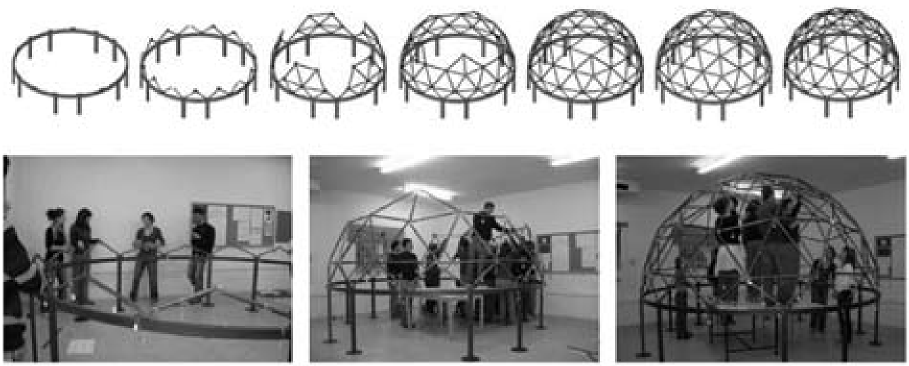

Fig. 10
Assembly sequence of the geodesic dome, smoothly completed in a day.

Building bamboo bridges: multi-disciplinarity in scale

The last example is a multi-disciplinary workshop on full-scale bamboo bridges, performed in France in March 2009. This workshop was one of the eleven themes developed within the framework of the Seminar 'Initiation au Design'[12], held by the Ecole des Ponts ParisTech and the Ecole d'Architecture de la Ville et des Territoires de Marne-la Vallee (other themes included cardboard bridges, light fixtures and sound devices, sculptural installations and kinetic sculptures, armchairs, glider and sailing boat models). The Seminar is an obligatory course (equivalent to 3 ECTS) for first year structural engineering and third year architecture and design students. It is a joint endeavor, addressed to schools of engineering, architecture, design and computer studies in order to promote inter-disciplinarity. Held annually for the past six years, it is a most celebrated educational module, involving more than 200 students and 20 instructors producing within a week about 50 projects around 10 themes every year.

In the specific workshop[13], fifteen students of diverse educational backgrounds supervised by two instructors (a structural engineer and an architect) worked in groups of five to produce three full-scale bamboo bridges in five days (fig. 11). Requirements were the following: 6 m length, 150 kg live load, 3 m^2 clearance. Materials were predefined in terms of type and quantity (bamboo canes and synthetic rope) allowing students to focus on subsequent tasks.

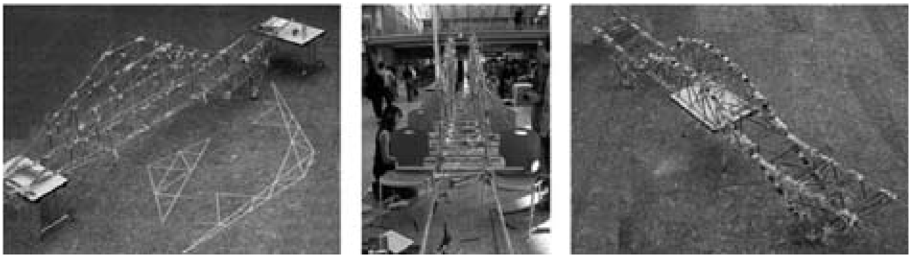

Fig. 11
The three 6 m long bamboo bridges.

The theoretical part of the workshop consisted of introductory lectures on inter-disciplinarity, bridge design, structural principles and bamboo technology, while subsequent tasks included evaluation of structural alternatives, explorations on different geometries, material tests and preliminary sizing, technical investigations on detailing and assembly sequence, actual construction and mounting and, finally, full-scale trials. Digital technology was seldom used, limited to final presentation purposes, while the design development was based on rough preliminary estimates, drafts, sketches, working models and full-scale mock-ups. Final reviews focused on optimum design in terms of material use, loading capacity to overall weight, structural, technical and functional decisions.

The primary goal of these workshops is to integrate structural, material and technical issues into the design process and introduce students in a working environment that is close to reality. Students go through an intense experience, characterized by constraints related to the program, as well as to the process. For this very reason, this endeavor entails a certain risk of reproducing stereotypes as far as methods and processes, especially allocation and sequence of tasks, are concerned and the actual challenge lies in dealing successfully with this probability.

In this case, the methodological approach is based on *real-time integration* (fig. 12). Inter-disciplinarity is achieved by default, yet interaction of disciplines and integration of tasks is by no means guaranteed. The nature of the project themes, usually research oriented, calls for a rather experimental approach (fig. 13); design possibilities rely upon formal and geometric explorations, as well as detailing and mounting considerations, yet the demanding schedule has little tolerance for errors. The actual degree of experimentation, as well as the applied working methods and tools, largely depend on the actual team synthesis and the balance within (fig. 14), basically coming down to three key parameters: the personalities of the students, their confidence in their know-how and their attitude towards experimentation, the latter strongly influenced by the educational background.

From the educational perspective, a multi-disciplinary workshop brings forward different priorities and working methods related to different educational backgrounds. Students start to develop an overall understanding of the project and the process. This is the opportunity to develop differentiated competences related to project, time, people and construction management, as well as communication and decision-making skills (fig. 15).

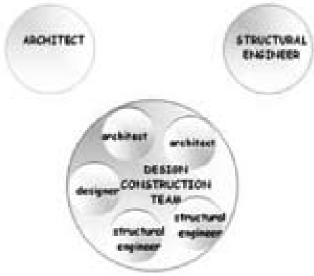

Fig. 12

'Inter-disciplinarity in scale': real-time integration – interaction of students with different educational backgrounds.

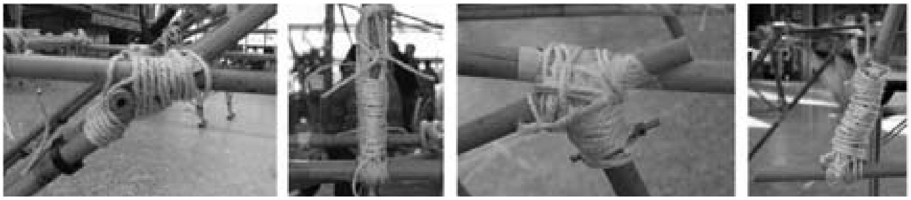

Fig. 13

Construction details of bamboo structures: experimenting with an unknown technology.

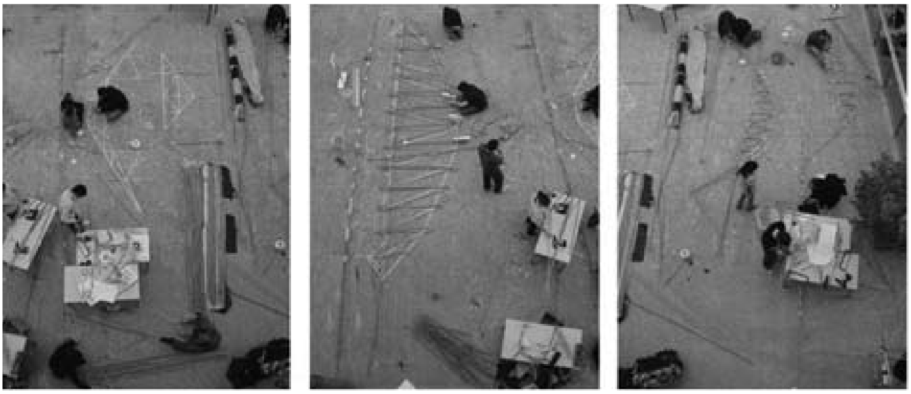

Fig. 14

Experimentation in the design, detailing and mounting sequence, largely depending on the actual team synthesis and the balance within.

Fig. 15

Lessons from real practice and on-site conditions: value multi-disciplinary input, appreciate team-work, apprehend communication and decision-making skills.

The design-built workshop: a meaningful educational structure

The design-built workshop is a module fostering expertise by training, inviting students to deal with real constraints and enjoy the delight of the final result. While providing content-specific knowledge, it is, furthermore, developing a broader know-how, giving valuable feedback to future design practitioners.

From an educational perspective, it is not just the means to acknowledge the structural, material and technical decisions as design parameters; nor just the place to experience the interaction of methods and disciplines; nor just the tool to facilitate design explorations. It is an *educational structure* re-introducing the physical characteristics of the architectural artifact, exposing the complexities of the design process and revealing the importance of experimentation to the design development. The design-built workshop is a practice-based[14] module of applied research[15], nurturing experimentation through merging professional practice with a pedagogic perspective.

In an educational structure, the pleasure of participation and satisfaction of realization cannot solely justify the endeavor, nor does the success or failure of the final result; questions regarding the actual process need to be addressed. Along with the pragmatic goal, educational objectives should be stated defining the skills, competences and attitudes to be developed. A sound methodology, receptive to documentation and dissemination, needs to be implemented identifying the focus of the work, outlining tasks and schedule, defining methods and tools of acquiring knowledge and expertise. Finally, the proper pedagogic strategy has to be conceived, carefully thought-out and wisely planned, understanding underlying challenges and constraints and setting constants and variables, in order to allow for the efficiency and effectiveness of the project, as well as for the validation of the learning process.

Putting together a design-built workshop is like setting up a play. While experiencing the performative nature of building, enjoying the process and celebrating the result, meticulous preparation, vigorous guidance and ardent commitment are needed to bring forward a meaningful performance.

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Session 3.2

Integration of environmental issues

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Linking and Integrating- Sustainability and Architectural Technologies

Context

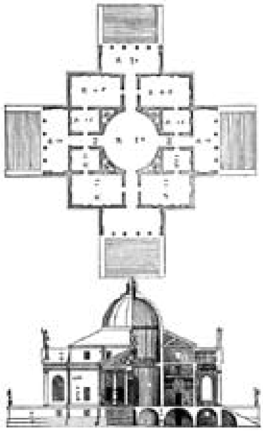


Fig. 1
Villa Rotunda
Palladio 1550.

Fig. 2
Jacobs house
Frank Lloyd Wright 1943.

Fig. 3
Sanatorium Paimio
Alvar Aalto 1930.

Sustainable architecture is not a recent invention; it is a rediscovery of an old set of design principles that places the emphasis on quality rather than quantity (ACE, 2002). Traditionally, the design of buildings responded to and modified microclimate, realised internal and external spaces appropriate to their function, were constructed from indigenous materials by local crafts people, and provided somewhat comfortable buildings with minimal impact on their surrounding environment during their life cycle. With the evolution of a changed social and commercial context, expanding regulations and legislation, increasing scale of work and specialisation, and the development of new materials and methods of construction, modes of practice and building procedures changed (O'Cofaigh, 2001). While many of the changes had the potential to be beneficial, the focus on quantity and intensity has reduced the emphasis on life long environmental quality (ACE, 2002).

The Union Internationale des Architectes (UIA) Declaration of Interdependence for a Sustainable Future (UIA/AIA, 1993) states that architects "must rediscover what it means to create buildings that have less of an impact on the environment" and should commit to "placing environmental and social sustainability at the core of their practices and professional responsibilities".

Not withstanding the EU and national legislative requirements for building designers to reduce carbon emissions and design energy efficient buildings, we as educators should be providing our students of architecture with skills to meet the policy outlined in the Architects' Council of Europe (ACE) Architecture and Quality of Life - "to deliver high quality, sustainable architecture" and prepare them better for professional life. "Sustainability issues cannot be considered only in their technical dimensions, as of their nature, these approaches and systems can have profound architectural implications" (ACE, 2004).

Many professional bodies have incorporated UIA and ACE principles in ethical codes and there is agreement that the concept should be integrated into professional practice, undergraduate education and CPD programmes (UIA, 1999, ACE, 2002, RIBA, 2002, RIAI, 2005, WFEO, 1997, ICE, 2002). Several of these bodies together with university teachers have developed networks to progress the integration of sustainable principles in design education.

Architectural Undergraduate Education

In its most recent Charter for Architectural Education (UIA, 2005) created on the initiative of UNESCO and the UIA to be applied internationally to architectural education, it concluded that "Beyond all aesthetic, technical and financial aspects of the professional responsibilities, the major concerns, expressed by the Charter, are the social commitment of the profession, i.e. the awareness of the role and responsibility of the architect in his or her respective society, as well as the improvement of the quality of life through sustainable human settlements". The UIA recommends that architectural education and professional training "undergo continuous change and review if it is to keep pace with the changing nature of practice and expectations of the public".

Amendment to the RIBA Criteria for Validation, (RIBA, 2003) states "greater emphasis is placed on knowledge and understanding of Technology and Environment and the ability to integrate this within design projects" and stipulate that in Part 1 Technology and Environment students "will demonstrate, within coherent architectural designs and academic portfolio, the ability to integrate knowledge of the principles of building technologies, environmental design and construction methods, in relation to human well-being, the welfare of future generations, the natural world, consideration of a sustainable environment, use of materials, process of assembly and structural principles". A recent amendment to the RIAI Statement of Policy on Architectural Education has reinforced the requirement for students to apply their academic knowledge of sustainability in design studio projects (RIAI, 2005).

However, the method of integrating these issues within design projects in undergraduate architectural design studios has been the subject of much discussion by educational bodies, such as the Society of Building Science Educators (SBSE) and European Association for Architectural Education (EAAE). At the Oxford Conference 2008 – Resetting the Agenda for Architectural Education, Tom Woolley, recently retired Professor of Architecture Queens University Belfast, stated that the environmental imperative is in danger of falling into the same Cinderella relationship with design as building technology.

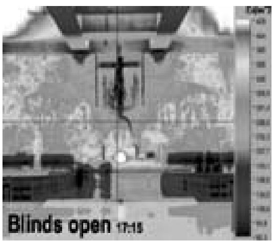
The Sustainability Special Interest Group (Architectural Education) on behalf of the Centre for Education in the Built Environment (CABE) (Fowles et al, 2003) conducted research into the learning and teaching of sustainability across the curriculum within Schools of Architecture across the UK. They found that sustainability has been relegated to technology subjects with very few links to studio work. The study concluded "a major change is required in attitudes, and curriculum content, to help future architects contribute to a sustainable future".

Architectural Design Process

Sustainability and technology are, of course, inextricably linked. Optimised performance and environmental quality of a building is based on passive design principles

Fig. 4, 5

Barcelona Pavilion
Mies van der Rohe.



Figs 6-8

Church of the Holy Trinity
Fatima
Alexandros Tombazis.

but achieved through the development of form, envelope and systems of the building. With the advance of modern architectural science; availability of innovative technologies and materials and computer software to simulate performance, the envelope has become an interactive environmental mediator rather than a separator as in the past. Research and demonstration projects have shown that the successful delivery of holistic sustainable building demands an inclusive design decision-making process, through which the interconnections between building form, envelope components and its systems are considered and pursued in integrated design strategies, to achieve cost effective optimal solutions and quality architecture. No longer can the traditional linear process where architects design and hand over to the technologist and engineer to deliver be applied (Brophy, 2005)

Mies van der Rohe said 'Less is more': Today, Alexandros Tombazis, international architect, says 'Less is beautiful'. At the recent Passive Low Energy Architecture (PLEA) conference in Dublin, he stated in his keynote address that "classic design elegance is found in the complete simple solution and sustainability is the key" (Tombazis, 2008). He exampled the design principles and strategies implemented in his recently completed Church of the Most Holy Trinity, the fourth largest Christian Church in the world accommodating 9,000 worshippers, in Fatima, Portugal. Based on traditional vernacular and modern movement principles, it is intimately tied to place. Orientation, siting, form and building envelope are optimised to provide natural daylight and ventilation and components and materials chosen to provide a sense of calm and beauty in the place of worship. There is no conflict between the materialisation of this sustainable enclosure and the delight of architecture. Nor is there evidence of tacked-on, eco-bling in this highly energy-efficient building. The success of the delightful spaces lies in thoughtful design. Tombazis would say that architectural delight and quality cannot be realised without consideration of these issues in the early stage of the design process.

In order that the student develop competence in the process of developing such enclosures they must have an understanding of the impact which siting, climate and form has on architectural design intentions and the external and internal environment of the building. To develop the appropriate envelope they must have knowledge of the characteristics, properties, design detailing and performance of the materials in use and an awareness of innovative components and technologies appropriate to scale.

Defining Pedagogy for Architectural Technologies

Comparing the potential of student-centered learning (studio) and teaching-centered delivery (lectures) pedagogy is a basis for evaluating the appropriate learning space for optimized teaching and learning of architectural technologies.

Students consider Design Studio to be of more importance that lecture supporting programmes due to its high credit load, time allocation, practice based tutors and the central ideological position it holds in the perception of what the architect does – and rightly so. Consequently in studio, student initiative and self learning is more pronounced and students become competent in their problem solving and design thinking.

There is an assumption that lecture based knowledge is transferred from lectures to studio design work; however, this has not been evident in design studio projects in the past. Although students may be competent in design thinking, they are poor in applying knowledge from other courses unless encouraged to do so in the design studio brief and by design studio tutors. To omit the issues embraced by Architectural Technologies from the design studio project suggest to the student that they are not relevant issues to the design decision making process and are addressed at a later stage (and perhaps by another person) than the design stage achieved in studio.

However there must be agreement within the architectural teaching staff that they have a responsibility to embed sustainability within the architecture curriculum and support the pedagogical approach outlined above. A framework must be developed that allows a common language to be developed that is familiar to all tutors (and students) – one that includes increased responsibility for social and environmental considerations at all stages, is evident in lecture content, expands the palette of design criteria and provides increased opportunities for application in design.

The issues to be addressed within the architecture programme include:

- Stages to be applied
- Learning outcomes redefined if necessary
- Level of subject inclusion – rules of thumb v. technical knowledge
- Standards of competences for each - awareness, knowledge, understanding, ability
- Assessment tasks – research, analysis, synthesis, application
- Teaching activities and aids/integrated briefs/staff responsibilities/timetable.

Fig. 9
La conversation
Henri Matisse.

Second Year 2008/2009 Semester 1 and 2
Design Studio and Architectural Technologies

The Second Year 2008/2009 Design Studio Programme integrated Architectural Technologies Design Studio, Lecture and Building Lab and Environmental Science Programmes. 'One design brief, one design process, one design review'!

The objective was to develop in the student:

- an understanding of the impact which the building's sitting, form and envelope have on the comfort of external and internal environments;
- an understanding of the impact which the construction of the building envelope has on architectural design intentions and environmental quality of spaces;
- a competence in the process of developing the building envelope of medium scale framed buildings;
- a knowledge of the characteristics, properties, design detailing and performance of the materials in use;
- an awareness of innovative technologies and materials.

Semester 1: Creating External space

The focus in Semester 1 was on the creation of a comfortable outdoor public space which provides a suitable environment for an activity appropriate to the function of the design studio project and the development of the building envelope as a connector/separator/threshold between external and internal space.

Semester 2: Creating internal space

The second semester focuses on the creation of good quality indoor space and the impact which the design and construction of the building envelope, as a climate mediator, has on the thermal, visual and acoustical environment of internal space. The integration of appropriate innovative components, technologies and renewable energy sources was investigated to improve internal environment and reduce environmental impact.

All design studio tutors support the student learning of AT in the design studio, however, one defined studio session each week focuses specifically on the principles of environment, structure and materials to be applied in design projects and assist in the students' development of specific skills - detail development, sketching and drawing skills and specification writing.

Third Year 2009/2010 Semester 1
Design Studio and Architectural Technologies

In 2009/2010 Semester 1 it is proposed that the second year integrated design process will be applied to third year design studio but will focus on issues related to life cycle assessment of materials and components, whole system thinking and innovative building envelopes.

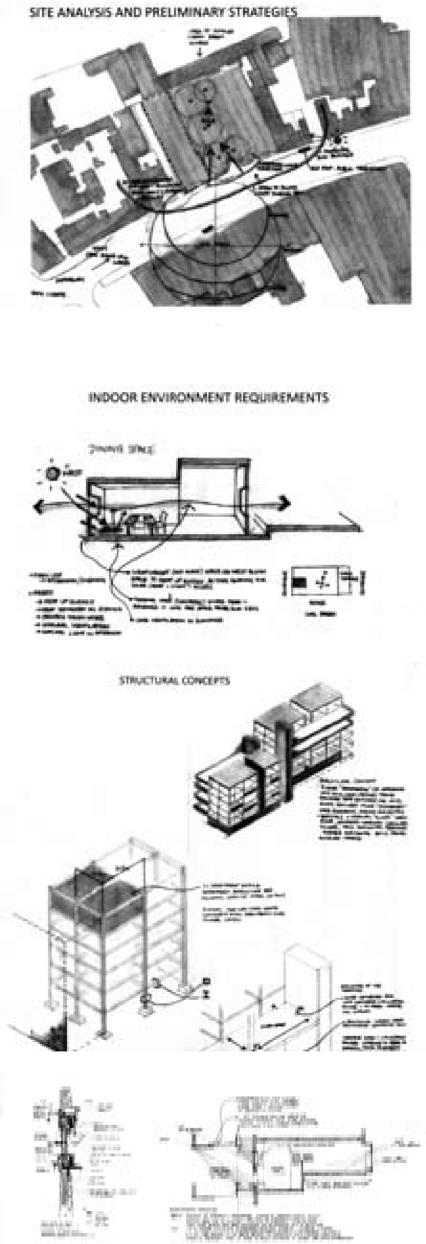


Fig. 10

Concept design student work
of Amy Learmont 2Y 2009.

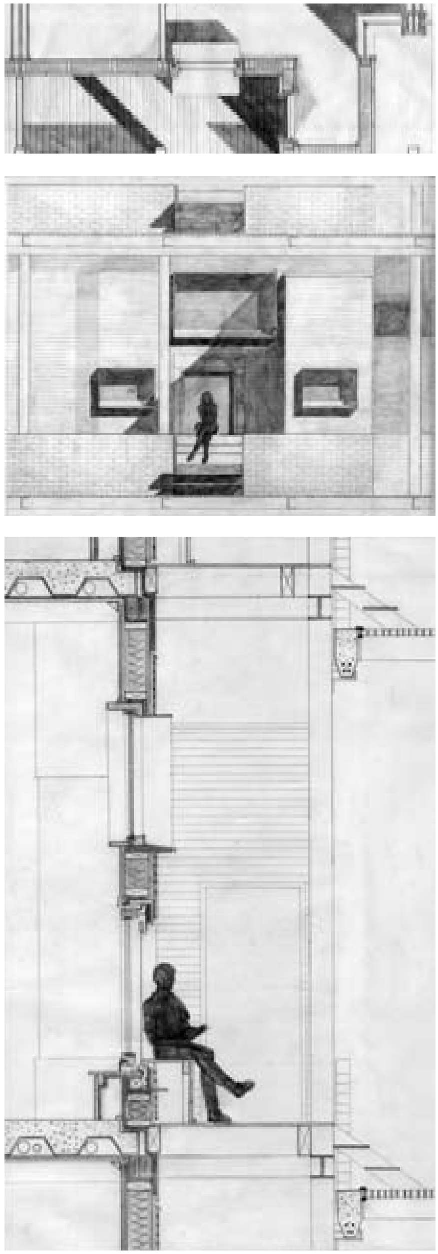


Fig. 11

Developed design student work
of Amy Learmont 2Y 2009.

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Assessment of Building Energetic Performance through Simulation Computer Programs

Summer Comfort in the Mediterranean Climate

Introduction – European Directive and building energy performance in Mediterranean countries

Environmental and climate changes urge us to think about how we use energy in our everyday life. The Kyoto protocol and the several national and European initiatives define a precise framework within which to operate for reducing CO_2 emissions.

Presently, in the European Community, buildings consume about 40% of primary energy and produce almost 30-40% of greenhouse gas emissions. This means that buildings contribute more CO_2 than traffic and industry.

In this context, the European Directive 2002/91/CE, called the Energy Performance of Building Directive (EPBD), was born with the aim to induce a sensitive reduction of energy consumed in the building sector through an improvement of energetic performance of both new and existing buildings. It is a very important directive since it introduces the Energetic Performance Certification not only for the new buildings but also for the existing ones.

One of the most significative and interesting novelties contained in the EPBD is the attention to summer energetic saving in Mediterranean countries: this implies to extending the assessment of building energetic performance to the summer period in addition to the winter one and, hence, the concept of "winter energetic performance" has been substitued by a wider "global energetic performance". Each member of EC has to individuate suitable strategies in order to improve summer energetic performance of the building envelopes and to adopt suitable techniques of passive cooling.

In the Green Paper on Energy Efficency of 2005, the European Community asks that by 2020 an improvement of 20% of global energetic consumption should be realized, equal to 190 MTEP (MTEP = 1 million tonnes of oil equivalent) and in particular, 45 MTEP (almost 24%) for what concerns the buildings, with a special attention to air-conditioning in summer for Mediterranean countries.

It is, hence, indispensable to make architecture students acquainted with the problem of energetic building performance in the project phase of a new building as well as in the rehabilitation of existing buildings. Moreover, for our students that belong to a southern region of Italy, it is very important to be aware of all the issues relative to summer air-conditioning.

Complexity in the evaluation of building energetic performance Need for simulation computer programs

A general overview of the energetic consumtion in the civil sector and of the recent European normative and legislative situation on such a matter is the starting point to make the students more aware of the problem.

On the other hand, the fact that the European Committee for Standardization (CEN) has been emitting no less than 40 norms for the standardization of the measures and the calculation of the improvement of the energetic efficency makes evident the complexity of the problem.

There are many factors that contribute to estimate the energetic building performance such as the ration of the building and glass forms, orientation, building use, outdoor and indoor climatic conditions, thermal behavior of opaque components of the envelope.

The evaluation of the influence of all these factors at the same time on the building's energetic performance would require heavy calculations but it is possible to overcome such a difficulty by using simulation computer programs. Nowdays there are several software, more or less sophisticated, that help the designer to choose, among different solutions, the most opportune in terms of energy saving and cost-effective not only in the design phase but also during the maintenance. They have become powerful tools for the designer and also for the improvement of envelope thermal behavior of old buildings in conformity with the European Directive.

There are several classes of software tools for different aims, relative to different design phases and that require specific input data. Hence the students must learn how to orient among them. One of the main differences consists in the skill of the software of evaluating the "dynamical" response of the building to the periodic variation of temperature due to solar radiation during the day. This feature is very useful in the assessment of building energetic performance in the summer period of Mediterranean climate, which has assumed particular importance in the European Directive 2002/91/CE.

Envelope and Mediterranean Climate

The concept of the superinsulated, hermetic house does not fit well with the needs of the houses in the Mediterranean climate that, on the contrary, in the hot summer require more permeable and active envelopes capable of exchanging heat with the outside under suitable conditions of temperature and ventilation.

It is fundamental that the students learn that such a dynamism is technologically obtained through the thermal capacity and the thermal inertia of the outer surface of the building. An element with high termal capacity and inertia will lower the temperature of the heat flow entering from outside and delay the passage inside, in such a way that the delivery of energy to inhabited areas only occurs during the cooler evening hours. Dampening, measured by the attenuation factor, and displacement of the thermal wave measured in hours, together with the transmittance, furnish the energy quality of the envelope of Mediterranean houses (see fig.1).

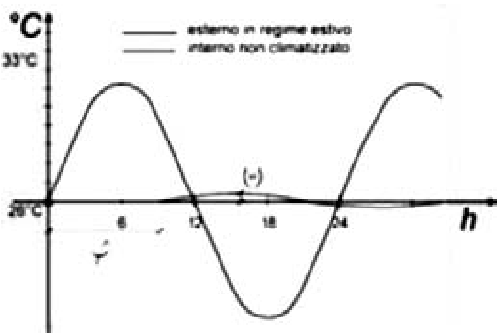


Fig.1
Dampening and displacement of the thermal wave

We recall, here, that a recent Italian Decree (Dpr 59/2009) requires the evaluation of periodic thermal trasmittance to check the energetic performance of the envelope in the summer season.

In this direction is oriented the choice of software that the students use in the course.

By inserting as input data the geographic site of the building and the stratigraphic layers of the opaque envelope components, it furnishes (fig. 2):

- The value of the superficial mass;
- The value of transmittance by Standard EN ISO 6946;
- Attenuation factor and displacement of thermal wave by Standard UNI EN ISO 13786;
- Interior and outside surface summer temperature by Standard EN ISO 13792.

The software also checks if the value of transmittance satisfies the limit required by the current legislation.

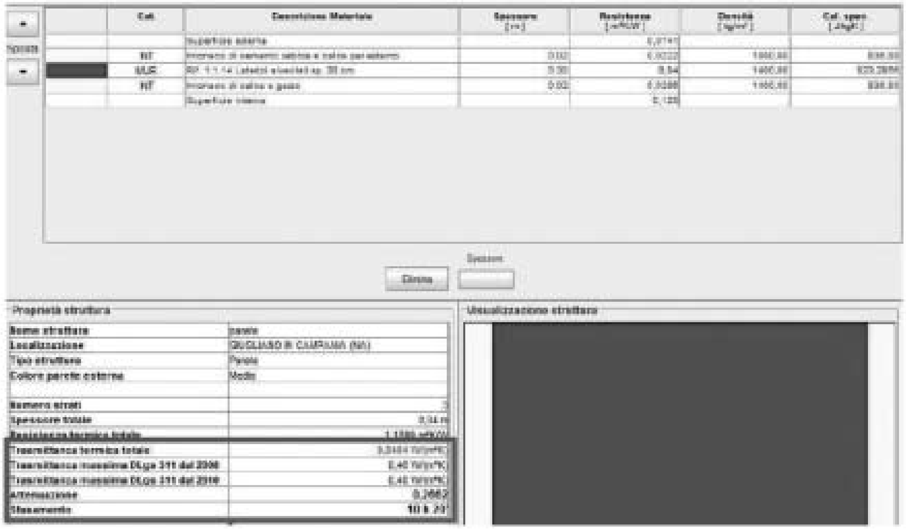
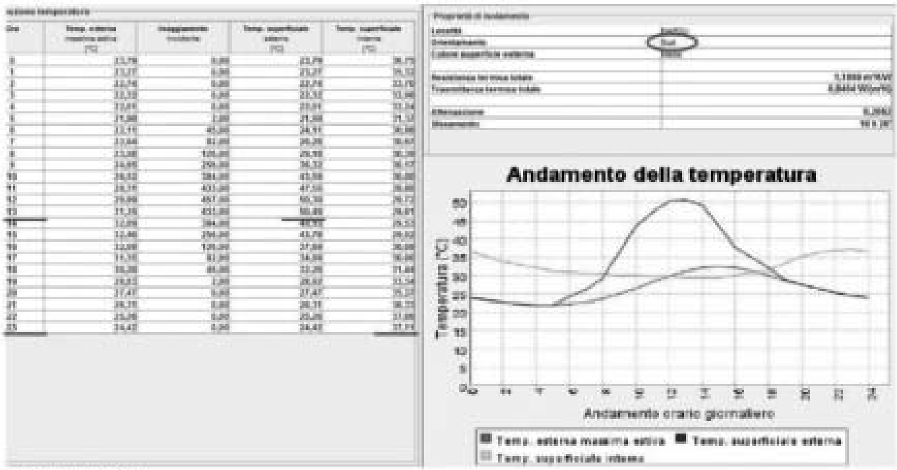


Fig. 2



Orientamento Sud

Fig. 3

South, Red

Moreover, the software furnishes the graphs of the behavior, during the 24 hours, of the interior and outside superficial temperature in function of the orientation and the colour of the outer surface of the envelope (see fig. 3 and 4).

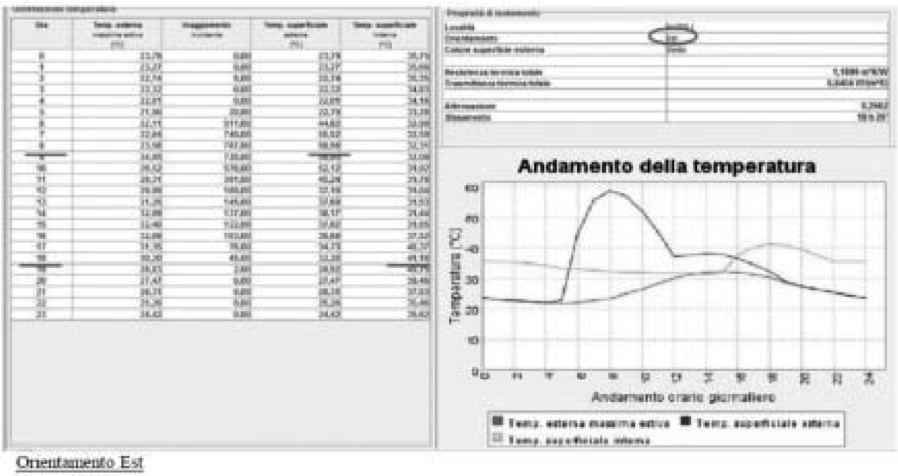


Fig. 4
East , Black

It is evident from the above figures how the students can learn, from the use of the software, the possible technological solutions in order to ensure comfort and by controlling, at the same time, the reduction in energy consumption for cooling the buildings. It is to be hoped that this theoretical analysis could be applied in a design or construction course where the students could check the feasibility of their solutions and try to realize them.

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Implementation of Environmental Issues and Sustainability in the Design Process

Energy and architecture have become a primary theme in the last years with architects and planners trying to define problems and identify effective design and planning responses.

Climate responsive design as well as issues of sustainability are an imperative to architectural teaching and should be introduced from the early years of study. Students should develop ecological and environmental awareness and perception and realize that sustainability with all its constraints should be a leading parameter from the early steps of conceptual design.

For years, the course of energy efficiency in buildings has been a topic that students did not take into serious consideration because they failed to correlate it with architectural design. The courses seemed more mechanical engineering oriented with calculations and numbers. Therefore, most of the students did not implement bioclimatic elements in the design process.

Climate responsive design is a part of a holistic design approach with sustainability in mind and cannot be separated from so many aspects that refer to architectural design and planning. The endeavor is relating built to natural environment.

With that in mind, students should become familiar with topics such as: energy and resource efficiency; alternative renewable energy applications to buildings and communities; self sufficiency and standalone systems vs. central systems; water conservation and recycling; land preservation and restoration; building pollution and healthy buildings; environmentally responsive building materials and systems, etc. All these matters must be introduced with underlying themes that relate to topics such as: structure and construction technology matters; the lessons of vernacular architecture; form that should fit to climate, context, culture and place; ecologically sound and planning principals and systems and their applications through examples.

The objective is to bring all these matters together focusing on innovative, architectural design that will combine the lessons and experience of significant examples of the past with new technological advances.

Teaching methodology

Last year we introduced a new course in the 5th semester (3rd year) with the title "Climate responsive design". We approached our teaching methodology following four basic directions:

- Understanding the climate;
- Lessons of vernacular precedents;
- Examples of contemporary buildings;
- A project.

1. Understanding of the climate

It is very important for architects to comprehend the climatic elements and how the natural environment works. We introduce the aspect of climate and microclimate and the nature of the factors that affect the climatic conditions of the earth such as solar radiation, longwave radiation to the sky, air temperature, humidity, wind and precipitation as well as the sun movement and natural lighting. We teach all these parameters and urge students to try and experience the phenomena in order to understand what thermal comfort and heat exchange are and how a building should work towards that direction. All this is necessary in order to go to the next step and make a climate analysis with data specific to the location under study. We use a program created at UCLA called climate consultant to produce the graphs that present the climatic characteristics and the psychrometric chart, in order to conclude to the bioclimatic strategies.

2. Vernacular precedents

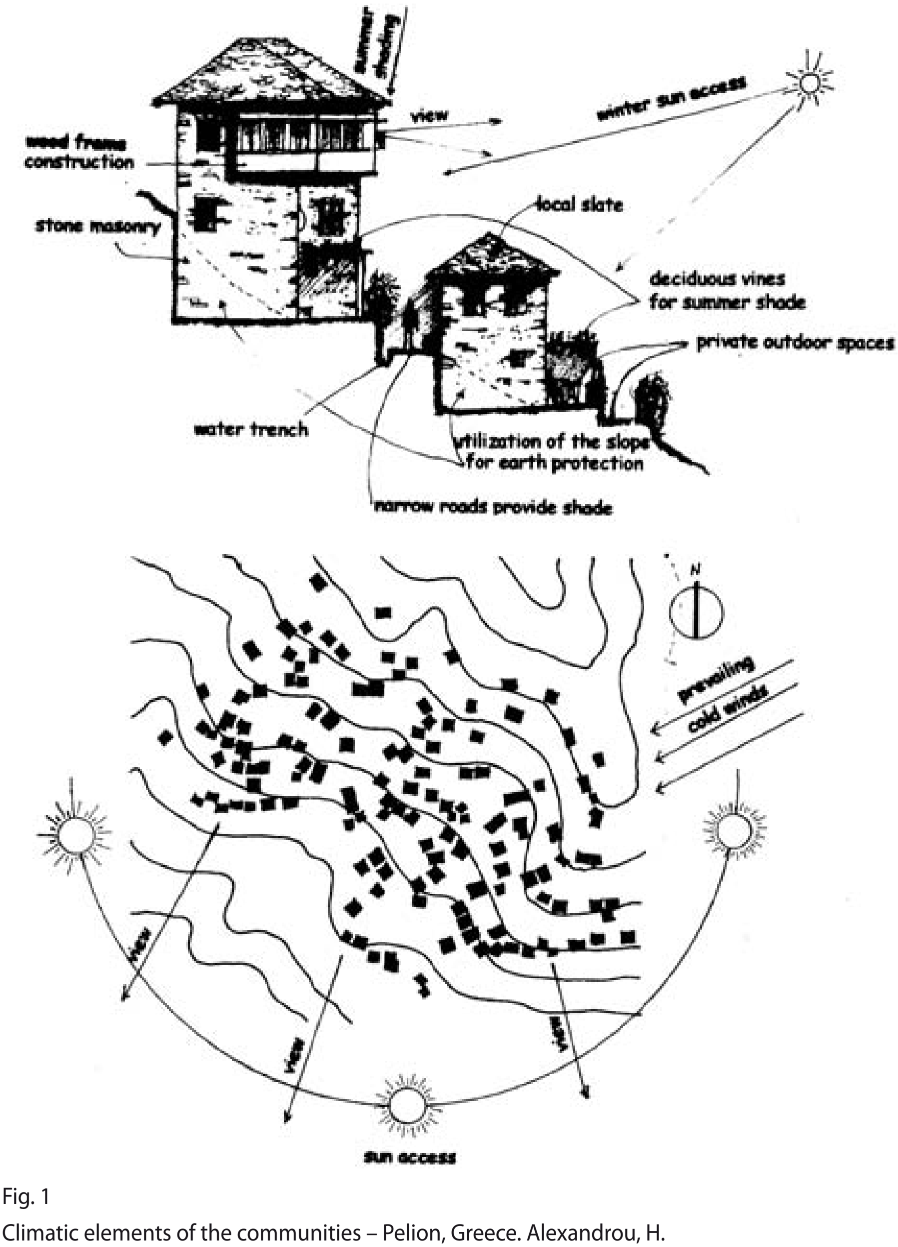


Fig. 1
Climatic elements of the communities – Pelion, Greece. Alexandrou, H.

The study of indigenous and traditional architecture is an important aspect as vernacular settlements present a wide range of lessons regarding sustainability. They demonstrate the concrete manifestation of the human–environment interaction that constitutes culture and has led to the development of a multitude of cultures by different people in different environments. The solutions provided by generations of traditional societies, which used only natural resources of energy, may be of great help in opening new fields for research and application.

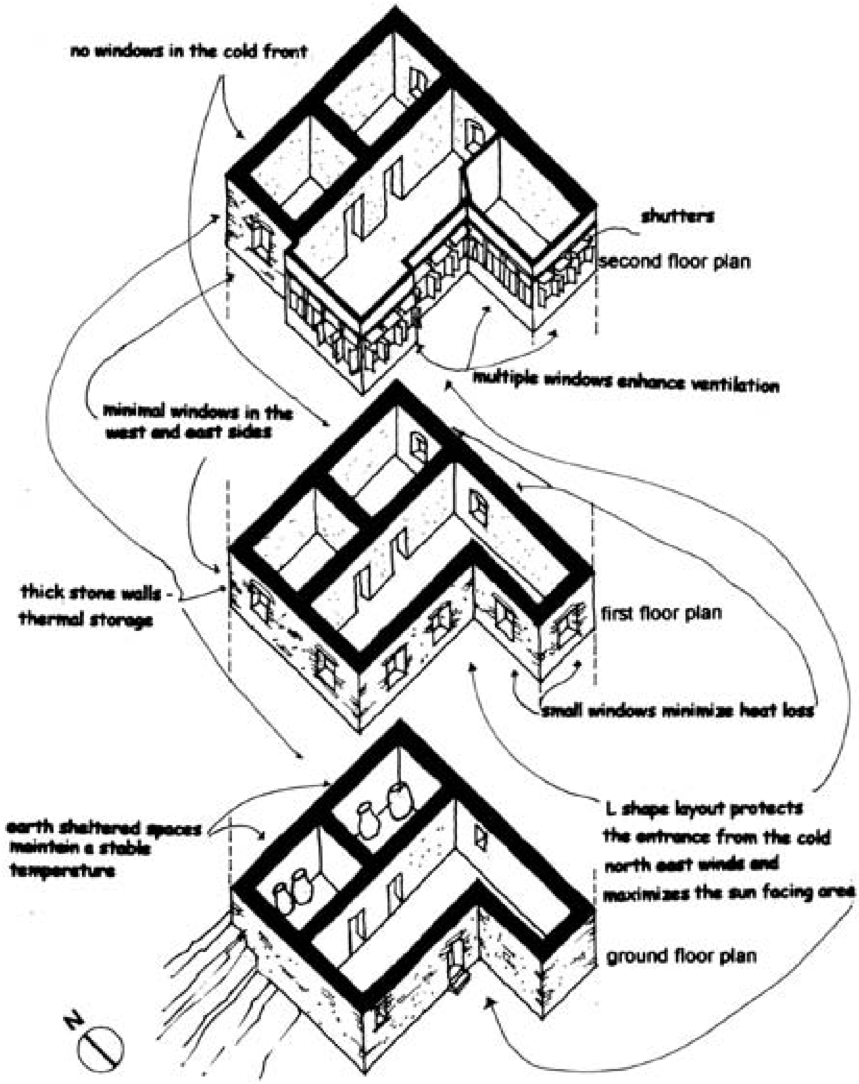


Fig. 2
Climatic elements of the vernacular structures – Pelion, Greece. Alexandrou, H.

The indigenous people succeeded in balancing culture, available materials and climate. They built in accordance with nature and not against it. They considered nature sacred since it provided vital resources and they realized their dependence upon it. Energy conscious principles are evident in many forms of vernacular architecture. For example, the thick adobe walls are well-known examples of intelligent architectural design with clear awareness of thermo-performance. According to the seveereness of the climate the climatic parameters may have a decisive impact on the form of the structure.

Fig. 3

Troglodyte house – Matmata, Tunisia.
Alexandrou, H.

The study of vernacular architecture demonstrates in the best way how cultural, technical and economic forces were integrated with those of thermal comfort to influence building form and reveals many sustainable attributes:

- Limited size and consistent human-comprehensible scale.
- Easy contact with natural world.
- Good use and preservation of natural resources.
- Exploitation and adaptation to the contextual forces of the site.
- Climatic characteristics such as orientation and arrangement are clear in community scale as well as in individual buildings for maximum indoor and outdoor comfort.
- The use of natural building materials in very strict conformity with other natural factors such as weather and location.

Unsuited architecture for climate arose with the industrial revolution and the dependence upon the machine. It seemed then that with mechanical contribution humans could overcome all the problems that nature imposed.

Fig. 4
Design Guidelines – Pelion, Greece, Alexandrou, H.

Another important factor in the success of this course is that the students that participate attend at the same semester a separate course called "Analysis of a traditional settlement". Every year they visit a settlement that preserves a significant proportion of its initial form and structure, and work on the field for about a week. We consider this work very important as the students have the opportunity to experience in person the basic elements that constitute vernacular architecture and collect all the necessary information in order to define the architectural and structural character of the settlement and respect the principles that produced the traditional solutions. They analyze all the parameters such as the configuration and arrangement of the buildings in community scale, as well as their form and structure, the apparent climatic characteristics such as orientation, and finally the use of building materials.

Fig. 5
Students working on the field.
Alexandrou, H.

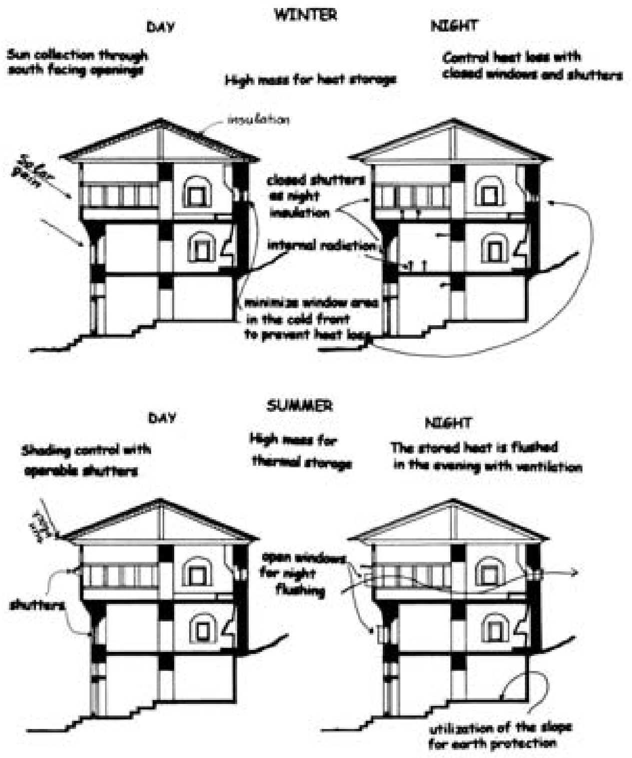


Fig. 5
Students working on the field.
Alexandrou, H.

Last year they visited an island in south Greece where they had the chance to record all these attributes mentioned and had the privilege to find authentic examples of buildings in their original condition constructed with thick stone walls and flat roofs made of wooden trunks and clay still in their original shape.

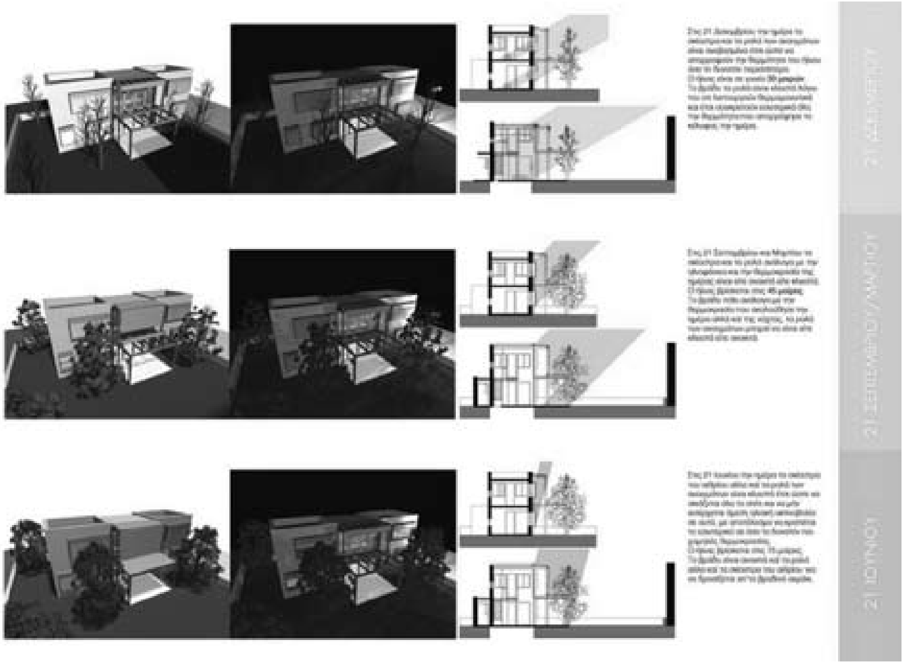
3. Examples of contemporary buildings in Greece and abroad

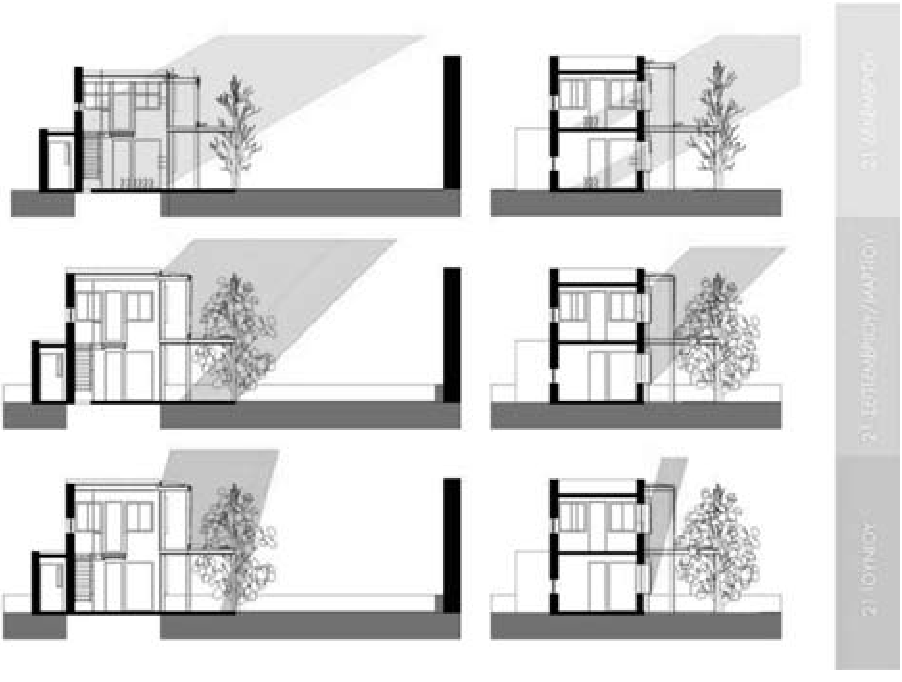
After the study of the vernacular architecture, we present an overview of the recent contemporary buildings that combine both simple and sophisticated technology systems and demonstrate efficiency and moderation in the use of materials, energy and spatial resources, in our country and abroad.

Students learn about of the increasing awareness of the environmental challenges presented by climate change and resource depletion. We also try to arrange as many field trips as possible to some of those buildings.

4. The project

As a project, the students had to redesign a little house that they worked on the previous year. They had to prepare the climate analysis of the given site and conclude in the strategies that should be implemented to the design along with the form and function as well as the construction.


21 ΙΟΥΝΙΟΥ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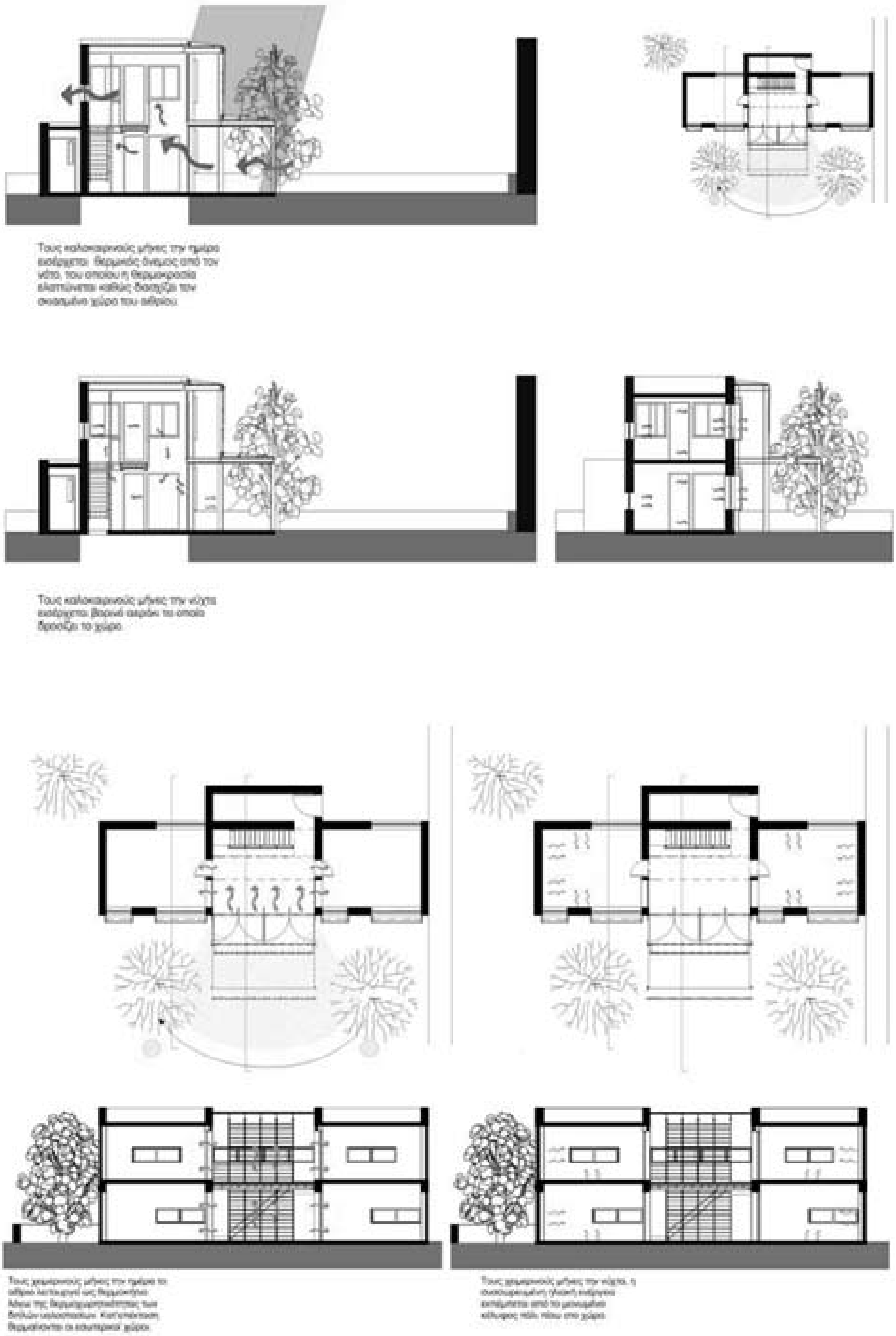

Fig. 7-10

Student project on "Climate Responsive Design" – Lampada, Thlimenou, Tzortzis

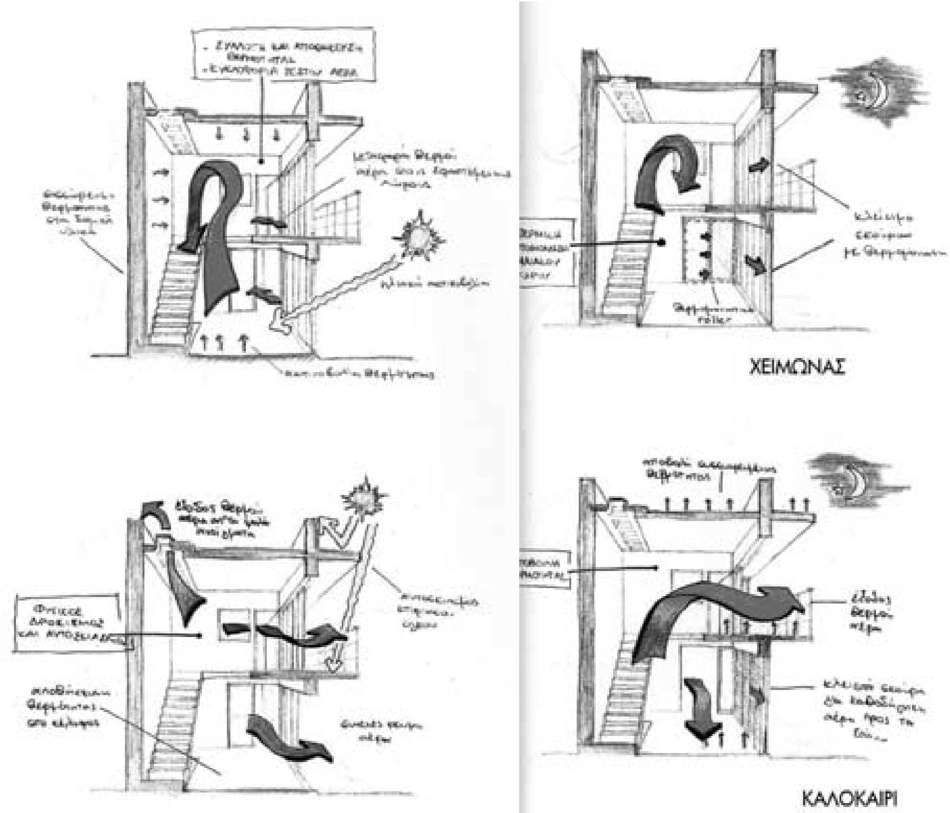

Fig. 11-12

Student project on “Climate Responsive Design” – Ntetsaves-Poga, Pantelakis, Tsafou

Conclusion

Sustainability along with the climate responsive design was for centuries -before the Industrial Revolution and technological advances- the natural way of building settlements. In our time we have depended totally on mechanical means and alienated ourselves from implementing nature in the process. Moreover it is very difficult to make the new generation that has grown totally accustomed to, familiarized with and dependent on the machine and technology to re-approach nature and its endeavors. It is a whole mechanism in order to make them think and acquire an ecological consciousness that will be implemented in their education and profession. Therefore, great effort is needed to help students realize the profoundness of sustainability and the interrelation with the environment.

They have to put together all the parameters that are sometimes superimposed on architectural design. In other words, what, how with what and for what climate and environment we should build. Building in a sustainable manner requires paying attention to the predictable and comprehensive outcomes of decisions and events throughout the life cycle of a building, as well as the renovation process of existing buildings and the reshaping of communities and cities.

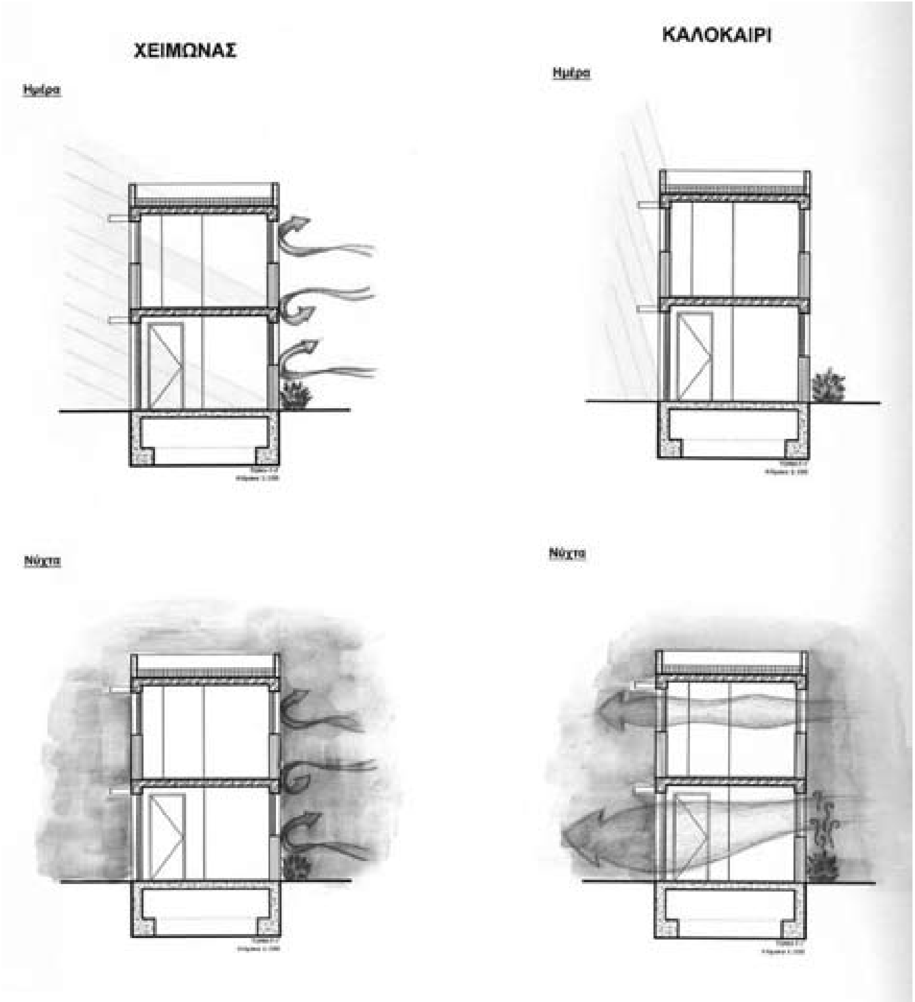

Fig. 13-14
Student project on "Climate Responsive Design" – Aggeli, Galiouna, Malaktou

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Technology needed by Architects: Integrating Architectural Design and Construction Teaching through a Combined Approach to Environmental Issues

Paper

In a short story published a year ago in Technology Review, the American science fiction writer Bruce Sterling (2007) writes about an architect, Yuri, who in the not too distant future describes a possible scenario in which architecture 'has given way to software management, so he turns buildings into brilliant yet often chaotic visions, easier to talk about than build'.

"This design isn't even a "building", from what I can understand. The way in which the structure keeps turning around … it is a process permanently being constructed and deconstructed"

This scenario projects us into a future that prefigures the possible consequences of the transformations in the entire production and construction process of an architectural project. Transformations already correctly identified by David Celento (2007) and influenced by the availability of new tools (such as *rapid fabrication*, parametric design and BIM-Building Information Management) which in turn determines the need for new professionals - defined by Kieran and Timberlake (2003) as 'Digital Master Builders' - capable of managing and integrating knowledge in order to create new architectural concepts.

Current changes in production and construction and modern experimental architectural design do not correspond to a reorganisation of technological knowledge and education, still entrusted to obsolete and fragmented studies on techniques.

These experiments demonstrate how scientific research and the contemporary architectural practice are contributing to establish new rules and principles to construction and how much innovation requires a revision of the teaching of building technology (at present relegated to being a specialist branch of Engineering) starting with the problem of integration between realistic practice and experimental research (on site or in the lab).

Context

The Roma Tre Faculty of Architecture is debating on these topics, criticizing the traditional integrated learning model of the atelier (Architectural Design-Construction). The curricula structure of the three-year course and the three magisterial degree courses, architectural technology studies are included throughout (Fig. 1). Technology is taught either in separate courses (workshop on the construction of architecture coupled with a module in architectural design or technical physics as part of the new format which will start next year) or in short modules in the architectural design workshops. The latter is the main format in the three magisterial degree courses.

A small experiment held in Roma Tre Faculty of Architecture, regarding an approach to design based on a few simple environmental aspects, could be taken as a case study to show the effort on finding new learning methods, especially in the field of Building Technology, and shows some interesting results. The experiment was carried out last December during a Magisterial Course in Architectural Design. It was conducted together with Prof. Piergiorgio Rossi.

The experimental study involved retrofitting some very tall houses used as offices and designing a completely new envelope to replace the one that had been turned into a curtain wall. The students were given a week to carry out a design exercise in

Fig. 1
Curricula structure of Roma Tre University Faculty of Architecture

which design and construction both used physical and virtual models; each model acted either as a way to test or support the other.

This experience provides a possible answer to two main issues crucial in the education and training of a young architect:

first issue - the inclusion of architecture in a realistic vision of the production process which requires new skills and expertise to manage the different specialisations involved (in this case, knowledge of the physical phenomena regulating the energy performance of an envelope; the performance of materials and several functional reference models);

second issue - the way in which the potential of new scientific and computation tools can help to simulate different design options quickly, simultaneously verifying their impact on the entire project.

However, these considerations deserve some observations about the general design approach proposed to the students.

First issue: managing specialisms

The general 'framework' of the experience was based on an easy access to new ideas and modern tools and technologies, often created for completely different reasons, and not strictly linked to production. Basically, we are beginning to realise that there is a shift away from the passive acceptance of the "expressive" creativity of architects to a market that demands of "artistic" design which delivers previously unthinkable qualitative improvements (i.e. in the design of light, load-bearing façades, in the design of large, complex geometrical structures etc.).

The first issue is about the relationship between the designer and the current production process employed to manage the different specialisations. In the feedback cycles of engineering design (problem-solution-assessment – yes, the end, no, a new solution) (Lawson 2006), the result of the ideation is the first element (problem). Therefore, to avoid separating the "solution to the problem" (for which the architect was once entirely responsible) from that of "ideation", the work of the designer must have well-defined effects on, and links to, the problem (without the typical complications of so many strange and improbable designs. This only can take place by studying the different specialisations in a holistic manner and countering the usual approach adopted towards 'specialisms' that have always narrowed the field of learning.

This kind of educational approach should be similar to the one cited in literature: "an ability to provide overall direction and a certain use of texts" (Sanguineti 2006), just as at sea we use numerous tools and technologies to find our way – maps, compasses and sextants. What is important is not only to understand them, but first to use them.

The basic and specialist information used in the study was organised in a representative conceptual map that compared the main concepts useful to the design. The study of conceptual maps is the applicable result of a research carried out with Prof. Giuseppe Morabito (Marrone&Morabito 2008).

The conceptual maps can be a useful starting point to study the elements of a construction. In fact, they make it possible to:

- organise basic information to be studied and continually updated,
- insert other specialist studies - for example, each single element of construction - in an overall vision of the design problems,
- turn technical information into a communicable representation,
- manage knowledge, above all when different disciplinary contents interact in the application (just imagine how much information is required to design an envelope.

The undoubtedly "abstract" knowledge of the maps was integrated with examples of real occurrences, using "detailed technical sheets" of particularly important and/or innovative case studies, to examine and critically observe and compare the different construction solutions.

By studying more than one example – using the detailed technical sheets – they become case studies illustrating how knowledge of a certain technique or construction element develops.

Second issue: the conscious use of instruments

The study of "specializations" introduces the second main issue: the need of a progressive integration between knowledge developed through pragmatic facts (code of practice, the art of good construction, etc., typical of the traditional profession of an architect) and scientific knowledge.

Architectural design appears to have lost the ideal freedom linking it to artistic creation.

In fact, reliable scientific information seems to be undermining a method consolidated down through the ages, forcing the architect to manage not only numerous "specialisms", but at the same time, to acquire and interpret an endless series of documents, principles and norms that are continually being updated.

Rigorously scientific design requires enormous amounts of data and collective information from different fields of learning (as well as the regulations that purport to control all aspects of every project objectively). All these requirements unnecessarily burden the design work and reduce creative margins, unless they use complicated external assistance and supports.

In short, if we do not want to frighten the architect with complicated theoretical issues, we have to enhance his creativity by providing him with the countless tools available (i.e. Parametric Design, BIM), helping him to simplify the design process (by not requiring overly specialist skills). Training and education should also be much more pragmatic.

The case study

The design exercise began with the creation of a scale model of the envelope concept (designed or re-elaborated on the basis of the examples provided). While perfecting the physical model, students were asked to develop a simple virtual model to test certain climatic or energy performance parameters of the test project. The students were encouraged to use physical and computation models for the simulation of design options and control of their performance.

In particular, they were advised to use a simple computation model - The MIT Design Advisor 1.6 freely available online, developed by the MIT and sponsored by Permasteelisa - studied to improve the comfort and energy performance of conceptual building designs.

The façade design was based on students' earlier studies of building façades and energy-saving strategies. Each group (2-3 students per group) chose a façade concept to work on and investigate in more depth. From the very first design stage, they were asked to build two different models of their design: a 1:20 scale maquette and a simulation model of its energy performance.

- The maquette is a simulation model that has always been used by architects. It makes it possible to represent certain fundamental characteristics of the design accurately: its proportions, and therefore size, and its spatial qualities and structural hierarchies. While perfecting the physical model, students were asked to develop a simple virtual model to test certain climatic or energy performance parameters of the test project (Fig.2, 3).
- Energy simulation model (MIT Design Advisor): by establishing a set of parameters and conditions of use, the students were able, in real time, to simulate their project's energy requirements (heating, cooling and artificial lighting) and the comfort levels (natural lighting and rooms temperature) (Fig. 4).

By combining the traditional tools used by architects (maquettes) with scientific and computation tools, students were able simultaneously to control various aspects of their project, take decisions and make changes.

In-depth, technical knowledge is not enough if one wants to learn to design a building and then construct it; much more knowledge is required in a variety of fields,

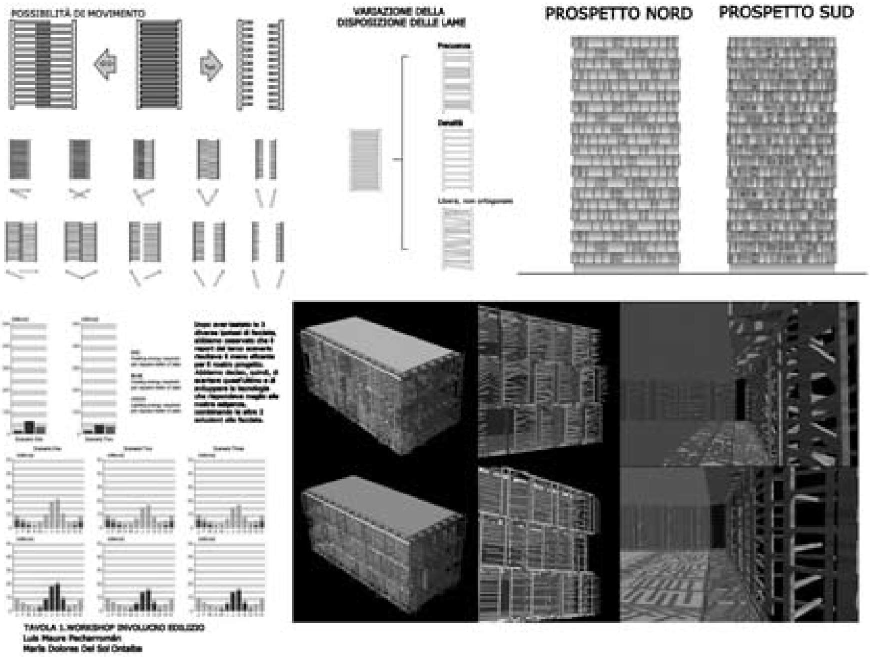

Fig. 2
Students' work: Luis Maure Pecharromàn and Marìa Dolores Del Sol Ontalba

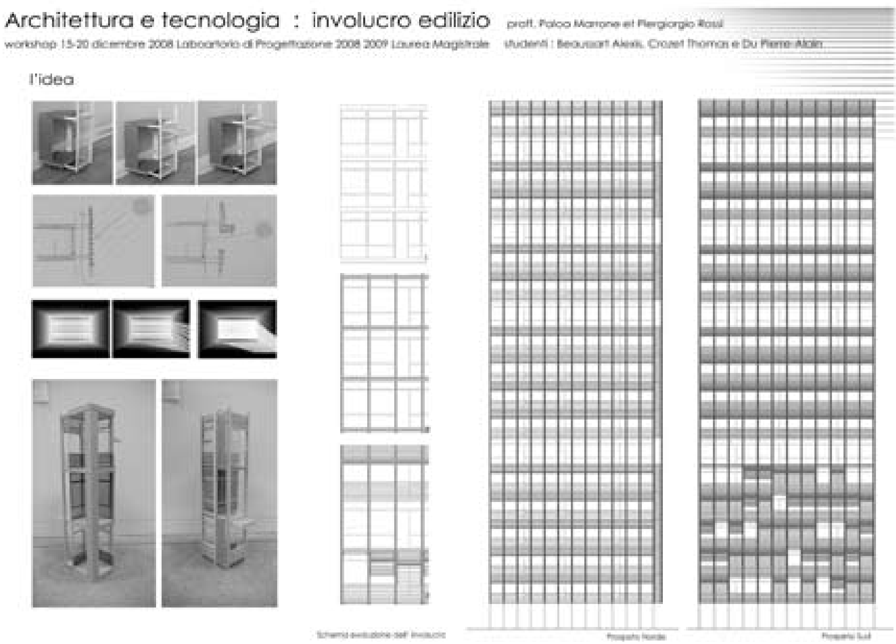

Fig. 3
Students' work: Alexis Beaussart, ThomasCrozet and Alain Du Pierre

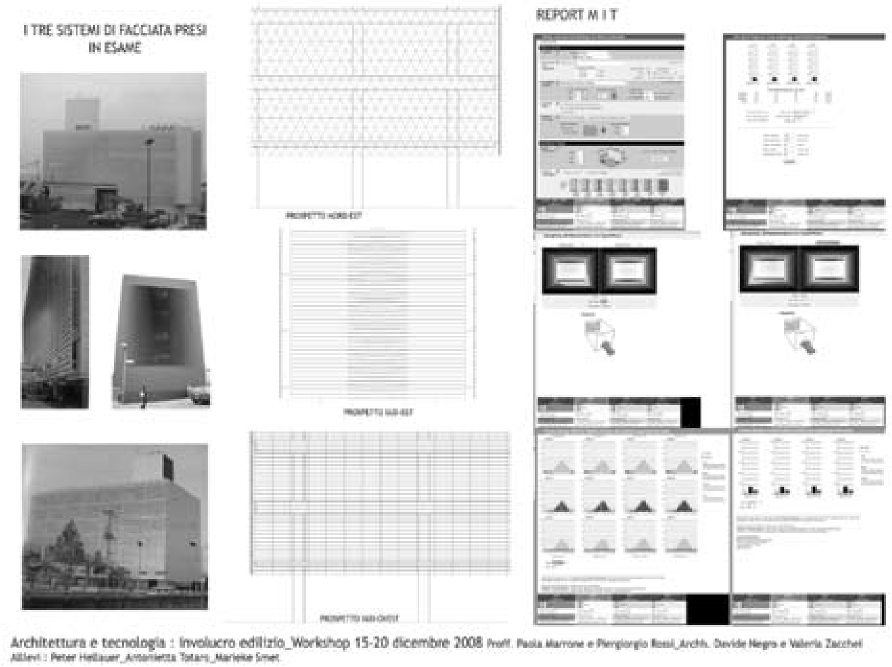

Fig. 4

Students' work: Peter Hellauer and Antonietta Totaro

the most important of which is certainly the worksite where designers can learn to prefigure the construction process – in a correct narrative and temporal sequence – by observing the main players and their work. This allows the designer to acquire the skills needed to make design choices and a good, well thought-out awareness of how to design details. This kind of experience is very difficult to implement in an academic course due to the limited resources available and the high number of students involved. In general, compensation comes in the form of the simulation of construction by making students build small scale physical models.

Conclusion

The workshop produced very interesting results appreciated also by my colleagues who teach architectural design (Fig. 5, 6).

The students were able to experiment with a broad range of design solutions, achieving a satisfactory level of in-depth elaboration and information for the project.

The combined use of traditional and innovative models as well as a design method which from the start uses support tools in decision-making frees up creativity and provides a variety of possible avenues of investigation; it also makes facilitates comprehension of the design tools and the elements involved.

Moreover, the use of models also allowed us to integrate knowledge and experience required in all those fields involving human creativity, just as it is in the design and construction of a building.

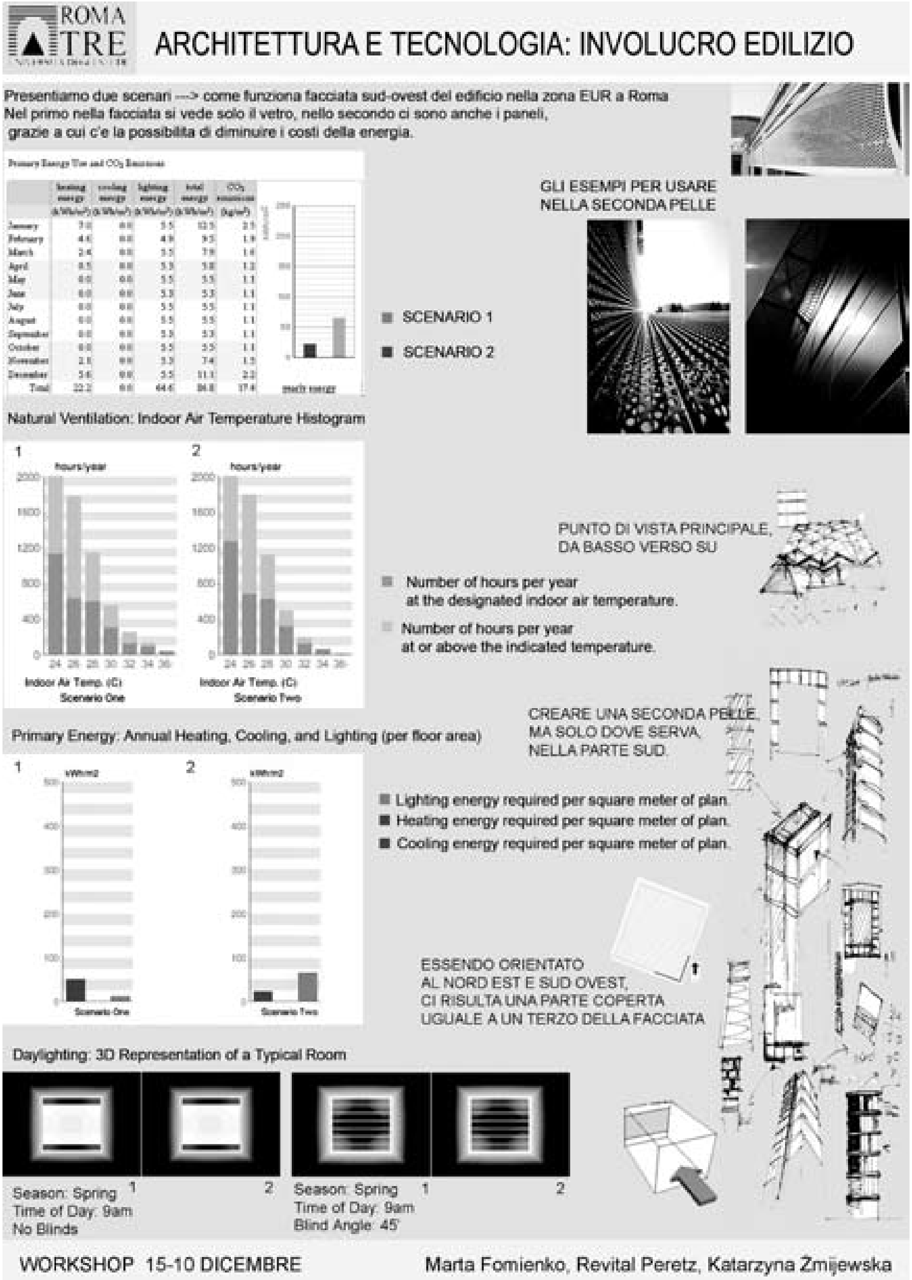

Fig. 5

Students' work: Marta Fomienko, Revital Peretz, Katarzyna Zmijeweska

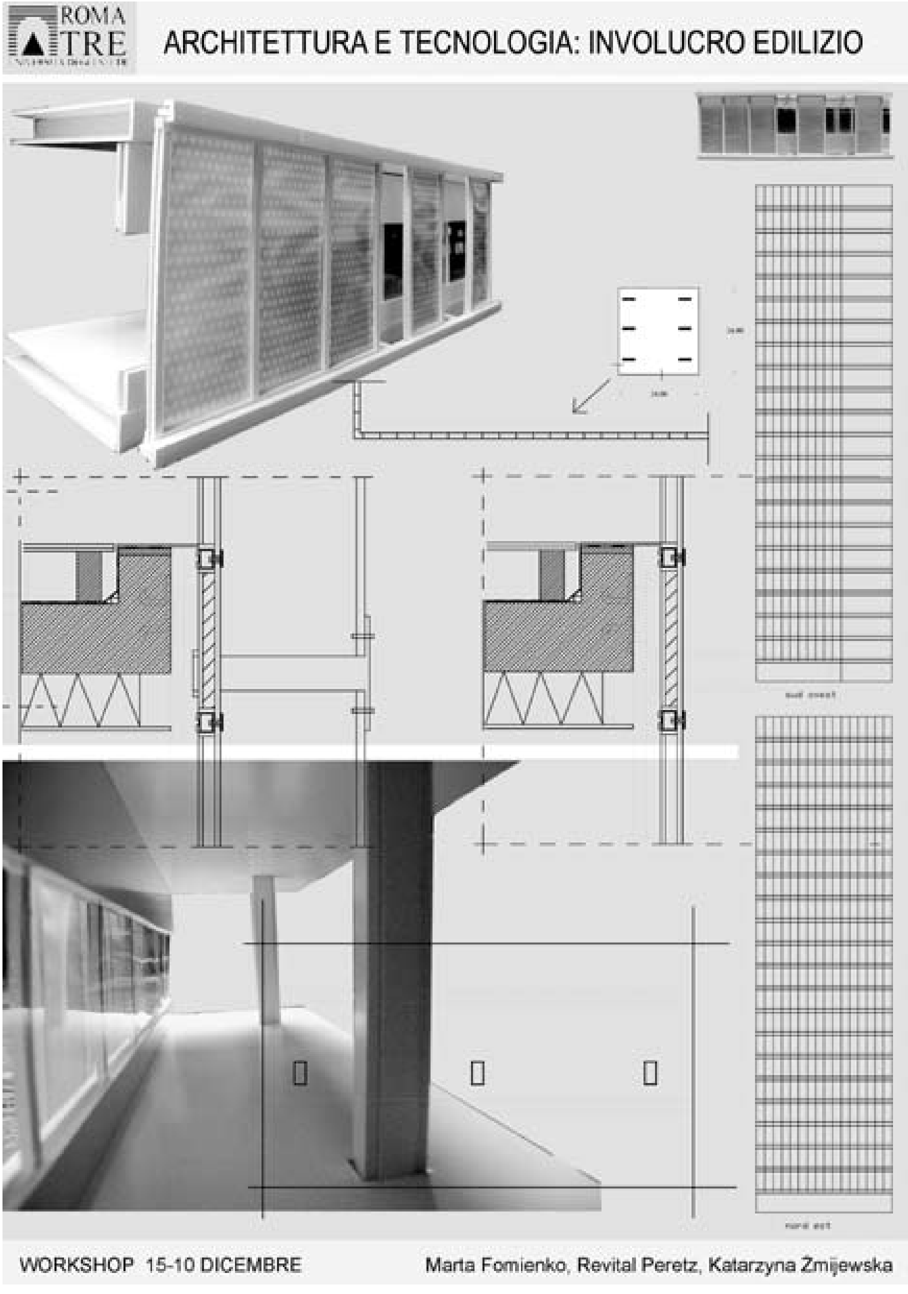

Fig. 6
Students' work: Marta Fomienko, Revital Peretz, Katarzyna Zmijeweska

According to the theorist Kolb (Fig. 7), this integration can basically be achieved by using two different learning processes that use the same elements: experimentation/observation, understanding, theoretical abstraction and experience.

Both end in the "experience" stage, but use the others in a different order. A clockwise cycle is typical of laboratories, an anticlockwise cycle is theoretical, i.e. didactic. The former kind of learning is natural and simple, but takes longer. The second is quicker, but much more difficult. For example, we all used the first method to learn our mother tongue and the second to learn Latin.

Our experience tried to follow the first learning model, the one of laboratories.

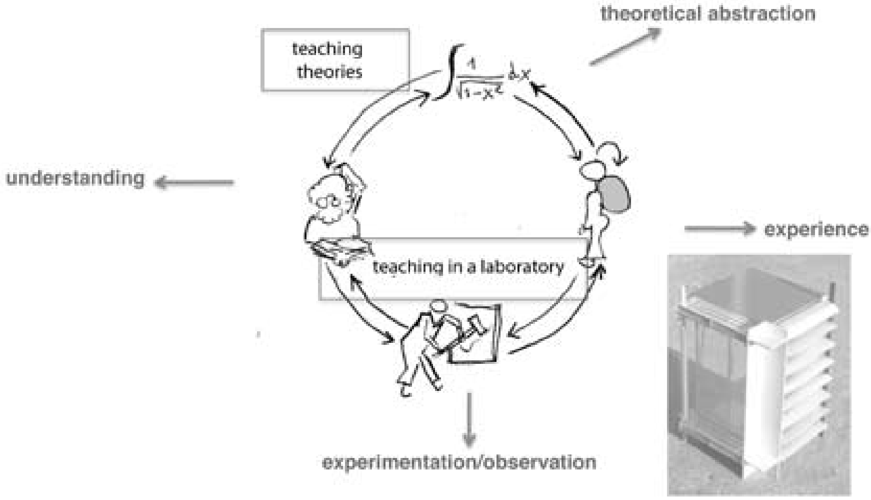

Fig. 7
Learning process accordino Kolb

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The Eco-oriented Architectural Design for Environmental Context

The Integration, the key word of innovative educational plans in the Faculty of Architecture (Second University of Naples)

European integration and the link with the job world are at the core of the Architectural School's academic debate. In the last years Faculties have to face up to the definition of new educational plans strictly aimed at knowledge of productive processes of materials, systems and components from an eco-oriented point of view. Having a good command of tools, both of technological innovation and building process management ending in an energetic and environmental performance evaluation, becomes the main element to be focused on: it represents what we should transmit within Degree Courses.

The concept of integration could assume, then, different meanings as integration both of knowledge and learning. In any case, what we want to emphasize is the need to transfer and implement knowledge and ability in a systematic manner, by using interdisciplinary contributions. In line with this idea, the role of Technology of Architecture and Environment, such as discipline sector, confirms and enriches its theoretical - critical criteria considering integration as one of the design approach's strength points.

This is the specific role which the Technology is building inside the educational plans of the Degree Courses at the Faculty of Architecture "Luigi Vanvitelli" (Second University of Naples). It is particulary evident in the Courses of new institution: the Technological Disciplines take shape both as base and typical disciplines in relation to the educational path selected, but they always come with students during all formative cycles from the educational background to the complex one.

In our Faculty, in accordance with the DM 270/04, the educational offer provides different possibilities of choice: the 1st level Degree Course in "Architectural and Engineering Sciences (AES)" (3 years); two 2nd levels Degree Courses (2 years) in "Architecture and Project of Urban Environment (APUE)" and "Architecture and Building Engineering (ABE)"; finally, a one – long cycle 2nd Degree Course in "Architecture" (5 years).

The 1st level Degree Course in Architectural and Engineering Sciences is characterized by an educational approach more oriented to graduates who will be aware of technical aspects about security and environmental control. The feasibility of the project, with its declinations, represents a key idea of this Degree Course:

- technical feasibility, pursued through the integration of knowledge both in structural field and laboratory of construction;
- legal and economic feasibility, pursued through the integration of estimative and legal disciplines with basic and characteristic disciplines;
- environmental feasibility, pursued through an "environmentally aware" design approach, and through the study of techniques for environmental control and innovative technologies (energetically efficient and architecturally integrated);
- administrative feasibility, pursued through training activities carried out for Public Administrations and Local Authorities.

The didactic offer is based on the integration of similar, basic and typical disciplines. In fact, the Degree Course deals with some important themes: environmental control, eco-compatible technologies, technical – economical project's evaluation, technique of architectonic restoration, building design and urban planning. These will be supported by a hard knowledge of History and Representation teachings, as well as other optional courses which students can choose.

The educational purpose of the 2nd level Degree Course in "Architecture and Project of Urban Environment" is, instead, a professional skill able to answer to the complexity of problems of a project at different application scales. This Degree Course is aimed to promote the care of urban and rural context, of environment and public space, through the rehabilitation of degraded areas. The proposed design approach is oriented to create a new social and productive model where there are the best environmental conditions as well as a low energetic consumption. The didactic offer is based on the integration of different competences in order to educate a graduate to be able to deal with fully creation and building processes of new architectonic works using suitable methods and tools in relation to the specificity of context.

The other 2nd level Degree Course, "Architecture and Building Engineering", should enable graduates to be able to answer in an innovative way the complexity of problems related to design, building, management and maintenance of works both on an architectonic and urban scale. The purpose is the unification of competences of architect and civil engineer into a unique cognitive-applicative core. The main part of the Degree Course is finalized to intervention on building: refurbishment, building recovery, static security, conservation of cultural heritage, technological innovation of processes and products, improvement of technical performances and energetic control, with particular attention to problems both of buildings in seismic areas and bioclimatic and environmental aspects.

Finally, the one – long cycle 2nd Degree Course in Architecture is aimed at the formation of a generalist architect with the ability both to create architectonic project in order to satisfy, aesthetic and technical needs, and knowledge of urban planning. This Degree Course aims to educate an architect sa as to be able to identify the relations between architectonic works and both people and environmental surroundings with a deep knowledge of: analysis and preparation methods for the building project; design problems about structure, building and civil engineering; physical problems and technologies.

The Course Degrees' organization is strongly oriented towards a professional skill's education which is able to manage the design process at different scales and in relation to the environmental super-system. The aim is to control variables which could influence the quality of the final product. The introduction of integrated laboratories and courses underlines the strong need for knowledge and ability transfer in an integrated way, starting from systemizing each disciplinal contribution.

The Technological Design (Integrated) Laboratory[1], and in particular, the Course of "Ecological Construction Processes Technologies" has been organized with the aim of answering to these requirements, promoting an eco-oriented design approach for the rehabilitation of a school building. It shares the main criteria of Environmental Design and, then, it can be seen as the integration of: environmental analysis (rational use of resources) and technological analysis (building envelope).

Fig. 1
ITG "P. Nervi" school building, Province of Caserta

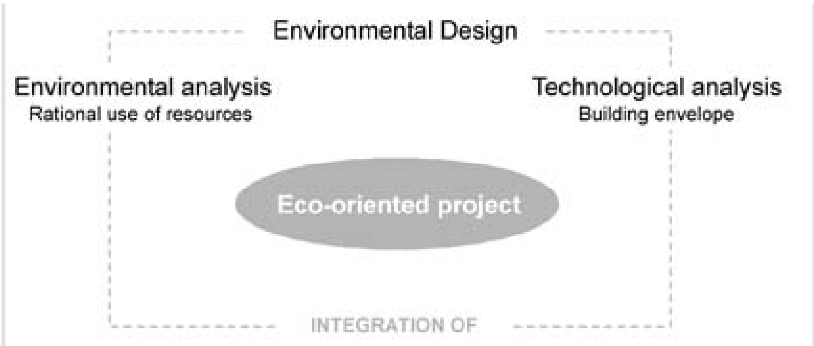

Fig. 2
Concept of integration

The didactic approach towards integration: from the environmental context to the building and vice versa.

The experience carried out within the Course of "Ecological Construction Processes Technologies" has been oriented towards a sustainable design of environmental surrounding of the ITG "P. Nervi" school building, characterized by a series of performance deficiencies, mainly caused by a weak relation between user needs, building choices and environmental context.

Sharing the idea that a building should be integrated with its environmental surrounding, the design approach pursued, primarily, focuses on the definition of the environmental quality of the site. Quality has to be interpreted starting from the identification of natural and anthropic characters of context. This critical understanding provided students with a decisional support to develop the different design strategies better based on both environmental sustainability and economic feasibility.

The relations that the building could establish with its environmental surroundings, both natural and man-made, have an effect on the quality of the building itself. Therefore, it becomes necessary to understand these relations to formulate appropriate actions that should enhance or mitigate their effects on the building. The environment

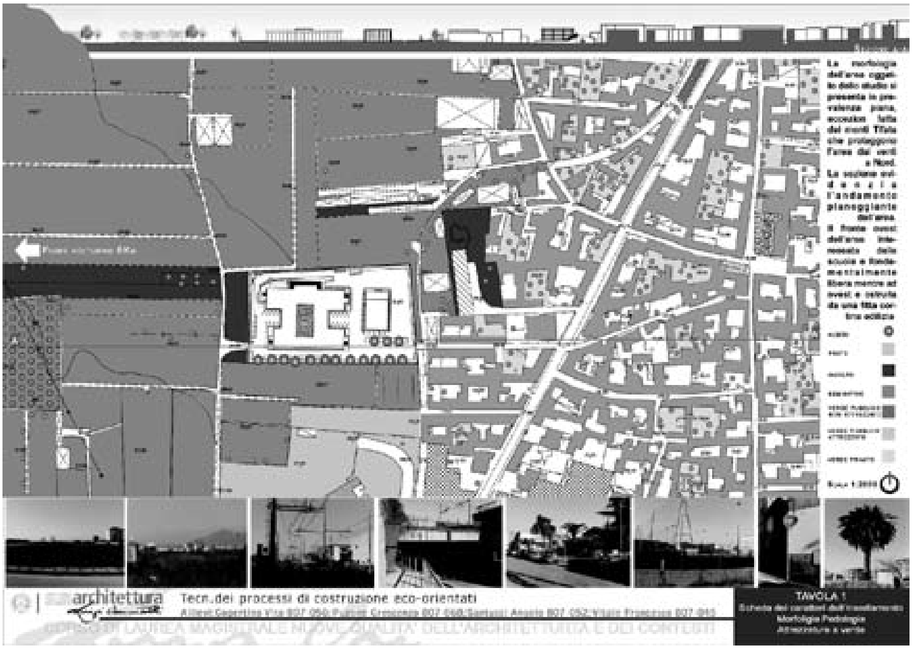

Fig. 3
Urban context's elements: furniture and green areas[2]

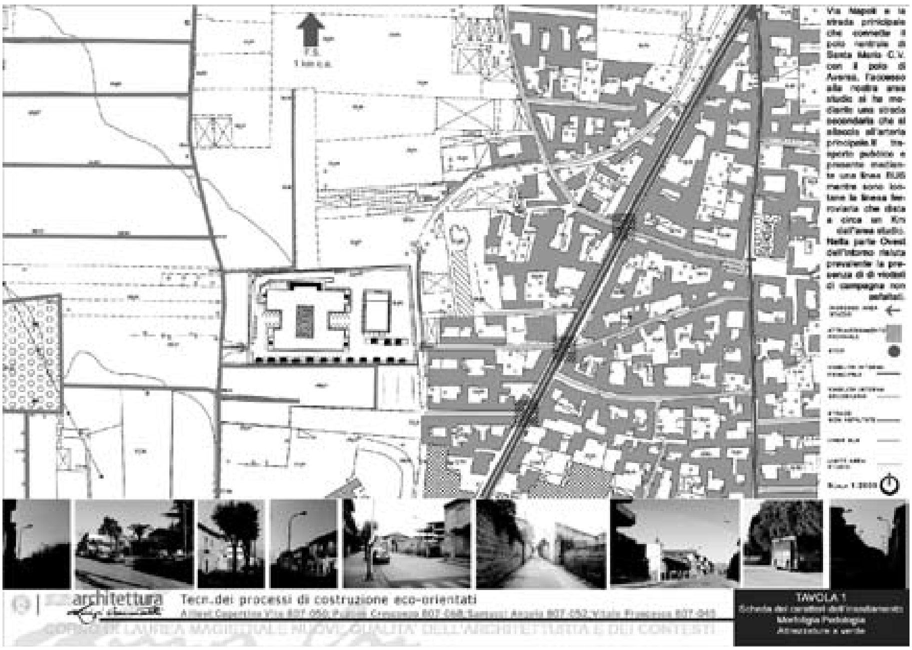

Fig. 4
Urban context's elements: traffic and pedestrian circulation

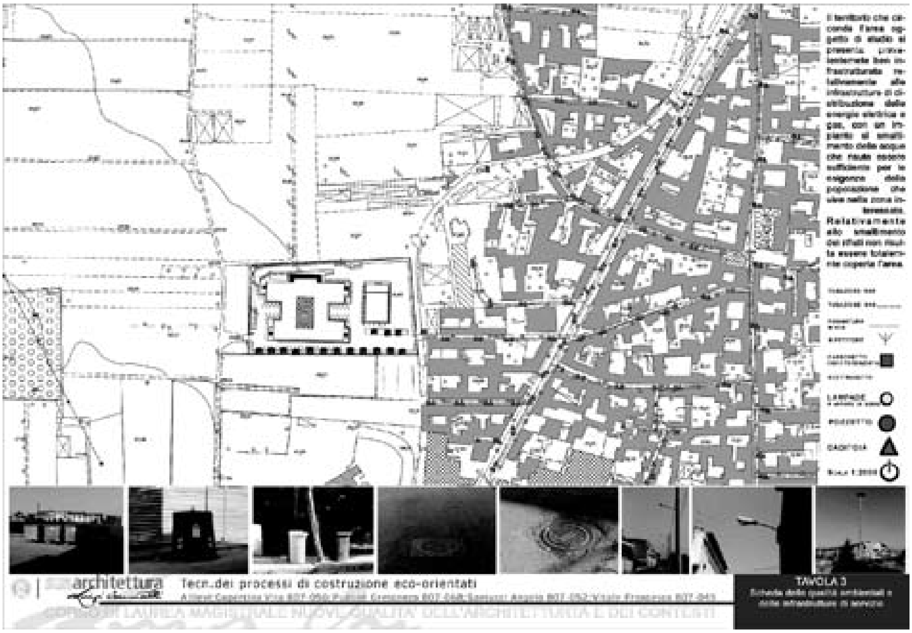

Fig. 5
Environmental network

surrounding should become a kind of buffer area that, if properly designed, can satisfy not only its specific functions but, also, contribute to a more aware energy behaviour of the building itself. In fact, the environmental context should be designed in accordance with bioclimatic principles mainly for two needs: making the area comfortable from a climatic point of view, and mitigating the effects of micro-clime on the building's energy performances.

Students have been invited to focus on the compatibility as the main issue of the design process, from the idea to the final construction. In particular attention has been oriented to the definition of strategies coherent both with Environmental Analysis of the site and design purposes. The eco-design approach promoted within the Laboratory Course, starting from bioclimatic criteria, tries to achieve a more compatible project, focusing on some specific areas of interest: spatial and functional layout; the green and water system; fruition's paths; technological systems. In addition to establishing the need for a design approach that takes into account the "building – environmental surrounding" as a single system, the hypothesis elaborated by students highlight the study of technological solutions mainly aimed at: reduction of environmental impacts, rational use of resources, definition both of a formal and functional identity for the object (building and its environmental surrounding) on which they operate.

An aware design, from an environmental point of view, should introduce elements that make the environmental surroundings more natural both to take advantage of self-regulation's mechanisms of nature and to place in less invasive works. This approach entails a rational management of rehabilitation projects and, above all, the choice of materials, both natural and artificial, as well as of barriers' systems (for sun and wind), in relation to the micro-clime conditions of the site. The appropriate use of local climatic conditions should promote the rational use of natural resources of the context too (like materials and energy). In fact, to realize an energy saving these must be important work on both the envelope of the building for active and passive technological solutions[3] and the design of its surround. The comfort, usability and the final quality of the environmental building's context will mainly depend on the balance of, among other things: paved and natural surfaces; shadow and sunny/windy areas; accessible and inaccessible zones.

The use of natural materials, like vegetation, comes up to more critical aspects. In fact, they are active materials characterized by different phases of growth strictly linked to the environmental peculiarities. That means, from a design point of view, that students (and designers) should take into account not only the formal aspects, but also the compatibility between natural elements and antrophic environmental ones. This is important for the management of the entire system "building - environment": from the economic aspects to the energetic ones.

Students, organized in groups, dealt with these issues focusing on the environmental context and taking into account the building's refurbishment purposes, as it emerges from the projects proposed.

The use of green barriers on the south façade of the school building, for instance, satisfies two main problems strictly linked to the creation of an area of shade for open air activities, as well as to the introduction of sun - shading. In this case, the choice of the appropriate kind of trees in relation to site's micro-clime and the different energetic performances in the hot and cold season was important. The selection of deciduous leaf trees permits sunrays to cross the barrier: so in the winter the building can benefit from them, realizing a more comfortable inside space, while, during the summer period, the leaves stop rays passing through, so that both the building and external paths can be shaded.

Fig. 6
Green barriers[4]

Another fine example of integrated design regards the use of natural resources like wind. In some projects students had considered the wind as an energy source as well as a passive cooling system to mitigate the negative micro-clime effects, both on the external and internal spaces of the building. Starting from the study of ventilation (in winter and summer season), they selected the areas of the plan influenced, in a negative or positive way, by the wind so as to design solutions in order to protect, or to benefit from it,both for the building and its open spaces. In some cases students designed a special micro-eolic system, correctly placed, with the aim of integrating the use of not renewable energy, and so to decrease economic costs.

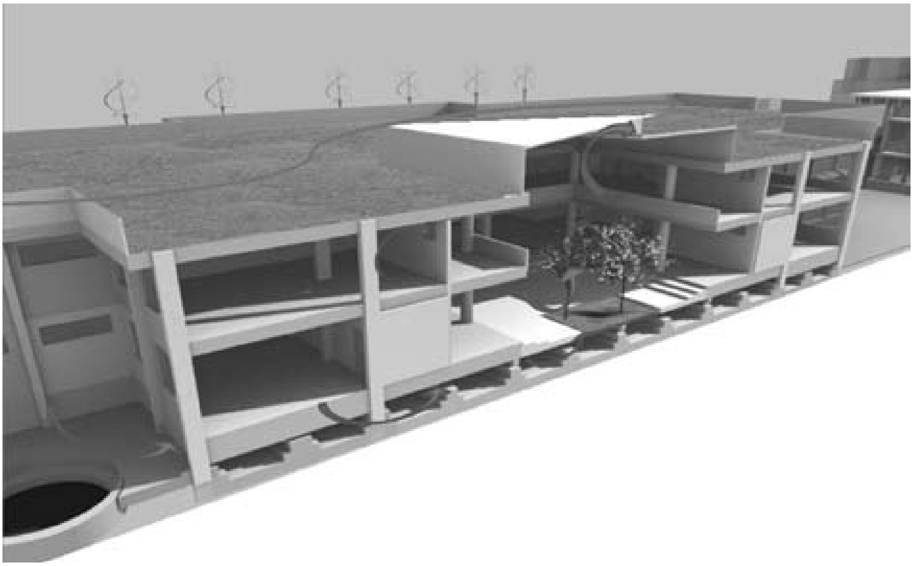

Fig. 7
Passive cooling system

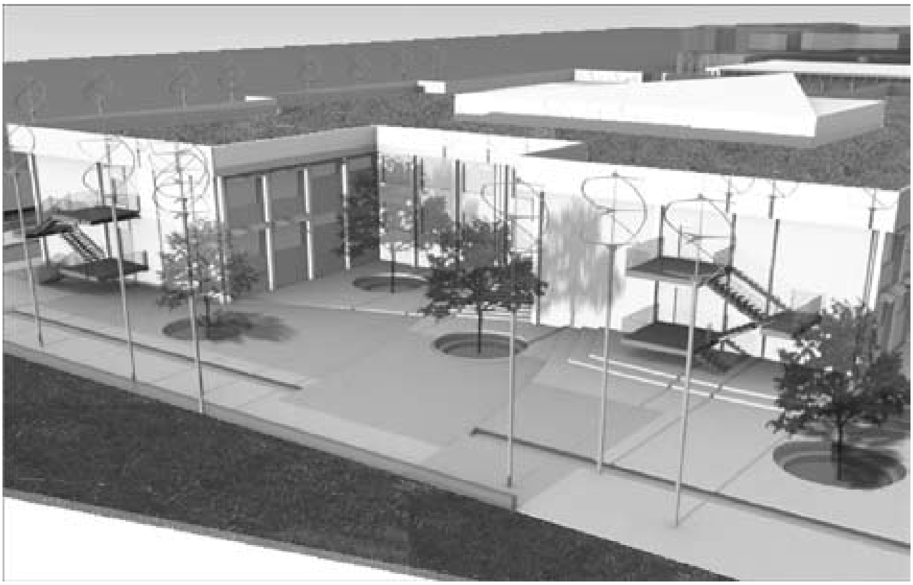

Fig. 8
Micro-eolic system

From a didactic perspective, it is very important for students to experiment theory through projects conducted on existent case studies. In our experience, this allowed them to collect "realistic" information about starting conditions of the site through the technological and environmental analysis, speaking with final users of the school building (students, teachers and administrators) too. The projects show, in fact, quite sustainable and feasible solutions, which take into account both needs as well as an economical budget to spend (hypothesized with the Dean of the school), so as to make the experience closer to a real one.

Fig. 9
Panoramic view of school building

Notes

1 The Laboratory is in the 2nd year of the Skilful Bachelor in "Buildings and Environment Innovative Quality" (Second University of Naples - Faculty of Architecture) and it is given by prof. arch. M. Isabella Amirante, with the collaboration of arch. Caterina Frettoloso.

2 The tables presented in Figures 3, 4 and 5 were elaborated by students: Copertino V., Puzone C., Santucci A., Vitale F.

3 These issues are being considered in the contribution of prof. arch. A. Violano, dealing with the "Technological innovative design for energetic rehabilitation of scholar building".

4 The renders presented in Figures 6, 7 and 8 were elaborated by students: Affinito A., De Cicco G., Pannella G., Puzella G.

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First Findings and Conclusions on the Teaching of Architectural Technology in the new School of Architecture of theTechnical University of Crete

Introduction

The Department of Architectural Engineering of the Technical University of Crete is the youngest of the six Schools of Architecture in Greece[1]. It is situated in the city of Chania, Crete, where it was established in September 2004. The premises of the Department are accommodated in a historic building of the city, the former French nuns' school, a building with a floor area of approximately 1500 m^2 (Fig 1).

Fig. 1

The former French School in Chania, where the Architectural Department of the Technical University of Crete is located.

At the present time (June 2009), it has 298 undergraduates who are taught by 9 appointed professors and 22 visiting lecturers. Additionally, some courses are taught by tutors coming from other Departments of the University.

Although the Department has no graduates yet (graduations will commence from the coming academic year), from the current academic year (2008-09) it is covering the complete (five year) program of architectural studies in Greece. The studies are organized in semesters (namely, the complete study program extends to 10 semesters). The total number of the courses included in the syllabus is 63. From this total, 45 courses are obligatory and 18 are optional[2].

The Studies in the Department

The courses of the study program of the Department deal with subjects concerning Architectural Design, Urban and City Design, Architectural Design with Digital Media, History and Theory of Architecture and Art, Landscape Architecture, History of City and City Planning, Architectural Technology, Plastic Arts, Restoration of Building and Building Sets. The program is also supplemented with courses on general knowledge of sciences (mathematics, statistics) and elements of social sciences. The obligations of the students are completed in the last two semesters with the elaboration of a research work and a diploma project.

The study program has undergone at least one widespread revision and other smaller-scale changes during the operation of the Department.

Although, the structure of the study program of the Department basically follows the structure and organization of the study programs of other schools of architecture in the country (and consequently, the corresponding, generally accepted and applied to schools of architect engineers in Europe[3]), it has its own identity. This identity is determined by its particularities and orientation that, as is defined in its foundation law, "...has the mission and aim to cultivate and to promote knowledge with teaching and the research of scientific areas of architecture, urban and land planning, architectural technology, protection and restoration of monuments and building sets, as well as the environmental-ecological dimension of architectural design."[4].

The studies in the Department of Architectural Engineering of the Technical University of Crete are not free of problems.

Part of these problems is owed to the lack of personnel (instructive, administrative, technical) and infrastructures. It is characteristic of this that the Department acquired the first appointed teaching staff members only in the fourth year of its operation as well as the fact that the building infrastructure that it uses is not sufficient to cover the needs of classrooms, offices, laboratories etc. Also, the Department has not yet organized a post-graduate program of study. Such gaps are largely due to the fact that the Department is new and consequently is more affected by the slow rates at which the needs of the universities in Greece are satisfied. Indeed, at times, these problems contributed to the worsening of relations between the administration of the Department and the students and drive subsequent upheavals which influenced the studies negatively.

The Courses of Architectural Technology

Architectural Technology, as a thematic field which is primarily concerned with the technological aspects of building design and construction, constitutes a significant subtotal of the study program. Courses of Architectural Technology are met in all semesters of the first four years of the studies in the Department and also offer subjects for research work and diploma projects (Table 1).

Table 1

Allocation of the courses of architecture technology per semester[2]

Semester	**Courses of Architectural Technology**	
1st	Construction I (4) *	
2nd	Construction II (4)	
3rd	Construction III (4)	Structural Mechanics I (4)
4th	Structural Mechanics I (4)	
5th	Reinforced Concrete (4)	Building Systems (2)
6th	Steel and Timber Constructions (4)	
7th	Special topics on Construction (optional) (4)	
8th	Building Physics and Principles of Environmental Design (optional) (4)	
9th	Research work with subject on A.T. (12)	
10th	Diploma project with subject on A.T. (30)	

* Numbers in parentheses indicate the credits per course. A total of 300 credits is required for a student to graduate.

The courses of Construction in the three earliest semesters of the studies and the optional courses of the 4th year are taught by two appointed professors and three visiting lecturers of the Department. The remainder of courses are taught by tutors from other faculties of the University with the speciality of Civil Engineer.

The experience from the courses of Architectural Technology

The experience so far of the teaching of courses of Architectural Technology in the Department revealed certain weaknesses. The students show that they do not realize the importance of relevant courses in their studies and largely consider them as an accessory in relation to the other courses and in particular to those of design for which they have high appraisal. However, the relative lack of value that the students attach to the courses of architectural technology has an impact on the knowledge and skills they acquire from them. Thus, in their dissertations in the frame of their studies, it is rather clear that they do not always manage the issues of architectural technology in a proper way. Gaps in issues of choice of materials, static behaviour, installations, insulations etc often characterize their work and cause confusion, particularly in the higher semesters of study.

Although these ascertainments are not novel to the studies of architecture in Greek universities[5] (and perhaps not only Greek ones), it is useful for them to be investigated under the conditions that characterize the Department. Towards this direction, beyond the responsibility of the instructors for teaching with a proper and persuading way (the author included), it is likely that additional, objective factors contribute something.

Among these, it is reasonable that the more general problems of studies that were mentioned previously (lack of personnel and infrastructures, changes in lecturers and the program etc) have an impact.

Moreover, in the possible reasons we should also include the fact that in the program of studies of the Department, the connection between the courses of technology and design has not been achieved yet. The corresponding courses and their exercises are conducted autonomously, a fact that does not help the students to realize their interdependence. In the same frame the fact that many of the courses of architectural technology are taught by non-architects, who objectively do not have a great ability to support their usefulness in the design, has a negative effect.

Still, to the most special reasons it is likely that belongs also the "incomprehensiveness" of certain topics and chapters of architectural technology (mathematic relations, natural concepts, terminology etc) belongs also, which makes them non-friendly to the students and does not encourage their assimilation.

This consideration led the instruction team for the courses of technology in the Department to elaborate proposals for the rehabilitation of the weaknesses. These proposals include:

1. The addition of one more course of Construction in the 4th semester of studies. This course will allow for the more complete and more comfortable development of the matters for the construction of buildings with the incorporation in it of elements of building physics.
2. The creation of at least two semester courses where design and technology will be taught integrated. These courses will result from the conjunction of relative courses from the two thematic fields that are now taught independently. Furthermore, enlargement of collaboration of the two thematic fields in the research and diploma works will be sought.

Conclusions

The Department of Architectural Engineering of the Technical University of Crete is the newest Department of architectural study in Greece, with a history of hardly 5 years. Despite the important progress that has been made in its establishment during these 5 years, the difficulties and the problems that it faced as a new department - and it continues to face - have an impact on the studies that it provides. More specifically, with regard to the courses of Architectural Technology, the main problems concern their relatively small assimilation from the students and the limited awareness they get of their role in architectural design and more generally, in the work of an architect. Among the more specific reasons for this reality, it is appreciated that the insufficient coverage of the instructive material of these courses under the current circumstances is of importance as well as the unsatisfactory, in the frames of the being in effect study program, connection of them with the courses of architectural design, that constitute the body of the architectural studies. These estimates led to the formulation of proposals for the revision of the curriculum of the Department which epigrammatically include the addition of an extra semester of Construction and the creation of mixed courses with technological and design parts.

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4 Greek Law No 3255, Government Gazette Issue No 138/22.07.2004 (in Greek). http://www.arch.tuc.gr/goals.html

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YTU Architectural Design Studio 3: Experiences of Second Year

Architectural education is a very special field having great differences from education of other disciplines. The architectural profession and education are discussed and evaluated in many national and international platforms. YTÜ Department of Architecture started its undergraduate program in the academic year 1942-43 for four years and master program in the academic year 1959-60 (for a year). In 1982 the master program was organized for two years.

YTU Architectural Faculty and Architectural Department is following these recent discussions and studies and evaluating the results to form a new educational program. This program is on charge since the 2003-04 academic year. Since the academic year 2003-04, the Department has been carrying out the program USIS that was organized to fulfill the increase of quality and efficiency in education and the preparation for national or international accreditation process. As a matter of fact, YTU Department of Architecture applied to the National Board of Architectural Education Accreditation (MIAK) and started the process of accreditation laboring by January 2009. Last but not least, the YTU Architectural Department is now studying an 4+1 architectural education program for the year 2010.

The department improves the educational programs with 5 to 6 years periods till 1984. The so-called USIS program gave its first graduates in the 2007-08 academic year. The program USIS was organized so as to fulfill the increase of quality and efficiency in education and the preparation for national or international accreditation process. USIS consists of one year of mandatory English prep. and four years of a bachelor degree with a total of 224 hours / 180 credits and 240 ECTS.

The distribution of courses of USIS is;

- 18% of general issues,
- 12% of history, human behaviors and environment issues,
- 32% of design studies,
- 20% of technical systems,
- 3% of application issues,
- 15% of elective courses.

The program consists of 52 compulsory courses (42 architectural + 10 social) and 74 elective courses.

The knowledge and skills of USIS Program

Outcomes of the program with the above distribution are aiming to fulfill the student performance criteria set in 27 criteria (these criteria are collapsing with the 33 Performance criteria emphasized by NAAB).

1st MODULE 1st year	2nd MODULE 2nd and / 3rd years	3rd MODULE 4th year
FOUNDATION Gaining knowledge and skill	**Using the gained knowledge and skill**	**Producing new knowledge and skill from the gained**
design, general issues, history, human behaviors and environmental issues	design, general issues, history, human behaviors and environmental issues, technical systems, application issues, electives	design, history, environmental issues, technical application issues systems, electives

Design studios

- Knowledge and skills of modules are studied on 7 semesters projects and 1 final (diploma) project in total. The scope of the design studios are determined according to the distribution of the knowledge and skills in years.
- In the education program the second year of the education, called the pre-graduate phase, indicates an important role. Taking place in the 4th semester, from the Architectural Design Studio 3 emerges the knowledge gained in the first foundation year, continuing in the 2nd year.

YTÜ FACULTY OF ARCHITECTURE DEPARTMENT OF ARCHITECTURE

EDUCATION PLAN

(U [illegible]-AFTER 2002)

	1. YEAR / 1. SEMESTER							1. YEAR / 2. SEMESTER				
CODE	COURSE NAME	ECTS	LE	A	L	C	CODE	COURSE NAME	ECTS	LE	A	L
0711021	INTRO. TO ARCH. DES.	6	2	4	0	4	0711022	ARCHITECTURAL DESIGN 1	9	4	4	0
0711211	BUILD. THE. AND DES. 1	3	1	2	0	2	0711102	INT. TO HIST. OF ART AND ARCH.	2	2	0	0
0711251	ARCH. DRAW. TECH.	6	2	4	0	4	0711212	BUILD. THE. AND DES. 2	3	1	2	0
0711261	BASIC DESIGN	3	1	2	0	2	0711402	BUILDING MATERIALS	2	1	2	0
0711271	DESCRIPTIVE GEOMETRY	2	1	2	0	2	0711482	STAT. AND STRE. OF MATERIALS	4	2	2	0
0251621	MATHEMATICS	5	2	2	0	3	0711502	CONSTR. EL. OF BUILD. 1	5	4	2	0
9061031	ADVANCED ENGLISH 1	3	3	0	0	3	9061032	ADVANCED ENGLISH 2	3	3	0	0
9061011	TURKISH 1	2	2	0	0	2	9061012	TURKISH 2	2	2	0	0
		30	14	16	0	22			30	19	12	0
	2. YEAR / 3. SEMESTER							2. YEAR / 4. SEMESTER				
CODE	COURSE NAME	ECTS	LE	A	L	C	CODE	COURSE NAME	ECTS	LE	A	L
0712021	ARCHITECTURAL DESIGN 2	9	4	4	0	6	0712022	ARCHITECTURAL DESIGN 3	9	4	4	
0712111	HISTORY OF ARCH. 1	2	2	0	0	2	0712112	HISTORY OF ARCH. 2	2	2	0	0
0712211	BUILD. THE. AND DES. 3	3	1	2	0	2	0712212	BUILD. THE. AND DES. 4	3	1	2	0
0712481	STRUCTURAL ANALYSIS	3	3	0	0	3	0712402	APPLICATION PROJECT 1	5	2	2	0
0712501	CONSTR. EL. OF BUILD. 2	7	4	2	0	5	0712482	STRUC. SYST. DESIGN 1	4	2	2	0
0712611	CAAD-PRESENTATION	3	2	2	0	3	0712522	PROFESSIONAL ENGLISH 1	2	2	0	0
9052031	ENGLISH READ. AND WRIT.	3	3	0	0	3	9031140	INTR. TO BASIC COMP. TECH.	4	2	2	0
								ELECTIVE COURSE	2	2	0	0
		30	19	10	0	24			31	17	12	0

Architectural Design Studio 3

The Architectural Design Studio 3 is the studio which 2nd year students attend and consists of 12 study groups including a tutor with 10-12 students and an approximate total of 120 students. The credit of the studio is 9 ECTS and 8 hours a week, but students have the opportunity to continue studying after studio hours.

The Studio is about designing a small-scaled multi-functional building within the urban land (urban-suburban).

The main design themes are grouped as,

- educational,
- recreational,
- cultural,
- public buildings.

From these groups students mostly prefer to study

- restaurant,
- school,

- museum,
- library,
- cultural center,
- student social center.

The total building area is limited to 1000 square meters but mostly they tend to exceed these limits. Each student chooses the land where he/she is going to design the building. Because students choose the topic and the area to design, they study more efficiently.

The objectives of the studio
- To emphasize the importance of early design phase,
- To assist/set the understanding of formal and functional relations,
- To emphasize the importance of the analyze-synthesis-evaluation system in the design process,
- To improve the design concepts of students in an interactive design studio environment.

The scope of the studio
The examination of design behavior approaches in the early design phase makes a considerable contribution to the development of architectural practice. From this point of view in general the studio is focused on,
- knowledge used in the design process,
- approaches to design problem solving,
- working styles on design problem,
- creating a model of the architectural environment in the design studio,
- improving presentation skills.

The more concentrated aims of the studio are,
- preparing a building program of a multifunction building,
- studying an existing urban land,
- evaluating a plot (design area),
    - analyses of a certain environment,
    - on site observations,
- synthesis of knowledge gained from site analysis and the design program,
- reaching the final product (design) by using design evaluation techniques.

The learning methods in the studio
- criticism,
- analyses of examples,
  (learning from precedents and learning from present life),
- evaluating / exploring experiences,
- individual learning,
- informal learning.

The Assessment system in the studio

3-4 groups study in each studio. Each studio consists of 4 tutors, 2-4 assistants and 30-40 students.

- Individual presentations/critics/discussions.
- Two mid term Jury assessments for evaluating both early design phase and design phase.
- A final jury assessment for evaluating the whole process.

Early design phase-first presentations

The consistent design ideas produced in the early design phase play an important role in the development of the design and in the end product:

- to create the first architectural representations (plan, section, elevation, perspective, etc.),
- to define the first design ideas,
- to begin to create a new knowledge. (Fig.1-2)

Early design phase-1st jury assessment

The first jury assessment is arranged at the end of the early design phase. Different design concepts produced in the early design phase are evaluated at the first jury assessment.

- To comment on first design representations.
- To transfer first design ideas by using architectural presentation techniques.
- To begin to use the new knowledge. (Fig. 3, 5)

Design phase-2nd jury assessment

The second jury assessment is carried out before the proposal of the end production. The development/progress of the design process is evaluated at the second jury assessment.

- To discuss the development of the design process
- To define the progress of first design ideas.
- To argue the sufficiency of the new knowledge. (Fig. 6)

Evaluation (Self-Assessment)

- AD3 is chosen as a case study for the research project called "AN EXAMINATION ON THE TRANSFORMATION OF THE KNOWLEDGE IN EARLY DESIGN PHASE AT ARCHITECTURAL DESIGN STUDIOS", which is supported by YTÜ BAP (Fund for Scientific Research Projects).
- The progress of students in AD3 are determined by using behavioral observation, interview and questionniare techniques. A survey is applied to AD3 students for the last 3 semesters. 90 students participated in the project.

Fig. 1
Early design phase - first presentations.

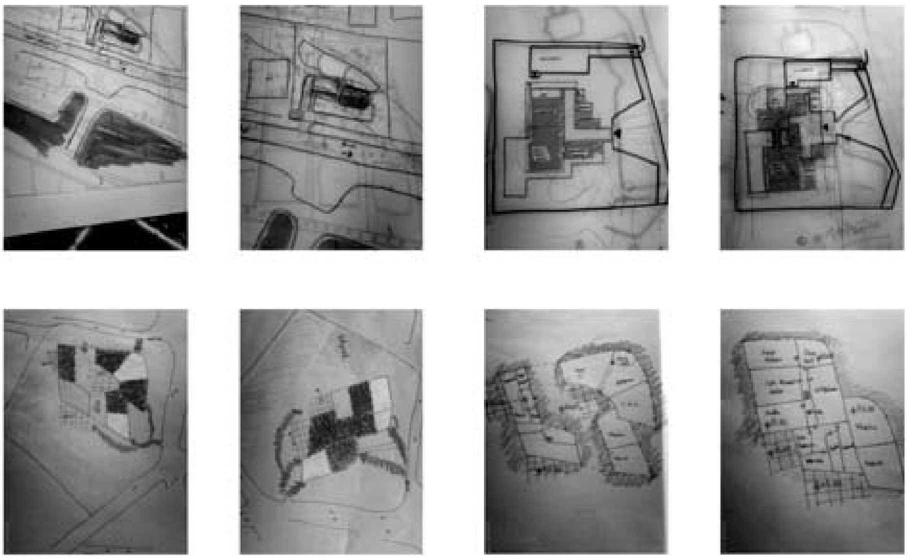

Fig. 2
Early design phase - first studies.

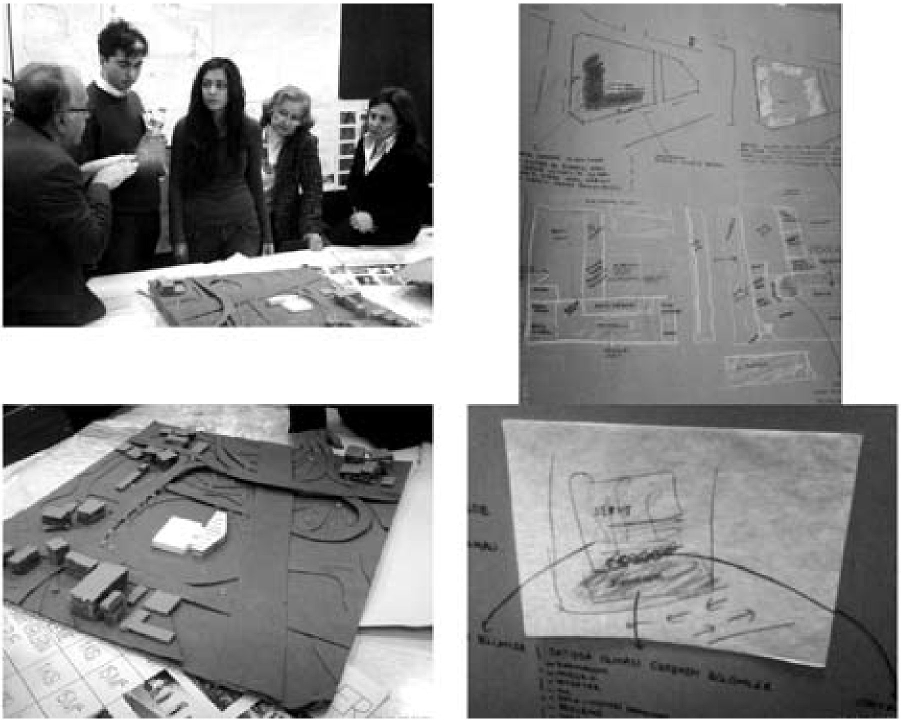

Fig. 3
Early design phase - first jury assessment.

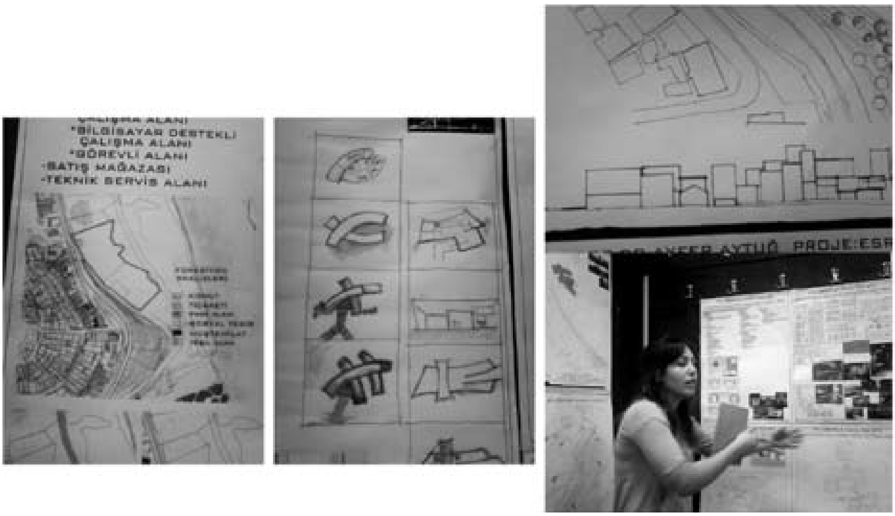

Fig. 4
Early design phase - first jury assessment.

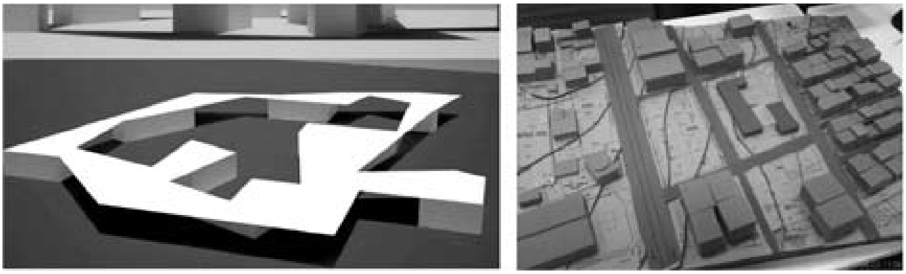

Fig. 5
Models of the process.

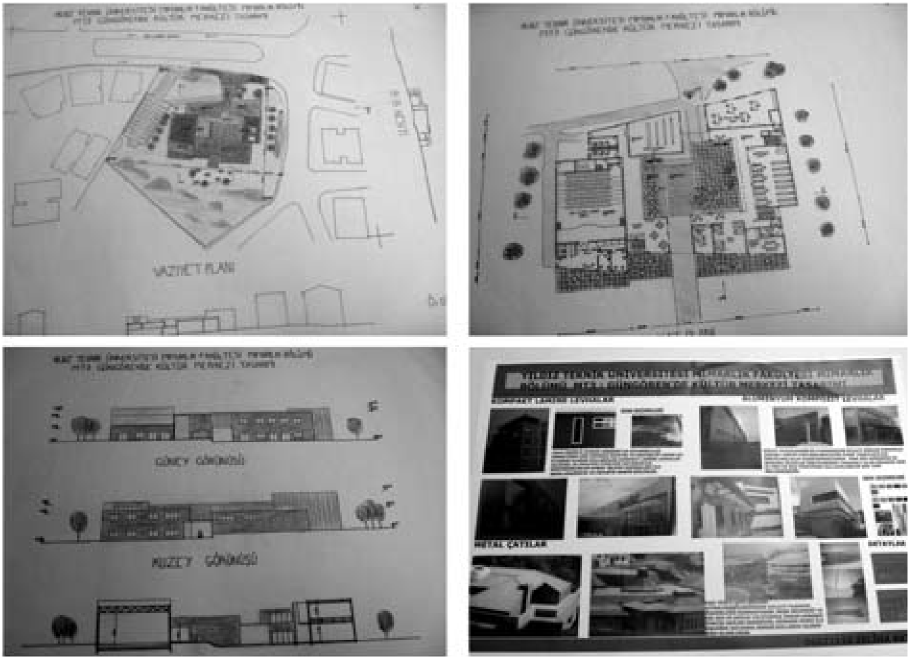

Fig. 6
Design phase - second jury assessment.

The questionnaire is composed of 4 parts of 20 questions:

- 1st part: general information about the student.
- 2nd part: the position of design studio in the curriculum.
- 3rd part: working styles of students in the design process.
- 4th part: the improvements developed by students in the design studio.

The most outstanding results:

- Representation techniques.
    - While transferring first design ideas, students begin to study by forming/ creating "plan representations".

    - Students frequently transfer their design ideas by means of "free hand drawings".
    - Resources of the knowledge.
    - The Internet is the most preferred knowledge source for searching the theme of design and site.
    - "Environment" and "Function" are the major knowledge groups used by students in design process.
- Analyses
    - Students state that in the early design phase, they mostly use "urban analyses techniques", "on site observation" and "sample reviews on design theme" respectively.
    - Students frequently use "physical context" by making design decisions and "social structure" and "cultural analyses" are less preferred by students.
    - "Function analyses" and "Design scenario" are the most preferred methods to transfer design decisions.
- Synthesis
    - Insufficient data was retrieved from students on how they synthesis knowledge for their designs.
- Evaluation
    - "Criticism" and "analyses of sample review" are the most essential education methods for students to develop/improve themselves in the studio.

Integration of the courses

Problematic issues

- In design
    - Disconnection of comments of analyses and internalization.
    - Difficulties in transformation of knowledge.
- In construction
    - Difficulties in integrating the knowledge of building elements and components on whole building scale.
    - Inadequate knowledge of structural solutions. (The most important factor of this problem is taking Application Project 1 and Structural System Design 1 courses together in the same semester as AD3).

Conclusion

In rapidly changing and developing architectural environment, the necessity of revising the available design studio systems is obvious. From this point of view we have to question.

- Lack of integrated thinking,
- Insufficiency of knowledge transmission,
- Discussion of architectural concepts in the studio both by students but especially by tutors.

- The progression of the design process in the studio should be explained to students.
- Informal learning activities should take place in the studio to support the individual and professional improvement of the student.
- Lack of communication which has a negative impact on knowledge transmission should be eliminated.

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A Substainable Approach to an Architectural Project

Students' Workshop Experiences

The environmental fragility of urban and semi-urban territories requires more and more planning awareness aiming to rebalance the relationship between buildings and environment.

During the five-year course of graduation in Architecture, the architectural building laboratories, held during the second year, offer didactic experimentation of planning where climate and context become instruments of the project.

Environmental design experiences

During the experience of the Environmental Design Laboratory on the architecture course of Second University of Naples, some experiments have been carried out as regard as urban renewal.

The experimentation is applied to a context developed at the beginning of the second half of the 20th century, in a high density concrete building area, with no collective open area, no greenery, no quality, one would says.

Architecture should also in this context try to find new solutions, and find new issues for renovation and, in order to improve the social aspect of living, the design should give an outdoor-indoor integration in a connection which helps human contact.[2]

Two fundamental goals have been energetic passive strategies and comprehensive architectural improvement. The two things are intended to be connected, bearing in mind the idea that only architectural research, looking for quality, is apt to create a real sustainable building improvement.

Following this approach implies the consequence that technological solutions could give expression to architecture. And in experimentation works, design details are studied with attention to visible comprehension of technological systems. The technologies should provide a clear and visible framework of the way they work, and technological processes are thought to be immediately visible and understandable in architecture itself.

Moreover, the physical and three-dimensional comprehension of the way technologies work could be a demonstration of sustainable technologies for educational purposes and, therefore, it provides useful information to encourage appreciation of this issue. These considerations are very important in modelling a wide knowledge process which should be promoted in a contemporary situation also because public belief about contemporary and collective issues should be always well received. If sustainable philosophy in any case promotes the requirement for passive rather than active construction, a new student's re-thinking in design has the idea that sustainable techniques like rainwater reuse, solar energy application, wind energy applications, green for rehabilitation and so on should facilitate an architect to clarify his specific thinking about architecture itself.

It is so possible to emphasize interaction among design and technology.

It is difficult to individualize proper design morphologies which can lead to a new dimension by adapting processes of building into the environment. However the idea is that it is necessary to move contemporary within a technical field with a wide inspiration from an architectural point of view, trying to reach an effective interaction among technical knowledge and competence and traditional formal experience, for a multi-comprehensive approach.

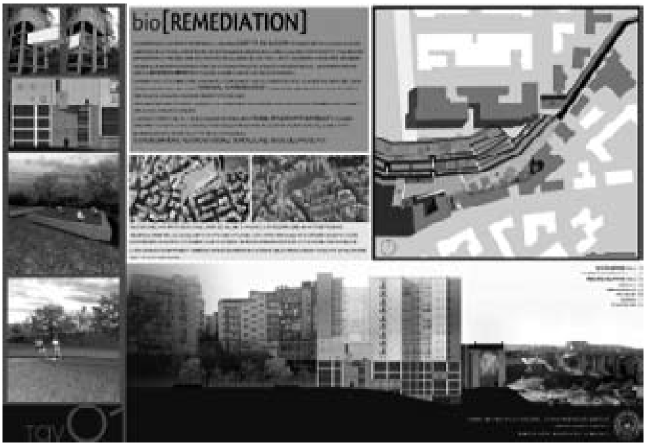

Fig. 1
Environmental design laboratory experience
students:
Francesco Aletta,
Roberto Bosco,
Andrea Gallo

New rural spaces for housing

In collecting and re-elaborating the heredity of traditional rural societies, it is thought that a new rurality should be entrusted to conscientious participating and culturally evolved societies. Some simple reasoning reveals to us that as in the rural world it is possible again to let us move with the dreams of inhabitants. The rural idea of living is not only a reference for architectural models but also for different ways of living. This perspective has a social meaning, as it introduces into the project also the concept of how useful it is in a project to support the social side, opening the architecture to those social values which we need nowadays.

The idea of open space and greenery as elements of continuity and safeguarding of the eco-compatibility of the installed systems re-proposes also the sense of inter-connection between closeness and interiority, the sense of belonging which has been destroyed in the enormous and undifferentiated development of the habitat.[3] Going towards the light, towards the water that runs, waiting in the green, fleeing from the

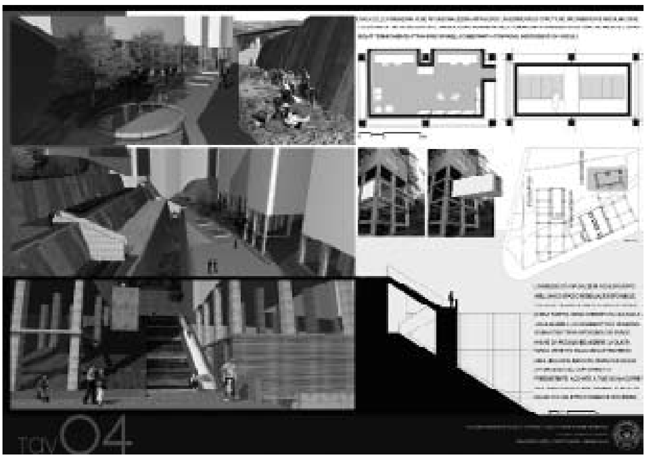

Fig. 2
Environmental design laboratory experience
students:
Francesco Aletta,
Roberto Bosco,
Andrea Gallo

darkness, even cultivating a creeper has always suggested a path for man to take towards a form of happiness which is considered as a personal sensation and is imagined as a shareable condition with others.

The apparent obviousness of the images has the meaning of a re-project of the most widespread models of habitat.

Moreover, students have to consider the idea that architecture should never be considered as only a three-dimensional habitat, but it is an engine which moves people time during the days. In that sense the opening for rural experiences has the meaning of new sense not only for open spaces but also for the whole context.

Creating a project

When we start planning a project, we have to consider at least three issues. The first is the necessity of building, the second is the freedom of typological and technologic choices, the third is the constriction which the environment puts on us. The right connection among these three matters determines the quality of the project. Students have to increase their own abilities in managing these three issues, so the second year building workshop of our school of architecture gives the student a design approach that consider both the knowledge of building and of environment. Buildings are seen like open systems that exchange matter, energy and information with the environment. Generally the first part of the workshop is dedicated to improving the constructive and functional aspect of buildings, the second part gives information on interaction among environmental features (climate, shape, and a number of other human and natural elements) and finally an application is made on a case study towards a sustainable design.

In some cases the final exercise consists of a renewal of an old building to apply the acquired basic knowledge of construction elements and a bio-climatic design approach. Thinking about renewing old buildings, which are very sensitive to inappropriate changes, drives students to increase their attention in order to define both innovative and soft design strategies.

Fig. 3

Construction laboratory experience, an ancient rural building becomes a fashion district.

Students:
Buanne Mariangela,
Russo Marco,
Scandurra Luca

In the case of building renewal there are many possibilities in the project approach and the students may choose to improve the quality of the old building with few structural and spatial changes. An alternative way is putting in new elements apt to dialogue with the existing structures clashing or following them. It is accepted the insertion of new constructions made of steel (framework) and glass (skin) that opposite light modern structures to old massive walls.

In this way they also can experiment with the use and integration of passive cooling or solar energy systems. Any transformation of the previous shape will be, however, appropriate for the new use and the changes should preserve the qualities of the old building such as the "genius loci".

Regional identity

The aim of the building workshop is to teach respect for the natural environment and the culture of landscape preservation also using modern technologies to make new buildings or to renew old buildings and country houses. In the final project exercise the ability to design innovative structural and energy systems and the integration in the landscape will be evaluated. Therefore the first step, of course, is to locate the building (case study) and to survey the surrounding region in order to define its peculiarity and its level of fragility. At the same time, students analyze regional climate and identify the system of restrictions coming from it.

On a geographical map, they highlight the natural remarkable parts, for instance, mountains, rivers, forests, and artificial objects like motorways, railways, gravel pits, and more. The analysis of the region is also made through cross-sections that shows the connection between built-up areas and background reliefs.

The analysis of the surroundings is carried out throughout the study, on an architectural scale, of the building environment to evaluate dimensions, shape of parcels such as the visual and geometrical relationship between building, roads, squares, garden and so on. In this way students can analyse and draw shadows, wind impact and obstructions.

After environment and landscape analysis, students make a relief of the building and its closer space to show shapes, materials and technologies in detail (scale of 1:500 to 1:50). We now can see masonry texture, materials' decay, the condition of systems, but also shape and consistence of green areas, external layout and access roads. It's useful to define the actual conditions of the building and its area also to compare afterwards the improvement achieved by the project. Finally, working drawings are required in scale of 1:20 to 1:2.

Climate analysis requires two steps. The former is the collection of data on a geographical scale, the latter is the representation and evaluation of the micro-climate conditions related to the building's location and characteristics of the site. At this stage, students work out a synthetic draft of the climate trend in the region (temperature, rain, wind, solar radiation, and so on) and draw sun and wind shadows of the building site at summer and winter solstice. They make also a study on real or potential solar passive behavior of the building through the analysis of internal distribution of spaces and typological and structural solutions.

At the planning stage students develop design strategies to obtain the best results in terms of living comfort, carrying out passive solar systems and, if necessary, new architectural additions. A complete project is not required, because the attention of the course is mainly focused on the analysis phase, but the illustration of the design ideas through sketches and working schemes of natural passive control of interior micro-climate is taken into appreciation.

Notes

1 A. Bosco wrote: "Creating a project" and "Regional identity"; F. Muzzillo wrote: "Environmental design experiences" and "New rural spaces for housing".

2 A. Bosco, E. Gravina, F. Muzzillo, Vegetation as relevant element of dwelling for inside-outside space, Sustainability of the Housing Project Trento 2004

3 R. Aben, S. De Wit, The enclosed garden. History and Development of the Hortus Conclusus and its Reintroduction into the Present day Urban Landscape, 010 Publishers, Rotterdam 2001

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An Innovative System for Reuse of Rain-water

Introduction

This contribution illustrates the teaching experience carried out during the course in "Technological Planning of Sanitation-Environmental Systems" (academic year 2008-09; lecturer: Prof. ing. Rossella Franchino) on the degree course in New Construction Quality and Contexts at the Faculty of Architecture of the Seconda Università di Napoli.

The aim of this experiment was the recovery of rainwater from a building and its reuse. The building was considered the central element in the water-use cycle as we examined the rainwater collection system, the treatment of the rainwater, its storage and finally its distribution for reuse.

Since any intervention within a territory gives great importance to the correct environmental design of a water-supply network, examining the network as a whole, instead of looking at its single elements, provides a more general overview, allowing us to make recommendations as to the re-use of this resource.

Water is an extremely valuable resource and therefore the overriding aim of the entire cycle of use must be how to save and to recycle it whenever possible.

Water-use integrated cycle networks

On a territorial scale, the integrated cycle of water-use undergoes different phases. From its point of origin, water reaches individual users through primary and secondary distribution and after whatever use it is put to, is discharged as waste water into the sewage system, which conveys it to where it will be finally treated.

The typical water-cycle is made up of: procurement, storage, use and disposal. Procurement may be from a spring, ground-water, freshwater supplies (rivers, lakes), and only in a few cases also rainfall and seawater. The latter two resources are used in special cases and for isolated areas of use, being constituted by holding-tanks for collecting rainwater and desalination processes for seawater.

In the other, more commonly-known cases there are collecting tanks and drainage channels for obtaining water from springs, artesian wells or wells for groundwater and plants which use river water and lake water from source. Having collected the water, a fundamental element for its use is naturally its quality, from an organic-oriented, chemical-physical and bacteriological viewpoint.

Depending on the eventual use of the water, in most cases it is necessary to resort to a series of drinkability measures, which might consist of neutralising certain pollutants that may be present, reducing their strength, modifying their ph value, disinfecting them etc. The water that has been drained off is collected in special holding devices where the necessary treatment takes place and it is from here that the flow begins for the various uses of water, which has to be supplied proportionately in order to satisfy current and potential water needs.

Generally this phase of the cycle consists of a process of heat transfer to the water which is mainly channelled, under pressure, but also in some cases, in the open air, to holding tanks situated in the proximity of end-users. These holding tanks have differing sizes and typologies in relation to the type of use, the topographical features of the catchment area and the type of function required.

The most common types are buried or above ground, depending on whether the area to be supplied contains natural elevations or is completely flat. The size of the tanks, besides being obviously dependent on the number of users, is also determined by the characteristics of the community and flow-rate coefficients required. From the holding tanks a distribution network is developed which must deliver punctually the necessary quantity of water required by individual users. This network is usually a mesh type since it is subjected to considerable variations in flow-rate and with this type it is possible to ensure the greatest flow to specific points. It would be pertinent to note the difference between the heat-transfer network which is proportional to average flow-rate required by users. The function of the holding tank is precisely that of receiving water constantly at an average rate of flow and delivering the required flow rate instantaneously.

Subsequent to water use is the discharge of waste water, in quantities conventionally set at 80% of that supplied, which takes into account those amounts of water which are not discharged into the sewage system but are used for irrigation or external flushing. It should also be noted in the water balance that water supply is generally equivalent to a maximum of 60% of the water that is drained since a considerable amount is lost in the conduits or from pump overflows and tanks. The waste water is transported through sewage conduits which take it to its final destination, following purification treatment. The sewage system may be of a mixed or separate type, depending on whether it collects rain water. The network elements should allow for, whenever possible, not only the discharge of waste water from all possible users, but also the distinction between runoff water and sewage water so that runoff water may be reused after treatment for watering green areas and street-cleaning, while sewage water is transported to purification plants where it is thoroughly treated.

In some cases, once the principal pollutants have been neutralised, the recycled water may be delivered to homes, through a system which is separate to the drinking water system, and used for WC flushes. It is also important that rainwater, which contains dust and pollutants of various kinds in solution, is separated from this recycled water through overflows and sent into the sewage system for subsequent purification treatment.

The final purification treatment takes place in plants which deal with the neutralisation of the main pollutants contained in the waste water so as to enable it to be sent to a final body of water. Emission limits on waste water issuing from purification plants are contained in Law DL 152/99 which governs urban waste water discharge in surface water bodies and in general, as far as their values are concerned, compares the chemical-physical qualities of the discharge against environmental quality objectives which "are defined according to the capacity of bodies of water to maintain the natural processes of self-purification and to support diverse communities of animal and plant life".

In order to protect the delicate equilibrium of the aquatic eco-systems of the receiving body of water, it is important that the effluent from the purification plants does not contain residual pollutants. Traditional treatments for purifying water are of a physical kind (sedimentation), of a chemical-physical kind (adding chemical reagents) or of a biological kind (active mud) and produce the so-called "purification mud" which has to be specially processed (in the past in special waste disposal sites but now in incinerators).

The location of these treatment plants is also of great importance since they represent sites of high environmental impact. This impact may be reduced through the use of tunnel plants or covering the tanks and taking steps to treat the air through deodorising scrubbers. Where possible, this deodorising treatment can also be carried out with deodorising aerosol systems.

Traditional purification systems, in small-scale cases, might be bolstered or even replaced by natural treatments which greatly reduce the content of artificial elements and the amount of energy consumption. For example, instead of constructing concrete holding tanks, particularly in naturally, humid areas, water flow can be, to all intents and purposes, implemented by gravity.

Such natural treatments can, in certain cases, be sandwiched between the pre-existing purification system and the final receiving body of water, in such a way as to neutralise the residual organic content and to protect the environment in case of malfunction of the pre-existing system.

To achieve purification of water without resorting to mechanical means, which have a high environmental impact, purification systems can be used in small-scale cases which are based on natural processes such as reed-bed purification.

Networks for the reuse of rainwater in buildings

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 the context of a 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, air-conditioners and heat pumps, reintegration water for anti-incendiary use and even for some electrical 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 holding-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. Those tanks which are placed outside have the advantage of being hidden from sight and protected from accidental damage while, those place 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, through which a control unit passes the water into the recovery plant.

The first case study (Figure 2) concerns the system for recovering water from the building of the Istituto Tecnico Statale Per Geometri "Pier Luigi Nervi", a high school in Santa Maria Capua Vetere in the Province of Caserta.

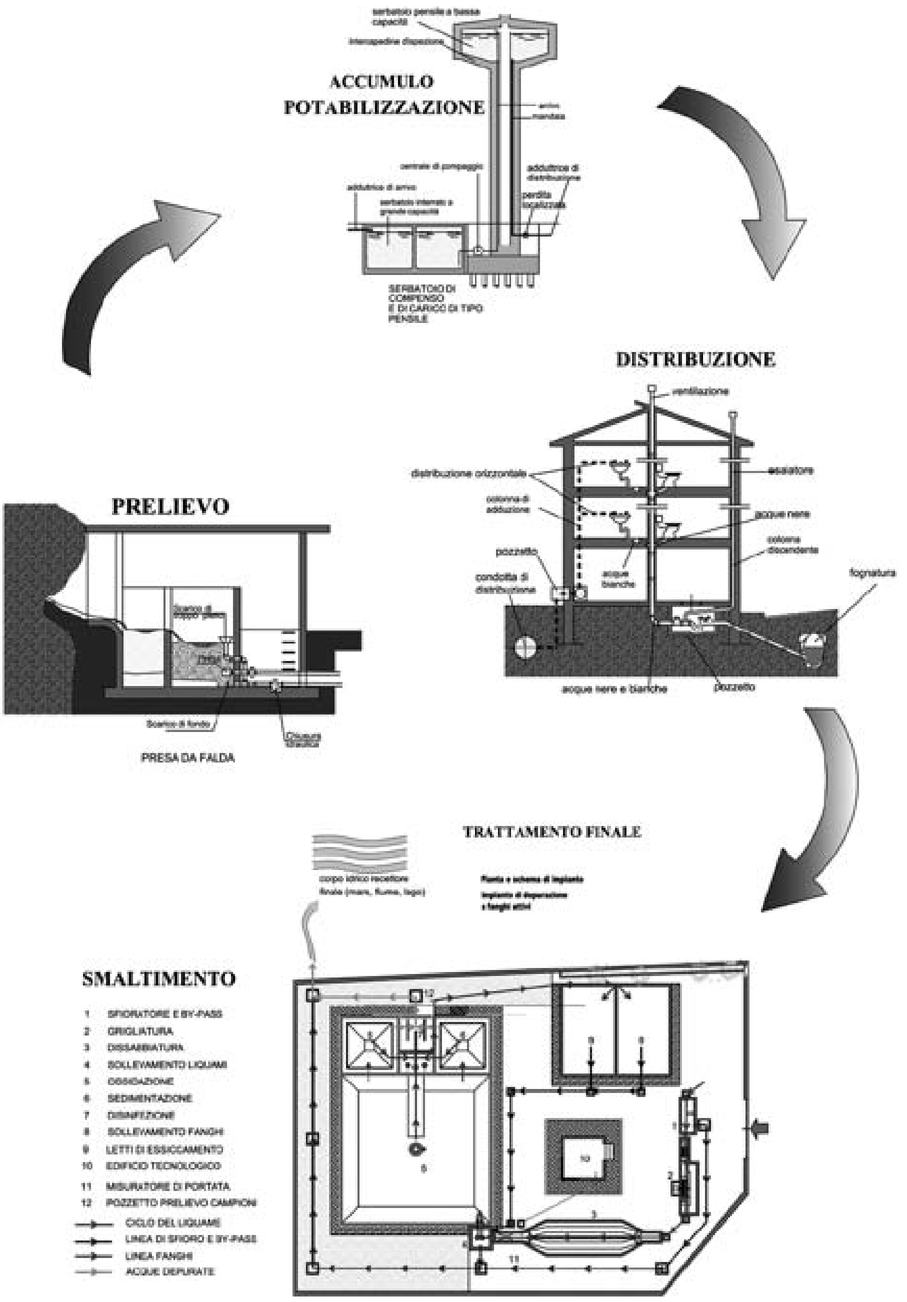

Fig. 1
The integrated water cycle[1].

The second case study (Figures 3 and 4) proposes an intervention for the recovery and re-use of rainwater in a terraced complex comprising eleven accommodation units in the Castel Campagnano Council District in the Province of Caserta. Each unit is made up of a basement level in which a garage and cellar is situated. The day area, comprising a double room and two single rooms with a WC, are situated on the first floor. Each accommodation unit is vertically connected by a staircase.

The complex comprises two living blocks, one made up of five accommodation units and the other of six. The former has an area of about 400 m^2 while the second has an area of about 480 m^2. A system of rainwater recovery has been scheduled for both blocks.

The two coverage areas constitute the collection surface for rainwater which is passed, through four drainpipes per block, to the collection tank where through a system of filtration it is accumulated for its subsequent use.

As a preliminary to the definition of the intervention for recovering rainwater, a data sheet was drawn up of the environmental features of the complex (Figure 2). This is necessary for integrating study of the installation with other considerations concerning the relationships between the intervention, the natural environment and the urban systems.

A reading of this data sheet, singling out the features of the complex and the environmental quality, gives us an immediate perception of the relations between the two blocks, which are the subject of the intervention, and the environment surrounding them, allowing also for qualitative and quantitative assessments. In this way it is possible to calibrate the intervention appropriately, permitting us to improve the relations between the building complex and its surroundings to the maximum of environmental sustainability.

Figure 2 shows the installation system, based, proportionately, on an analysis of average precipitation in the area and user needs.

The system is composed of a tank for water collection, a water filter system and a pump system. The rain water collected on the roof is conveyed through the gutters, filtered and collected in tanks. The recycled waters are used for watering external green areas and WC flushes. A pump system siphons water from the tank, which after treatment, is ready to use.

The system has a distribution network inside the building which is separate from the drinking water network. This is to prevent possible hygienic and sanitary problems.

Notes

1 The tables presented in Figures 1, 3 and 4 were elaborated by students: Matarazzo Salvatore, Nigro Matteo, Vita Giovanni during the course entitled Technological Planning of Sanitation-Environmental Systems (academic year 2008-09, lecturer: Prof. Ing Franchino Rossella) on the degree course in New Construction Quality and Contexts at the Faculty of Architecture of the Seconda Università di Napoli.

2 The table presented in Figure 2 was elaborated by students: De Maio Gianpiero, Perillo Monica, Piazza Elena during the course entitled "Technological Innovation for Building Energetic Quality" (academic year 2008-09, lecturer: Prof. arch. Antonella Violano) on the degree course in New Construction Quality and Contexts at the Faculty of Architecture of the Seconda Università di Napoli.

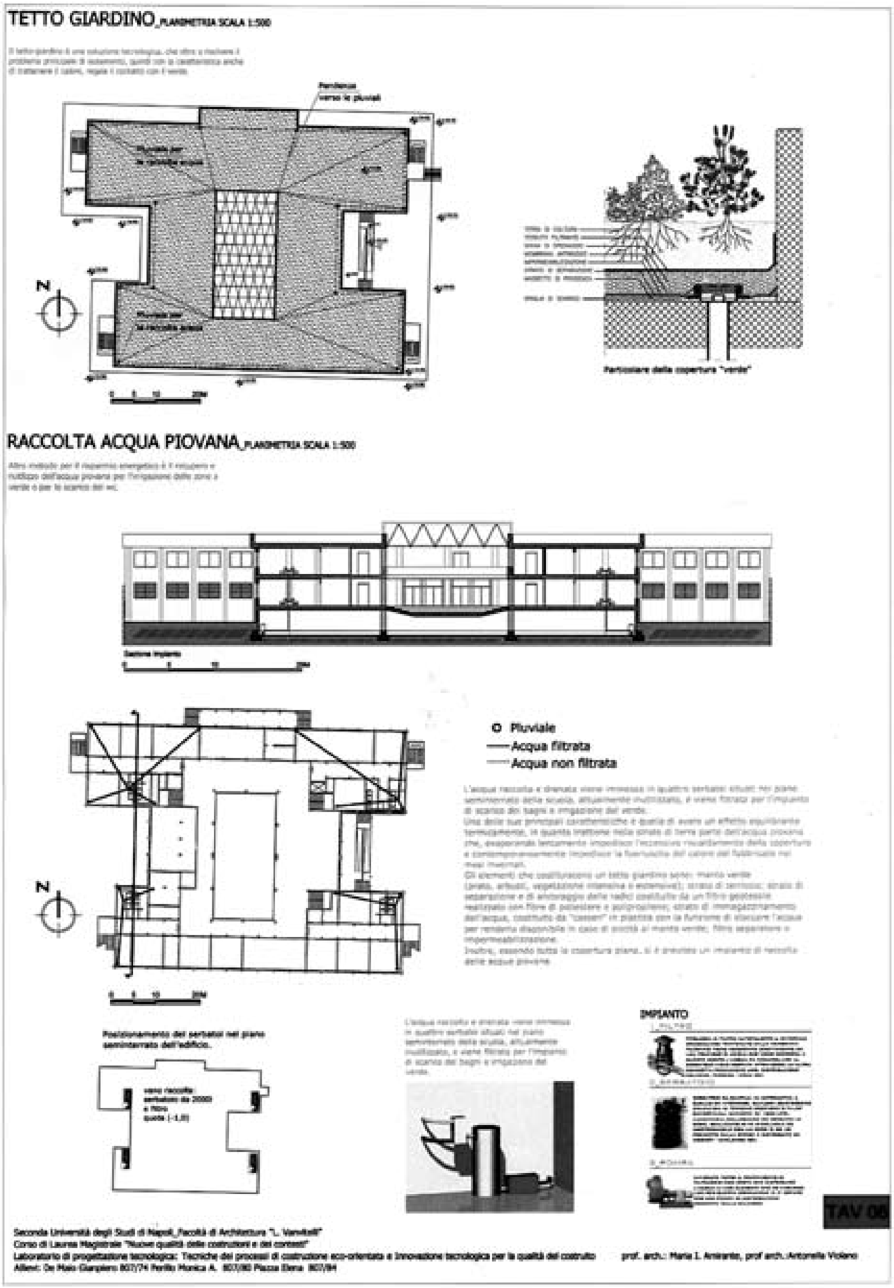

Fig. 2

Installation for the recovery of rainwater (case study of ITSG "Pier Luigi Nervi" in Santa Maria Capua Vetere - Caserta)[2].

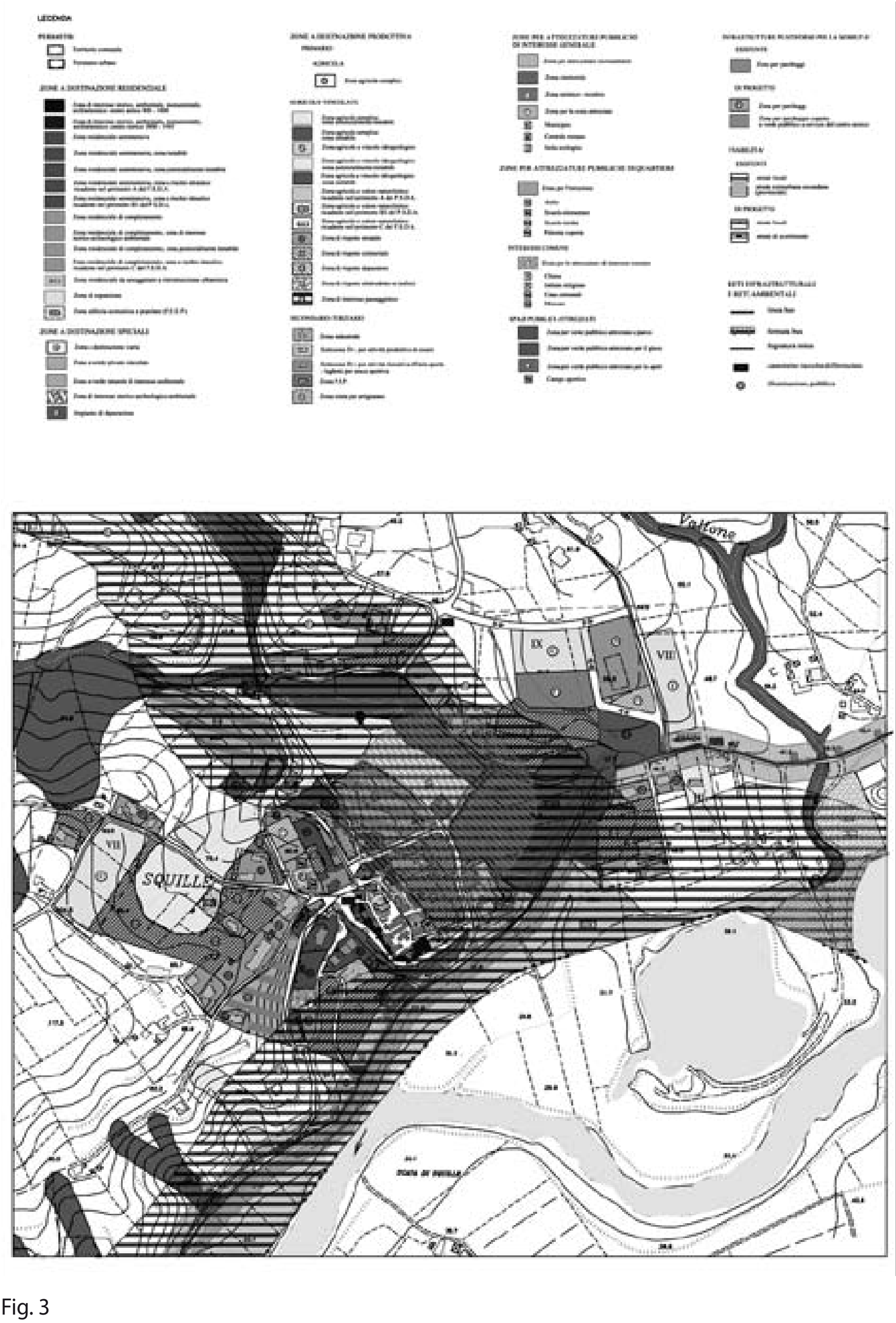

Fig. 3
Environmental features of the complex.

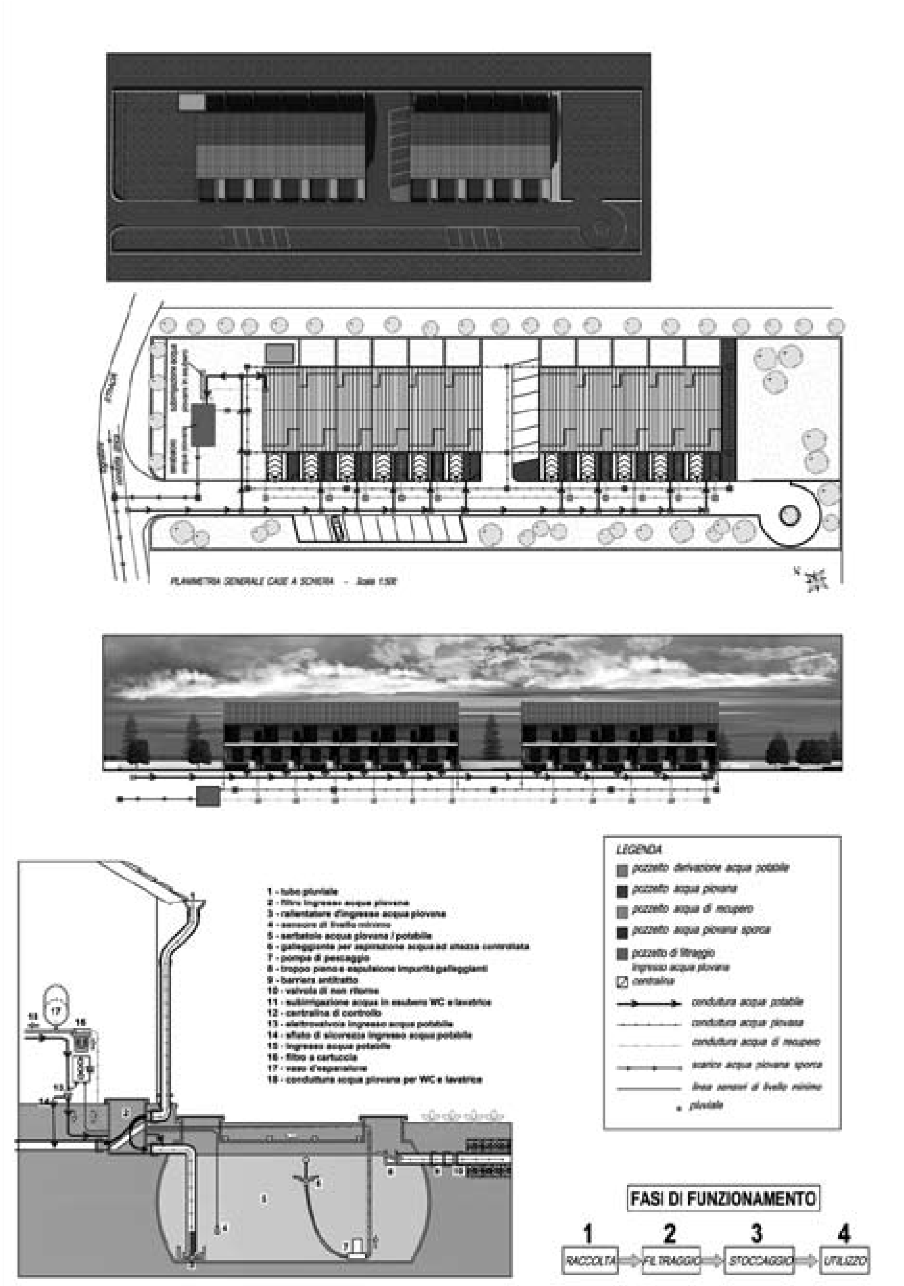

Fig. 4

Installation for the recovery of rainwater (Case study of buildings in Castel Campagnano - Caserta).

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Construction vs Design: a Pedagogy for Basic Education

The contribution presented here regards a pedagogic approach to construction teaching in the first and second year (degree in Architecture), where main "formative objectives" of the courses are to make the students able to understand and to know basic elements of the construction process (1st) and to translate them into simple design esperimentation (2nd).

On the one side there are students, with different cultural background (sometimes not concerning architecture and construction at all), one the other side there is a complex architectural production - especially in our contemporary age - that the student can see but not immediately understand in all its aspects.

For a few years now, in education in the first cicle, urgent questions arise:

- how it is possible to take possession of a basic "language" and "knowledge" (materials, elements, parts and building structures) without giving up a holistic and creative approach in architectural design?
- or (from the call) «how we can offer an integrated knowledge where structures, materials and forms are one unique and inseparabile question-issue?»
- and, moreover, how we can teach basic elements assuring, from the beginning, the evident or hidden relations between shape, materiality, structural principles, architectural intentions and linguistic meanings?

The contribution to the debate intends to give partial answers to the questions raised above through the explanations of objectives, principles, methodology and examples.

The main aim of the education course of "Introduction to Technology of Architecture" (8 ECTS, first year) is to assure to the student fundamental knowledge on building materials (performances and uses), production process, structural behavior of materials and simple shapes, organization of building process, needs and requests from final users. In other terms, the course intends to ensure the student to learn the basic language of architecture (that is made of materials and not only of shapes), extremely necessary for the training of future architects. The student is in fact requested to understand as much as possible of existing architectures in relation to their historical and environmental context, to their structural shape and behaviour, to their (also hidden) meanings in terms of language and signs. Alongside this, he students should not ignore human needs in terms of health, wellbeing, safety and saving, all necessary attributes of architecture.

The student is therefore forced, from the beginning, to develop a multi-disciplinary attitude that should be developed during his academic carrier into an inter-disciplinary and even trans-disciplinary approach to the design process.

Unfortunately students do not belong to the same education path: some of them passed the previous five years of secondary school to develop classical-humanistic studies (philosophy, ancient Latin and Greek), some of them preferred scientific studies (physics, mathematics and natural science), some of them began technical studies (building materials and simple constructive elements and design), other preferred an artistic education (drawing and painting). In any case, generations of students, independently form their provenence, do not even remain the same in time: they are used to employing innovative tools, they speak a language that is different from the generation of their teachers, they are also used to learning and to studying also in different ways (not better or worse, just different from the past, surely their refusal to read too much!).

The final object of the teaching, in any case, should not change: architecture is always architecture, building materials, at least traditional ones, have the same behaviour (although they could change under technical innovative transforming processes); in other words the main aim to assure quality in the design process should not change, even if the kind of building materials become much more numerous, digital instruments allowing a reduction in time in representing complicated shapes.

Here in succession some necessary assumption is hidden behind the education approach proposed and behind the idea that architectural design is a synthesis of art and technique, between the culture of ideas and the culture of doing.

Creativity. Creativity is seen as the capacity to create new and useful connections between things apparently unknown. Architecture is a discipline eminently connective, that asks of the professional the attitude to strike the interdependence of knowledge.

Rationality. Art and technique propose an ethic of the project founded on the capacity to create conditions of freedom, to listen to human needs and different points of view. Rational thought means the capacity of sharing (knowledge, results…) and not to rationalise.

Complexity. The word has assumed, in our contemporary age, the value of a trans-disciplinary paradigm, not only related to a concept of scale (the territory instead of the building) but also related to a multi-focus of problems on the same scale (both the territory and the building).

Curiosity. The link between different knowledge demands a disposition, free from prejudices, towards new and innovation; curiosity should become one of the fundamental attribute of the work (of the teacher and of the student). At the same time, curiosity should become a source of risks (like the "globalized" use of digital tools that allow a process of "cut and paste" prefab images, shapes or architectural details.

Doubt. Curiosity should be accompanied by the category of "doubt", as a filter to read and to understand real things; the practice of doubt prevents the risk of superficiality.

Sustainabilty/ecological approach. Sustainability expresses, today, the worry for the safeguarding of our planet and for a future development in a holistic, systemic and dynamic dimension. From the point of view of the teacher, sustainability does not only mean saving sources (material and immaterial) but also to stress to the student to have an ecological approach, to be able to contextualise and to think in terms of impacts and consequences of his actions.

Dialectics material/shape

Materiality is the basic aspect to be investigated in the course in the first year, posed in relation with shape and architectural quality. Aristotle thought of material as "potential shape" and shape as "acting material". This fundamental acquisition is at the base of each applied art founded on the idea of transformation, process and evolution.

In architecture, anyway, the relation with materiality is not only direct and immediate, but also mediated through our memory, or, in other words, our culture, as a complex stratification of things, names, objects and background experiences. In this sense, creativity becomes the personal way to solve a problem, to discover the way and to overcome the difficulty that is the base of the planning or designing item.

So, the way to teach a common and basic language (constructive of course) becomes the real challenge to make the student aware, from the beginning, of the complexity of the world and the work he has chosen. Using a comparison with semantics, language is made from words, words are made from phonemes, poetry combines words to change signs and to create metaphors. Like that world, the constructive system is made from elements, the elements are made from parts, the parts are made of materials. Architecture is, from the beginning, also the way to connect pieces and parts creating new senses and cultural signs.

The students should make an effort to learn phonemes, words and syntax to combine and assemble parts correctly, but they also should aware that creativity and poetry, not immediately transferable to them by the teacher, pose their bases on the hidden world of signs and significance that is behind the parts and the way to combine them.

The main aim of pedagogy in the first year is, in fact, teaching architectural and constructive language, to compare "intention" with "building results", "meanings" and "constructive solutions", "image" and "intentional thought" of various architectures both from the traditional and contemporary age. The *shape* of the connections between parts of architecture hide in fact some *concepts*, intended as a term that expresses the necessary *essence* of the things (materiality) and also *poetic* expression.

Besides the knowledge of materials and structural principles, the real aim of the pedagogy approach is to look at architecture as the expression - through its physicality - of concepts, to recognize one or even more aspect of quality and - hopefully - stimulate creativity in the students.

Construction vs. design

The main aim of the pedagogy in the second year is to make the student able to use knowledge acquired facing simple problems in architectural design, but not with a simplistic approach. The student is guided through the simulation of a complete design process, from the first ideas and their evaluation, to the drawing of details, to the simulation of real construction, to the "management" of the architecture in time (that means, besides its energetic behaviour, to consider, from the beginning, its propension to physical decay and the way of its maintenance).

The didactic example shown in the pictures is related to the didactic experience in the second year (annual workshop, 10 ECTS), where the students approach simple design problems with a complex attitude in mind. One of the themes assigned during this year (2008/09) was the project for the "torre Delfinale", a tower belonging to the fortified system of a valley in Piedmont. The tower is located in Oulx (TURIN) at a high of 1.127 over the sea level. It dates from at least the 14th century (written traces of the monument), it is an isolated structure well visible and abandoned for more than a century.

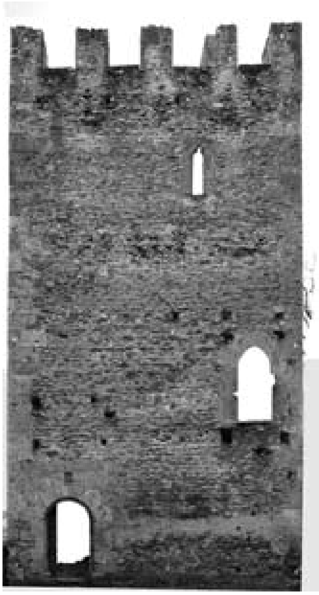


Fig. 1

View of the tower of Oulx, north façade (elaboration by C. Mondino, B. Murzio, M. Teixeira).

Fig. 2

Tower of Oulx, state of conservation.

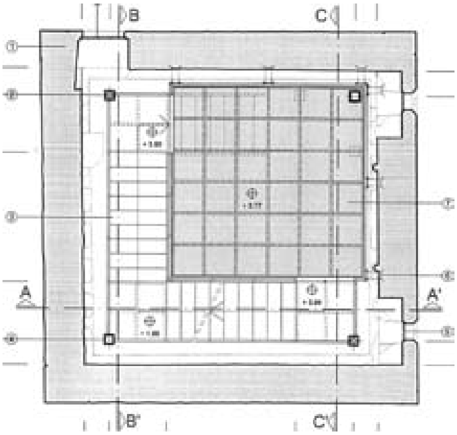


Fig. 3

Results of the design workshop: a new horizontal structure in steel detached form the existing tower and self-supported by steel columns (D. Ghetti).

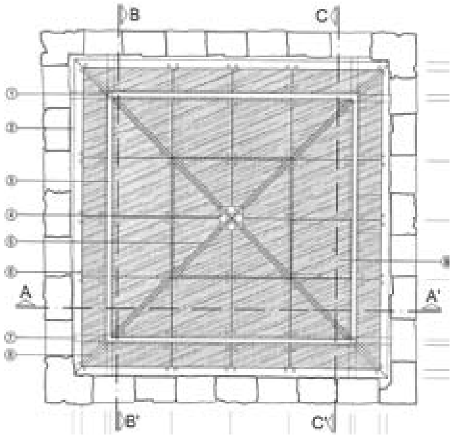


Fig. 4

A new covering structure, made by steel and glass, not visibile from outside to maintain the perception of the architecture as it is since centuries. The new structure in elevation is also used to canalise rainwater (D. Ghetti).

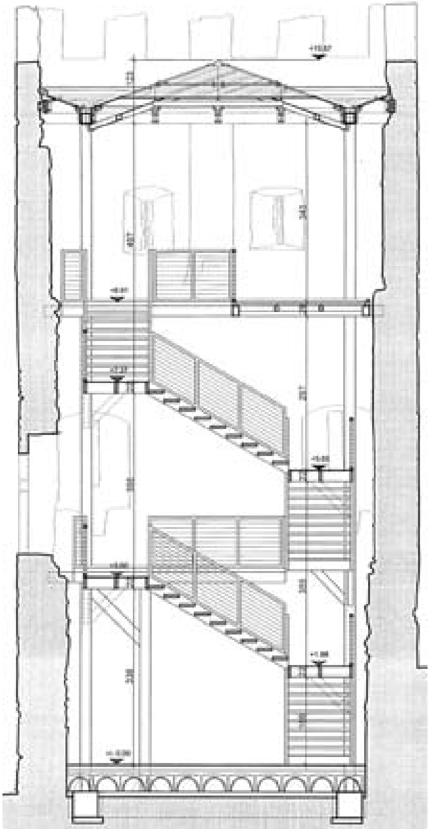


Fig. 5

Section of the tower with the new floors and stair (D. Ghetti).

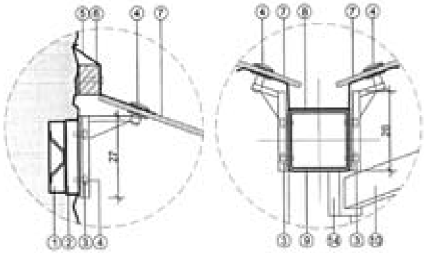


Fig. 7

Connections in the roof structure (D. Ghetti).

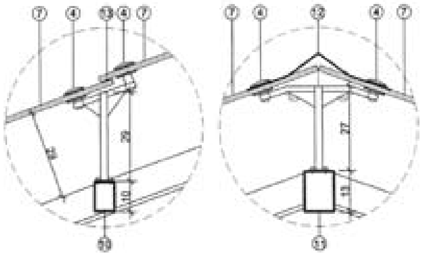


Fig. 8

Connections in the roof structure (D. Ghetti).

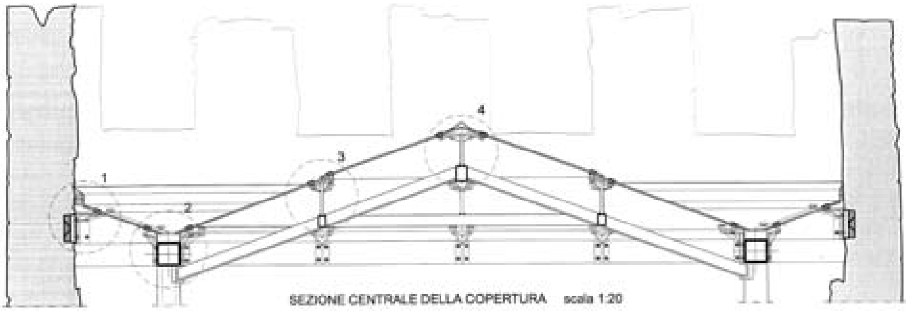


Fig. 6

Detailed section of the new roof structure (D. Ghetti).

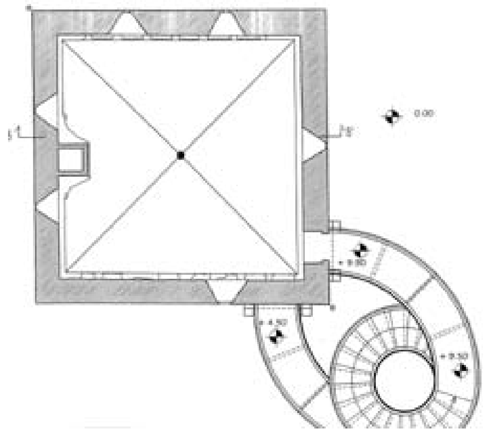


Fig. 9

Results of the design workshop: a new staircase partially external and self-supporting (F. Gasparetto, G. Galmozzi, S. Roncallo).

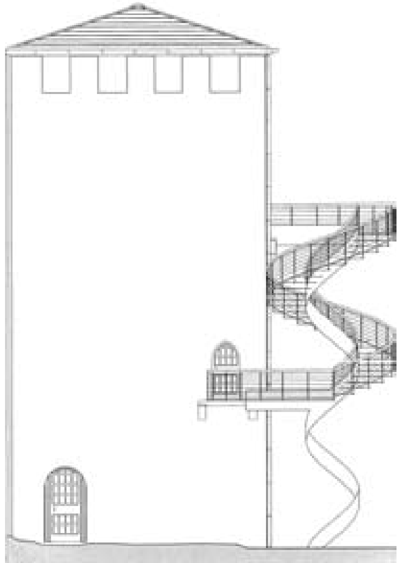
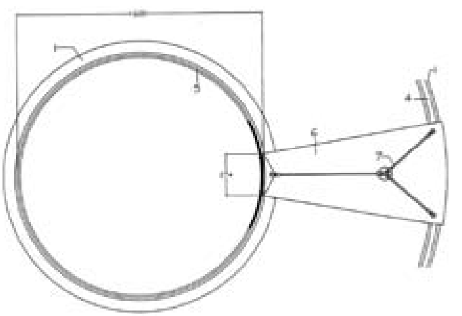
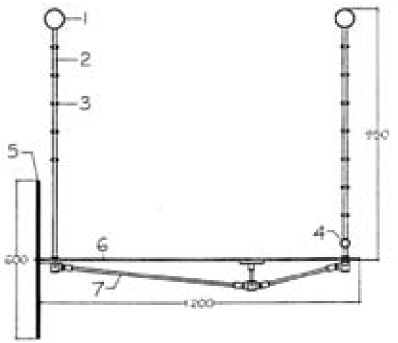


Fig. 10

View of the façade with the new staircase (F. Gasparetto, G. Galmozzi, S. Roncallo).





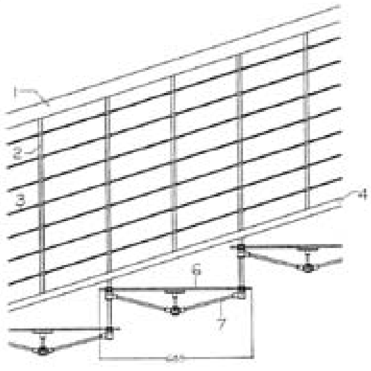


Fig. 11-13

Details of the new self-supporting staircase (F. Gasparetto, G. Galmozzi, S. Roncallo).

Students were asked to design the lacking floors and covering system, the ground floor, the staircase to connect all the levels, including the roof (that had to be accessible at least for the maintenance), the window frames and the entrance door.

The didactic experience, which intends to stimulate the student to develop his own sense of creativity in a conditioned context, is a synthesis of all the principles mentioned above (creativity vs. rationality, sustainability vs. ecology, conservation vs. innovation).

During the design process, the student is forced to consider several aspects and themes to better refine his rational approach in terms of a careful evaluation of the consequences of different creative approaches, using a circular process of continual checking of hypothesis and results.

Belonging to the "problem-solving" approach:

- constraints form the existing architecture (character of external walls, system of openings, probable structural system of inner floors and of the covering, state of conservation of the building, decay of materials, presence of dampness);
- constraints form environmental conditions (climatic features of the site);
- requirements of horizontal structures and of staircases and structural performances of vertical existing walls;
- relation between the new horizontals structures and the existing one, especially in terms of general structural behaviour and of connections with stone walls;
- materials, building techniques and constructive aspects of the new floors, roof and stair and possible materials handling (simulation of the constructive process and phases);
- possible decay of the designed structures and way and time of future maintenance.

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Environmental Design Teaching for Projects in Open Spaces

Methodology

Teaching Environmental Design at School of Architecture of SUN allows us to experiment and compare strategies dedicated to the Architecture Program and to the Design Program, as both host the topic. The common aspect is the purpose[1] to predispose students to define urban open spaces, like places for congregating and social identification.

As courses are actually organised to integrate architectural design modules, collegues from different fields of research work together, sharing teaching strategies and results also through workshops. Multidisciplinarity is explained starting from Edgar Morin's theory about *La tête bien faite*[2], where alliance between humanistic and scientific disciplines is indicated as urgent teaching for new generations. This is why explainations about theorical issues and technical realisations are also presented by specialists from other scientific sectors, such as botanics, geology and geomorphology, or by material or component producers.

The urban environment is considered like an ecosystem, a whole of biotic and abiotic elements, interacting between themselves according to different social relations. A holistic approach is necessary to define and assess all the aspects at the same time, with equal dignity but various weights. According to this, the proposed frame makes a distinction between dynamics correlated to use and control of natural resources, on the one hand, and project and management of manmade processes on the other. To define natural resources, the distinction between *structural* elements (air, water, green and soil) and *superstructural* elements (energy, sonorous environment and information) is illustrated to the students. This distinction is based on the acknowledgment of the qualitative levels, connected to the presence of each element in the urban system. We refer to the control of emissions in the atmosphere, to the correct management of the cycle of waters, while for the green resource, attention is turned to thermic, hygrometric, acoustic and depurative modifications (re-balance), so that the vegetable system can have an effect on the city atmosphere. Finally, the pedologic and geologic features of the territory allow us to assess the quality of the soil.

The *structural* elements are considered in relation to the correct management of the renewable and traditional energetic sources, the control of acoustic emissions, the diffuse and interactive management of data traffic, related to administrative and cultural public activity[3].

Project and management of the anthropic processes request to focus on the matters and the quality of the constructed environment, the analysis of mobility, the organization of the cycle of waste and the control of the productive activities. To analyse the quality of constructions implies studying the typological characteristics of the building heritage, with particular attention to the bioclimatic behaviour. The control of the quality of materials is tied to the management of the project of urban surfaces, to guarantee desired performances, with particular attention to their perceptive characteristics, such as texture and colour. Urban mobility must be analyzed from the point of view of the reduction of vehicular traffic flows, through the boost of alternative systems of private and public transport. Correct waste management must instead be interpreted starting from the analysis of the collection modalities, with special reference to the spin-off on the design of the new endowed image of connective urban space.

Training students to understand a correct environmental reading means leading them to the sense of urban landscape, according to the approach defined by Christian Norberg-Schultz, from an anthropological point of view, and Kevin Lynch, relating to perceptive dimension[4]. Applying these cultural references to the analysis of the townscape, we propose a framework based on *listening* places, catching suggestions, cultural echoes, presence of social communities, degradation and matter aspects, state of infrastructure networks and services[5].

A methodological structure distinguishes elements of the system as *structural* ones and *superstructural* ones (but also structuring and superstructuring) from the project point of view (*classifying* mark) and the listening criteria (*cultural* mark). Together, they define a grid to guide students towards a sustainable design, in which social equity, development and respect for environment coexist.

As still happens in small towns, public urban open spaces were once places to host socialisation. For a progressive change of their function now they are not for staying, but for being trespassed upon, possibly fast, no longer fit for interpersonal relationships, but even potentially dangerous. The urban renewal design must counter this trend, creating premises for a resumption of open spaces by users, also inserting new and unexpected functions.

We propose the topic of the project for urban voids, of the open space between buildings, especially in those places where the need to give sense to the public space is more urgent, as today this is mostly virtual. The question is what is important to do to really look each other, to exchange emotions and how it is possibile to generate meetings and exchanges, when nowadays riots and robbery prevail. As design must start from the user's needs, we discuss what the needs are of the temporary user of such a dynamic space as the street is, with the aim to focus on what a designer must propose to set sustainable lifestyles.

Moreover, in addition, to solve bioclimatic and environmental problems, we wish to add to the project the cultural value of a narration: open space has engraven on it the flows that generate it and it simultaneously carves this while determining social relations.

Exercising

Sites of study are places in the town of Naples and the small cities of Marcianise and Aversa (CE) in Southern Italy. In the first case, the projects was the Environmental Recovery at East periphery (see figures from 1 to 6). The site is at the eastern outskirts of town, in a zone already destined to industrial and handicraft activities with a resident population of workers of industry, today shut. Usually the periphery can be meant as a laboratory, often hosting an alternative artistic and creative cultural component, to which is given a *kairetic* dimension and this is why we choose it for our reflections.The area shows the strong presence of the infrastructure network (made of highway junctions and railway lines), a scarce density of dwellings and large industrial buildings, partially inactive, now used for improper or illegal functions. The urban landscape has the widespread presence of walls and hedges, bordering the big plots with productive destination. Here the problem of renewal cannot be divided from the reconstitution of social values, that is cause and effect of the project act. The design idea must be integrated with a hypothesis of urban development, defined in the main lines by local administration, through a continual and productive dialogue between private and public subjects.

On this site (sub area 12 E of the adopted town-planning scheme) the Town Administration has foreseen as new destinations an urban park, new settlements for pro-

Fig. 1

Environmental Recovery at East Naples, work by students D. Girasole, G. E. Girasole, S. Perrotta of Design Program, reviewed by prof. arch. R. Valente.

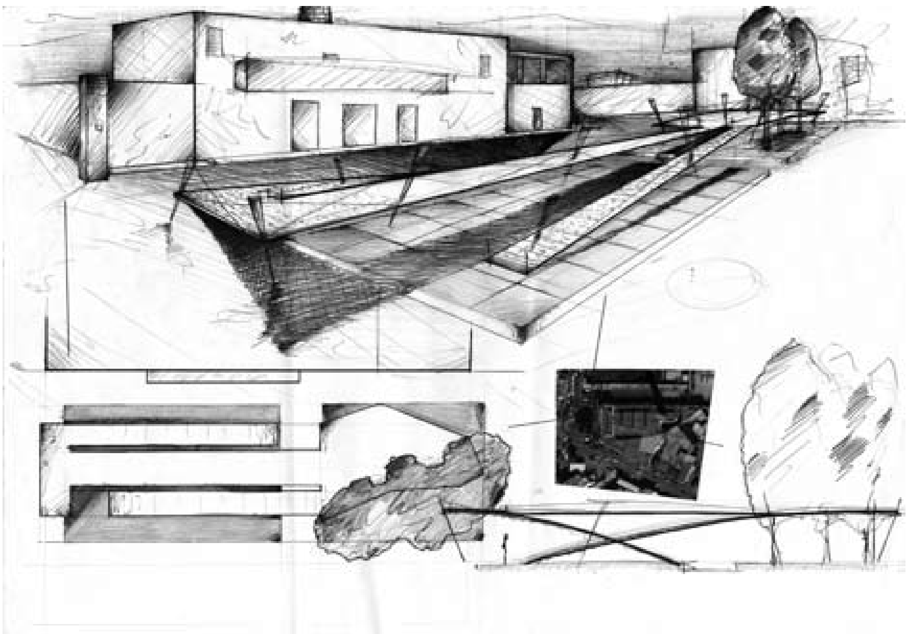

Fig. 2

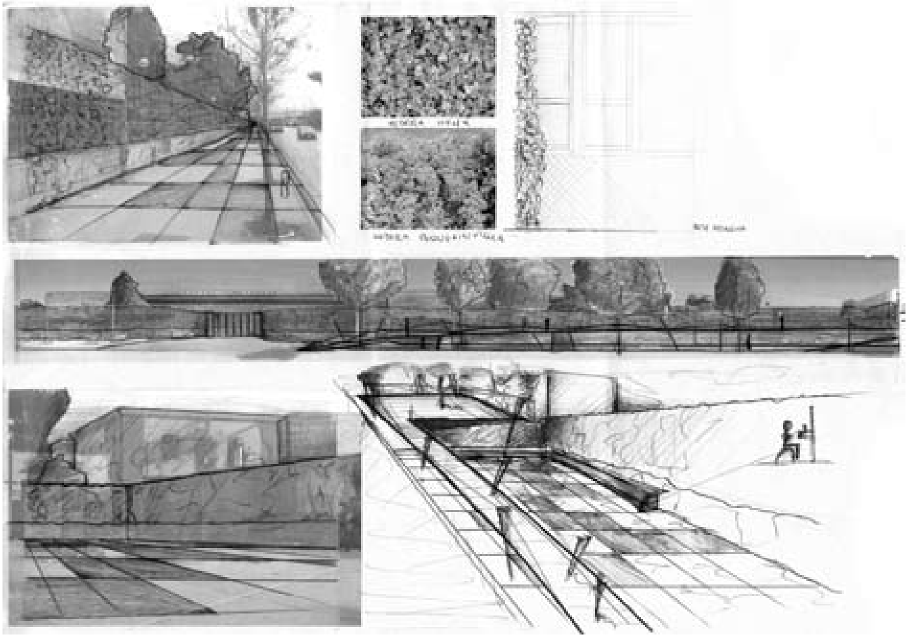

Fig. 3

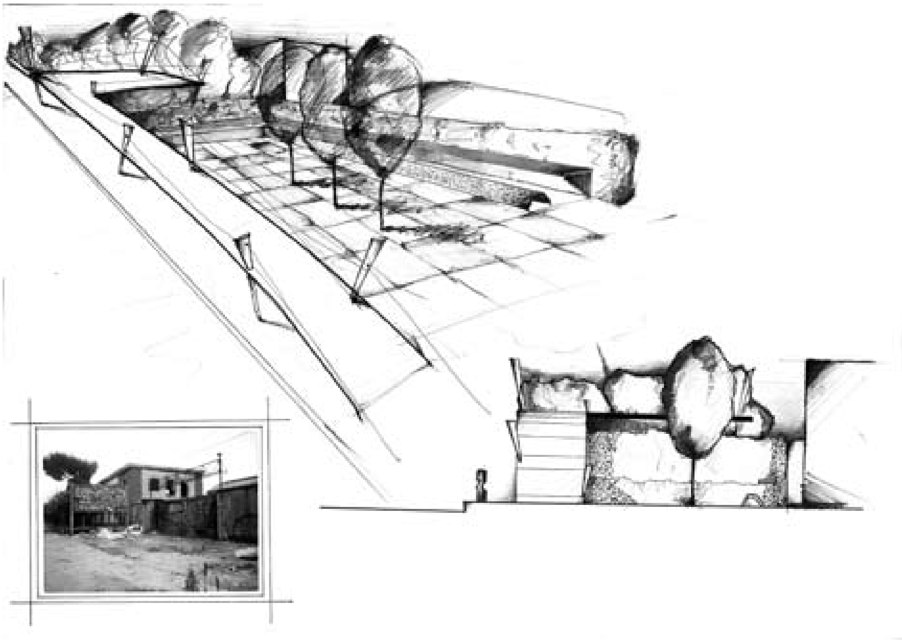

Fig. 4

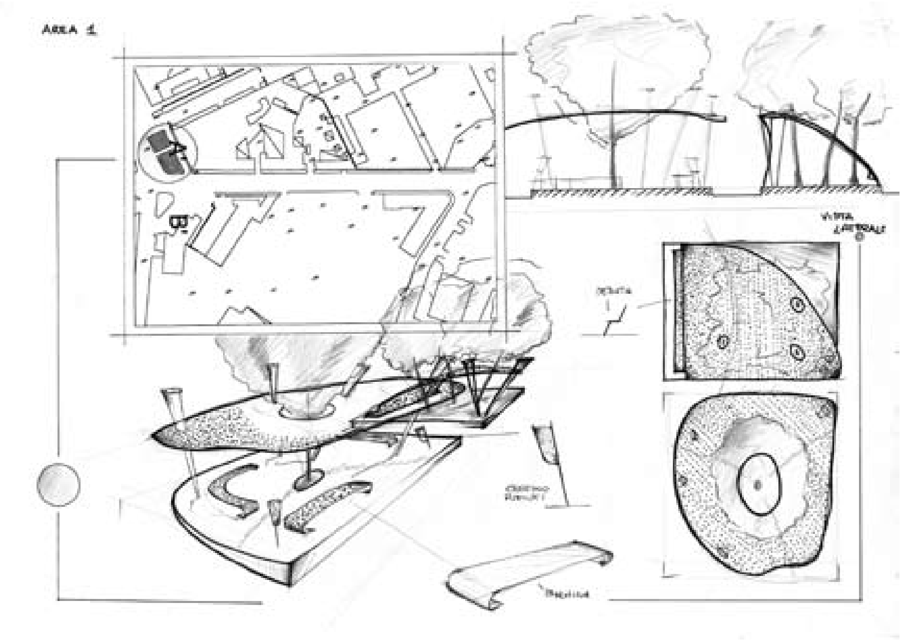

Fig. 5

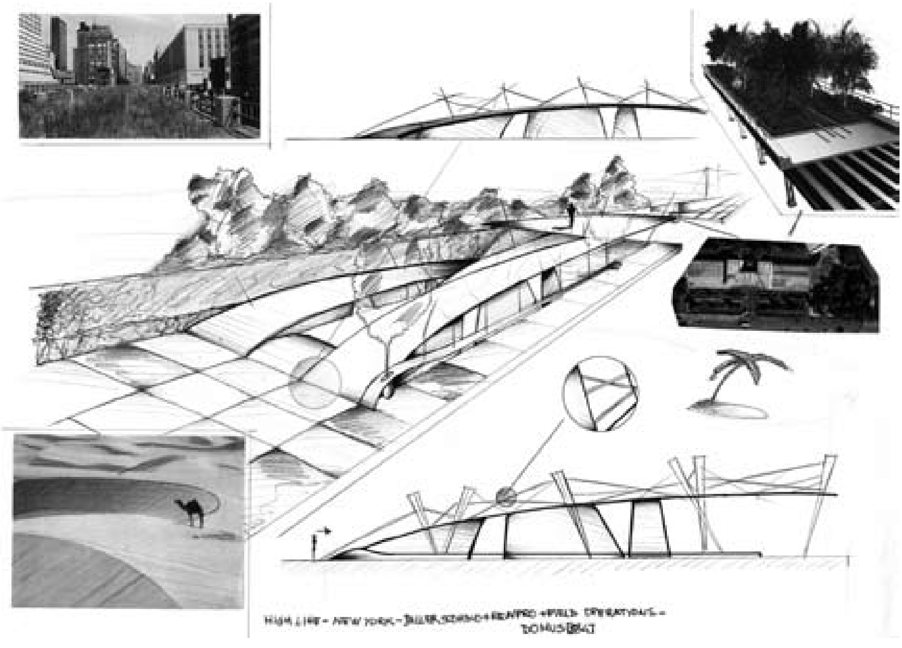

Fig. 6

Fig. 2-6

Environmental Recovery at East Naples, work by students P. Aversario, G. De Stefano of Architecture Program, reviewed by prof. arch. R. Valente.

duction of goods and services, dwelling, through new constructions, valorisation and recovery of historical industrial buildings and the new organisation of the infrastructure net with an increase in public transport.

The other sites in last years have been Public Open Spaces at Marcianise (CE), Southern Italy (see figures from 7 to 9), interested in environmental recovery also comprising the project for a playground for children and some projects for urban green spaces, and the Environmental reclaim of piazza del Carmine, in Aversa (CE) Southern Italy (see figures from 10 to 15).

For the work in all these sites, students have received a frame and a sequence of points to follow, useful to guide them towards the design process. The indications are about the typology of the survey elements, the choice of the ones to be deleted, the research of the needs of the place and of its qualities to be reinforced.

The project guidelines imply the attitude to act on the entities structuring the urban landscape; the operating tools to reach this target include a number of drawings, containing the vegetation map (with indication of species, the number of examples and their state of conservation), the table of hedges, with related features, the map of floorings. The drawings are specifically oriented to the knowledge of the matter of handicrafts, to determine ways of intervention, to have a dialogue with the existent urban tissue.

The choosen intervention scale is usually the micro architectonic one or, if it is preferred, of the macro object of industrial production one. The design systems to integrate and describe are: pathways, rest areas, lightings, shadows and materials.

We indicated to the students some project domains, regarding micro landscape aspects, including, on the one hand, interventions on the surfaces, such as floorings, green walls, gates and hedges, climatic and acoustic barriers, buildings façades and, on the other hand, the invention of new street furniture for the renewal of the urban tissue. These domains have been defined in categories to refer to the projects[6], such as a) coatings, b) wings, c) shelters, d) volumes, e) objects, f) tectonics.

The proposals concern paths or rest areas, equipped with shelter and pergolas, or the redefinition of the related spaces, through partitioning of private areas underused, like gardens and internal courts. The choice of materials is directed towards products with high eco-compatibility, relating both to their life cycle, and their features of laying and functioning, keeping in mind that these materials are permeable, recyclable, not toxic and easy to maintain. The target is the design of a *performative* environment, in the sense of a landscape integrating natural and artificial aspects, related together[7].

Last but not least, a fundamental aspect of the projects requested of the students a control of the time dimension. This implies the definition of what parts of the project must be permanent, which ones must have a transitory character, which ones may or must transform themselves during their existence.

Actually we know that temporariness is used to define public space. "It is use that defines the temporary public space: shelters for non-vigorous activities, where now and again something is designed and accomplished. Places that may later conserve traces of its intensity and varying duration (...) It is a matter of understanding in what way we can call certain uses temporary and then reshaping public spaces according to this characteristic"[8]. New temporary spaces design the town: through those we learn and exchange with strangers, looking for new conviviality. This is necessary to design complete and (for this) complex public urban environments, exercising on playing the spirit of places in a satisfactory, contemporary meaning.

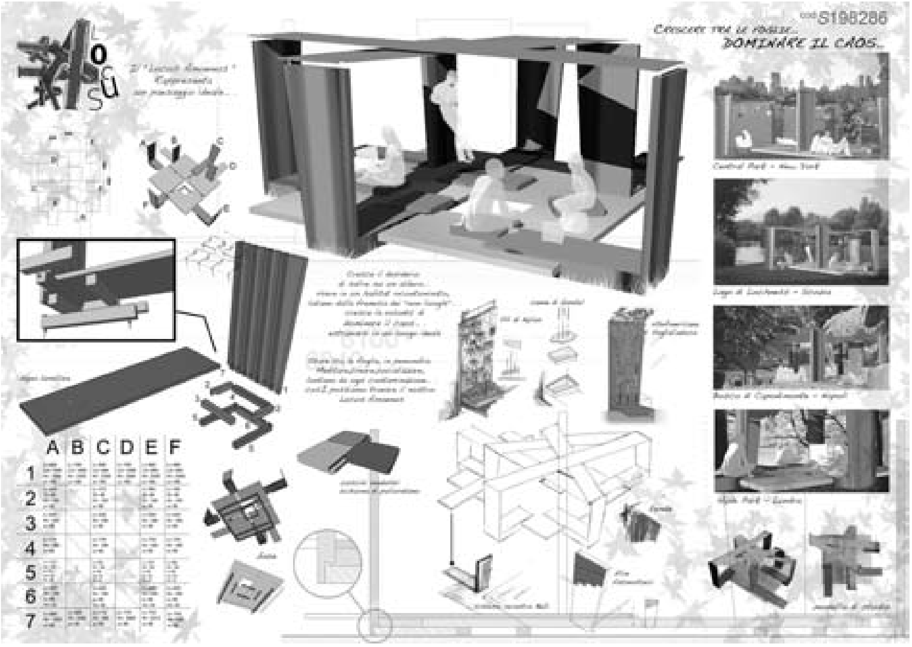

Fig. 7

Public Open Spaces Environmental Recovery at Marcianise (CE) Southern Italy, work by students E. Altieri, G. Iannotta of Design Program, reviewed by prof. arch. R. Valente.

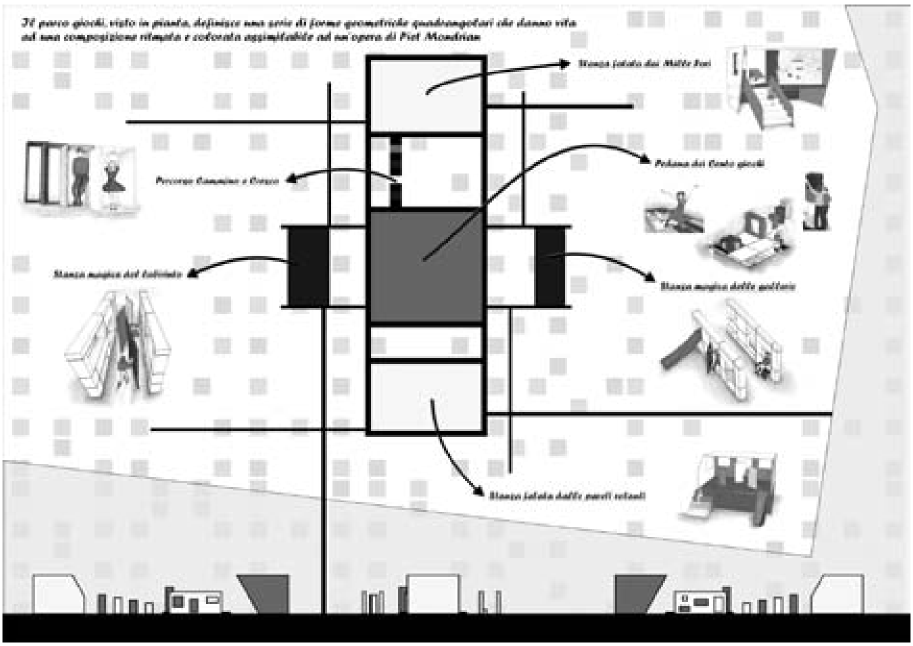

Fig. 8

Public Open Spaces Environmental Recovery at Marcianise (CE) Southern Italy, work by students D. Dalia, E. Nappi of Design Program, reviewed by prof. arch. R. Valente.

Fig. 9

Public Open Spaces Environmental Recovery at Marcianise (CE) Southern Italy, work by students of Design Program, reviewed by prof. arch. R. Valente.

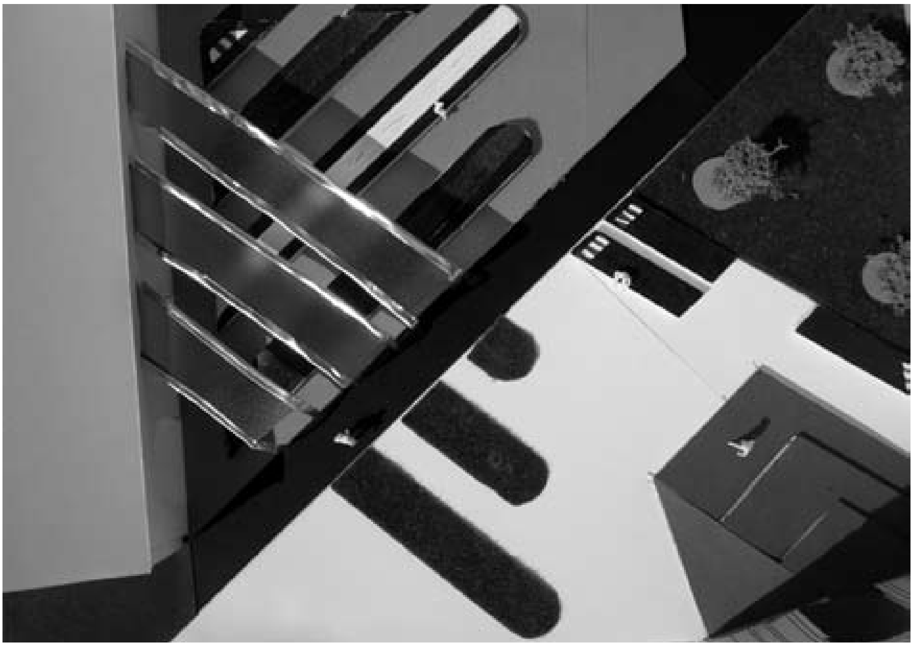

Fig. 10

Environmental Recovery of piazza del Carmine, Aversa (CE) Southern Italy, work by students M. Elefante, S. Esposito of Design Program, reviewed by prof. arch. R. Valente.

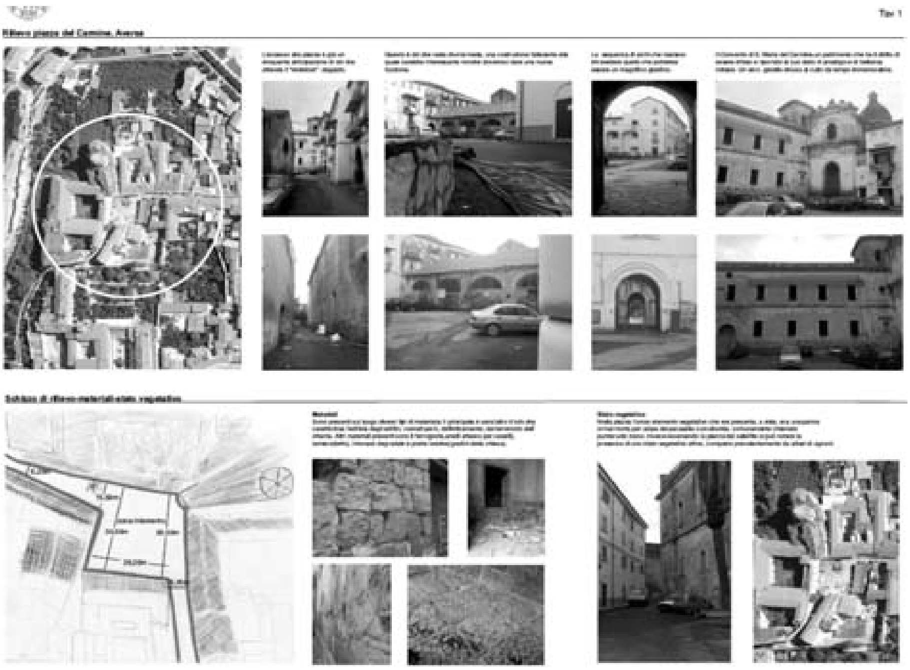

Fig. 11

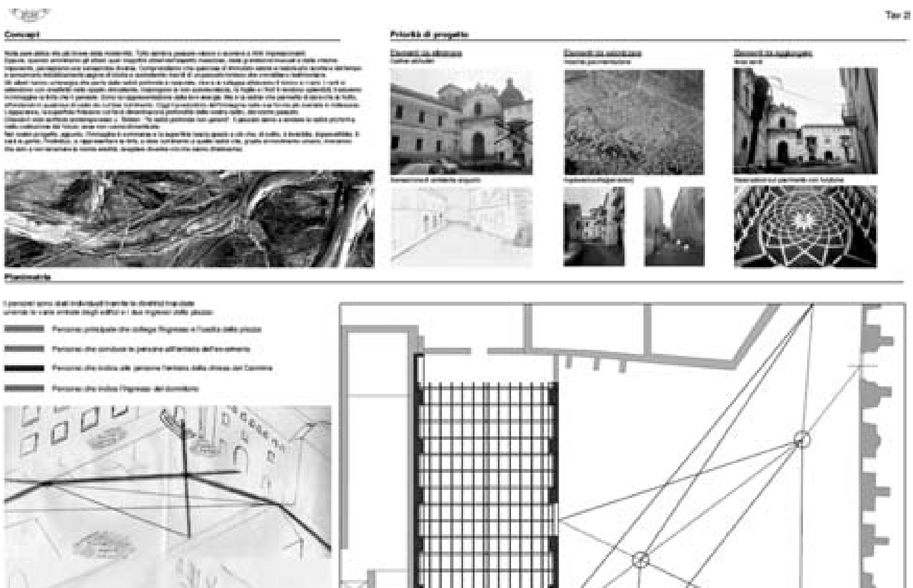

Fig. 12

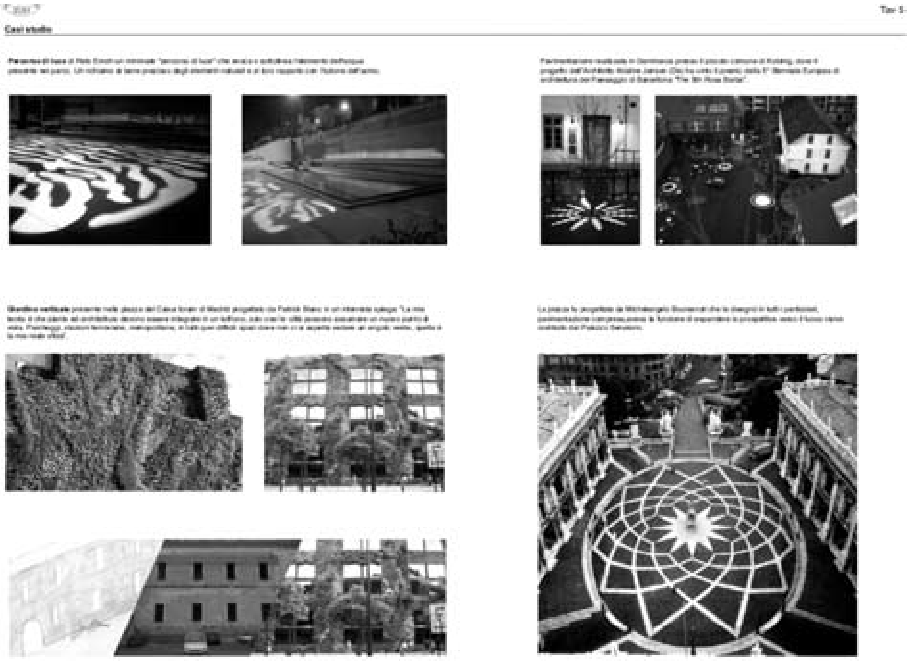

Fig. 13

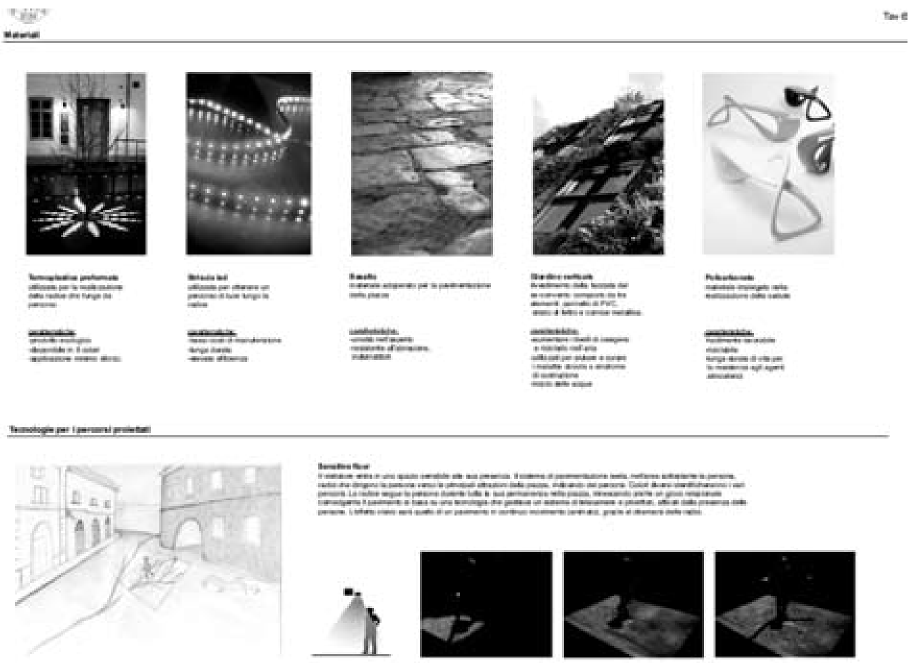

Fig. 14

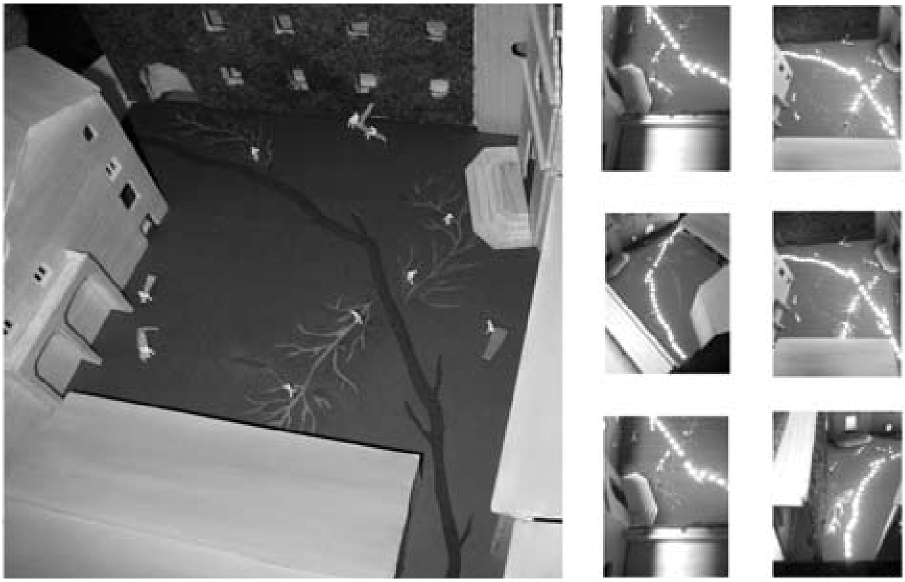

Fig. 11 -15

Environmental Recovery of piazza del Carmine, Aversa (CE) Southern Italy, the sequence of drawings by students F. A. Di lorenzo, A. Iorio, O. Ottaviano of Design Program, reviewed by prof. arch. R. Valente.

Notes

1 From A. Bosco, R. Valente, "Experimenting Environmental Design for public open spaces with industrial design students", in Proceedings of *World Renewable Energy Congress Ix, International TIA Session Day in WREC, international session "TIA – Sustainable Teaching for Sustainable Architecture",* 2006, Firenze, p. 131 e seg. The concepts have been developed with A. Bosco in many scientific contributions since 2005.

3 see E. Morin, *La testa ben fatta Riforma dell'insegnamento e riforma del pensiero*, it. transl. Raffaello Cortina editore, Milano 2000

3 in A. Bosco, R. Valente, op.cit

4 C. Norberg-Schultz, *Genius Loci. Paesaggio ambiente architettura*, it. transl. Electa Monadori Milano 1979; K. Lynch, *L'immagine della città*, it. transl. Marsilio editore, Padova 2004.

5 See also F. La Cecla, *Mente Locale*, Eleuthera, Milano 1993

6 This classification has been prepared developing our teaching strategy starting from the content of the text by A. Aymonino, V. Mosco, *Spazi pubblici contemporanei. Architettura a volume zero*, Skira editrice 2006

7 see W. Hood "Improvised Ecologies; Sampling and Enmeshing" in *Hybrid Spaces and Public Design*, conference during *Design in Mostra*, Mostra d'Oltremare, Naples, Italy, june 2009, chairman R. Valente, scientific coordination P. Ranzo

8 from C. Bianchetti, "La città provvisoria" in "Domus" 904, Milano 2006

Image Sources

All illustrations are from students' works made during the courses of Environmental Design held by prof. arch. R. Valente at School of Architecture of SUN Second University of Naples, Italy.

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Technological Innovative Design for the Energetic Rehabilitation of Scholar Building

Introduction

The interest from the scientific, institutional and professional world towards the energetic efficiency of the building sector is directing the carrying out of "technological bases" on which plays the competitive bet that aims at higher levels of efficiency in the management of energy. When a public subject intervenes with promulgations of norms and funds in favour of his/her own building patrimony in order to improve its energetic performances, he/she has a double aim: on the one hand, getting direct benefits in terms of reduction of the consumptions, on the other hand, carrying out a demonstrative action that acts as a stimulus and model for the private sector, contributing to spread the "awareness" culture towards the environmental problems.

In a strategic-political program aimed to the optimization of the energetic performances of the existing building patrimony, the school buildings represent an important sector where the action of sensitiveness towards the energetic problems can be particularly effective. This is for three substantial reasons: they are buildings of public ownership that have a "widened" fruition to a remarkable number of subjects that are, besides, the future generations of citizens into whose care the existing environmental and humanmade patrimony will be delivered.

The didactic experimentation

This contribution illustrates the didactic experience carried out within the Technological Design Laboratory (2008-2009 academic year; Course of "Technological Innovation for building energetic Quality" teacher: prof. arch. Antonella Violano) in the 2nd year of the Skilful Bachelor in "Buildings and Environment Innovative Quality" at the Second University of Naples - Faculty of Architecture.

The scholar building energy performance evaluation brought out the importance within the architecture design to realize objects as: sustainable use of natural resources, energy waste reduction and quality of life. Students were requested to check the energy performances of the "P. L. Nervi" ITG scholar building in Santa Maria Capua Vetere (placed in the province of Caserta - Italy). A Protocol of Agreement for the energetic analysis and the development of efficient technological solutions has been stipulated with the school.

The didactic experimentation is organized in four phases:

PHASE I *Preliminary analysis of environmental characters:* external environment and climate (sun, wind, rain, humidity level, ...), the study of shades and local ventilation, as regards the morphology and the mutual disposition of volumes and anthropic or natural obstructions;

PHASE II *Study of the building system:* building construction, dimensional data, typological data, characters of building envelope, usage disposition connected to the solar exposition, analysis of the dispersing outer/inner surface of the building and the arena, air-conditioning system, electrical system, heating system;

PHASE III *Pre-design:* application of the Energetic Audit to know the energetic performances of the scholar building.

PHASE IV *Design:* technological design solutions finalized to the energetic rehabilitation of the scholar building and the arena.

According to our approach of rational management of natural resources, the students paid particular attention to the building active solar systems (i.e. photovoltaic).

PHASE I Preliminary analysis of environmental characters

The school, carried out by the Province of Caserta in 1999, rises in a flat area near the south limit of the inhabited centre, in an area of expansion where there are other two school facilities: a Liceo specialising in scientific studies and another one specialising in art subjects. You can enter the site from the east, through a narrow street that opens into a rather compact but low building curtain (max 3 floors from the ground), while the other three sides (north, south and west) look out on agricultural areas that are free from barriers.

Fig. 1
Environmental surroundings.

In the environmental surroundings, the presence of both a RDF and a tannery in the south is a negative factor of socio-environmental impact, particularly noticeable in spring and summer, when bad smells are spread by the prevailing winds blowing from south-west. Moreover, the proximity of the TAV layout that, at the moment, is still a yard, will be a further factor of environmental impact (of acoustic type) in the future.

The planning has aimed to make these points of weakness become points of strength, focusing on the valorisation of the bio-physical (morphology of the ground, presence/absence of superficial waters, typology of vegetation) and bio-climatic components (sun, natural ventilation and damp).

The energetic performance knowledge was the moment at which programmatic decisions were taken, thus orienting the project through conscious operations of:

- analysis and evaluation of the quality and quantity of energy flows occurring between built area and surrounding environment;
- choice of the project strategies to be adopted: use of active or passive solar systems;
- design and tailoring of the technical solutions best fitting the surveyed conditions.

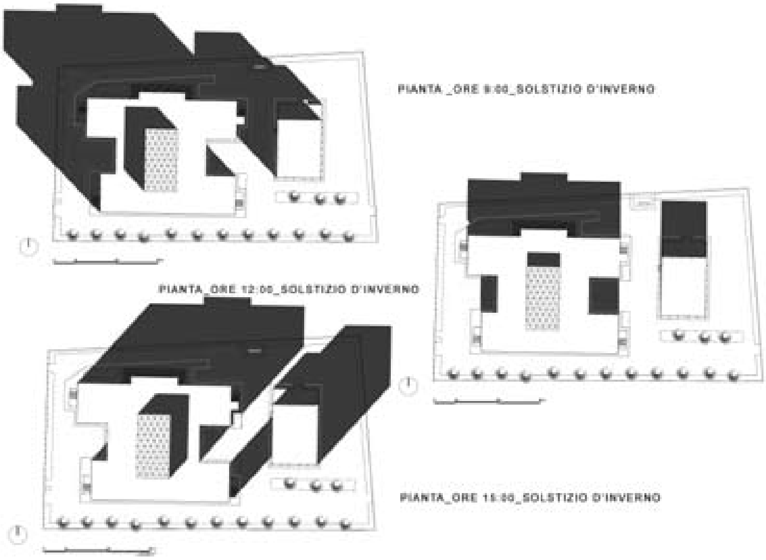

Fig. 2
Bioclimatic components – winter solar exposition.

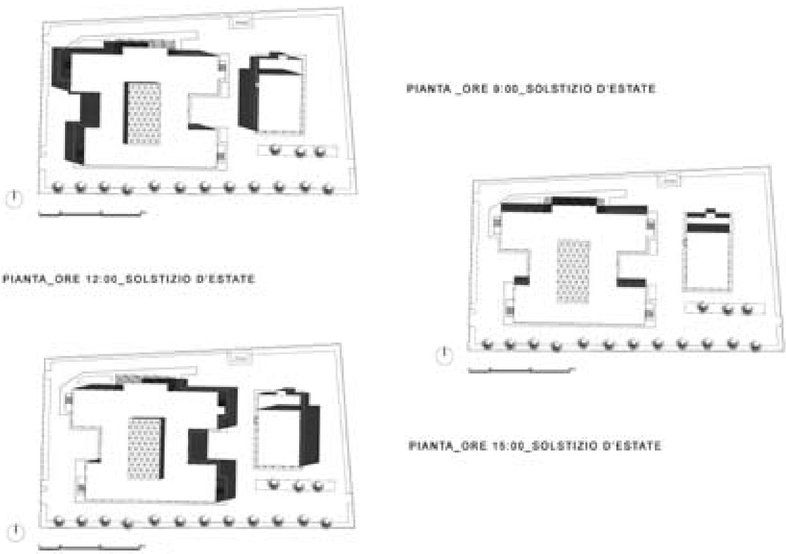

Fig. 3
Bioclimatic components – summer solar exposition.

PHASE II Study of the building system

From the typifying point of view, the building has got a little compact H shape, with a large central hall that is the space of relationship of the school and it links all the other places both physically and perceptibly .The hall is illuminated by a poly-methyl-methacrylate (PMMA) skylight and a Grecian plate, held up by a spatial, reticular steel beam, with problems of water infiltration and without any system of natural ventilation, denying, especially in the warmest season, any possibility of regulating the inside microclimate. Moreover, the articulation of the surfaces does not guarantee the acoustic control, (an annoying boom of the sounds is clearly perceived) both in this central space and in all the other spaces overlooking it.

The entrance is positioned in the north, protected by a wide portico that cannot protect the hall from the prevailing winter cold winds, despite carrying out a filter area with a second fixture that is made of glass as well. Its large and regular classrooms are exposed in the north and south, while its laboratories, which are larger classrooms according to the modularity defined by the structural link, face the east and west.

The vertical elements of connection among the various levels are of two types: those of daily use that does not face outside and are illuminated through the skylight of the hall and the safety ones, situated at the extremities of the corridors as a service of the classrooms and set outside the building in the four corners of the east and west fronts.

The covering is made up of:

- a flat covering, without any shades brought except those made by the leaning body of the skylight, and accessible only from fireproof staircase positioned in the north-east;
- opaque vertical perimeter walls, in perforated self-loading bricks, with emerging pilasters in comparison with the external edge that marks the façade vertically and is the only (and insufficient) shielding frame of the fronts exposed to the direct sun radiation;
- glass surfaces without any external shielding, provided just with curtains inside the Venetian blind that are not an effective darkening system and play an inefficient shielding role during the summer (making the component heat of the sun radiation penetrate through the glass); the fixtures are in aluminium and double glazing glass with sliding doors and closings with scarce seal;
- foundations, carried out with ground beams, directly accessible from the hall of the school and situated on a ground with a height under the beam of about m 1.80 m; these environments act bio-climatically as an air space ventilated by air-bricks put into the perimeter walls that link it directly with outside.

The system foresees a thermal plant for the winter heating with radiators, fed by gas oil through the thermal plant set in a technical volume that is external to the building situated along the north border; in the offices, some summer air conditioners, traditional waterworks and electric installation have been installed.

Finally, the body of the gym is an independent building without any covered connection with the school, heated by a noisy and scarcely efficient convector plant and illuminated by high, unshielded, big windows that project concentrated light and do not guarantee an effective ventilation for the difficult handling of their opening systems.

Despite the school complex having existed for less than a decade, the quality of the outside finishing does not guarantee a suitable durability in time: in fact there is already evident damage, caused by water dripping and stagnation along the perimeter, the connection to the ground and along the superior moulding.

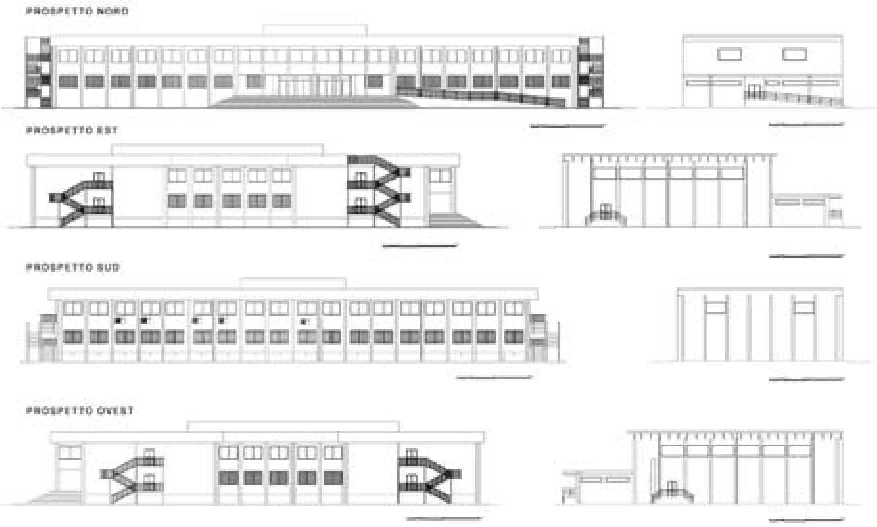

Fig. 4
The building.

Fig. 5
The hall.

PHASE III Pre-design

The made Energy Audit aimed to notice the consumptions and formalities of consumption of energy in all the environments of the school. The students were lead in the control, with an investigation on the spot aimed to pick up all the meaningful data related to the electric instruments (Number, type, times of use,...) that there were in each environment of the school.

The data given belong to the following categories:

1. type of electric equipment used, location and their formality of operation,
2. supply data from the Company of electric distribution,
3. other data that can be important for the energetic operation.

Two cards were filled:

- Model A for both the school building and the gym,
- Model B for the external parts of the whole school complex.

Each card is made up of three parts:

- in the first part the general identification data that involve the energetic management (data that represent location, size, ownership and other information about the source) are picked up;
- in the second part the data of use for either installation or instrument are picked up (the table in the first column lists all the equipments and the electric installations in the school and all the equipments and the installations in operation; in the second column it lists the standard powers that is those normally absorbed ones; in the third column it lists the controlled powers when its observation is possible; in the fourth and fifth column it lists the periods of the equipment daily working: such periods, which depend on the direct consumers' habits, have been verified through interview; in the sixth column the products of the powers per working hour are listed, thus underlining the energy consumed by each piece of equipment in a typical day).
- in the third part it lists both the general electric data that include the overall designation power that is the sum of the powers of the single instruments; and the electricity consumed daily that is the sum of the energies listed in the sixth column of the second part; and the average electricity deduced monthly.

In the model A is also noticed the availability to change the diagram of load and, as a consequence, the habits of use of the school spaces with the aim of achieving savings or eventually optimizing the use of photovoltaic systems.

Through the cards, the essential information is available in order to elaborate the diagram of daily electric load of a typical day for each of the residential unities, which are the object of investigation, and you can go on with an energetically aware planning.

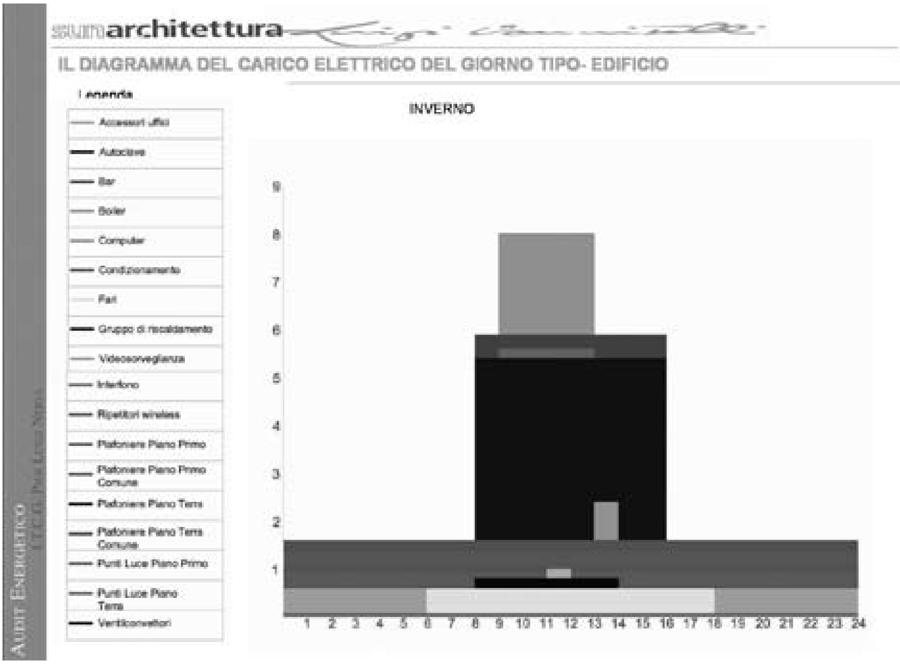

Fig. 6
The winter energy audit.

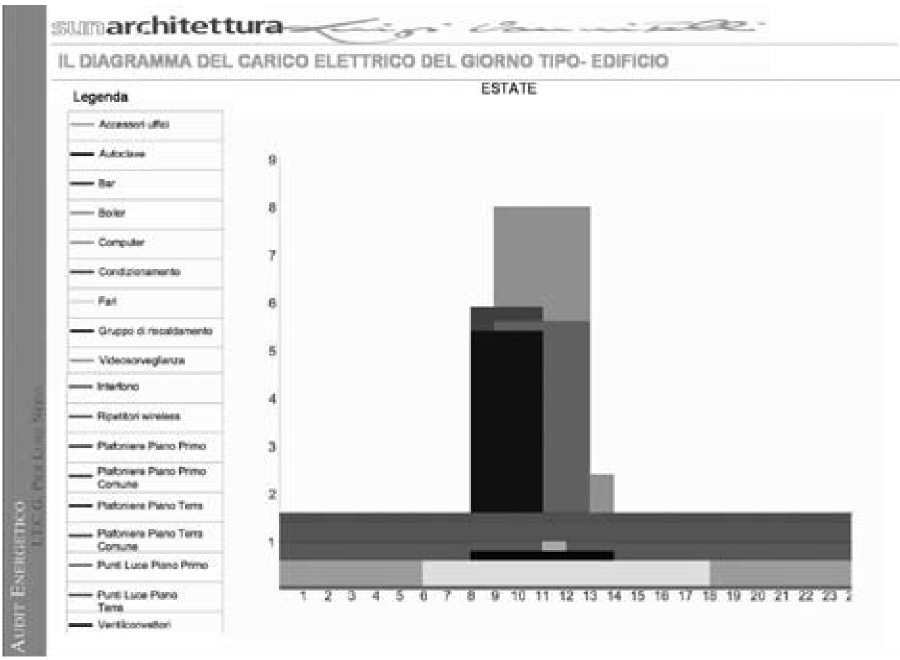

Fig. 7
The summer energy audit.

PHASE IV Design

From the analysis made with the involvement of the Executive, teachers and students, different problems were underlined that led to many strategies of improving intervention, synthesized as follows:

- Energy (reducing the dispersions with the thermal isolation of the vertical perimeter walls and planning again the covering foreseeing it as isolated and ventilated; planning active solar systems - shelters, skylights and photovoltaic breis-soleil – in order to reduce the actual excessive electricity consumption from a non renewable source...);
- Waters (optimizing the closing of the water cycle increasing the permeable surface; carrying out integrated systems for using the rain water again...);
- Environmental hygiene (shielding the lot from the bad smells coming from both the CdR and tannery; guaranteeing the natural ventilation of both the classrooms and central hall; increasing the quality of inside finishing - floors, plasters, facings, fixtures...);
- Functionality (guaranteeing a greater flexibility in the use of the spaces and a use of the blind rooms, carrying out a school-gym covered connection, planning again the parking areas increasing both green areas, and outdoor sporting areas, and indoor and outdoor aggregate areas...).

The images that follow show some projects elaborated by the students during the course.

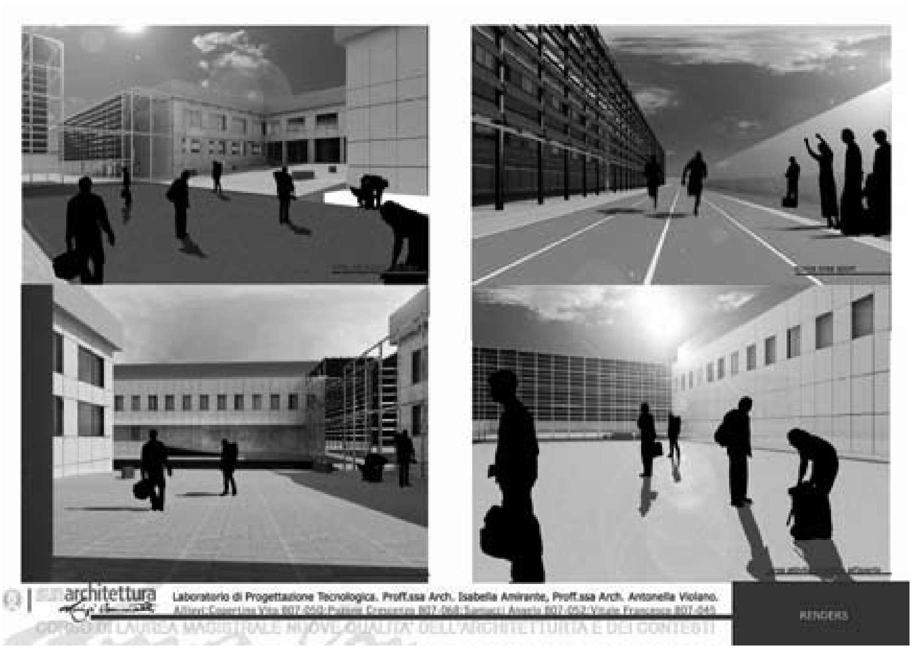

Fig. 8
Project n° 1

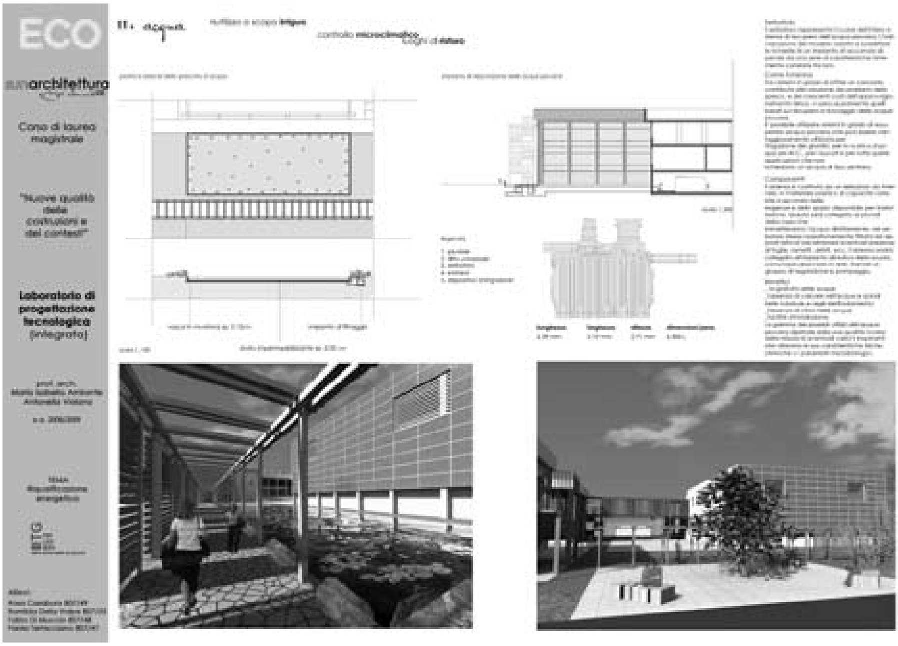

Fig. 9
Project n° 2

Fig. 10
Project n° 3

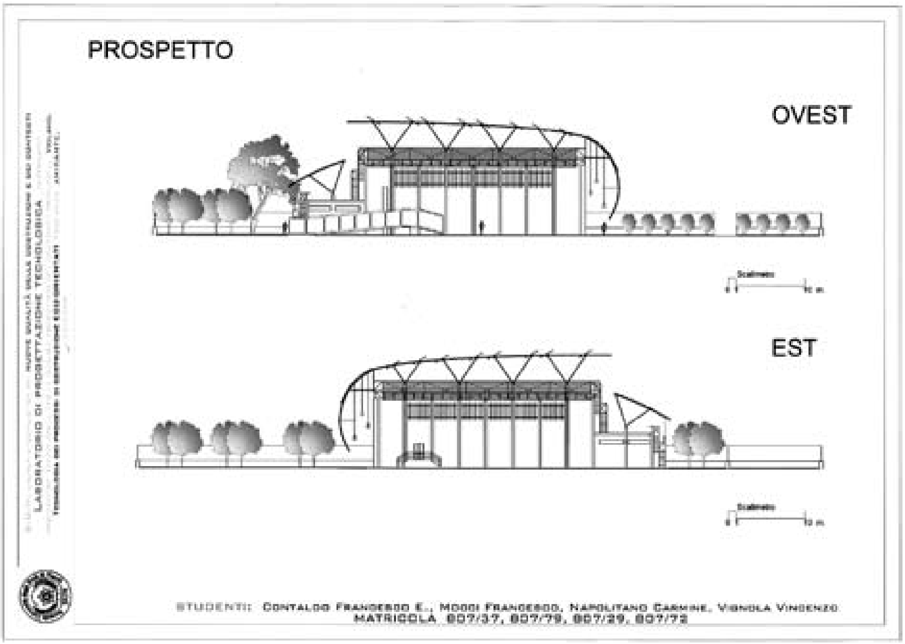

Fig. 11
Project n° 4a

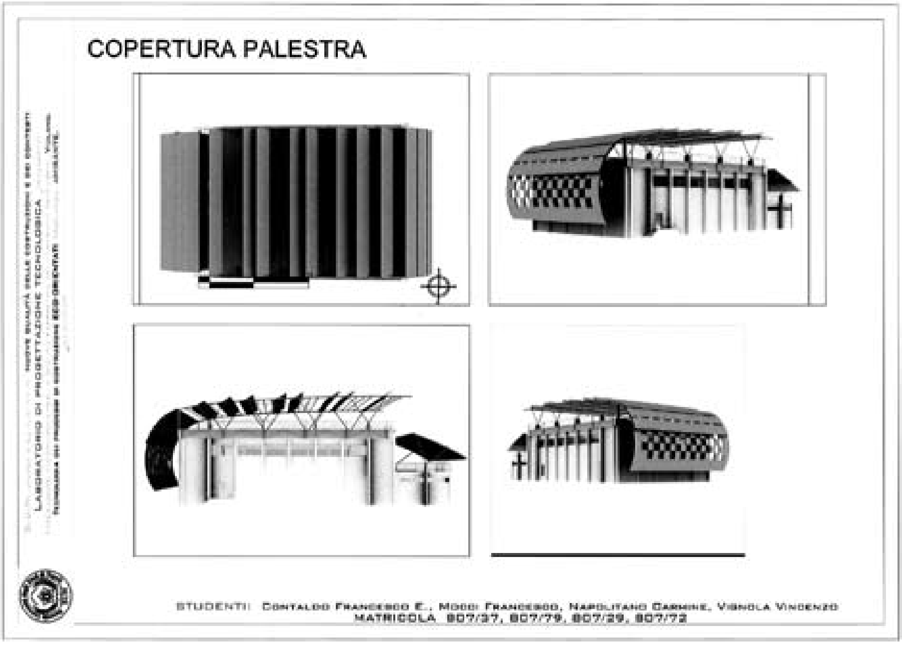

Fig. 12
Project n° 4b

Susanna Fülöp

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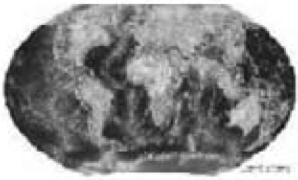
Hungary

Sustainable Environmental Design – Responsibility of Architects

Sustainability and energy efficiency are very important aspects of contemporary architecture. To understand the concept of "sustainability" we must understand the principles it is built upon and the definitions behind it.



Sustainable Development: In 1987 the World Commission on Environment and Development (WCED) recommended in its report 'Our Common Future' (also known as the 'Brundtland Report') to the United Nations the creation of a new charter or universal declaration on environmental protection and sustainable development.

Building on the 1972 Stockholm Declaration, the 1982 Nairobi Declaration and many existing international conventions and General Assembly resolutions, this report introduced the concept of "sustainable development" to the world. It defines "*sustainable development"* as *"development which meets the needs of the present without compromising the ability of future generations to meet their own needs."* Building upon this the Rio Earth Summit in June 1992 declared that "the right to development must be fulfilled so as to *equitably* meet developmental and environmental needs of present and future generations."

The Rio Summit states that sustainable development is not just about the environment, but it also has to deal with the economical and social aspects of development, recognizing that all people on Earth have the same basic needs and that all people as well as coming generations should have equal rights and opportunities to satisfy these needs.

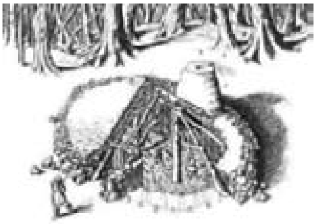
The Rio Summit in 1992 represented a major step forward towards the goal of achieving sustainability, with international agreements made on climate change, forests and biodiversity.

Out of the Earth Summit came Agenda 21, a blueprint for sustainability in the 21st century. Building on the concept of sustainable development, Agenda 21 provides a framework for tackling today's social and environmental problems, including air pollution, forests, biodiversity, human health, population, poverty, energy consumption, waste production and transport issues. Agenda 21 requires each country to draw up a national strategy of sustainable development.

Widespread awareness of climate change together with technical requirements arising from new regulations such as the Directive on Energy Performance of Buildings have triggered professional demands for architects with advanced skills in sustainable design and energy efficiency. This paradigm shift in professional responsibility has subsequently required that a robust environmental education sits at the core of the architectural curriculum at university and professional level. Unfortunately, the successful integration of environmental principles into a creative design process has proven elusive and, consequently, both education and the profession at large have been slow to respond to the demands of enhanced energy efficiency in buildings.

Although most European practices claim environmental sustainability as a key element of their design approach, few recent buildings have lived up to these claims. Conversely, where sustainability has proven to be a major design driver, energy efficiency has often been prioritized over architectural creativity. In order to support the diffusion of environmentally, economically, culturally, and socially valuable design, we have to facilitate exchanges of expertise between higher education and the profession and disseminate know-how and best practice of environmental sustainability to architects and the general public.

Shelter and comfort is a basic need for all human beings no matter where you live. We want a comfortable place to protect us against heat/cold, humidity, environmental diseases, dangerous animals, burglary and other possible threats. We want a comfortable environment where we can live a protected and healthy life. The first houses were built by the inhabitants' own hands from local materials.



The houses were a part of the local own eco-system. Later the development of society and industrialization resulted in the fact that we started to move away from the individual houses and instead started to build uniform and anonymous houses located close to factories and in the course of time they have spread from the centre of the city to enormous suburbs. Each individual therefore no longer has influence over or understanding of the relation between house and the external environment.

Unfortunately, due to many reasons, the development has caused our houses not to be simply the protecting and healthy "shelter" we want them to be. Political and financial reasons can cause this as well as ignorance of a new material's influence on our health.

It is a reality that during the last two to three hundrend years a lot of physiologically unhealthy and too expensive houses were built, houses which today require enormous resources to keep them up to date, healthy and comfortable to a standard that we today consider to be a human right. Many countries are today making a great effort to turn our cities into decent areas by removing the dangerous and unhygienic conditions such as fire risks, collapse of buildings, humidity, bad sanitary arrangements, leak, cold, noise, chemical pollution etc. The problem not only exists in old antiquated houses. Many new buildings have proven to be physiologically uncomfortable and unhealthy too. Many people who live and work in modern houses have complained of periodic symptoms of malaise (headache, fatigues, drowsiness, irritation in the eyes and nose, a dry throat, non-concentration, nausea and allergic symptoms).

The word "sustainable" is a key term, not only when we talk about 'environmentally friendly building and construction', but also when we talk about lifestyle and development in general. It is a term which is used and misused to label almost everything today. But what does it really mean and how do we define and measure, whether or not we are progressing towards sustainability?

According to the holistic approach, a building should be thought of and approached as a whole, as a complete system with specific features and performance requirements, not as a collection of industrial engineering disciplines (electrical, mechanical, structural, and so on). A building should be seen as an integrated part of a living process in dialog with the surroundings and its occupants.

The design of the building should take into account the cost and ecological impact of the building over its entire lifetime - from extraction and processing of the building materials to construction, occupation and the eventual demolition of the building at the end of its useful life.

In this context, important factors are running costs, energy efficiency, maintenance and durability of materials, pollution minimization, the energy embodied in the materials during their manufacture, and the building's potential for refurbishment or adaptive reuse.

In summary, sustainable environmental building design should:

- Take full account of the climate.
- Design for durability.
- Use renewable local building materials wherever possible.
- Design for increased efficiency in the use of materials, energy and other resources.
- Use life-cycle analysis in decision-making about materials and construction techniques.
- Minimize the consumption of resources, especially non-renewable ones.
- Use materials with low embodied energy.
- Design buildings to use renewable energy.
- Minimize pollution of soil, air and water.
- Identify opportunities for and make it easy for occupants to re-use and recycle waste.
- Identify opportunities for water conservation and re-use.
- Maintain or, where it has been disturbed, restore biodiversity.
- Reinforce and exemplify environmental responsiveness.
- Enhance appreciation and awareness of the environment.
- Be subordinate to and aesthetically sympathetic to the natural environment and cultural context.
- Take care of sewage treatment and waste treatment.

Performances of buildings:

- External visual appearance of the building/design.
- Quality of internal/external spaces (e.G. Day lighting, materials, air quality).
- Construction technology (detailing, maintenance, recyclability, etc.).
- Duration and simplicity of construction.
- Occupant comfort (thermal, visual, acoustical, physiological, psychological).
- Energy performance in production (embodied energy).
- Energy performance in use.
- Life cycle of materials.
- Financial efficiency.
- Ways and means of facility management and maintenance.

Energy consumption, day lighting in connection with thermal and visual indoor comfort, using renewable energy resources, energy efficiency, pollution are the key factors of the sustainable environmental design.

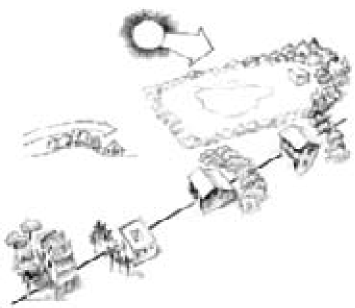
Human beings have adapted to live under extreme climatic conditions. People survive in Siberia under temperatures down to -50 °C as well as in Central Africa under temperatures up to +50 °C. However, nobody would feel well at the mentioned temperature if we could not somehow protect ourselves. This protection we get from our clothes and our houses. The aim is to create a more comfortable and stable climate. We want to create a small "world" with a suitable climate we can control and regulate according to our needs.

The indoor climate should then be regulated by high-tech solutions like ventilation systems or other installations. In other places in the world you want to keep the heat out of the houses by the help of energy absorbing technical equipment. Fundamentally the function of the house is to set the framework for a climate which is different from the outdoor climate. Thus there is a close connection between the way we design our houses and the surrounding climate.

An extreme example is that it was first possible to build a city like Las Vegas when air conditioning was introduced. It is a city where people, in general, only move by car or stay in air-conditioned houses. Based on one invention a city was built on a place where there are no natural life conditions for human beings, with the help of an invention that is dependant on an enormous supply of energy. Las Vegas, unfortunately, is not a unique example of how human beings try to control external surroundings by use of extremely large quantities of energy at the expense of the environment.

The surroundings, the location and orientation of the house are very important aspects for protection against cold winter winds and hot summers. The way we build should reflect and be in dialogue with the local climatic conditions instead of working against it.

The best location of the buildings depends on the local climate.



Despite climate - cold, hot, temperate, dry, and humid - houses should be built so that the local conditions are being utilized to a maximum. This has been done by human beings since the beginning of time. Most old cultures had a good knowledge of the local climate and understood how to utilize it instead of working against it. All over the world there are specific ways of relating to the climate. For instance houses were built on pillars in humid areas or dugouts in very hot or cold climate in order to utilize the natural conditions for the benefit of human comfort. Unfortunately much of this knowledge is being forgotten.

Now, houses are centrally heated and air-conditioned and the location of the house in relation to the natural conditions is not that important any more. However, due to the increasing pressure on our energy resources we should again start to make use of experience and knowledge of natural resources. They should again be taken into consideration before deciding the location of a new building. The best location naturally depends on the climate of the specific place. It is important to place a house taking trees, landscape, local wind and water conditions into consideration in order to give protection against cold winds and to take advantage of the wind for ventilation in the hot and humid parts of the world etc.

There are parts of the world where the climate is very close to what we humans consider to be optimal - i.e. most people find the Mediterranean regions very comfortable. When the climate in the northern countries gets too cold and wet, body and soul is influenced negatively, and if possible we travel to a more comfortable climate.

Built examples in different climate zones

Built examples in the Mediterranean zone

Terrace houses in Ossuna (architects: J. Lopez - P. Sottomayor). Courtyards represent transient space where the effect of shadowing, stratification, evaporative cooling of trees and thermal mass provides acceptable comfort and fresh air supply into the house.

Scandinavian residential houses built around an atrium

Heating is required round the year. Strong wind, driving rain and very expensive power supply.

The solar gain of the sunspace through the great South and West facing and roof glazing is 100 kWh/day in summer.

Built examples in the temperate zone

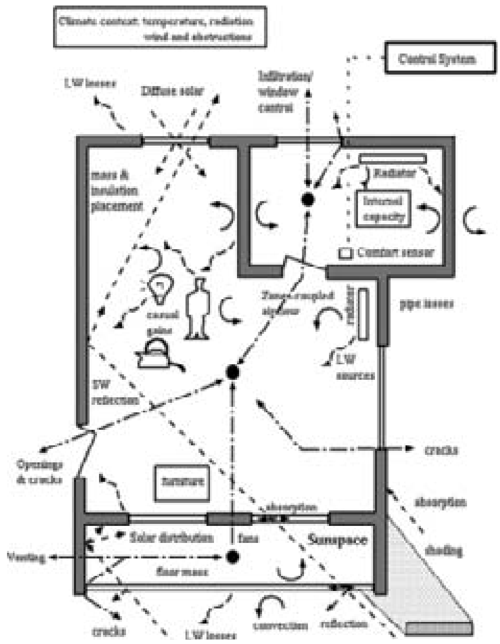
Solar house in Pécs, Hungary

Living room on the ground floor, kitchen, bath, entrance, store in the North-facing buffer zone, bed rooms upstairs, intensive vegetation on the East and West façade. Green roof, compact form (cylindrical form in the cross section), earth sheltered buffer zone towards North.

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. Careful consideration of the above issues at the earliest stages of a design can have an enormous impact on reducing subsequent operating costs.

	Heating	**Cooling**	**Lighting**
Design issues Thermal and Visual comfort	1.Surface to volume ratio	1. Shading	1. Windows
	2. Insulation	2. Exterior colors	2. Glazing
	3.Infiltration	3. Insulation	3. Interior finishes

The figure attempts to identify all of the energy flow paths within the building and between the building and the external environment.



Energy flow mechanisms include:

- Surface convection is caused by buoyancy and mechanical forces and is influenced by surface finishes, geometry and temperature distribution.
- Inter-surface long wave radiation exchanges are caused by temperature differences and are influenced by geometry and surface finishes.
- Surface shortwave gains are caused by the date dependent sun path and influenced by site location and obstruction, building geometry, orientation and the transmittance, absorbance and reflectance characteristics of constructional materials.
- Shading and insulation are dictated by surrounding and façade obstructions and are influenced by site topology and cloud conditions.
- External surface long wave exchanges are influenced by sky conditions and the degree of exposure of the site.
- Energy transmission of natural ventilation influenced by wind.

How the building is oriented and located in its site is of major importance in its response to microclimate. The issues to consider are solar radiation, humidity and wind.

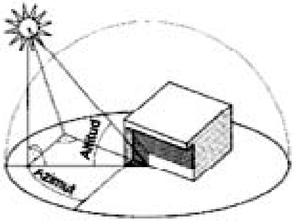
Solar radiation

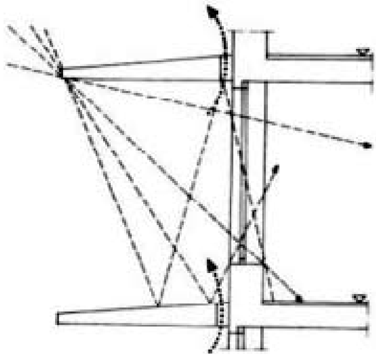
The availability of solar radiation will depend on latitude, climate and the shape and orientation of the building.

The amount of solar radiation received at the site depends on:

- the surface areas of the building geometry which are oriented North/South and East/West,
- the relationship of the building to neighborhood buildings or to the site topography,
- the proximity of vegetation, both deciduous (which impacts differently in summer and winter) and non-deciduous.

The way in which the building overshadows itself is also significant.

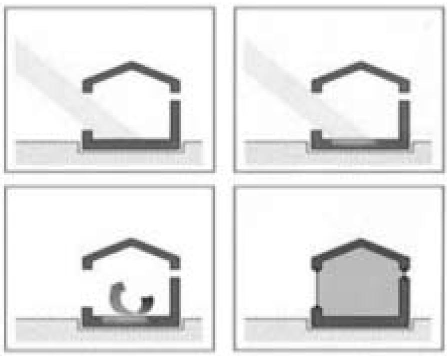




Solar radiation effect

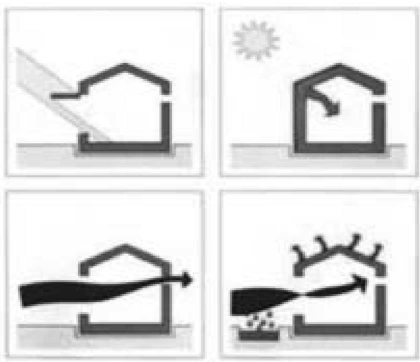
Heating

Solar energy is collected, stored, distributed conserved.

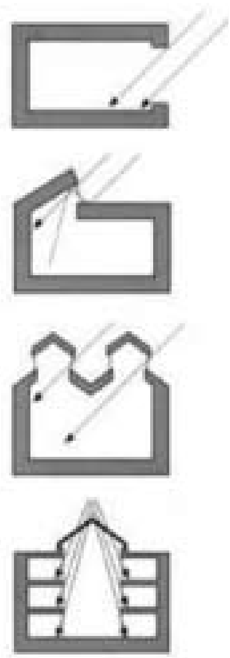


Cooling

Cooling is promoted by window and overhangs, reducing internal heat gain, cross ventilation and evaporative cooling.



Light is a key component of the built environment. It is a key factor in dictating the appearance and functionality of a building and its surrounding landscape.

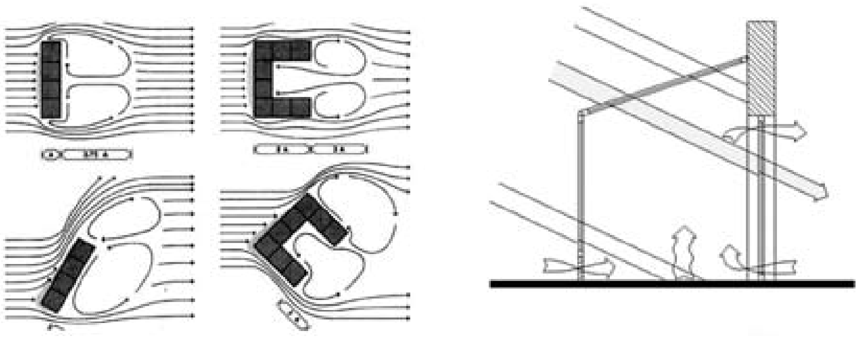


Lighting is one of the most important requirements of interiors, as the visible environment is an essential condition of our activity. Although nowadays there are two possibilities of meet the demands - with natural or artificial lighting - the two options are not equivalent.

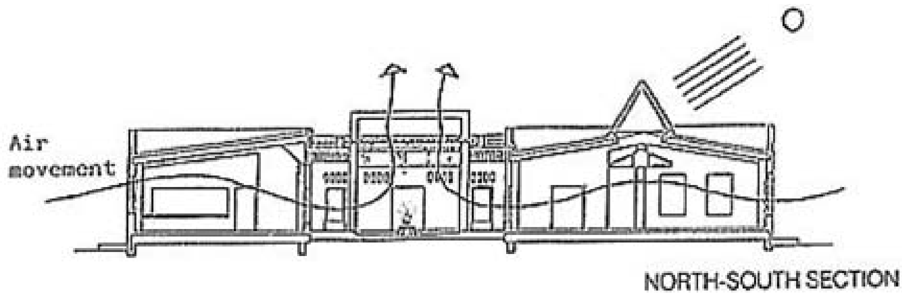
Being able to design the artificial lighting of interiors for permanent quantity and quality is undoubtedly favourable, however features of daylighting are advantageous in the following respects:

- Quality of daylight is best, in spite of the fact that it changes permanently. It is best first of all, because human vision developed by natural lighting.
- Its quantity enables it to provide larger and preferred illuminance than that of artificial lighting during daytime in a considerable part of the year. We may enjoy an illuminance of a thousand lux or larger in rooms where level of artificial illuminance is only a couple of hundred lux.
- Daylighting works with renewable energy, daylighting is the most friendly available usage of the Sun and sky radiation.

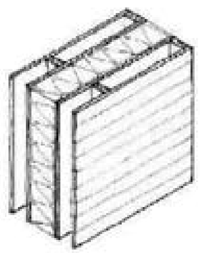
Wind patterns around a building - related problems: wind pressure, natural ventilation, air infiltration, driving rain, smoke distribution, energy consumption of building, street comfort, air change, air pollution in urban spaces.



Orientation and filtration



Are well-insulated houses good for the environment?



The building materials alone cannot control the air humidity in the house. A regular airing is necessary. This airing of course should not create an uncomfortable draught or suck out the heat from the house. The problem by mechanical exhaustion is that the air will become too dry. The movement of very fine dust particles may cause problems as well. Therefore, it is important that the houses are built from materials that keep the interior climate in a balance: Materials that can store and give off humidity and heat.

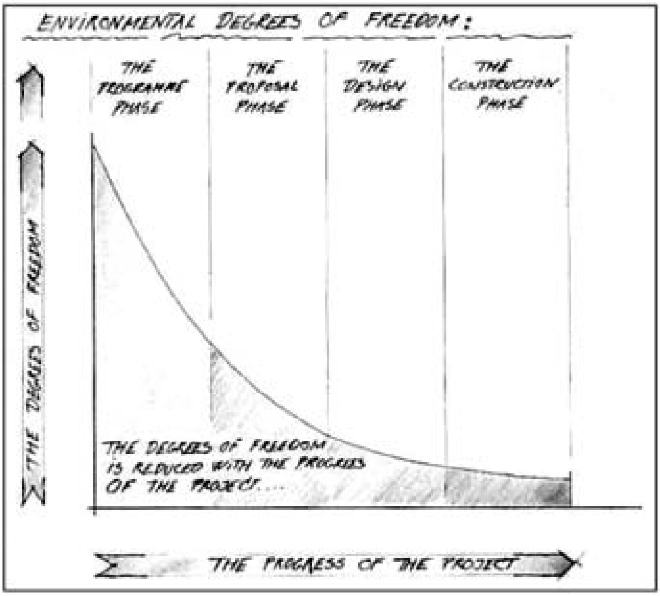
The average atmospheric air speed in a room should be below 0.15 m. per second equal to an air vibration that can make a candle flame bow 10°. Only by extreme summer heat will a higher air speed be comfortable. This information may seem rather abstract, but the opposite is known to most of us. Leaky windows, bad insulated and cold outer walls, overheated radiators fighting with humid walls are all factors that are important to our comfort and health.

The conclusion is that tight, well-insulated houses are good for the environment as well as to the well-being of people. We should try to avoid leaky doors and windows. Supply of heat should be as regular as possible via large radiation surfaces. Heat and cold storing heavy interior building parts like massive walls or stone floors sufficiently porous to absorb and give off humidity can secure harmonic humidity and temperature conditions.

Society considers architects, first, as building artists and some architects are reticent to expose their procedural methods and followed "recipes" during their design developments.

By re-thinking the architectural design process as a coordinated set of stages, and sub-stages, replacing the traditional experience-related process by a more conscious, rational, and theory based approach; choices and solutions for specific design problems, traditionally taken base on experience or individual thinking, can be now taken, base in technical awareness and attentive to potential alternatives.

The environmental work should be an integrated part of the designing process. It is worth emphasizing that it is important to start the environmental activities as early as possible in the course of the project. It is at the stage when the framework is established that it is possible to choose between different environmental alternatives. As the project takes shape and becomes more detailed the degrees of freedom and the possibilities of choosing environmentally better alternatives are reduced.



THE ARCHITECT MUST EVALUATE CONNECTIONS BETWEEN BUILDING ENVIRONMENT (EFFECTS) AND STRUCTURAL PERFORMANCES FROM THE VERY FIRST STEP OF THE DESIGN PROCESS

The architect has to pay close attention to possible environmental, structural and construction problems from the very beginning of the design process.

The difference is actually, in how each designer interprets, synthesizes, and evaluates all the collected data, as well as his design product, as a real simulation result of all his perceptions, aims, and convictions. To support his decision steps, among his expertise, each designer needs to consult, during his own design processes, useful "tools" to support and help him achieving the targeted goals. Consultants have to offer expert strategic advice on energy planning and policy, regulatory requirements, energy procurement, alternative energy options, environmental impact assessments and water conservation strategies meeting sustainability targets as well from the first step of the designing process.

Environmental relations focus on three main areas of the planning process:

Locality , Form and function, Technology and materials

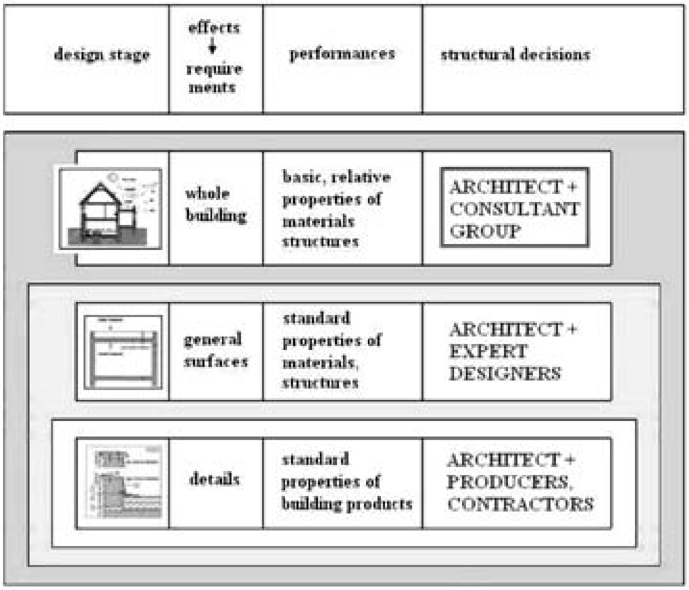
dealing with aspects of the locality:

Natural conditions, Cultural conditions, Legislations

These three main areas should within each sub-item be evaluated according to the environmental impacts and effects related to one or more of the life cycle phases.

Consulting Services according to the environmental targets:

Sustainable design, Cost management, Lighting design, Inclusive design, CoSA solutions (analysis strategy which is able to quantify the future performance of a building), Fire and smoke computational fluid dynamics, Sustainability and alternative technologies, Energy consultancy e.t.c.



The aim of architecture should be that ecology and environmental concerns become a natural part of the planning. What we today call "Environmental Planning" or "Green Architecture" should in time be the normal "Planning" and "Architecture".

Session 4.1

Integrating the teaching of structures

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Design of Structures in Architecture

Architectural Vision towards Structural Innovation

Design of Structures within an Interdisciplinary Design Context

At the Program of Architecture at the University of Cyprus, architectural designs with an emphasis on technology, practised within the framework of the construction design courses in the micro-studio and in the framework of the sixth main architectural design in the studio, seek to activate through integrated design respective decision making processes within an interdisciplinary design context. The integral development and the application of technological parameters in the designs are based on the main areas of the morphology, the construction and the energy efficiency of the buildings. The structures developed support the framework of design. The practice of integrated design within the relevant courses of construction and architectural design is aimed primarily at the consistent gradation of the design scale, from the capture of the architectural concept up to the construction detail in 1:1; furthermore, it is aimed at the development of the respective areas of design based on a technology-driven design syntax.

While the design examples selected for the case studies of this paper are of a higher standard than the "average" ones, it is important to recognize that this is firstly place due to the considerable progress of the students' knowledge, skills and expertise gained in the first three years of education in the relevant technological areas. The challenge can be posed in an interdisciplinary micro-studio for the construction courses, in the second and third year of studies, or in the main studio for the architectural design of the sixth semester. In all cases the design of the structure is part of an integrated whole, which supports and facilitates evenly all areas of the design development: morphology, construction, energy efficiency. The proposed method of practice of structural design (within an integrated architectural design process) serves not only relevant pedagogical issues of development and integration, but it also often leads towards innovative systems that arise from the holistic context of considerations and within the respective project-specific architectural visions set.

The Micro-Studio

In the framework of the Construction III course (Construction in Steel), the development of a temporary building unit for environmental briefings was required in the Fall Semester 2008, with a total area of about 260 m^2. The floor area was to include an exhibition space of 200 m^2 and secondary spaces of about 60 m^2. The design proposals refer to integrated functional buildings that are composed of element parts of the lightweight steel structure and envelope. The development of the load-bearing and non load-bearing elements and their connections design favour a standardization of the structure, an easy erection and a possible perspective extension of the building.

The "Flower" Project and the Wheel-Mechanism

The first design example, shown in Fig. 1, refers morphologically to a flower shape, structurally realized through the "wheel" principle (an innovative technological patent), successfully improved and tailored to the particular project design. International structural applications, where an improved "patent" of the bicycle wheel in real structures could be met, such as the Fort Canning Tower design in Singapore, 1991, the D.G.Bank, Bariserplatz in Berlin, 1998, the "London eye" project in London, 2000, as well as the Killersberg Tower in Stuttgart, 2001, were the initial references as part of the investigations preceding the design process.

Fig. 1
Design Project 1.

The technically developed petals of the flower came about through a slow learning process. The idea of the proposed shape was tested against a number of criteria (strength, stiffness, weight, demanding effort, ease of erection, appearance etc). The lightweight roof features eight individually articulated wing structures, similar to the petals of a flower, arranged in a radial pattern at the horizontal plan enclosing a main exhibition area of 150 m^2, whereas all the remaining spaces are hosted in movable, transportable containers, Fig. 2. The geometrical shape of the petals was seen as a strong architectural concept that also became the primary aim task for the structural- and construction design orientation.

The wings are curved in a convex form, clad with a doubly curved 2 mm thick ETFE-membrane. The vertical loads, distributed to the top membrane surface of each petal, are transferred to a linear member that divides each petal's surface into two individual parts, following different curvatures. The primary curved member forms an arch, in each petal's longitudinal length, extending 16 m between its ends and 5.86 m in its maximum width. Circular hollow sections and bracing rods, along with cables, were adopted in both directions to allow the "petal" wings to remain stable and torsionally stiff. The elements are arranged in a radial pattern forming a complete circle measuring 36 m in diameter. Curving is successfully formed with the use of horizontal primary circular members, connected in pairs to the main longitudinal arch. The development of the structural system (by applying the cable trussing method principle), for each individual and self-sustained petal wing, resulted creatively in some basic innovations, Fig. 3, such as:

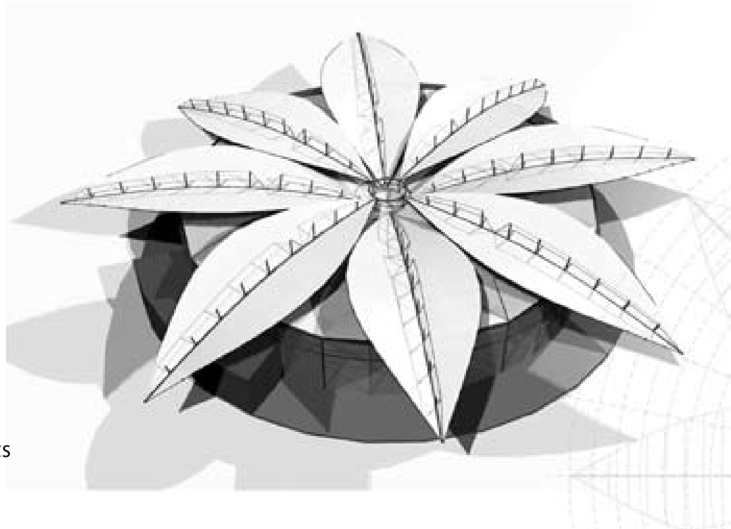

Fig. 2
Building Elements Synthesis.

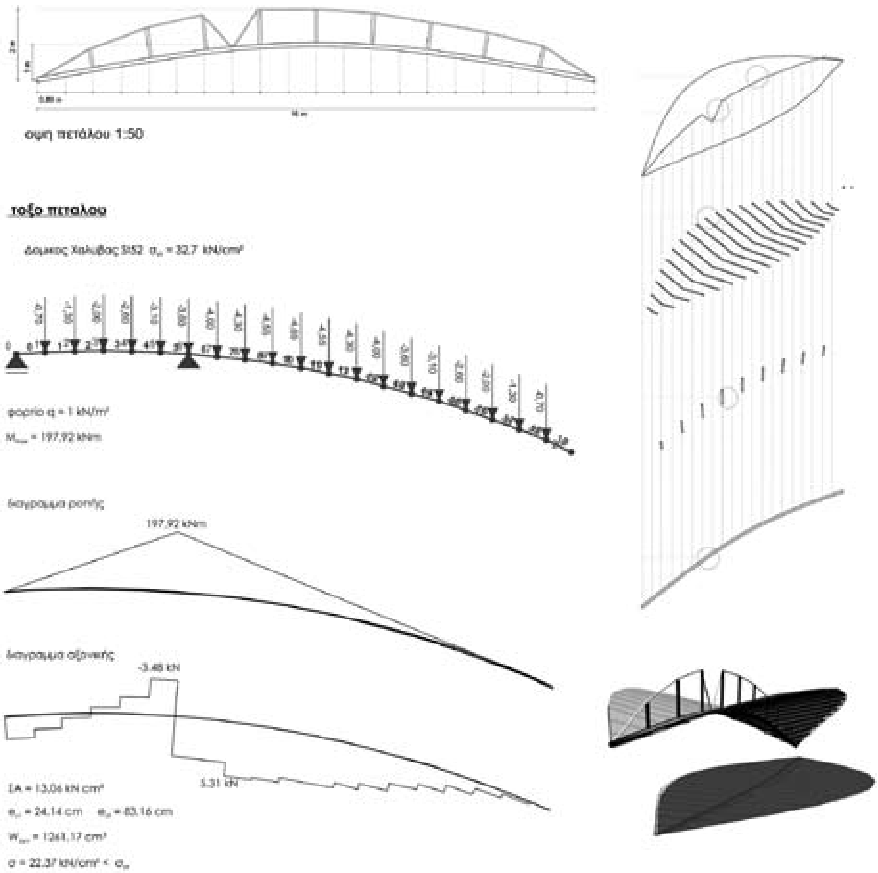

Fig. 3
Structural Analysis of the Wings Components.

- A decrease in bending stiffness demand on the main arch, since bending moments can be handled with the combination of tension members and compression on the basic arch, whereas shear stresses are handled by the added struts.
- A decrease in possible rotations of the added struts' connection joints through internal hinges.

A final decision, coming from the members of the design team, was for the one end of each of the petals to be connected to a centrally located spatial "element". Half of the petals ended up at a height of 2.5 m from ground level and the other half, 1 m higher. The structural design of the central ring-element was a challenge; left "free-standing". The technological patent of the wheel seemed like the perfect means to serve the idea of the free-standing of the central ring-element. The supporting system of the wings is composed of two double height rings, connected together with radial cables. The cables are connected to the central ring in pairs and are spread horizontally in a triangular configuration to meet an intermediate "rim"-ring, supported on eight primary vertical columns, knot braced, forming a plan circle with a diameter of 11.2 m. The cables are spatially extended from the rim-ring, not only to activate the façade's structure, but also to decrease the bending stresses within the vertical columns, Fig. 4.

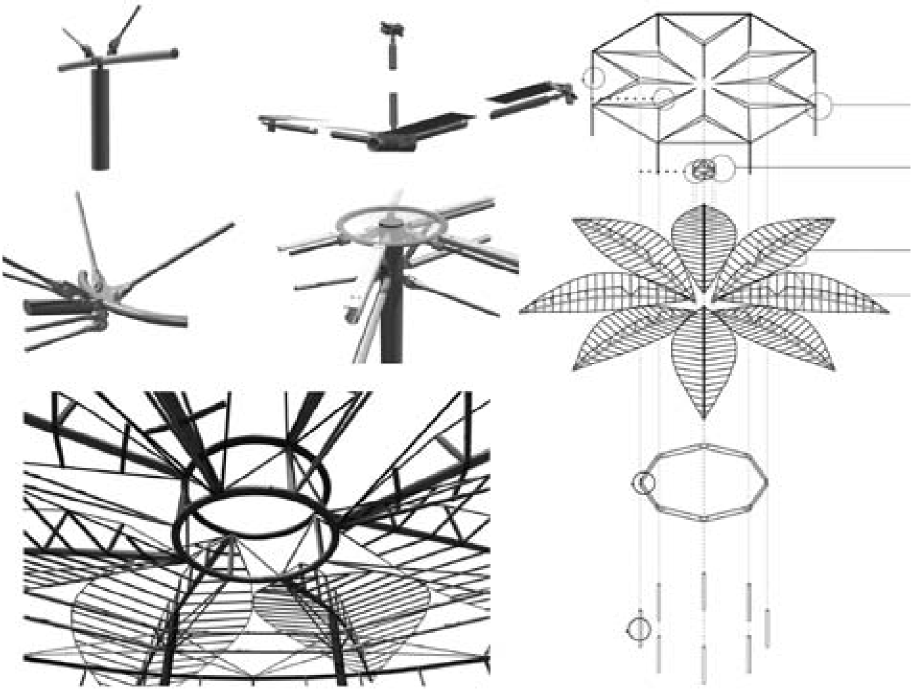

Fig. 4
Load-bearing Elements.

The structural system was evaluated through a preliminary analysis that indicated perhaps the most significant benefit from the structural system's interaction: reaction forces from each wing on its support resulted in a tensioning of the central ring element. A continuous tension ring could therefore be used to support the wings in a most effective way. The self contained system developed, stabilized by spokes, resulted in one of the most efficient forms of constructing the project's initial form driven concept, the flower. The load bearing system for this lightweight and relative long-span design demand, Fig. 5, was a much more suitable choice.

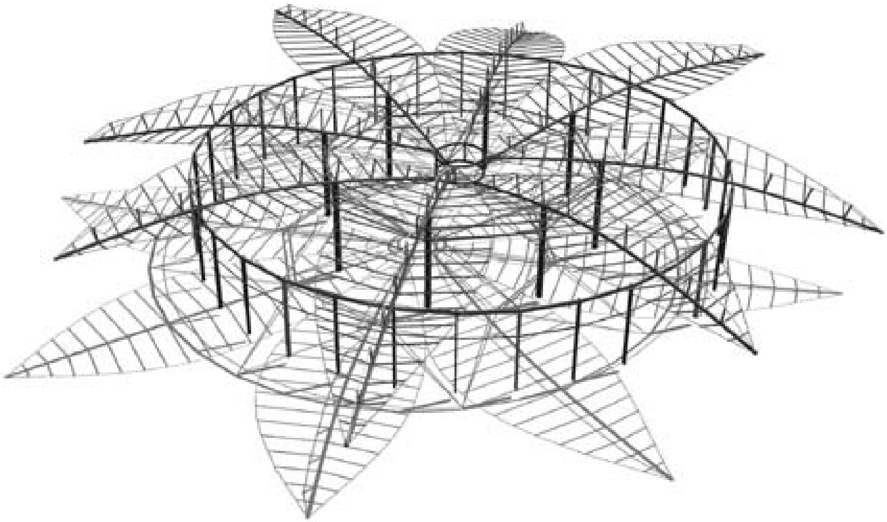

Fig. 5
Synergy of the "Flower's" Building Structure.

The "Seashell" Project and the Vierendeel-Arch System

The design example, shown in Fig. 6, addresses primarily the interactive development of the architectural concept and the building structure. The particular group of students was inspired by a "shell" form that had never existed before and they had to make believe that it could exist. The realization of the design intentions was achieved through the interdisciplinary design analysis.

In compliance with the architectural intentions, the longitudinal direction was chosen to be the main axis around which the primary arch shape structure would be extended, contrary to structural demands for the best possible loads-transfer path. Preliminary structural analysis investigations had indicated that the best choice, serving the architectural cause (and opposing the best suitable choice for the structural cause), could also meet the structural requirements. The required strength and stiffness demands, due to the deviation of the form of the arch from the funicular shape, were initially suggested to be provided either through the development of a trussed-arch, or a hybrid latticed-arch, composed of strengthening tension diagonals and struts, Fig. 7.

Indications of the possible behaviour that both systems would develop in terms of limiting the deformations and the bending moments were encouraging. Neverthe-

Fig. 6
Design Project 2.

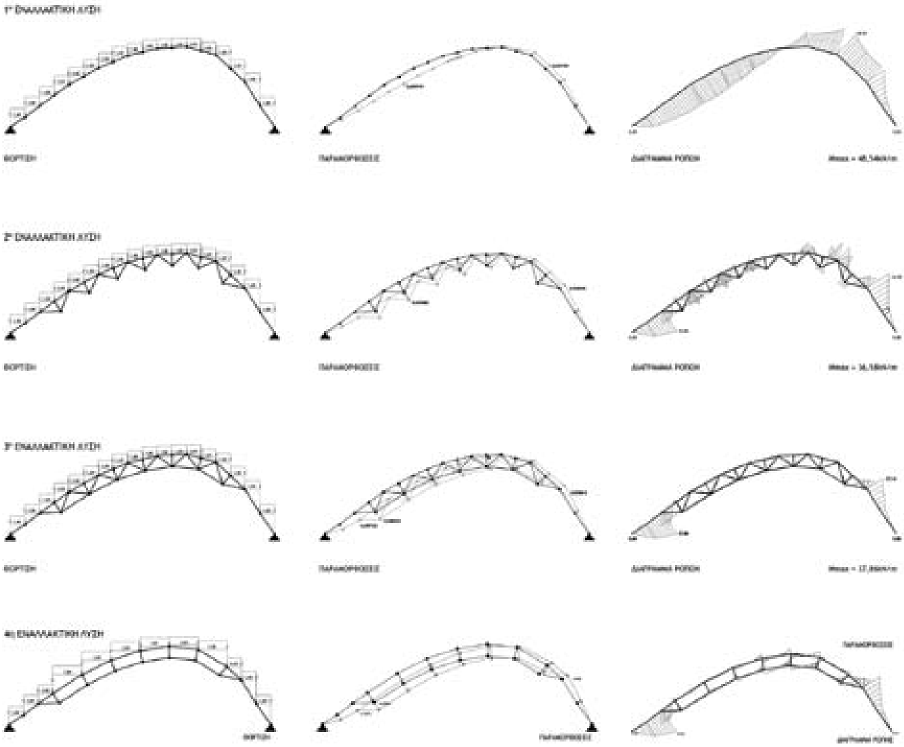

Fig. 7
Preliminary Structural Analysis of Design Alternatives.

less, the proposed structural systems were both rejected; they were both sacrificed for the architectural predominance. There was no place for diagonal members; transparency and natural ventilation was a necessity through clear passes between the vertical struts. Therefore a Vierendeel-arch was finally adopted, Fig. 7. Circular hollow sections were proposed for the longitudinal- and transverse members of the primary elements. In addition, ephemeral design requirements were the main reason for investigating the effectiveness of a rigid connected grid forming a steel foundation slab that could also be raised from the ground.

In the particular design example the "junction" between the best possible solution for an architectural and a structural cause was in favour for the conceptual intention. In this framework of development the decision making process and result has revealed that the design of the structure was the most influential parameter for the realization of the initial design vision set, Fig. 8.

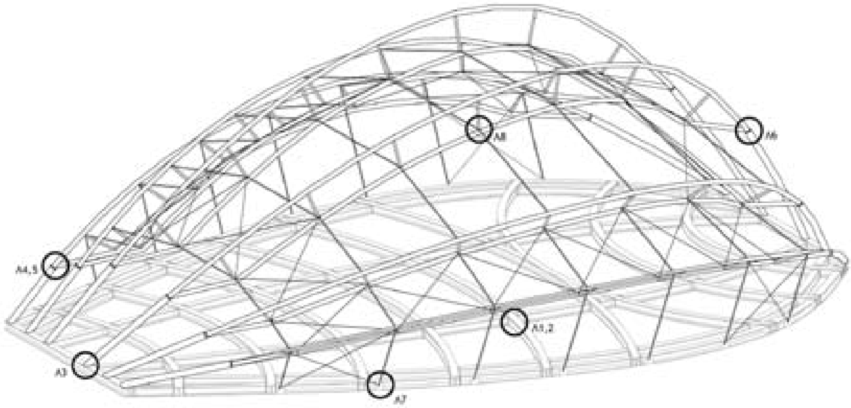

Fig. 8
Synergy of the "Shell's" Building Structure.

The Main Studio

In the framework of the main architectural design studio with an emphasis on technology, followed by the students in the sixth semester of studies, the development of a Platform for Digital Research and Technology of about 1.500 m^2 was required in the Spring Semester 2009. The building's primary purpose was to accommodate research activities and dissemination of the results achieved in digital design and simulations for different scientific areas. The research spaces had to support fundamental research in digital environments, including 3D- and 4D-modelling and virtual environments, as well as interdisciplinary advanced research, based on various possible effected synergies among different disciplines (i.e. pure sciences, technology, engineering, architecture, sociology, biomedicine and psychology). The building was proposed to be sited on the air lane of the Nicosia International Airport, since 1974 under the supervision of the United Nations, whereas the activities of the Platform had to be characterized by a high degree of adaptability, as is the case for relevant international scientific needs and cooperation networks of the research institutions and the industry.

The "Sky-Capsule" Project and the Hybrid Strengthening System

The "Sky-Capsule" building features a design solution of similar intentions to the Renault Sales Center in Swindon, 1982, Fig. 9. Key architectural features arose from the development of a closed ellipsoid volume, raised in a distance above the ground to "capsule" all interdisciplinary demands; functional, structural and mechanical services. The building is sectioned in standardized elements, maximizing on the one hand the articulation potential of an easily erectable building, unbound to the specific site, and on the other hand being able to accommodate additional elements for further extension of the structure.

Fig. 9
Design Project 3.

The overall profile of the exclusively hinge-connected structure has been made to conform to its bending moment diagram under gravitational loads, Fig. 10. The "opening-up" of the structure was developed in a particularly elegant way of matching the internal forces diagrams through the addition of the strengthening system of cables and struts. The articulation is made possible through two-hinged arches for the primary load-bearing system. The arches repeat every 5 m along the longitudinal direction, span 8 m over platforms and "capsule" the cabin rooms. The hybrid arch is supported on a semi-active form of inclined steel member elements.

The functional autonomous inner cabins are attached to the inner edges of the structure on the periphery, in a varying location, Fig. 11. In addition, platforms of glass were the preference of the students for the floor, supported on a tensegrity system. The design of the transparent building envelope allows an interesting architectural experience of the space from both inside and outside, (the visitor from outside may be surprised by the views of greenery).

The structural design solution was made flexible enough to allow the possibility of future addition of as many identical arches as the architectural intent would demand. A main aesthetical objective throughout the design was to achieve strong architectural self-identification characteristics through the construction design development, Fig. 12.

Fig. 10
Preliminary Structural Analysis of the “Sky-Capsule”.

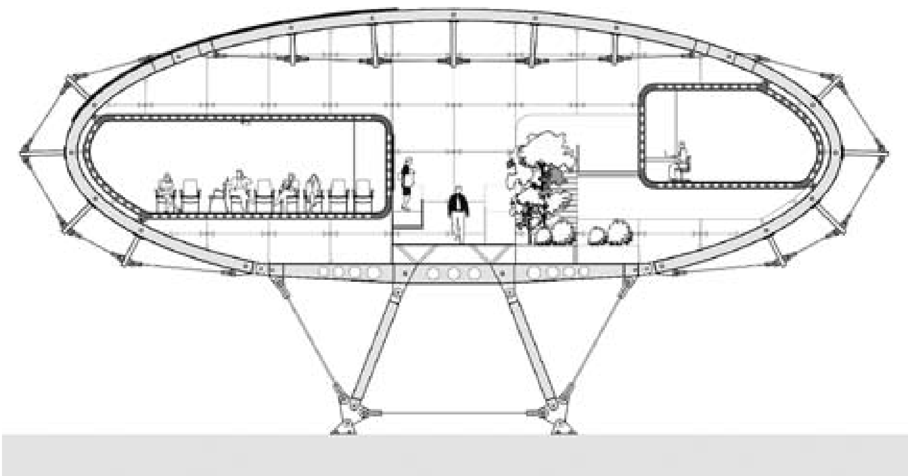

Fig. 11
Building Section.

Fig. 12
Primary Building Structure.

Closing Remarks

The practice of integrated interdisciplinary design in relevant courses of architectural- and construction design at the Program of Architecture at the University of Cyprus was presented in the present paper, based on three selected project designs. The development of the designs, based on a specific technology driven design syntax, proves in the first place the technological potentialities, made possible by incorporating and further developing technology patents tailored to the specific requirements of the respective design tasks and aims. In all case examples, the design of the structure cannot be seen as a separate aspect of the building design; on the contrary, it is part of an integrated whole that supports evenly all main areas of architectural development; morphology, construction and energy efficiency.

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Structural Design in Architectural Education

Workshop -the learning-through-play approach

Introduction

What is the right way to teach Structural Design to Architecture students?

As a lecturer and tutor on Structures, I felt that there was a 'missing link' in the connection between architecture design and structural thinking; I was quite intrigued by the students' response while attending these courses. You are certainly aware that this is not a subject that architecture students especially enjoy. That is why finding the right way to teach it and knowing how to integrate it in the student's mind is so crucially important, and so difficult.

In what follows, I will highlight my workshop-version, as one of the most effective ways to implement Structural Design in Architectural education successfully. I had the opportunity to put my ideas into effect in several courses, both at the Department of Architecture of the WIZO School of Design and at the Faculty of Architecture and Town Planning of the Technion, Israel Institute of Technology. The research is based on a post-doctoral thesis, carried out in the Welsh School of Architecture - University of Cardiff, UK (Frances 2001) and is part of a joint educational experiment under the name of 'Quadrivium Novum' (Rapaport and Frances 2006, 2008).

It is a well known fact that teaching structures is often treated as the unwanted stepchild of the Architectural curriculum, being seen as not only difficult to learn by the students, but also difficult to teach by the academic staff. We could concentrate the main problem on the following diagnosis: The engineering analytical methodology to teaching structures is in conflict with the architectural holistic and qualitative approach to design. In general, the engineering approach to teaching structures is quantitative. The courses are considered difficult, involving a lot of physics and mathematics. Architecture students have neither the inclination nor the time needed to master these skills. As a result there is a loss of enthusiasm accompanying the study of Structures. Needless to say, without true enthusiasm, true knowledge is impossible (Frances 2001, Frances 2006). The purpose of this research is to suggest an appropriate vehicle to pass Structural data to Architecture Students effectively.

There is no doubt that studying is better in a creative climate of curiosity and inquiry, in an environment which 'emphasizes learning instead of teaching' (Alexander, 1977). Attributes of an effective teaching approach are interest, involvement, relevance, empathy, curiosity and of course enthusiasm. These attributes are the main characteristics of a playing situation. The workshop method of study, the learning-by-doing and the learning through play, fulfils this kind of activity (Fig.1).

The model-making and testing experience is reminiscent of the infant's discovery of gravity; 'before even learning how to speak, an infant experiences and plays with gravity' (Von Meiss, 2000). The child involves trial-and-error explorations in creating an intuitive feeling of structural behavior. The workshop intends to use similar tools in order to create and enhance the understanding of structural principles. It proffers a visualization of physical laws, of theoretical issues and mathematical equations. Feynman, the influential American physicist, known for expanding greatly the theory of quantum electrodynamics and one of the recipients of the Nobel Prize in Physics, declared:

> *'If you want to learn about nature, to appreciate nature, it is necessary to learn the language that she speaks'.*

Fig. 1
The workshop's playful atmosphere.

Therefore, the main contribution of the workshop is to reconnect the intuitive feeling of nature embedded in human beings, helping to transform it into a comprehensive understanding.

Learning through play

> *'Play and education are not opposite things ... play is learning, and even more, it is one of the most effective kinds of learning known".*
>
> Marzollo & Lloyd (1972)

A play-based curriculum is now widely considered to be the most appropriate approach for facilitating learning and development. Play is a natural way for children to learn new concepts and to develop skills. It is through play that children explore their world, take risks, make mistakes and achieve success. Play, both directed and undirected, is a critical component of learning. Play helps children learn new concepts and problem-solving skills in a natural, fun way. Play is, by definition, a friendly activity – children play instinctively and derive a great deal of pleasure from it.

Positive play experiences develop positive well-being. The emotional benefits include: enjoyment, fun, anxiety reduction, self-expression, self-confidence to try new experiences and explore new environments. The freedom to play, to feel secure, to take risks as a designer, to be relaxed, are among others the benefits of the workshop. Playfulness is important, it helps to create original solutions and to feel secure to explore. Kids are more engaged with open possibilities. This openness is the beginning of exploration, giving infinite number of choices. The workshop is a powerful way to learn by repetitively doing; by falling down and repairing; it is classically *thinking- by-hands* learning by doing.

A workshop conveys educational inspiration and motivates students to active participation. The modeling generates personification and empathy; it involves 'inventiveness and creativity -skills otherwise quite difficult to be taught' (Ben Arroyo, 1970). The learning-through-play approach offers choice, control and freedom within reasonable boundaries. It provides opportunities for collaborative learning, communication, sharing, and conflict negotiation skills. All these qualities made the workshop approach a key tool for improving the teaching of Structural Design in Architecture Schools.

Teaching strategies and practices

> *'Providing effective learning experiences … is something of an art. It seems to be a matter of suggesting the right activity at the right time'.*
>
> Marzollo & Lloyd (1972)

Play is not anarchy, it needs rules. *'Playing rules'* strategies are vital in providing students with absorbing and stimulating practices. Many different tasks and meaningful exercises are adopted at the different workshops and at the various levels of study. All these activities have their own uniqueness; nevertheless, they have common main characteristics, which will be presented briefly next. Selected examples and pictures, which will provide an additional visual text, will accompany the topics.

Main characteristics of the workshop

The workshop studio module is offered alongside the lectures on Structures, enhancing and demonstrating the material taught in frontal lessons. For every topic on Structures, a concurrent workshop is dedicated; for instance, while learning funicular shapes, students are demanded to built a shelter according to Heisler's affirmation:

> *'One does not actually create the form; one lets it become, as it has to according to its own law.'*

Students are asked to execute a number of tasks, in an increasing complexity (Fig. 2 to Fig. 6). The early organization of students has a decisive effect on the workshop's success; therefore considerable thought was invested in the choice of the size of the ideal team. Two different modes of operation are separated in each assignment: The first one is the diverging mode, the playfulness, the exploring of ideas and alternatives while the second one is the converging mode that which brings to the serious developing of the solution (Brown, 2008). Students are divided into groups of two to three in order to create these modes of cooperation, developing valuable brainstorming discussion. From a technical point of view, the group size of two to three participants is practical for the construction of models. Furthermore, the division into groups reduces the number of models to be discussed and tested.

The extent of the exercise has a decisive effect on the workshop's effectiveness; therefore careful thought was invested in the choice of the ideal duration of the assignment. Accordingly, it is given two weeks in advance. In this time the team devel-

Fig. 2

The workshop adopts a studio-oriented learning format.

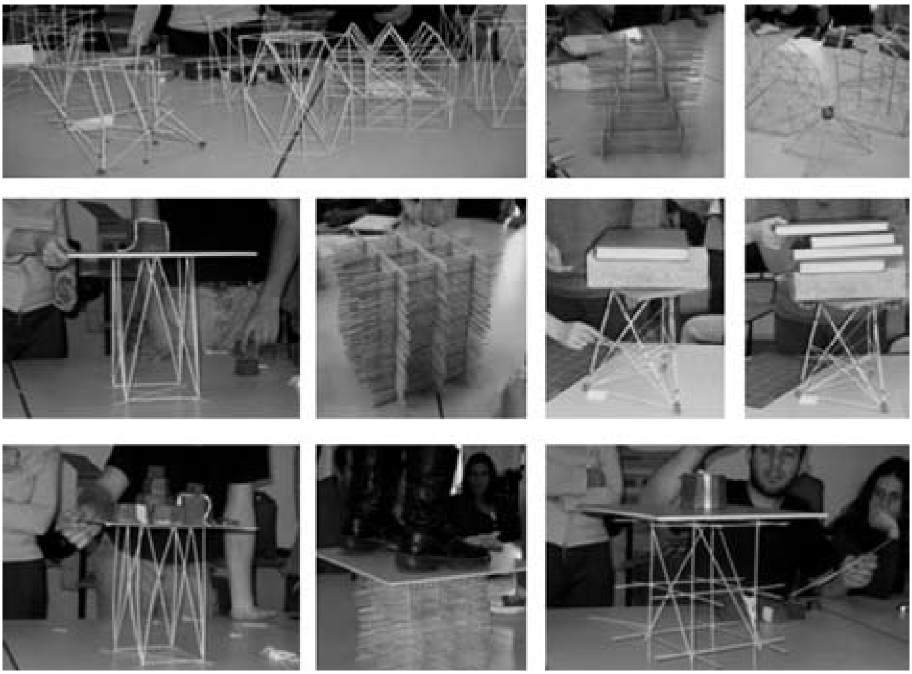

Fig. 3

The opening Session: 1st year course, first Model: to build a 300 mm height wooden-stick model, which carries a 2 kg weight; Different typologies of models being submitted to loading and experimental investigation.

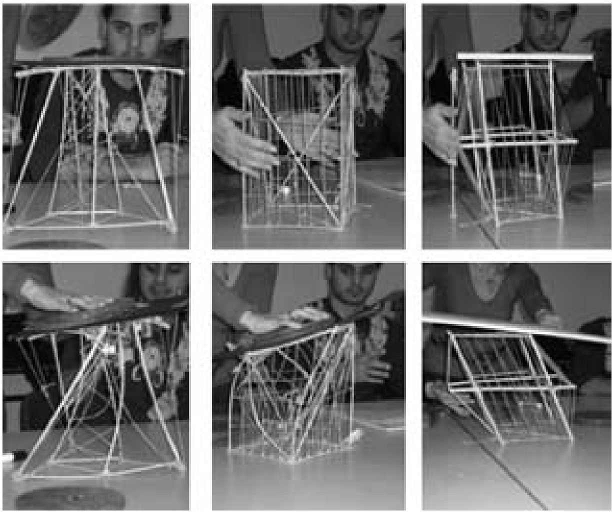

Fig. 4

1st year course, second model: to construct a 300 mm height structure, to carry a 2 kg weight, using sticks restricted to minimum and strings without any limitation; visualization of sudden and undesired structural behavior: twisting and buckling.

Fig. 5

The surprising structural capacity of a simple cartoon column of different shapes and lengths. Experimenting with body weight.

Fig. 6

Playful introduction to the study of absorptive, shocking resistant structures: to throw a fresh egg from the 4th floor and to keep it unbroken!

ops the idea, considers structural alternatives, prepares sketches and when all is said and done builds the model, and presents it in the forum of the class.

During the studio meeting, all the models are analyzed from a conceptual and structural point of view, and then they are subjected to loading test -till destruction. In the next meeting the group would present a report that describes the execution of the task, from the capture of the idea, to the actual functioning of the model, including criticism and conclusions. The vast variety of models on the same subject is worthy of note: this way it's possible for the students to learn from a large repertoire of structural typologies, developing on the one hand their creativeness and on the other their critical thinking.

Always an underlying requirement is imposed in every task, that the model must achieve stability *through elegant performance, using a minimum of material*. The loading test's derivates are the model's factors of *structural efficiency* and of *safety*. The task sometimes seems easy and then students are surprised by the disappointing behavior of the structure. Very often, on the contrary, the mission is regarded as impossible and then students are surprised to discover the capacity of clever structural systems, despite their weak materials (Fig. 3, Fig. 5, Fig. 6, Fig. 12, and Fig. 13). This way, structural principles are exposed to their enthusiastic eyes, discovering by themselves Dieste's affirmation (Dieste, 1987):

> *'The resistant virtues of the structures that we seek depend on their form; it is through their form that they are stable, not because of awkward accumulation of material. There is nothing more noble and elegant from an intellectual viewpoint than this: "to resist through form'.*

Experimental parametric investigation

> *'A picture is worth thousand words, a model is worth thousand pictures'*
>
> Popular saying

An experimental parametric method is developed by the author in order to translate complex behavior and formulas into comprehensive knowledge. For instance, the second year of studies at WIZO School of Design copes with different structural systems, between them the trusses. Following the statics taught in class, students were asked to build different types of trusses, based on a systematic typology (Fig. 7). In strategic positions in the models they asked to comprise string members, while others were left rigid. Under testing, models with rigid compressive or string tensile members stayed stable. Models with string compressive members collapsed (Fig. 8). This way, students discovered the systematic of axial forces, especially of diagonals and of zero-force members. Other phenomena were visible as well, like the buckling of the compressive members or the collapse of faulty joints.

Discovering the thesaurus of architectural structures

> *'What I cannot create, I do not understand'*
>
> R. Feynman

This topic is an interdisciplinary joint platform of architecture and engineering. Students are demanding to build structural models of a masterpiece. The aim is to discov-

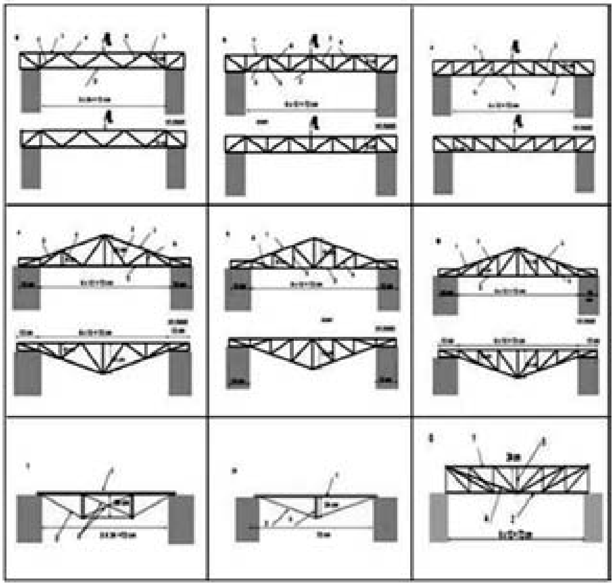

Fig. 7

Typological instructions for the parametric investigation of trusses.

trusses under investigation:
string diagonals under tension
keep truss's stability;
strings under compression
bring structure to collapse.

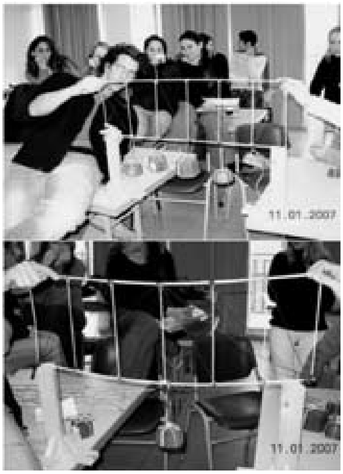

Fig. 8

Trusses under investigation.

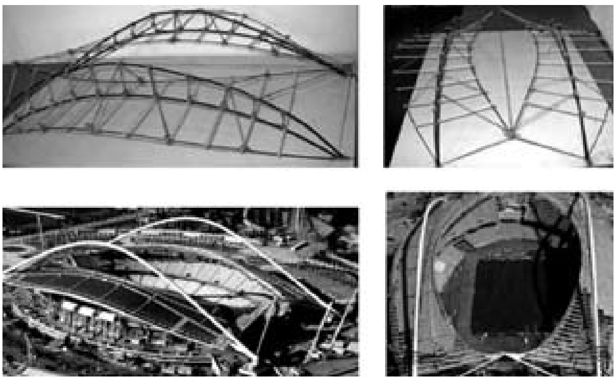

Fig. 9

Top: the Athens Olympic Stadium (OAKA), skeleton; Student's mode. Bottom: the stadium refurbished by Calatrava for the 2004 Olympic Games er the discipline's thesaurus, while the underlying objective is to create an awareness of the engineering role to enable the most exciting pieces of architecture to be realized; to emphasize how the borderline between structure and architecture becomes increasingly indistinct (Fig. 9). This *learning- by-doing* and *learning- by- hands* process exposes students to intelligent design and stresses the importance of painstaking detailing. Moreover, students learn to recognize and incorporate cultural values into their work, understanding technology as a cultural and rational process of choice (Rapaport and Frances 2006, 2008).

Homage to an architect / engineer

Through intentional referencing, research and models, students are asked to pay homage to an architect or an engineer, discovering how their creative work and masterpieces greatly influenced the discipline. Homage is paid to engineers like Calatrava (Jodidio, 2007), Rice (Rice, 1994), Dieste (Dieste, 1987), Balmond (Balmond, 2001) and others who play a crucial role in architecture; to engineers who pushed the boundaries of their profession, producing work which demonstrates not only a mastery of the challenges of their profession, but also an equally strong sense of architectural form (Fig. 10).

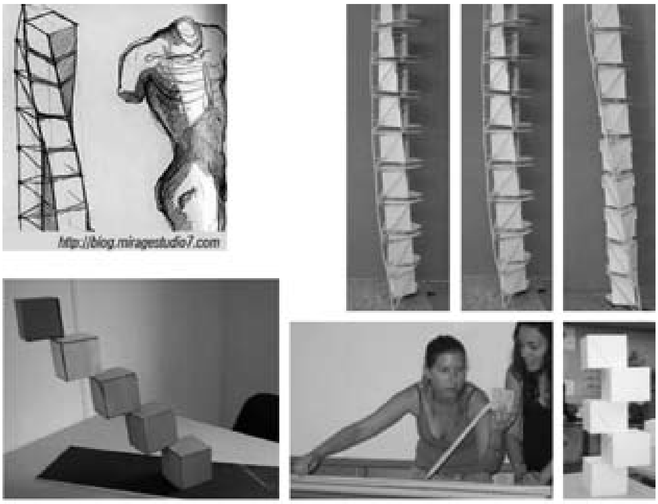

Fig. 10
A homage to Santiago Calatrava.

Group Projects

As a rule, group projects close the workshop's terms. Three of them are shortly introduced next (Fig. 11 to Fig. 15). For the first's year first - term project, students were asked to build a model which would respond to several spatial limitations and would carry a heavy symmetrical load on a very short base (Fig. 11). Students were very intrigued with the problematic basement and the minimum-weight requirement. During the test, they could recognize appropriate structural systems which allowed direct load propagation and on the contrary they could be aware of the faulty ones which caused buckling and twisting effects; realizing for instance that a sphere was not a good option for this assignment.

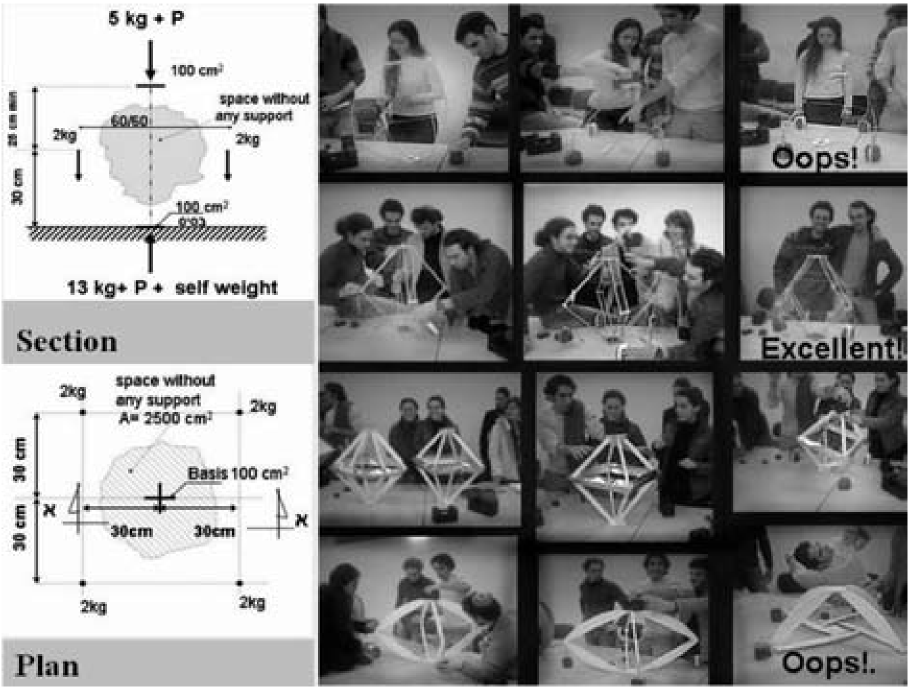

Fig. 11

1st year, first project: Building instructions and demands; Different structural behaviour under loading (the same model is demonstrated in each horizontal row).

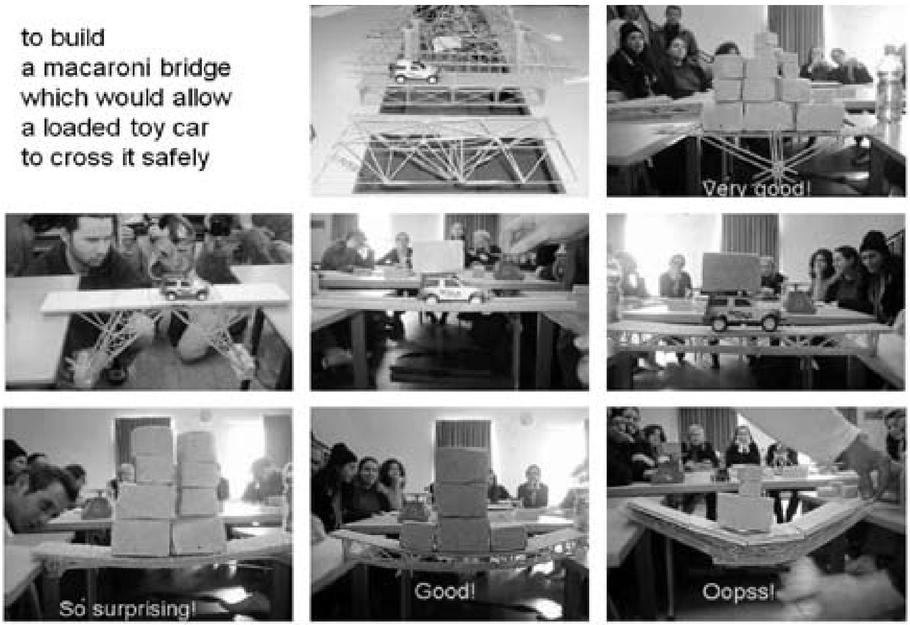

Fig. 12

1st year, second project: to build a macaroni bridge.

The first year's - second term project is surprising at the beginning. Its conventional aim is to build a bridge, which permits a loaded car toy to cross it safely. Completely unpredicted though is the building material: macaroni of all kinds! The material is so fragile as always to surprise students how it could ever be possible to stabilize and even over load the bridge. In an amusing way, the project gives freshmen the opportunity to recognize the high efficiency of clever structural systems (Fig. 12, Fig. 13). Students always wait for the *Grand Finale*- the collapse, which certainly awakens distorting catastrophic aptitudes, reminiscent of childhood and buried deep in human's nature (Fig. 13).

> *At the height of laughter, the universe is flung into a kaleidoscope of new possibilities."*
>
> Jean Houston

The third year's project requests structural research and design through an architectural project. Its purpose is to break down the cage that separates structural engineering from architectural design and to help students to incorporate structural design as a part of a holistic approach. Students become aware of the exciting experience of conceiving space in terms of structure, and conceiving structure in terms of the place it defines; that is, to think of space, place and structure as one integrated whole (Fig. 14, 15).

Closing Remarks

Concluding, I believe that the workshop approach is a well applied method of study. By giving students the ability to use concrete materials to explore spatial, physical and mathematical relationships and by making learning fun and enjoyable, the workshop provides a meaningful context to learn concepts and accurate skills on Structural Design.

This paper did not intend to introduce the workshop approach, which is already quite familiar; its purpose was rather to highlight different aspects, to diversify the emphasis and to enlarge the perspectives. Probably this approach might be seen basic or

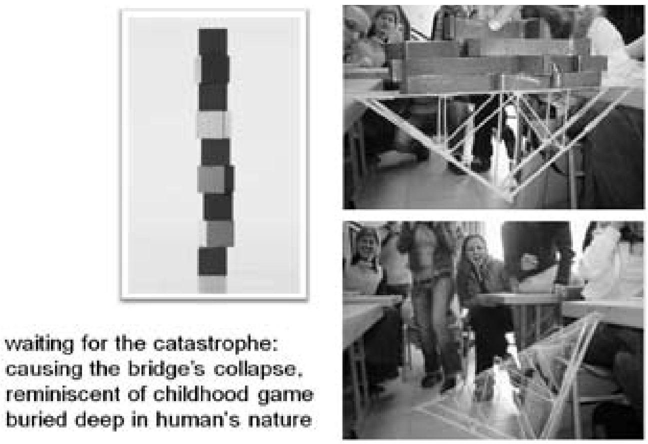

Fig. 13

A macaroni bridge demonstrating high structural capacity, finally collapsing by the shear force at the support.

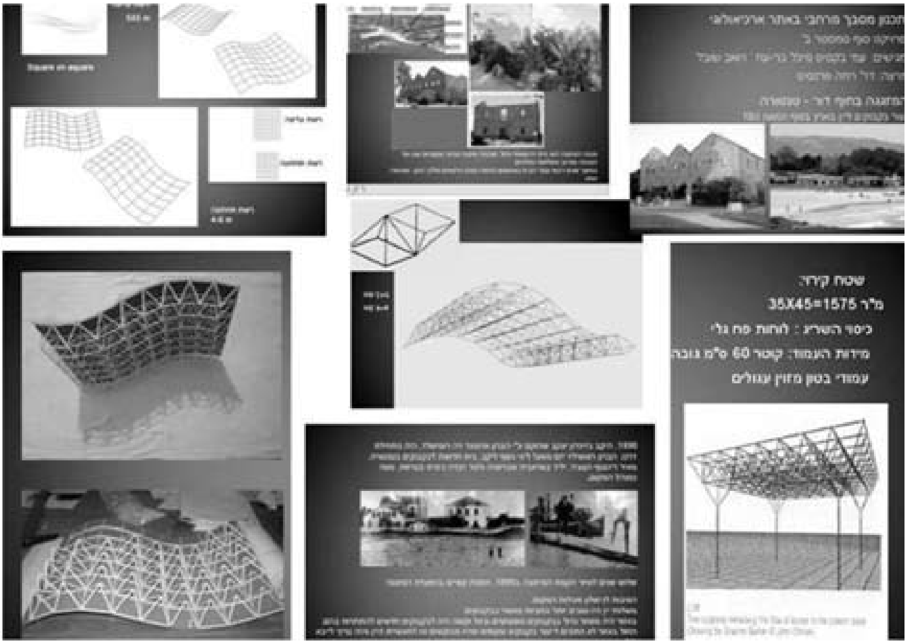

Fig. 14

Third-year project: Building in an archeological site; architectural and structural investigation -student's presentation.

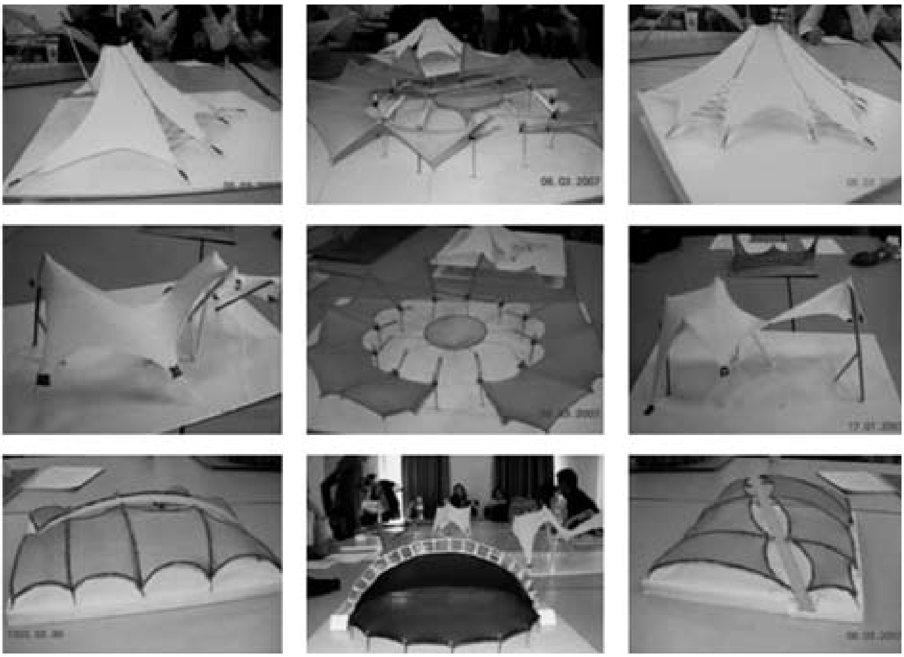

Fig. 15

Third-year project: Building in an archeological site -selective models.

very simple. Nevertheless, after all the high statements for an appropriate structural design education (Frances, 2001), a serious practical effort had to be made in order to apply the high philosophies to a continuous series of well considered exercises. The didactic creativeness strove to adapt the right exercise at the right stage of learning and to the right level of knowledge. All this, by dressing difficult issues in an amusing disguise which keeps students in a good mood and enforces their success. Students' enthusiastic responses can only endorse this procedure.

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Experiment and Reflexions on Structural Sense in Design

Introduction

Structural design remains a complex matter when elevated to working on forms which involves both architectural and structural issues. Working judiciously on structural issues means that relevant conceptions have to be integrated. Integrating both disciplines around designs – either by an individual or by sharing relevant conceptions on structures – could refer to a specific view that we could term "structural sense in design". Our intention is to explore what a competence like this means, both in its practical application and in teaching.

My intention will be trying to broach this view on structural design in three different ways:

- by putting the theories of structural design into a historical perspective;
- by taking a quick look at the remarkable design methods employed by an engineer like Robert Maillart;
- and by critically reviewing some approaches to structural education which we have tried out with our students.

Finally, we will be trying to share useful conclusions on approaches that are of great benefit to engineers involved in structural design that incorporate an architectural dimension... to be precise, it is not just about resolving mechanical issues.

Some historical perspectives

Studying the history of the different disciplines shows some of the origins of the modern divide between architectural and structural practices (fig. 1) (Benvenuto [1991]; Hesse & Flamen-Hennebique [1941]; Heyman [1996]; Schädlich [1997]; Vaudeville [1997]; Vaniscotte et Clerget [1997]).

Up to the end of the Middle Ages – and to the middle of the Renaissance – issues of structure were managed by architects using geometrical construction. The Renaissance was the start of the age of engineering, applying mathematics to physical issues, but – at that time – geometry remained a typical feature of it.

Things really began changing in 1608 with the work of Simon Stevin, followed by Pierre Varignon.

Both began to work mathematically on loads and forces, notably working on what would later become vectorial equilibriums.

The science that came to be called the Strength of Material commenced with Galileo's work on the failure of beams. He was followed by Hooke, Bernoulli, Euler and others.

Simultaneously, the first schools of engineering started to appear: for example in France in 1716 the *Ecole des Ponts et Chaussées* founded by Perronet. At the same time, engineering treatises also appeared.

All this would set the foundations for what was to become the Theory of Elasticity which was established as a (consistent) discipline by Navier's *Leçons* in 1826. Navier's methods would subsequently be improved on (Heyman [1999]), but the basis of his theories would not be challenged before the mid-twentieth century. His theories are actually still being used by most systems for resolving mechanical issues.

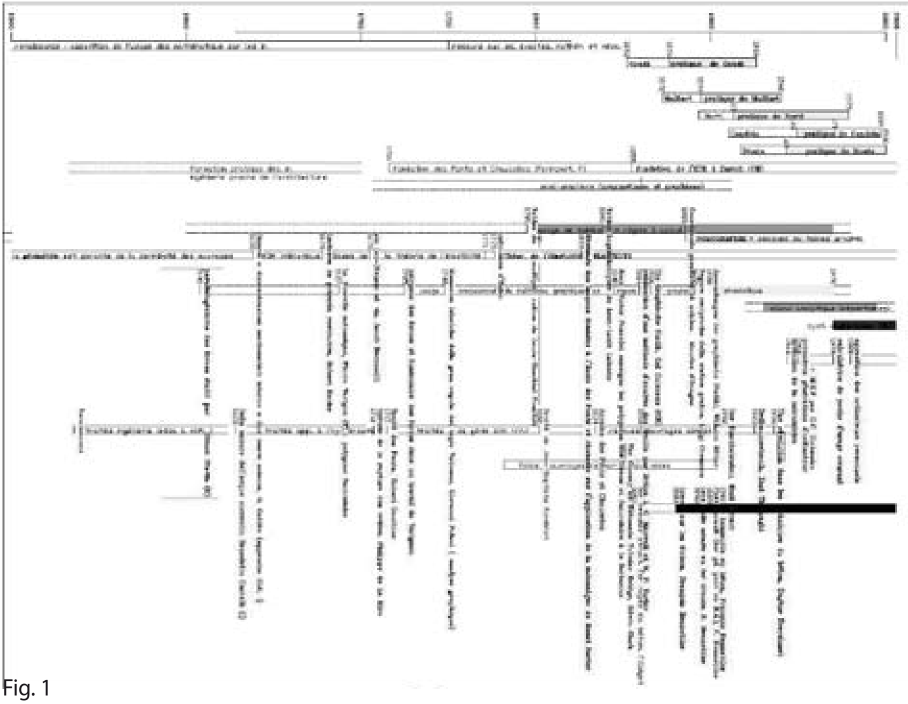

Fig. 1

A partial history of engineering sciences and practices (source: Zastavni [2008a]).

Mathematical developments became useful for practising elastic theories. In the end, our new tools for performing calculations simplified their application. On the basis of this, current computerised analysis has become standard for managing structural issues.

Looking back at features of these methods of the past will enlighten the evolution of views on structural issues. Up to the beginning of the eighteenth century, devising a structure was an exercise involving graphics (as form and geometry)... and practised by architects. Here we encounter rules of proportion and graphical rules such as those developed in work by Da Vinci, Durand, Blondel and later Poleni's works (Poleni [1748])(fig. 2). Indeed, these rules mainly concerned stone constructions.

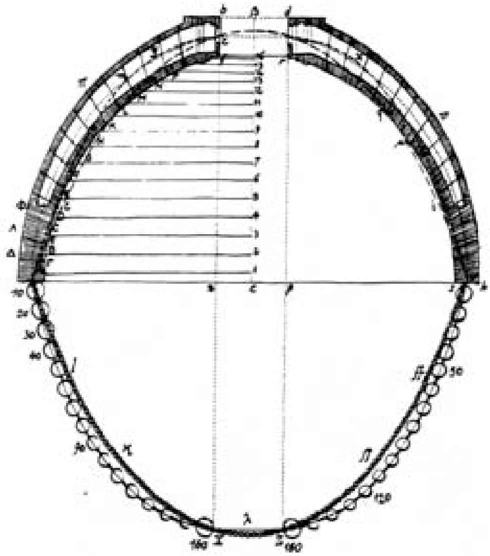

Fig. 2

Memories istoriche della gran cupola del tepio Vaticano (source: Poleni [1748]).

With Navier's theories, structural design started to become one of differential analysis. The language was maths. A structural engineer, as we have seen, became a mathematician specialising in construction issues through the use of mechanics. Architects, focusing on geometrical and graphical issues, thought that structural issues emerging from their graphical design fell within the competence of the former (the engineer).

The separation between the two is complete.

Except for issues that are particularly difficult to solve, the engineer is not concerned with geometry or with the basis of the design. His main concern is with analysis. His elaborate tools allow him to import geometries into his computer software to simulate loadings, to provide the dimensions of physical arrangements and sometimes to optimise them. And for most engineers, designing now just means "calculating the dimensions of sections or joints".

Might there not be a fertile common ground between strictly geometrical and mathematical views on design?

Some of Robert Maillart's views

Let's review some of the practices of one of the most important engineers of our times.

By carefully studying the structural practices of the Swiss engineer Robert Maillart, it appears that – for him – the structural issue has to remain as simple as possible to have any chance of being mastered in its entirety.

His own expertise was in producing the most efficient structural arrangement to fulfil his goals. Maillart made his mind up beforehand on the status to be given to the structural material he used –predominantly concrete to be precise. He was attentive to construction methods as well as to aesthetics (Billington [1979]; Billington [1997a]).

When all is said and done, by using his methods he managed to produce works of great architectural quality and relevance.

In particular (fig. 3), Maillart made specific use of graphic statics (Zastavni [2008a]; Zastavni [2008b]) far beyond simple analysis (Culmann [1880]).

Having gained some preliminary ideas and established a particular theoretical context, graphic statics permit him to:

- sketch the trajectories of forces,
- prepare bending calculations,
- and validate or rework the equilibrium of forces in a structure .

Some of the prerequisites are:

- remembering that the first logic followed in establishing the structural pattern for most of HIS structures is to favour compression;
- concrete has an ability to resist bending forces, allowing corrections to be made to an imperfect configuration of forces;
- equilibrating compression and traction forces is made possible by influencing geometry, notably by using the graphical means of graphic statics.

This way of using graphic tools is only possible under precise conditions:

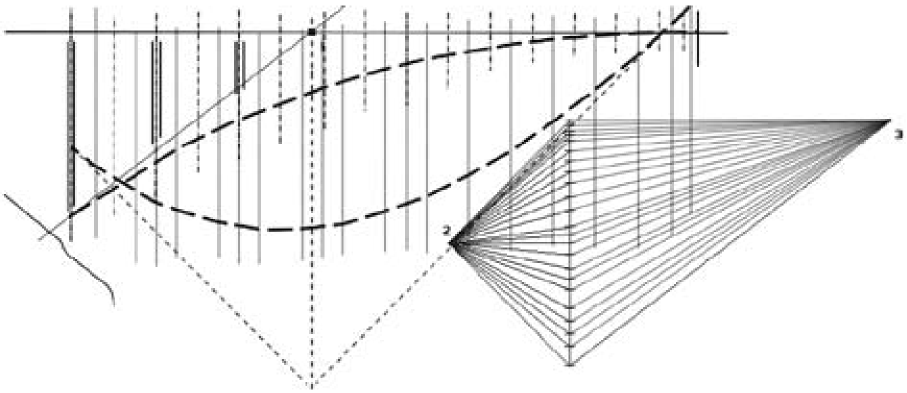

Fig. 3

Graphic statics for designing the Salginatobel Bridge after Robert Maillart's working drawings (source: Zastavni [2008a]).

- having a simple model of the structure during the design process,
- initially determining the structural behaviour of the design,
- having structural behaviour considered as symmetric,
- not considering any complex interactions during the design,
- for concrete, placing the emphasis on thrust (or traction),
- and knowing a certain redistribution of forces in the structure is possible.

In this context, which can still be adapted for contemporary design, graphic statics is an efficient tool for morphogenesis. It is however complemented by the use of geometrical drawings to complete the design at the drawing stage of the work.

Critical review of approaches to structural education

Now, equipped with these initial observations and conclusions about structural design, and having put structural design in its context,we are able to take a new look at practices in structural education. Of course, I have taken these examples from those we have explored with our own students. For some years now, different approaches have been tested with different audiences to teach structural issues related to architectural practice.

Some years ago, we began trying to reinforce the link between architectural workshops and structural design by organising short interstitial sessions on structure. These exercises that we called interstitial workshops were intended for fourth year Architecture & Building Engineering students (what we call "*ingénieurs architectes*"). Practically it consisted of short sessions checking – and sometime calculating – students' designs. (At two thirds of the workshop programme).

But we ended up concluding that structural issues are indeed rooted in early approaches to forms, and that it cannot be solved with mechanics alone without a great amount of work far in excess of that offered by interstitial interventions. So, unless you have a workshop leader teacher trained in structural issues AND who is careful to organise the first reflections on structure, this interstitial formula cannot be a success. Later, we used dedicated exercises based on using physical models (according to a questionnaire).

Those taking part were 1st year Architecture & Building Engineering students (still what we call "*ingénieurs architectes*"). We wanted to give them a physical sense of the mechanical behaviour of structures (fig. 4).

While this activity is perceived as entertaining and didactically efficient – indeed we gave a physical sense to the behaviour of materials – there was NO opportunity to explore structural design practices. And there were no practical applications for their architectural or structural education. In other words, we remained bound to a mechanical approach, so this activity is only relevant if it supplements an entire course dedicated to analysis.

Another kind of exercise that supplements an entire session on tackling structural issues: a complete one-day exercise for answering a structural issue by designing a physical model, with a limited amount of material (fig. 5). The models constructed are intended to be loaded up to the point of collapse to demonstrate failure mechanisms and structural shortcomings. Again, we explored this practice with first-year Architecture & Building Engineering students (the same "Ir. Architectes"). Students have to manage quantities of materials, construction and organisation within groups, and fulfil structural resistance and efficiency.

It is an entertaining and didactically efficient activity AND we are developing structural skills since the whole process of the design has been managed. It is definitely the kind of exercise we should be encouraging, but it is not linked to strong architectural constraints.

We managed coaching sessions on analysing constructions that demonstrate in-depth structural design with second-year Architecture & Building Engineering students (Ir. Architectes) and third-year Civil Engineering *(Ingénieur civil des Constructions)* students.

The objectives were to introduce to a qualitative structural analysis. By this I mean:

- analysis of spatial arrangements,
- dimensioning done by hand or by computer,
- physical modelling which involves ensuring the stability of a structural system by way of the stability of the wooden model itself.

Exercises were judged to be relevant in terms of analysing objectives and they develop a critical sense of contemporary structural practices. As a conclusion for this kind of activity, it is a useful supplement to an introduction to structural analysis.

We experimented using an exercise to design a tensegrity structure (with a geometrical approach). We devoted only two hours to the introduction and preliminary experiments, and four hours to designing the structure. Instructions were to use only models made from wooden sticks and steel wire to devise the geometry; models were to

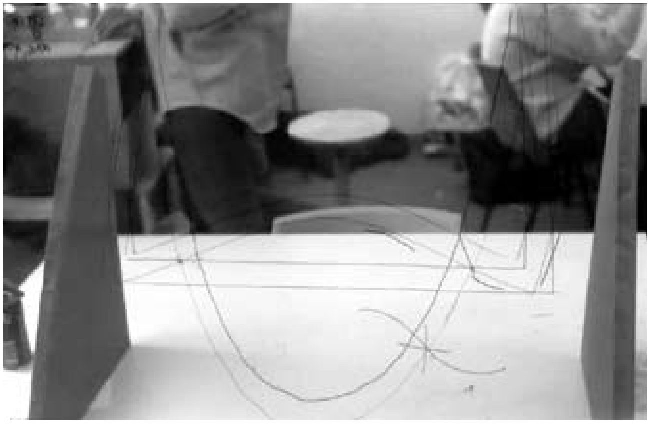

Fig. 4
Dedicated exercises using physical models to give a physical sense of the behaviour of structures (source: FSAR1382 – UCL 2001).

Fig. 5
A complete one-day exercise for answering a structural issue by designing a physical model (source: FSAR1382 – UCL 2003).

be tested for their resistance to warping. This exercise was intended for third-year Civil Engineering students (Ir. Construction).

The objective was to introduce students to thinking about and determining the efficient form to be given to a structural issue. For me, the exercise was a success in terms of everything the students were shown, BUT, due to their the cultural background (I mean systematically using a high level of mechanics for every structural problem), most students cannot grasp the connection between their usual practice and the practice of complete structural design.

So this kind of activity needs to be set out to provide a thorough positioning of the global structural issue if it is to become convincing to the students themselves.

Other experiments: we worked a great deal using films (distributed on DVDs: see Zastavni [2006]) featuring analogical explanations of structural principles and films with a graphical analysis of bridges as bi-dimensional reference structures (fig. 7). The targeted audience is larger: It has been tested on 1st and 2nd year Architecture & Building Engineering students, 3rd year Civil Engineering students, in Architecture education and in

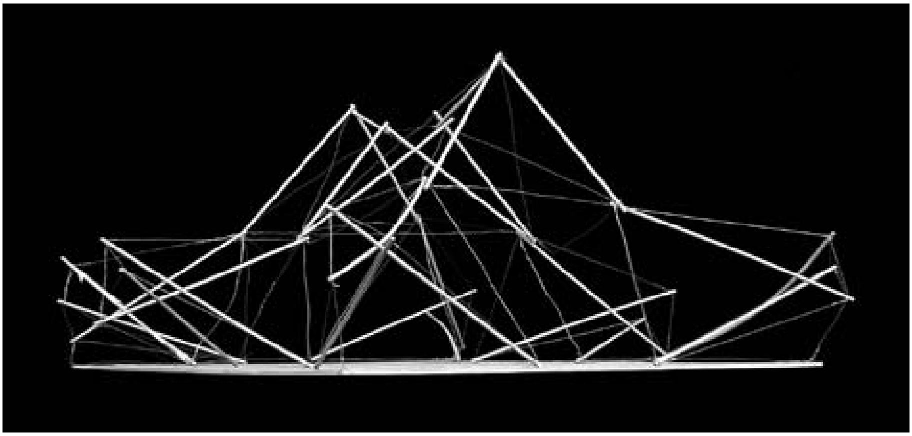

Fig. 6
Designing a tensegrity structure with a geometrical approach (source: FSAR1482 – UCL 2005).

Industrial Engineering. I think the whole experience touches on a structural approach to a relatively high degree but requires a good basic knowledge of statics and students remain passive, so these films needs to be linked to other activities or lectures.

By running partly structure-oriented workshops (on large timber building for instance), I think we have highlighted a high degree of relevance if it is possible to allocate a considerable amount of time to it (indeed two parallel workshops have to be managed: one for architecture and one for structure) and if this practice is repeated in all years of the course.

For these workshops, graphic statics has been used as a tool for regulating structural forms.

Currently, we are also exploring the pedagogical use of graphic statics to study structural arrangements in architecture (fig. 8). At this point, to become very efficient, it appears that the tool needs to be used continuously so that the full potential of it can be realised.

A completely new cultural background therefore needs to be established.

A temporary conclusion

Structural education – both for architects and engineers – covers different aspects:
- basic mechanical training;
- illustrating mechanical behaviour;
- explaining the working of a structure;
- developing skills in structural analysis;
- developing skills in detailing for structural design;
- developing skills in average morphogenesis for structural design.

Fig. 7
Graphical analysis of bridges as bi-dimensional reference structures (source: Zastavni [2006]).

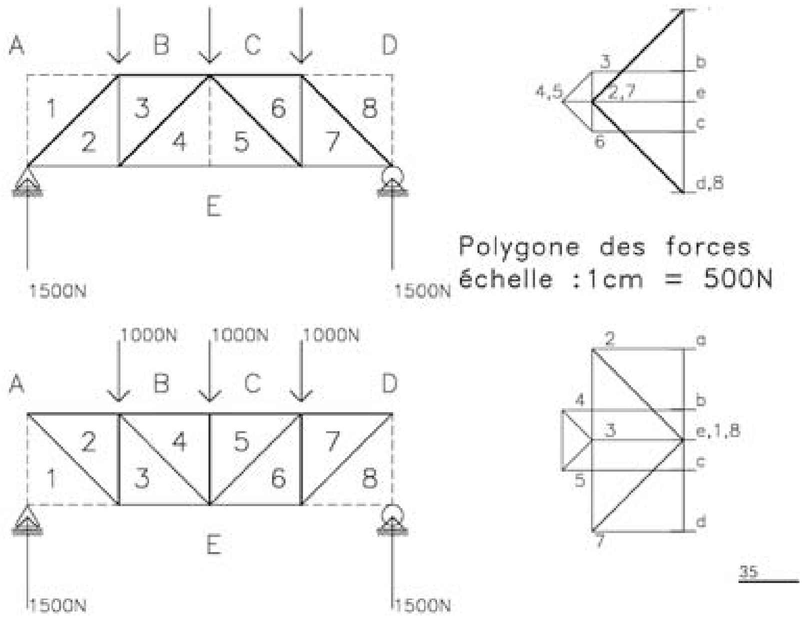

Fig. 8
Using graphic statics for teaching mechanics (drawing: Zastavni, AUCE1701 – UCL 2008).

A skill in the design of structural forms is a respectable end goal. It makes sense for this work to ideally be rationally managed by both architects and engineers. Some tools and approaches can accompany work on both structural studies and the design of structural forms. For instance, reasoning on equilibrium, struts-and-ties and using graphic statics have this potential.

But we have a long way to go before we discover a suitable way of articulating architectural and structural thinking around a structural issue.

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Construction Design Studio – Bridging the gaps

3 cases of integration at K.U. Leuven

Vitruvius' Firmitas - Utilitas - Venustas has been misread by many as being distinct categories, but those who really read Vitruvius will soon find out that he, on the contrary, tells one discourse in which all three (and more) dimensions of architecture melt together without any distinction, subordination or priority.

The materiality of architecture is created by using materials, put together in building elements according to the rules of building technology and realizing the structure of a building.

Ever since Vitruvius the body of knowledge has been expanding and -especially from the nineteenth century onwards- specialization has become the condition in which we live, in which we work, in which we teach.

Today the challenge is re-uniting what has been split. Not that the solution will be to unite all teaching subjects in one melting pot, because as well ex cathedra teaching as design studio have their own legitimization. What seems more meaningful and feasible is to come up with punctual activities breaking the traditional patterns of organizing (architectural) education. That is not an easy task and we even need conferences and workshops to address the issue.

In our opinion, the qualification pertaining construction and structure in the EU Qualifications Directive – 2005, listed as one of the 11 qualifications of an architect in annex 8 sounds like:

> *"(h) understanding of the structural design, constructional and engineering problems associated with building design".* [1]

This competence is quite weak in level of achievement, and not very much in line with the new developments in structure and materials of the last decades. The description is clearly the bottom line of what has to be achieved as compared to the Dublin descriptors:[2] 1. knowledge and understanding-insight, 2. applying knowledge and insight, 3. judgment, 4. communication, 5. learning to learn.

Our school, where architecture is a part of the faculty of engineering, has a polytechnic signature, has a higher ambition regarding structures and building technology. In order to achieve this, students have to study mathematics, mechanics, physics, materials sciences, stress and strain. The aim is not only that they understand structures, but also develop the capability of conceiving structures, compute these and optimize these understanding why they react as computed. Materiality of a building has to be solved to correct detailing and knowing why, computing where necessary.

There is no shape without construction and no construction without shape. Therefore all our design assignments have a real site and in embryo at least all age-old Vitruvian categories solved.

In this paper and presentation we will highlight three examples, three cases of how to bridge the manifold gaps between studio design, teaching of construction and building the real world.

Case 1: bridge design and real bridge building competition.

Case 2: multidisciplinary design teams including students from architecture, engineer architects and civil engineering students in the same studio.

Case 3: design of a railway station track roof structure.

Education today is in a permanent struggle between integration and fragmentation. Specialization is the motto ruling and pervading the real world, the world of research and hence the world of education. Architectural education always is focused on design and the design studio is the melting pot of all that nourishes it. Looking more closely into the design studio reveals however lots of schisms, missing links, incomplete processes, missing partners, gaps between theory and practice, mutual ignorance of subjects taught, etc.

Experiments to organize education only in and via project work have failed. So most of the known programs in architectural education, including ours at K.U.Leuven, are fully modularized, showing a mix of theory and design. Whereas specialization leads to fragmentation, the challenge becomes to include what necessarily has to stay united.

In this contribution we report on several integration initiatives at K.U.Leuven:

1. Integration of all design studios within the five year curriculum. Every year, at the end of the second semester, all teachers present to all colleagues the design projects running in the school showing the best, worst and average student work result. This initiative means that all studio teachers know each other, that they know from each other what they do and why, and it guarantees a logic and pedagogical sequence of all design assignments over the five years (three years Bachelor, two years Master) of the curriculum. We also use a scheme providing us with an overview of all studios day by day.
2. An important strategy to guarantee integration is to have the same teachers teaching the courses as well as a design studio.
3. All theoretical courses are conceived as learning lines (or course stems) ending with "capita selecta" , mostly optional and without chair so as to be open to new contents every year. It thus happens that this course becomes a brochette of activities with guest lectures , seminars and a design assignment. The first case " Martens bridges" that we present here fits into this pattern.
4. In case two we will report on an experiment to mix students from different (albeit related) disciplines in the same studio.
5. Another way towards integration of design and construction in particular, is to choose a design theme which naturally leads to a focus on construction. This is our third case.
6. Furthering the issue of integration we mention here the MACE project aiming at integrating online repositories of architectural contents in Europe. These repositories comprise as well architectural topics as well as constructional aspects.

Case 1: MARTENS bridges: design, build and test

Theme: design and build. Students participated in a competition issued by the "MARTENS" company from the Netherlands producing concrete building elements (foundation pillars) and PVC sewage tubes. They launched a competition for the design of a 10 m length x 1m height clear span bridge using their materials within the limits of a very precise budget[3] (Fig. 1-4). Selected bridges had to be built by the students in one day and the 20.000 euro winner was for the bridge carrying the heaviest load before collapsing. Six bridges were built and loaded until collapse.

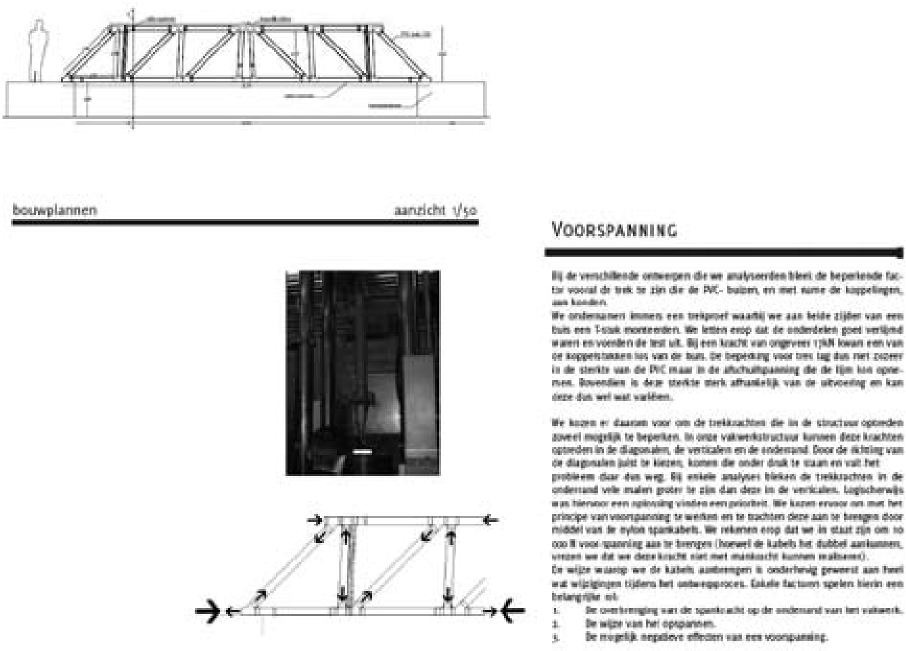

Fig. 1

Testing PVC tubes in traction. Students: Hermans / Janssens / Maes

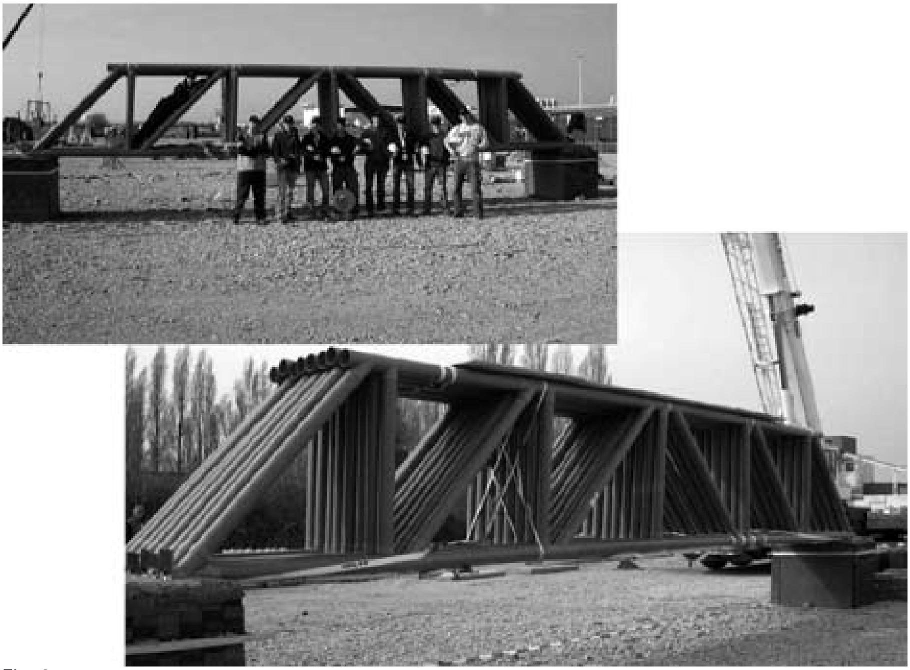

Fig. 2

Real bridge as build

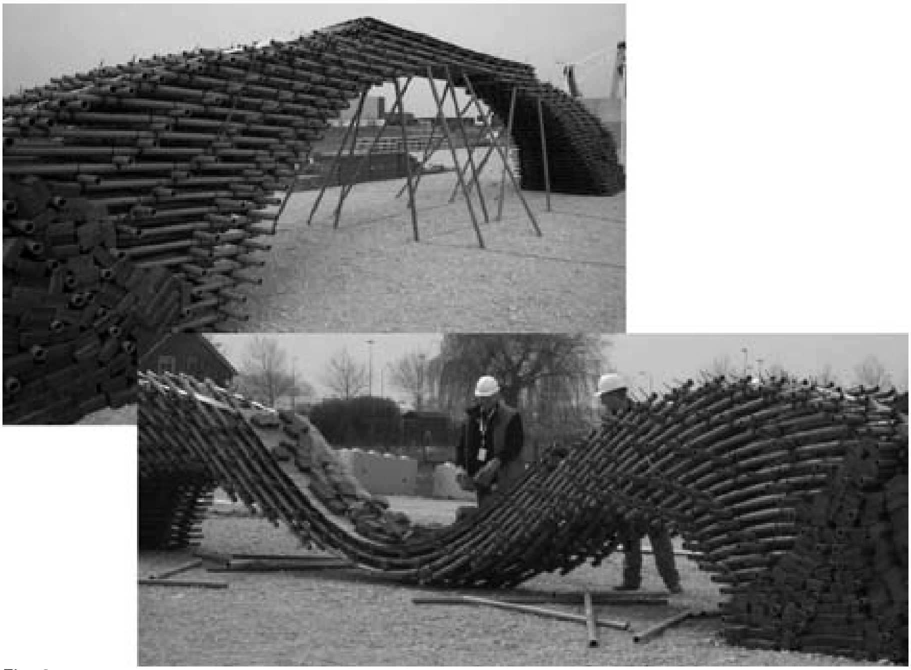

Fig. 3

Plastic deformation. Students: TU Eindhoven

Fig. 4

Collapsing under non-uniform loading. Students: Torbeyns / Baetens / Staljanssens

Process: The design phase itself was an interaction between conceiving solutions and computing the load bearing capacity of their bridge. The conceiving was done in groups, sketches were produced and teachers acted as advisers. For the first time in their curriculum students had to compute the cost of materials, finding out quantities and optimal use of tubes with a given length, how to use efficiently the means at hand and the feasibility of what they were conceiving within the budget. A major decision was whether to include heavy weight concrete blocks or not, because 'renting' a crane costs, for example, 150 ducats from the 850 they were allocated.

Learning outcomes: It was the first time that students had to conceive something taking into account that they really had to build it, within a absolutely strict cost and time frame. They had to organize themselves, getting cutting machines sponsored, organize transportation to the Netherlands, finding out what the mechanical characteristics of the plastic pipes are, reflecting on how they would realize the bridge in one day as a team, ciphering the cost, working together. The failure of the bridges provided the students with feedback from the making of the design, they learned by experience about rigidity, plasticity, buckling, tilt, the effect of non-uniform loading, the effect of imprecise cutting and gluing, etc.. Those who were selected to build their bridge definitely had a unique experience.

Case 2: multidisciplinary design teams: design, compute and detail

Theme: engineering and architecture students working together in design teams. By means of a didactic experiment, students of architecture (St-Lucas – Brussels and Gent), engineer-architects (K.U. Leuven), civil engineers (K.U. Leuven), industry engineers (KaHo St-Lieven Gent) worked together in a project for the renovation/rehabilitation of an apartment block designed in the nineteen fifties by Willy Van Der Meeren.[4] The building is listed by Docomomo[5] (Fig. 5).

Process: The students worked in mixed teams always including a civil engineering group. The project unfolds in phases of analysis / design / building construction technology.

During the analysis phase the 'designers/architects' produce a preliminary design through a process of research by design, whereas the engineering students who are playing the role of 'consultancy engineers' come up with construction oriented preliminary analysis (building mechanics/-materials/-acoustics/-physics), This phase was concluded with a presentation of Preliminary Design and other exploratory studies (Fig. 6).

During the design phase the preliminary design was further elaborated and construction problems were solved.

In the Building construction/technology design phase building physical and technological details were elaborated (Fig. 7, 8). The whole process ended with a presentation to an external jury.

Learning outcomes: The experiment appeared to be an eye opener as much for the architects as for the engineering students. They learned about the reasoning and thinking process of the other: on the one hand the analytical, rational and computational approach of the engineering students, on the other hand the conceptual, holistic,

Fig. 5

Apartments arch.Van Der Meeren

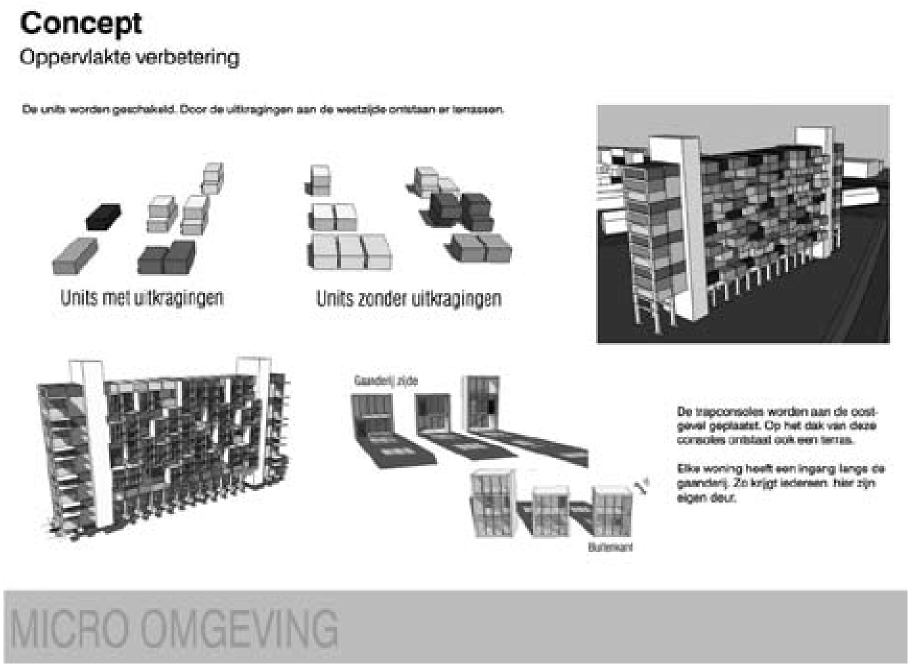

Fig. 6

Increasing the size of the apartments. Students: Honai / Pellens / Brems /Janssens

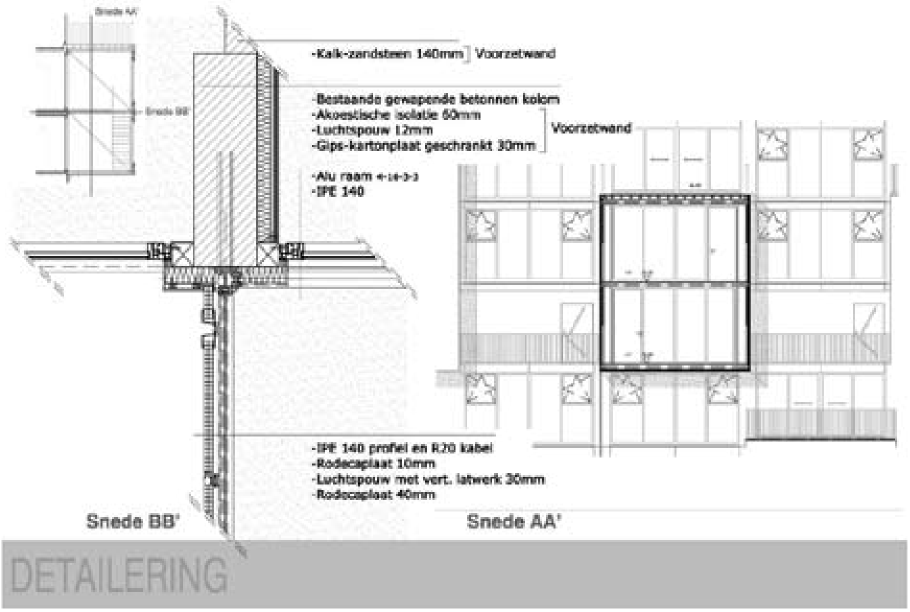

Fig. 7

Detailing the improvements. Students: Honai / Pellens / Brems /Janssens

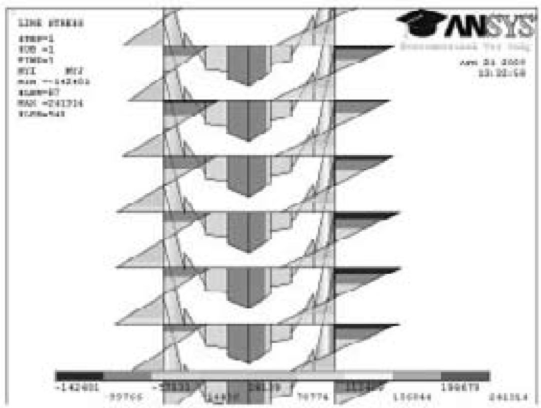

Fig. 8

Engineering students contributions

graphic and artistic thinking of the architecture students. A clear pre-figuration of what happens in real practice. As difficult as it was, the confrontation was experienced as very revealing. Students learned how to analyze an existing building in terms of what is valuable/essential to be preserved, how to assess the building mechanical and physical characteristics of an existing building, how to rethink the spatial organization of an existing building in view of today's needs, how to adapt an existing building to the energetic needs of today. They learned to work with people from other disciplines.

Case 3: design of a railway station track roof system: design and compute

Theme: design of a large span architecture. The very nature of the program guarantees that the design will focus on large span systems. This leads to a perfect integration between the design studio and construction courses, also because the tutor is the teacher of the structures course. Students have to design a roof structure covering the tracks of the train station in Aalst, a small size city in Belgium.

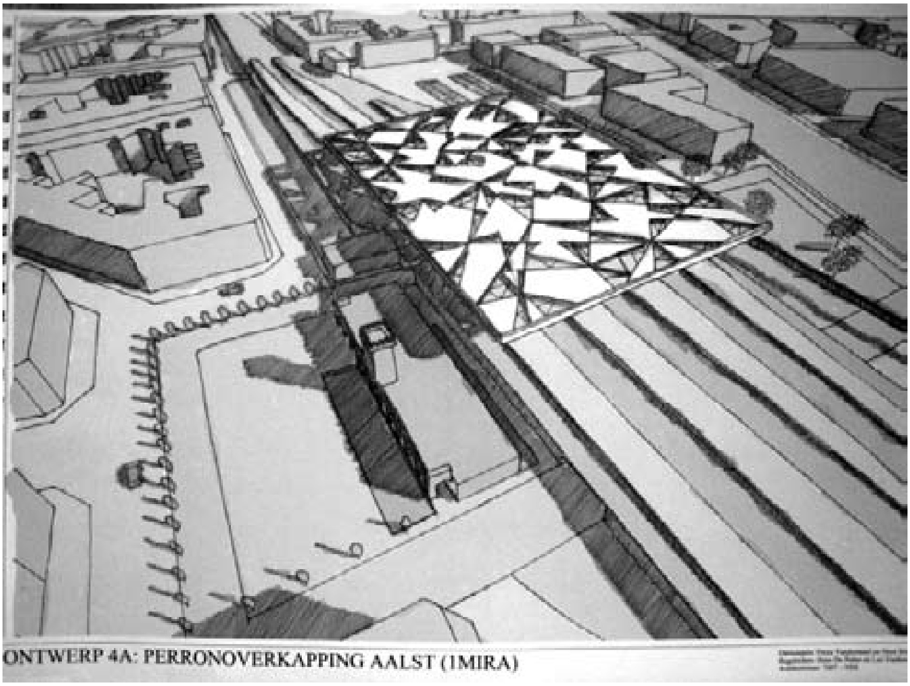

Fig. 9

Student design. Students: Vandormael / Roussel

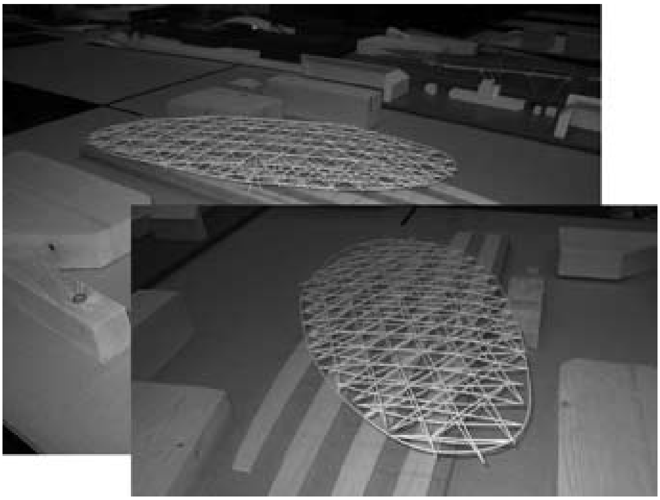

Fig. 10

Student design.
Students: Spillebeen /
Teblick / Van Cauteren

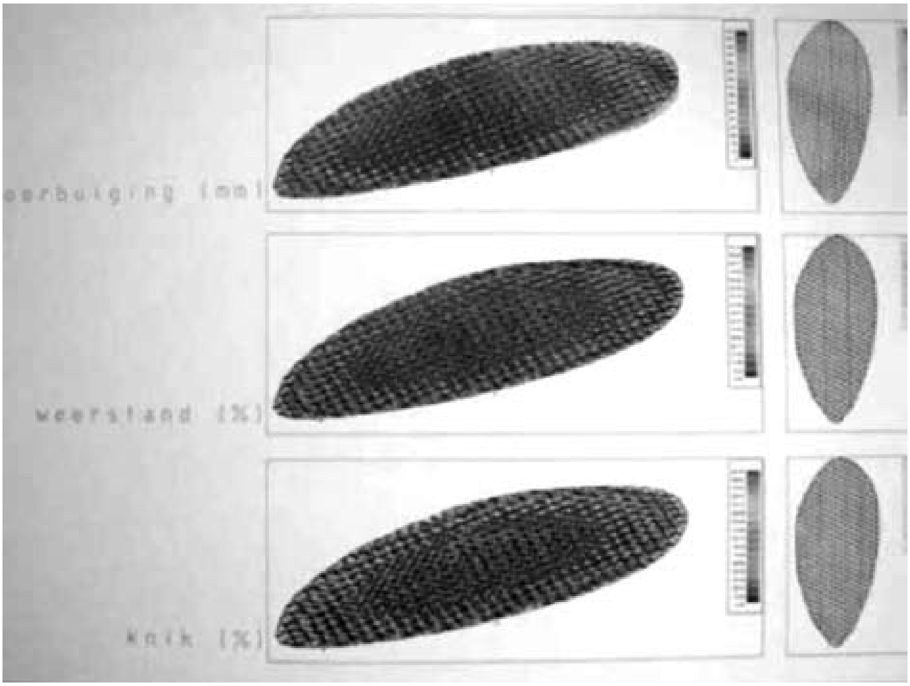

Fig. 11
Computation of stress, strain, buckling. Students: Spillebeen / Teblick / Van Cauteren

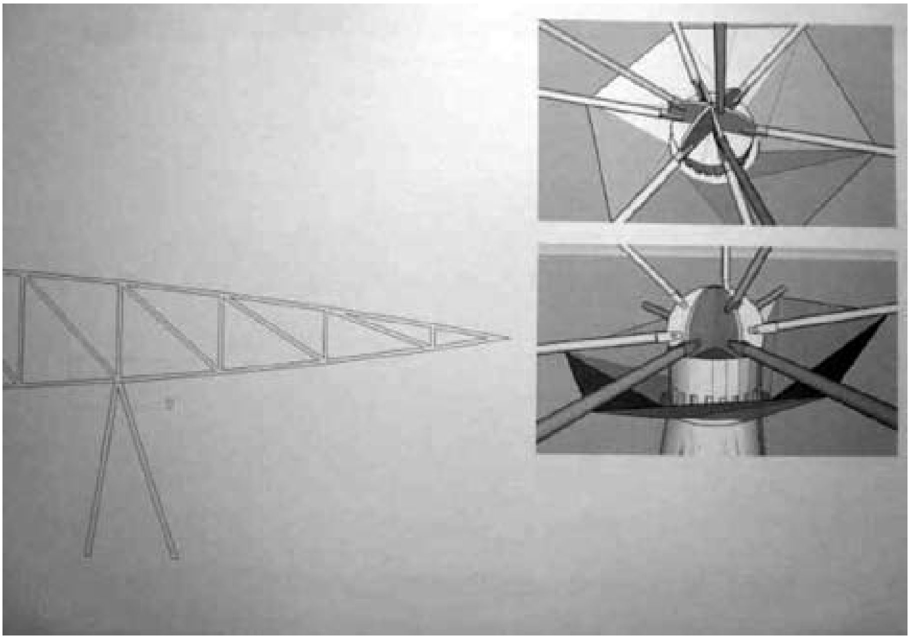

Fig. 12
Detailing. Students: Spillebeen / Teblick / Van Cauteren

Process: They start by a visit on site and have to match their design into the urban context. They study precedents as input for their design work. Since engineer-architect students have learned how to compute structures, they generate their design by iterating between conceiving and computing the structure. This is done using powerframe from Buildsoft, a graphic interactive software, for doing the computations (Fig. 11). When the overall structure and the dimensioning is done, they have to detail the nodes of the structure and detail the roof system (Fig. 12).

They produce a portfolio and a physical model as illustrated in Fig. 9,10.

Learning outcomes: develop the capability to conceive and compute a large span building program and repeat this process until a full fledged architectural design is created. Develop the capability to detail such a structure, especially its structural nodes.

While designing, our students make use of MACE[6], a tool developed in the frame of the European eContentplus program. MACE is federating online architectural repositories and makes them accessible from one portal site: <http://mace-project.eu> (Fig. 13)

MACE federates contents from different nature and addresses architects and construction people while conceiving as well as detailing. Today only a limited number of repositories have joined MACE: Winds, ICONDA, Cumincad, Dynamo, World Heritage Fund. Others are in the pipeline: BAUFO, FORS, Mimoa, world-architects, nextroom, archit. Repository owners keep their data and MACE is performing the searches on the harvested metadata. The course material in WINDS representing 17187 objects is relat-

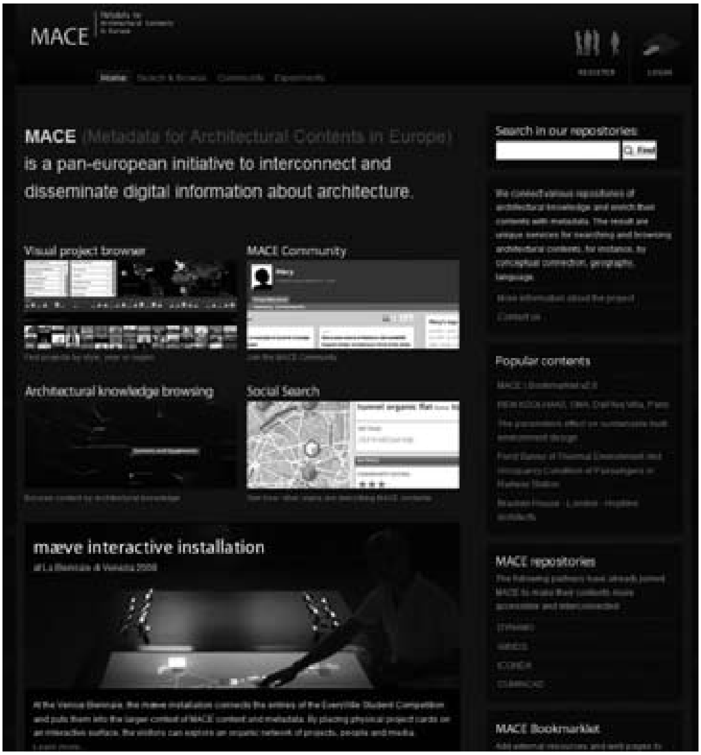

Fig. 13
MACE portal site.

ed to construction issues. ICONDA from IRB excerpts 400 journals and contains 15974 abstracts, related to architecture, construction, landscape, urban design and planning from all over the world, Dynamo containing 14824 objects is a case based architecture repository showing photos as well as plans, details, materials, CUMINCAD offers 9021 article references and/or full texts published in the proceedings of conferences organized by eCAADe, CAADRIA, CAADfutures, SIGraDi, CSAAR, ACADIA. The World Heritage Fund database is documenting 850 sites of capital importance for humanity.

MACE allows these contents to be searched on the basis of content, context, social and competence metadata.

Dynamo[7] is one of the federated repositories, the architectural case based repository (Fig.14) developed at the CADlab – K.U.Leuven. <http;//dynamo.asro.kuleuven.be> It counts more than 1000 projects documented with photos, drawings, texts. All contents are checked by an academic staff member of architecture. Free registration is requested for reasons of copyright.

Notes

1 The Qualifications Directive 2005/36/EC of 7 Sept 2005 - section 8, Architect / Article 46, pp.47,48 (reiterated from the "Architects' Directive 85/384/EEC art.3 ").

2 http://www.jointquality.nl/content/descriptors/CompleteDublinDescriptors.doc

3 Koninklijke H.H.Martens & Zoon b.v; Stanedamweg 75, postbus 30, 4900 AA Oosterhout, Nederland www.martensgroep.eu

4 this experiment ran for 2 years in the context of an education innovation project lead by Prof. Staf Roels sponsored by the K.U.Leuven Association.

5 Ref to DOCOMOMO filing card 2004

6 MACE home page: http://www.mace-project.eu/index.php?option=com_frontpage&Itemid=1

7 http://dynamo.asro.kuleuven.be

Fig. 14
Dynamo portal

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The Architecture Student as part of an Interdisciplinary Design Team

An experimental design studio of architecture students and engineers

Theoretical reflections

Already in 1967 Engel is convinced that in order to design 'contemporary' buildings, teamwork between experts in science and architecture is necessary (Engel and Rapson, 1967).This is in opposition to the architect as 'homo universalis', expert in all disciplines, designing buildings on his own. Engel believes in a collaboration where the architect generally designs the structural concept of the building and the structural engineer merely dimensions this structure.

Today it is common practice for architect and engineer[1] to work together. And beyond Engel's belief of the architect as main designer of the (structural) concept, the challenge in their collaboration lays in combining both their knowledge into a creative process where architect and engineer design together, integrating both disciplines. In this design team, the engineer has an important role as a creative contributor to the architectural design process, dealing not only with purely engineering problems, but also with architectural ones.

Such a creative interdisciplinary design team uses the know-how of all team members, architects and engineers, during the design process. The shape of the building is then not only an aesthetical or architectural choice, but also a structural and building technical one. And thus, for their contribution to be meaningful, the engineers need to be involved early in the architectural design process.

During this early collaboration, all experts need to understand each other in order to be able to design as a team. And for this communication to be successful, the experts need to possess sufficient knowledge of the opposite discipline(s): the engineer needs to know something about architecture to understand the architectural concept, and the architect something about engineering sciences to understand the engineer's discourse. This mutually possessed knowledge on architecture and engineering science within the interdisciplinary team, enables a design process where demands and desires of the opposite discipline can be integrated in the search of a design solution within the own discipline (e.g. the engineer designing a structure for an architecture with an aggressive expression).

This kind of collaboration between architect and engineer puts a strong emphasis on their communication: it must enable the architect to guide the engineer in generating, through the engineering sciences, design proposals that enrich the overall architecture.

For example, in the collaboration with the structural engineer, the architect's task lays not in designing the structural concept himself, but primarily to convey his architectural desires to the engineer, and understand the essence of the proposed structural solutions of the engineer. This requires of the architect mainly to be skilled in communicating with the engineer, and not in designing the structure, which after all is the expertise of the structural engineer. In return, this kind of collaboration demands for similar communication abilities of the engineer, and a commitment to creatively develop design proposals within the own discipline in function of architectural demands (and not just structural demands).

If we transpose this to the education of the architect, it means that the student needs to be trained in this kind of collaboration with engineers as co-designers. The emphasis lays then less on the question of whwther the student is, for example, able to design a structure, but more on how he can instigate the structural engineer to contribute to the creative process. What can the engineer do for the architecture student? How can the engineer be deployed to enrich and inspire the design process? What language does the student need to use with the engineer? How is he supposed to interpret the engineer's proposal? How is he to incorporate the engineering logics and numbers, during the evaluation of the overall design quality?

From this perspective, a research seminar has been set up in the second master year of architecture, with the following purposes:

- to confront the students with this kind of collaboration by developing experiential knowledge through the design studio.
- to investigate some of the characteristics of this interdisciplinary teamwork.
- to evaluate the pedagogical value of this experimental seminar.

This research is part of my doctoral work which investigates the communication between architect and structural engineer during this interdisciplinary teamwork early in the design process.

Research Seminar Setup

With the condition of being 'sustainable' -in it its broadest interpretation-, students are asked to design an architecture office combined with a studio apartment. From the start of their design process, the students have to take into account the requirements of the building services, the construction and the structure of the building. This will enable us as researchers to investigate the relation between the engineering sciences and the architectural design process.

In order to instigate a researching attitude, the students have to design at least three different volume studies, and evaluate them through a matrix of different criteria. Afterwards one of these studies is selected for further design refinement.

As teachers of this design studio, my colleague and I are to be consulted weekly by the students: Sandy De Bruycker as building service engineer and myself as structural engineer. (We both have respectively a professional practice in this matter). This forces the students to investigate how to make these consultancy opportunities useful for their design process. These consultancy meetings are video-recorded for further evaluation.

The students are required to log their design process, making them more aware of their activities and the choices they make. This logbook also gives us an insight of the student's design process.

The presented work is essentially graded for the researching attitude during the design process, rather than for the overall architectural value of the final design.

Evaluation of the seminar

The engineering perspective and the condition of sustainability have clearly influenced the design outcome (Fig. 1). In many cases this approach has lead to very inspiring design developments. The technique to guide the design process through engineering sciences is fundamentally the same as when it is guided through urbanism or interior design (which is more commonly applied in the design studios). It is essential in this technique to find a balance between the engineering perspective and the overall quality of the architectural design. A building technical sound design still has to contain a clear architectural value. This implies that sometimes the compelling engineering logics, with its precise numbers and rules, have to be abandoned in order to achieve architecture. For some students this was more obvious than for others.

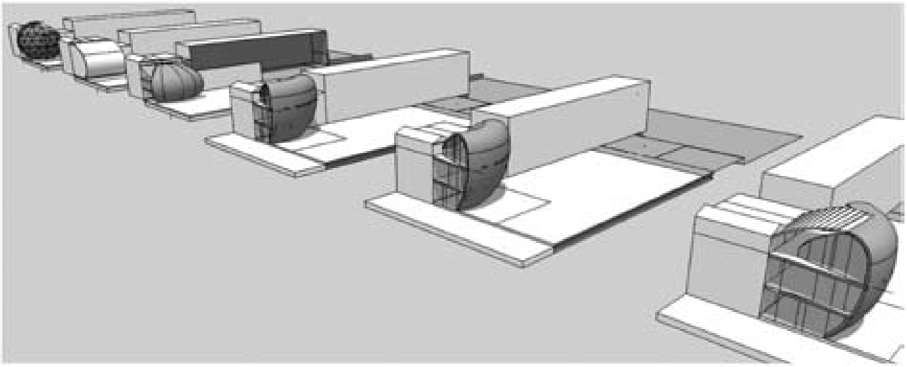
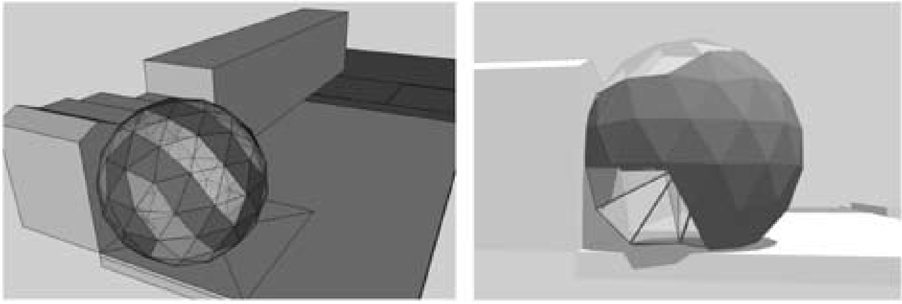


Fig. 1
Design evolution (example from the work of Hanne De Vos en Els Terryn).

An example of this can be found in the search for a compact building in order to achieve a minimum area of heat loss for a certain volume. In free space this compact volume is a sphere. Within the engineering sciences every space in this sphere is then equal, which is not the case in an architectural space. So within the architectural discipline this mathematical formula for compactness (=Volume/Area of heat loss) makes little sense. But by investigating this mathematical compactness, the students develop a more tacit knowledge on compactness, which meaningfully enriches their design capabilities (Fig. 2).

The students are stimulated to evaluate their different design proposals by a matrix of several criteria (Fig. 3). By clarifying the advantages and disadvantages of their proposals, students are not only able to justify certain design choices to others, but also to themselves, making them more confident of the design path chosen. It is remarkable that these evaluation criteria, chosen by the students, mainly deal with building technical aspects, ignoring the architectural qualities of their design. This is probably due to the imposed engineering perspective of the design studio setup.

The typical teacher/student relation makes it hard as teacher to take on the role of co-designing engineer. Even being in their last year, students still doubt their own design maturity: the quality of their design is only as good as the teacher says it is. This attitude sometimes prevents the students from acting as full-fledged co-designers, and hinders the interdisciplinary collaboration from starting up. In a future seminar this issue might be counteracted by providing an extra teacher, responsible for the architectural qualities of the student's design.



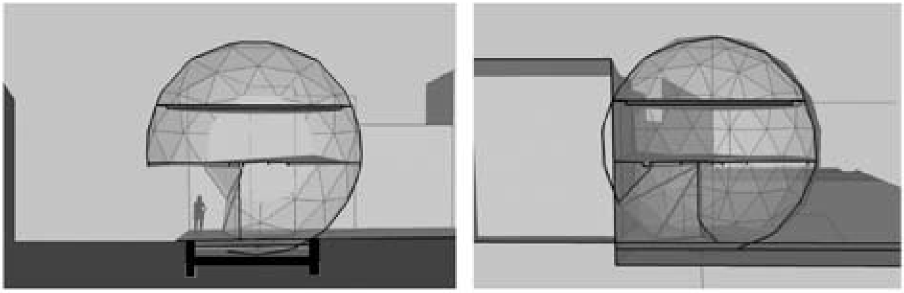


Fig. 2

Research sphere volume (example from the work of Hanne De Vos en Els Terryn).

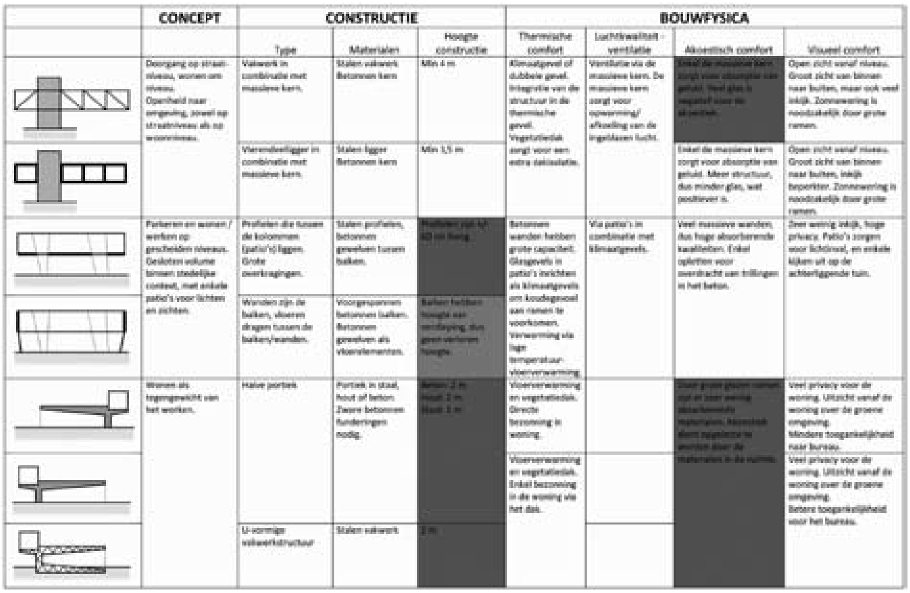


Fig. 3

Evaluation through matrix of criteria (example from the work of Bart De Decker en Glenn De Hondt).

An early collaboration between engineer and architect has some specific characteristics. At the start of the design process, when the architectural overall concept is still being developed, a clear shape of the building is still missing. In this phase, it is often not feasible to propose an appropriate structural concept. Still, structural input can be very useful, but it needs to be of a relevant nature.

Students often present their architectural concepts through images and analogies of other buildings (Fig.4). I believe that a catalogue of structural concepts exemplified by architecturally qualitative buildings can be a guidance and an inspiration for the design process. The taxonomy of this catalogue is then to serve the architectural and not the structural design process. This catalogue has, for example, a different nature than the work of Engel (Engel & Rapson 1967), which lacks materialisation of the structures and examples of the built reality, and is constructed from an engineering point of view.

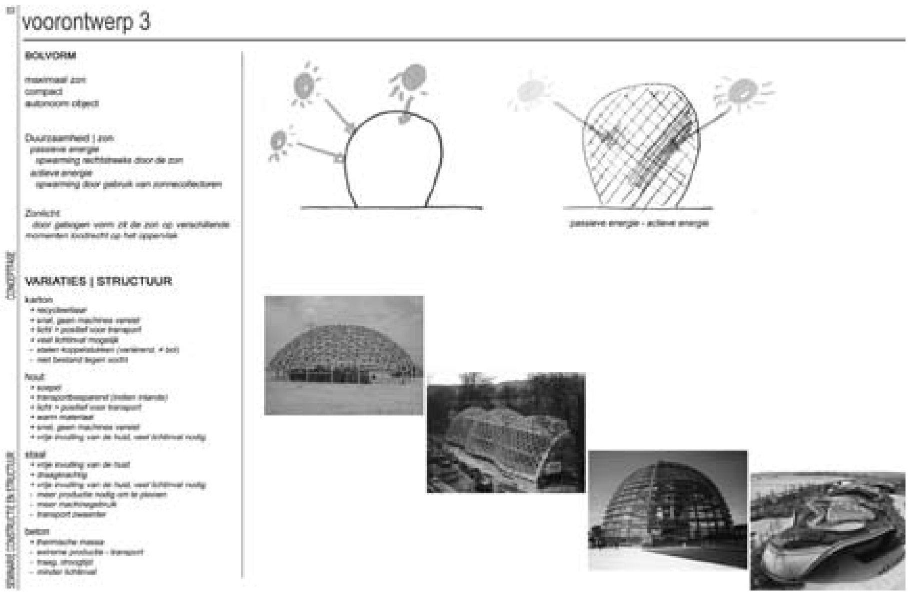


Fig. 4

Presentation of a concept through analogies (example of the work of Charlotte De Baets en Sarah Cuveele).

Another aspect of this early collaboration is the more abstract communication in concepts and idioms of both disciplines of architecture and engineering sciences. The built reality of materials and dimensions is less present in this stage of the design process. This demands a certain knowledge of the opposite discipline in order to understand each other (see higher): this knowledge is not only related to the specific lexicon applied within the discipline, but also to its logics. For example, a slender column integrated in the window frame might be nonexistent as a column to the architect because it is not expressed as such in the architectural shape, but for the structural engineer it might be very much a column because of the weight it is carrying: both use the word 'column' in a different manner, according to the logics of their discipline.

Conclusion

The architect as 'homo universalis', expert in art and sciences, is an outdated concept. The reality (and future) of architectural design lies in interdisciplinary teamwork. The challenge for this kind of collaboration is to generate a team creativity that integrates the different disciplines. This brings about an important responsibility for the different team partners to guarantee a creative contribution to the overall design process.

The architects as well as the engineers need to be prepared for this kind of collaboration during their education by training them as creative partners within an interdisciplinary design team. Both educational systems are responsible for establishing a professional ethic which guarantees a constructive and creative contribution to the design process.

So within the architectural education, students need to become acquainted with design with the engineers as creative co-designers and not only as experts in dimensioning. This seminar was an explorative step in that direction.

Reference

Engel, H. & Rapson, R., 1967. *Tragsysteme/Structure Systems*, Stuttgart: Deutsche Verlags-Anstalt.

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Cyprus

Year 3, 2nd Semester: Architectural Design, Building Technology (Project: "Buster's Bedroom, The Endless Remake") + Construction + Building Services

Introduction - Why/how experimentation

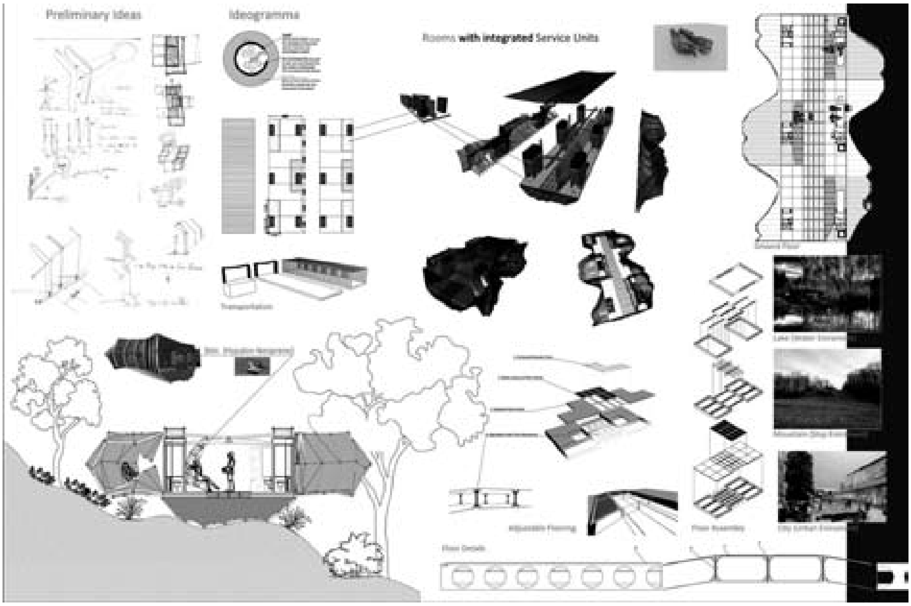

Fig. 1
Indicative completed student project.

The 3rd year/2nd semester programme was approached as a common landscape, where the seemingly isolated modules of Architectural Design, Construction and Building Services were integrated into a coherent body of knowledge.

The pedagogic strategy of interrelating knowledge between the different technology courses and the core design studio was spread throughout the semester as a continuous cross-over of themes, methodologies, references/textbooks, case studies, discussions and crits. Key to this experimentation was the correlation/sharing of output between the modules.

This experimentation was facilitated by the fact that the co-teachers of the Design Studio were teaching the technology courses in parallel. This was a happy accident as it was not intentionally planned in the existing curriculum but rather simply embraced by the individual instructors.

In addition to this, the theme of the specific design studio again happened to be with a concentration on technology. The design studio's objective was in fact to tackle issues of technology as they relate to architecture. Technology was considered on both a theoretical/conceptual level, as well as on an application/performance level.

Individual modules- overview of outputs

Course: Architectural Design, Building Technology

The programmatic brief was student-derived, departing from observations of the film-book "Buster's Bedroom" by contemporary artist Rebecca Horn.

The film-book as a departure point was chosen deliberately in order to help students:

- Understand and appreciate the complexities of human needs, desires and aspirations.
- Take into consideration the anti-scientific approach, as a requirement, and as a potential measuring/checking apparatus for "building technology".
- Integrate within their proposals a developed understanding of building technologies that is founded in socially sensitive contexts.

The size of the resultant architectural proposition was very restricted, with emphasis on building intelligence. Additionally there was no prescribed site, but rather, distinctly different environments were used as testing "grounds" to generate adaptable contextual strategies.

Course: "Building Services": concentration in 'integrated thinking"

- The course was offered in parallel with the design studio(3rd year) and is mainly lecture-based with additional site visits.
- The course is the only course on building services offered within the pathway.
- Consequently, the course is an overview of aspects of sustainable mechanical, heating/cooling, electrical, and 'lighting'.

The focus of the course was "integrated thinking", meaning learning the conventional systems in order to attempt to re-invent them within original proposals, and thinking about all components of "building systems" in parallel with conceptual architectural, construction and theory of technology.

Output:

- End-of-semester assignment comprising a detailed model of construction/systems and an accompanying booklet with drawings, diagrams.
- The student assignment was common for all "design studio", "construction" and "building services" courses.
- A written examination whose educational valve was restricted to formal reading and comprehension of the required text and lecture material.

Course: "Construction II"

- This module follows Construction I in the 2nd year.
- It also follows 3 previous courses in Structures.
- It introduces students to the application of a knowledge base that clearly differentiates architecture from other processes of cultural production.
- The course moves from basic technical knowledge and awareness of the principles underlying performance criteria in construction to an integrated approach of technology with design strategies.

Output:

- Case studies analysis (relevant to the studio technology theme) to develop analytical methodologies as a learning tool and develop a 'language of construction'.

- End-of-semester assignment comprising a detailed model of construction/systems and an accompanying booklet with drawings, diagrams.(an integral part of the assessment in all 3 modules)
- Final exam testing 'knowledge' and 'understanding' of basic concept, principles and terminology.

The integrated Design Studio

Observing the characters

Fig. 2
Observing the characters -Psychosomatic charting.

Investigation and invention were at the core of the studio, in order to stimulate the students' ability to generate creatively new ideas and forms with materiality/construction as integral parts of their design process. Students found poetry both in their programmatic/spatial systems but also in their "tectonics".

Rebecca Horn's film-book "Buster's Bedroom" was used as an inspirational launch pad for the generation of scenarios and the development of personalised building briefs. The required resultant brief should be a type of 'sanatorium' or more generally an alternative type of assisted communal living deriving from the characters of the film-book. The investigations were undertaken via primarily observing and analyzing the characters. The specific aspects and/or requested student output could include:

- Psychosomatic charting,
- Dependency/relationship with objects/operations,
- Occupations and activities – fixtures and fittings,
- Individual character analysis and initial provisions,
- Hierarchies of power/dominances /dependencies within the sanatorium.

Observing everyday common objects

Fig. 3

Observing everyday common objects - Functions/Operations/joints/mechanisms.

Parallel to the programmatic explorations, everyday life components / mechanisms were investigated, adapted and reinterpreted. This research extended to fields commonly referred to as non-architecture; universal products / industrial machinery / military technologies / handling equipment / prosthetics / functions / operations/ joints / mechanisms / economy of means / tolerances / materials / ergonomics / ephemerality / longevity / connectors / deployability / fasteners / manufacturing process /details / interface components / handing.

What was required from the students was to understand eventually the relevance of intelligent systems that we usually take for granted or we mistake as “non-architectural”, and extract the ingenuity.

Adapting and extending findings

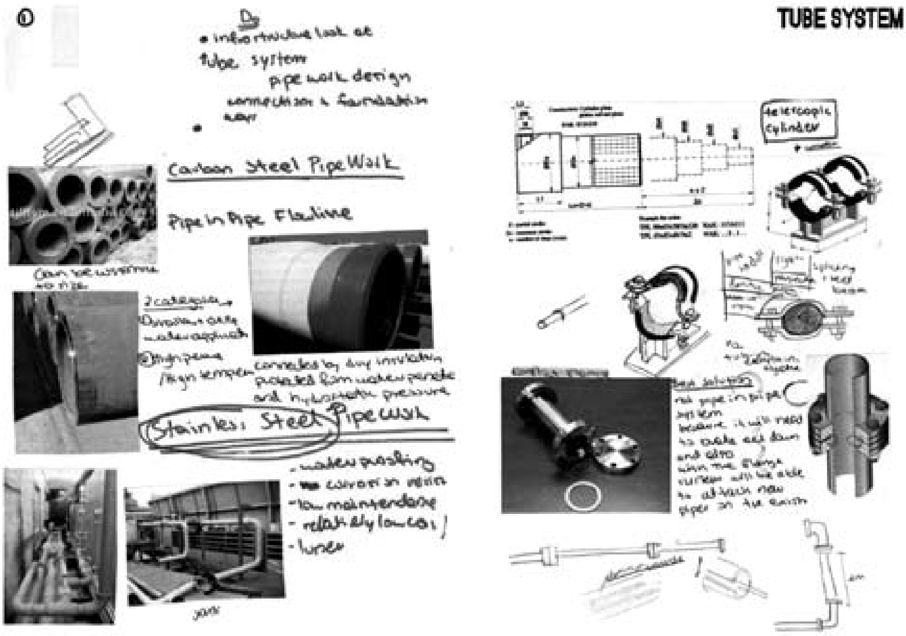

Fig. 4
Observing everyday common objects - Extracting the ingenuity.

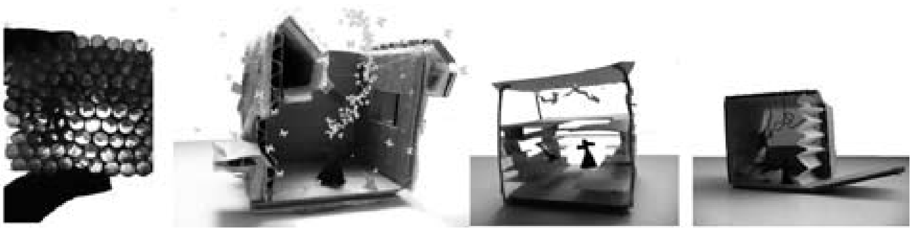

Fig. 5
Adapting and extending findings - Provisions for the individual character needs.

By integrating the aforementioned two seemingly divergent starting points, students then developed innovative intelligent systems, through an accumulative process of reflective testing at different scales. The needs of the characters were inventively solved and extended through new technological solutions.

Methodology

- Throughout the studio a culture of reflective making was developed. Students were encouraged to see drawing, model making, computer modelling and hybrid

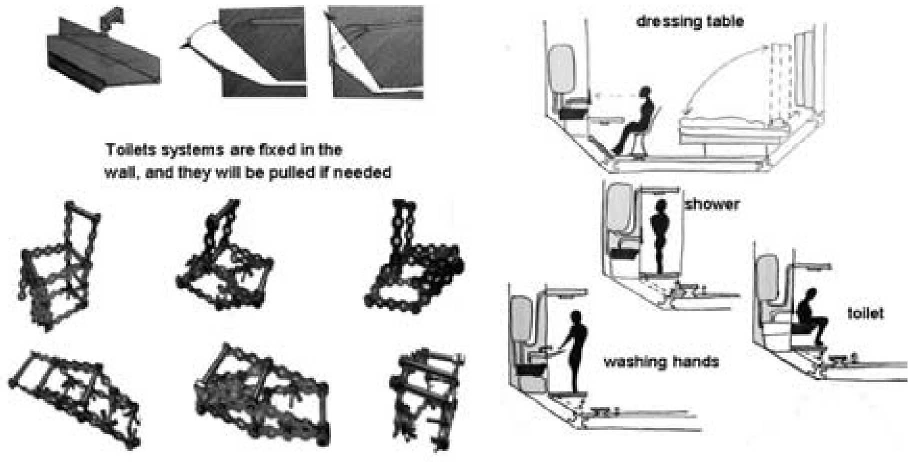

Fig. 6
Provisions for the individual needs – transformative elements/uses.

graphic representation as vehicles for conceptualisation and reflection – a means by which to test and explore the architectural problem and not merely as a means of representation of the final stage of the project.

- Rules of thumb for techniques in structure, environmental modification, empirical calculations, material invention were encouraged.
- Standards and constraints were viewed as opportunities to generate intelligent solutions.
- The students explored provisions for the individual needs - climate modification/ user customisation / transformative elements/uses etc.

From the individual 'module' to the 'construction logic' to the 'assembly'

Following their initial development students then proceeded towards some initial propositions of integrated intelligent systems. Their investigations followed a cyclical process. Starting from the individual 'module', to the 'construction logic', to the 'assembly', students then continuously revisited each stage, cross-referencing and enhancing their propositions. The pedagogic approach was one encouraging non-linear design development, but rather a suggested "endless-remaking".

Emphasis was given to a developing understanding of the idea of design and how technological phenomena can inform and drive design development and 'realisation'. Students were encouraged to draw upon methodology from technology and theory courses. They were also exposed to appropriate technology theory references that have informed an attitude in respect to the construction of architecture.

The evolving student proposals were driven by the integration of: design concepts / manufacturability / buildability / sustainability / material development / logistics /

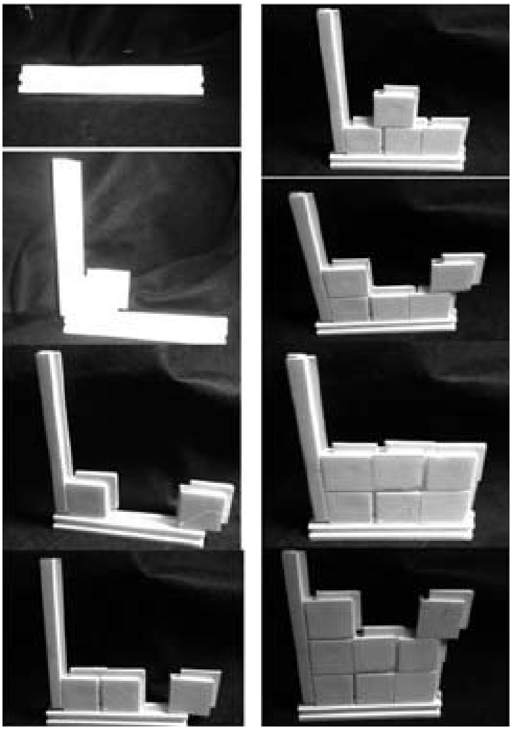

Fig. 7

From the individual 'module' to the 'construction logic' to the 'assembly'.

- Configuring/inventing the appropriate module.

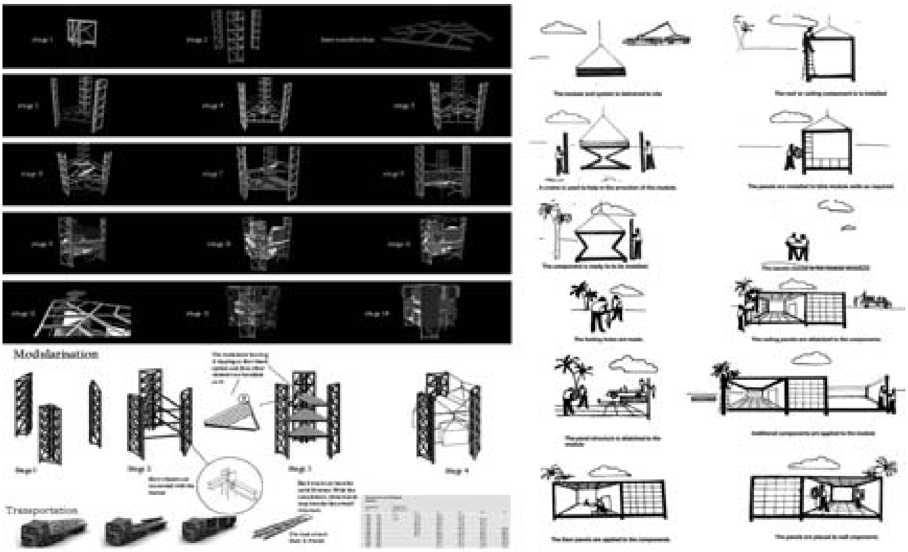

Fig. 8

Process of construction and assembly / buildability.

modularisation / prefabrication / process of construction and assembly/ operations/ structural investigation / performance criteria / climate adaptability / flexibility / technology transfer / socio-political dimension / sensuality.

Overall arrangement possibilities (testing the ground)

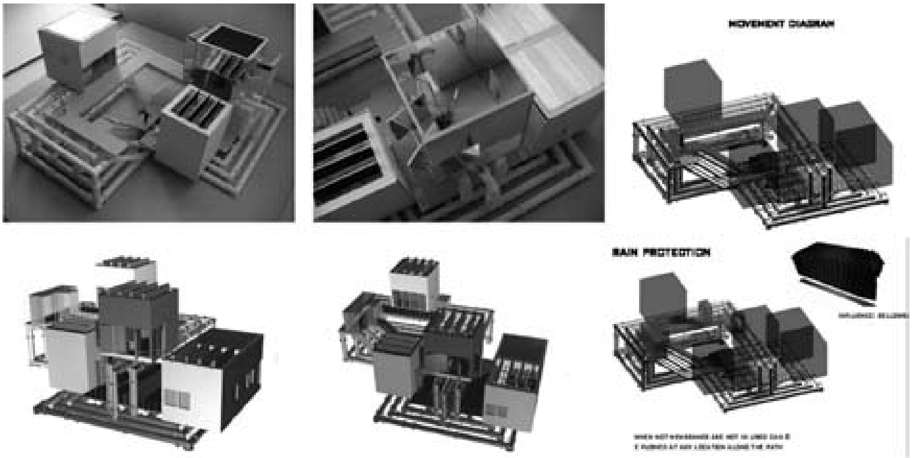

Fig. 9
System arrangement resolution.

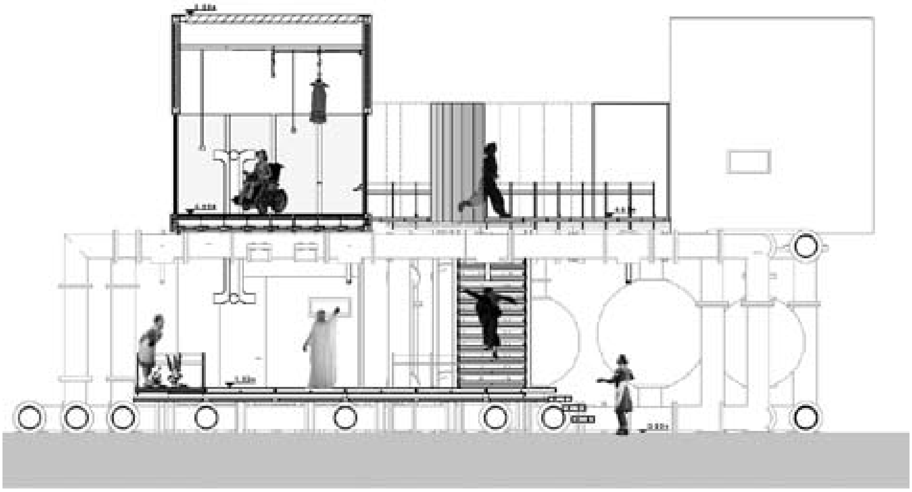

Fig. 10
Sectional arrangement.

Unlike common practice in architectural teaching, the students were encouraged to deal with overall arrangement not as an imposed "masterplan" but rather as an open-ended process; from the part to the whole and vice-versa. This would be achieved by considering issues of: user customisation, programmatic flexibility, future expansive/ contractive possibilities, site adaptability, and climatic modification.

Detailed resolutions

"Technology is the answer, but what was the question?"
Cedric Price

The pedagogic objective was not to require students to blindly understand and implement architectural/technological "conventions" but rather to understand these "conventions" in order to appropriately re-invent them. In this way the theme of technology was not a given but was posed as a question. In addition the required detailed resolution again was not restricted to the technological (nuts and bolts) but extended into the realm of human psychology and physical needs. The instructors' prime aim was to direct students to develop critical thinking in relation to issues usually taken for granted and thus develop their own personalised understanding of architectural technology by questioning. Similarly knowledge deriving from the other technology courses (construction/building services)was pursued and applied as inseparable parts of the design process from inception to realisation(and back again).

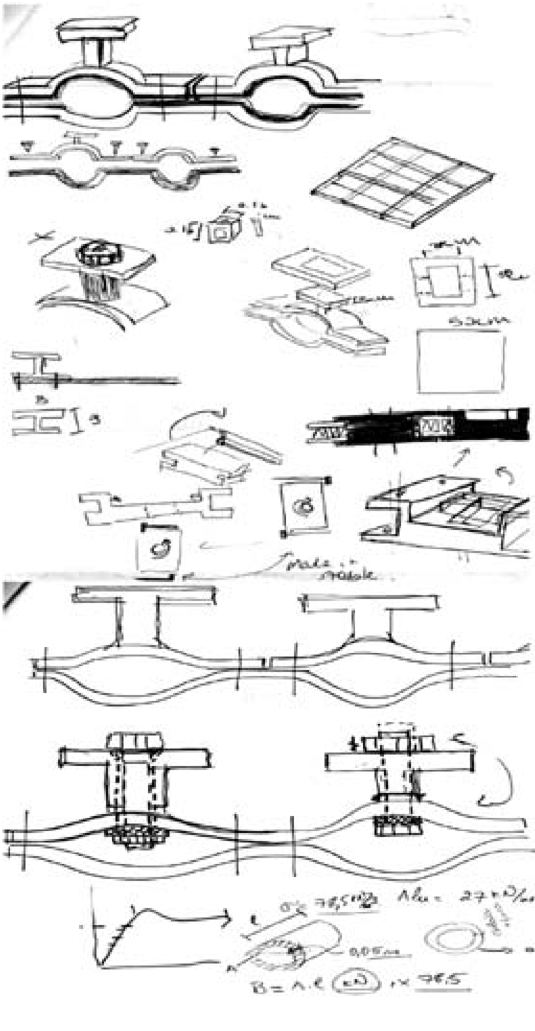

Fig. 11
Connectors and locking mechanisms development.

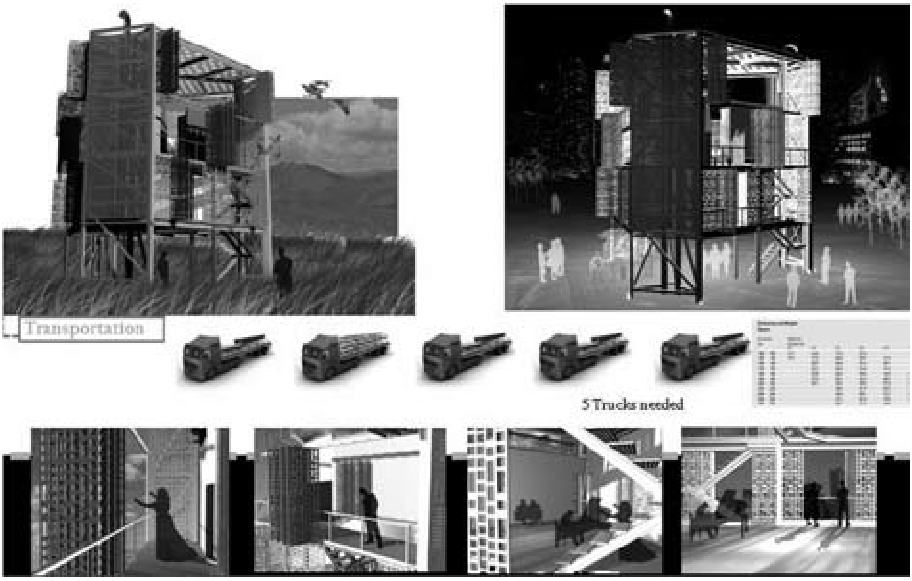

Fig. 12
System arrangement resolution – adjustability.

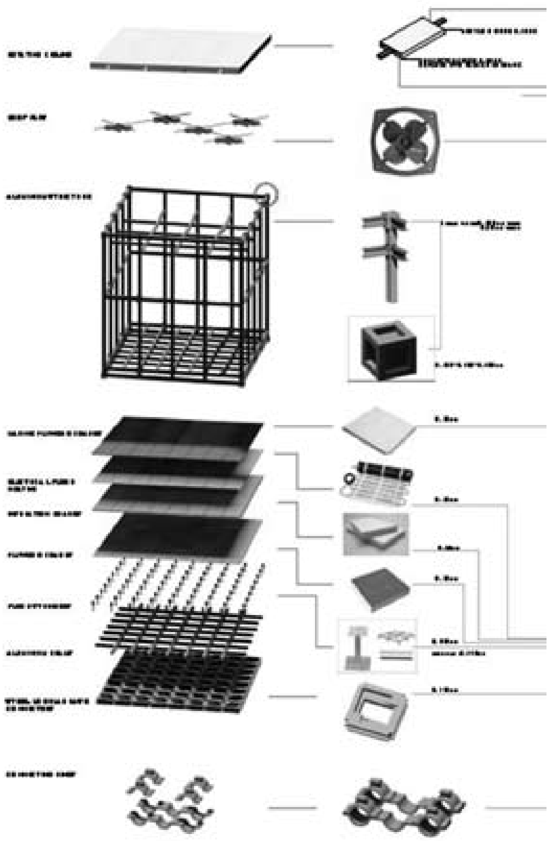

Fig. 13
Indicative Detailed resolutions.

Retrospective critical reflection

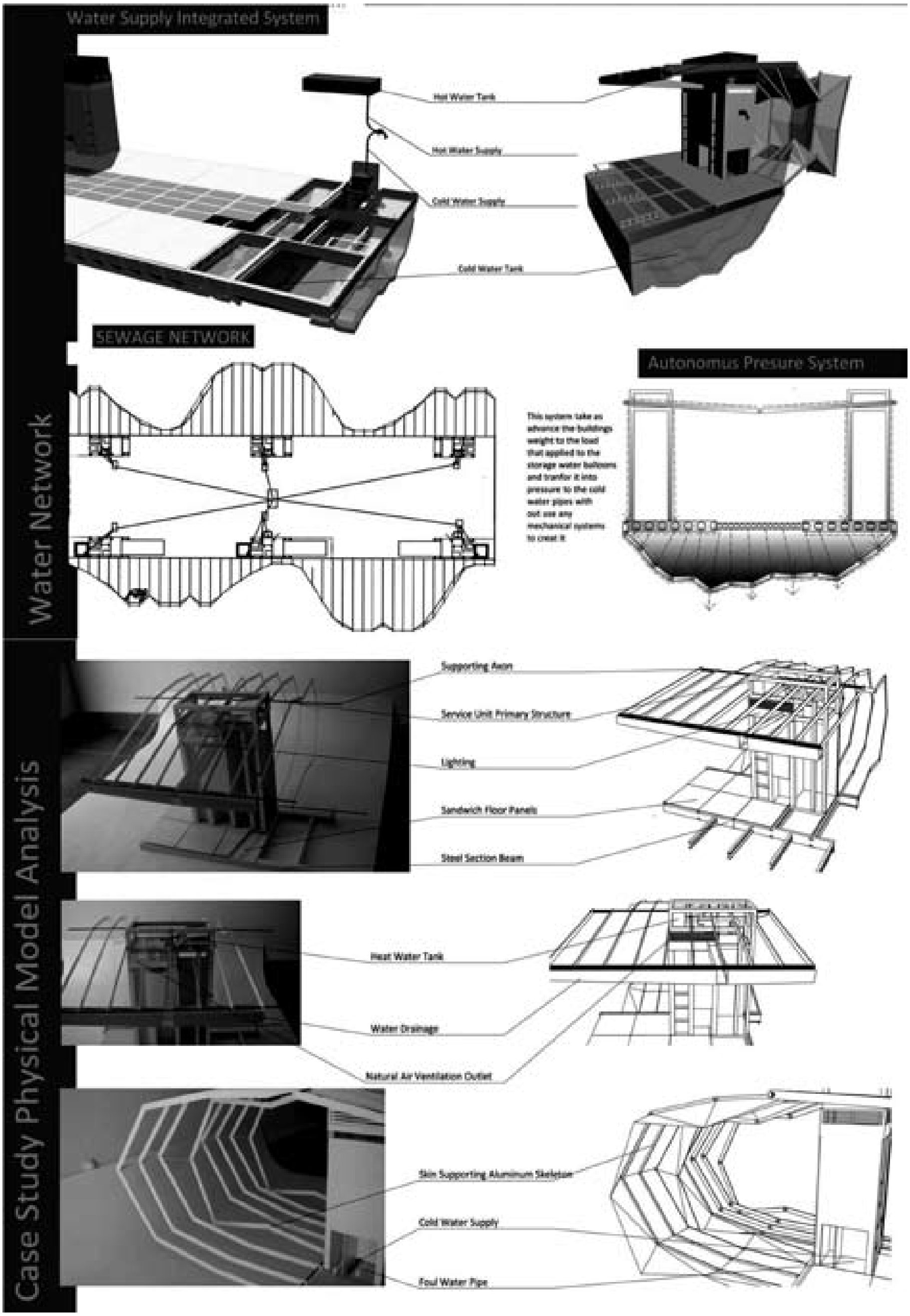

Fig. 14
Indicative completed student project.

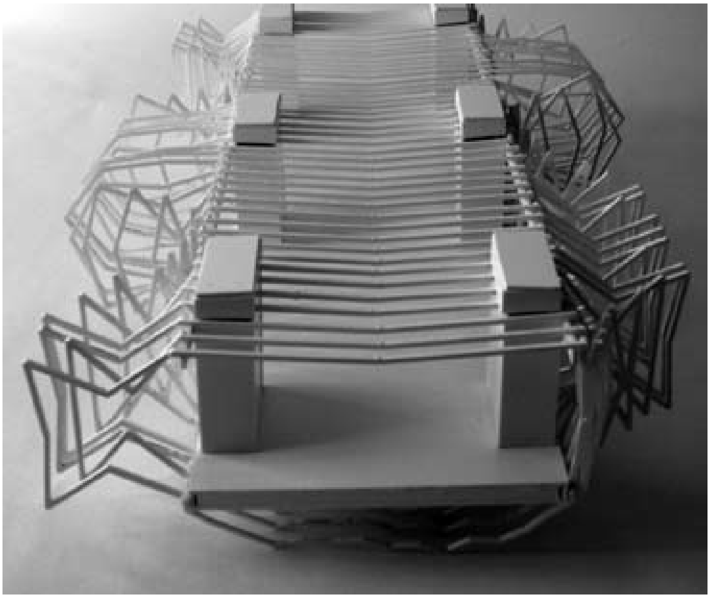

Fig. 15
Study model.

Retrospectively, through this experiment the most valued outcome is deemed to be an achieved student "epiphany": a newly found awareness of the thickly interwoven areas of architecture as opposed to the misleading fragmented student understanding resulting from the isolated modules of the current academic course structure. Additionally the students have successfully grasped the cross-fertilization between the 'technological' and the 'artistic/poetic'. A by-product of this positive result was the usually difficult educational task of making students appreciate the creative prospects of technology.

On the contrary through constructive criticism several deficiencies prompted the authors to consider some failures as points for future improvement:

- A necessity to curb the students' often over-enthusiastic approach to the newly introduced subjects(such as technology) which as a consequence resulted in a number of student projects missing the opportunity of evenly integrating all aspects.
- To clarify more adequately the equal importance of involved issues: a number of students misinterpreted the given brief and disproportionally focused on a single subject of investigation.
- To measure more accurately the demanded output and resultant student input: the list of output requirements demanded by the instructors seems to have been overwhelming for most of the students.
- To provide systematic direction (that is both definite and open-ended): the time structure was too open-ended which meant that some students could get lost in their inability to self-manage and prioritise their time.

Conclusion

As the obvious inherently integral parts of Architecture (ranging from the poetic to the hard-core scientific) have been inappropriately separated by the majority of curricula in European Architecture Schools, we as educators find ourselves in the inevitable process of "re-inventing the wheel", in other words trying to find ways to re-institute in the students mind that no "part" of Architecture may be "chosen" or "left-out", or "prioritised".

The educational model of the architectural design studio as the "core" of all learning including all "specialised" learning such as "technology" would seem to be the most appropriate educational vehicle for re-establishing what has been known since Vitruvius: Architectural knowledge and practice cannot be compartmentalised.

In lieu of this model in most contemporary European architecture curricula, it seems that developing methods of creating common cross-over parts between the separated courses both in terms of thematic as well as output might be one way to approximate a "simulation" of total integration within the curriculum, and most importantly, in the students' appreciation of the "totality" of Architecture.

Within the existing structures of the curricula the issue of integration is primarily a matter of developing an appropriate culture within individual schools and actually shifts down to the individual educator's awareness and understanding.

Source of illustrations

All illustrations are taken from the Year 3, 2nd Semester, Spring 2009: Architectural Design studio ("Buster's Bedroom, The Endless Remake"), University of Nicosia. Participating students:

Amini Nasim

Constantinides Christoforos

Evangelidou Despina

Evangelou Chrystalla

Evangelou Evangelos

Hadjimarkou Markos

Khakpour Mohammad

Kotzia Mikaela

Marcou Zoi

Moutiris Vrahimis

Neocleous Sophia

Postekkis Alexandros

Sevtali Genovefa

Stephanidou Maria-Ermina

Session 4.2

Experimenting with integration

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Brussels
Belgium

(re)classify

Introduction

Much has been said and written about the necessity for a better integration of architectural design with construction technology. Various teaching curricula, exercices, workshops and others have been elaborated with the goal of reaching a greater symbiosis between both in architectural education. Nevertheless, in most of those models the tension between the conceptual, reflective and explorative nature of the architectural design process on the one hand, and the scientific logic and rationality of construction technology on the other, remains present and often unresolved. It thus keeps on generating problems regarding the aim for a better integration between design and construction technology.

The goal of this text is to explore a hypothesis about a possible way to handle aforementioned tension.

Every knowledge field or field of experience uses classification methods in one way or another to organise and structure its avalaible knowledge. The available information is arranged in categories, using classification principles based on relations or attributes. Primarily, a classification is a facilitator, a means to access, use and communicate knowledge by revealing resemblance, differentiation, multiplicity, diversity. It is a way to create links and increase understanding. The same applies to the knowledge field we are concerned with, i.e. architecture and construction technology as an integral part of architecture.

The use of classification principles as a powerful tool to support architectural and artistic discourse has already been shown by f.e. OMA / Rem Koolhaas (S M L XL), Foreign Office Architects (Phylogenesis - FOA's ark), Reiser + Umemoto (Atlas of Novel Tectonics), AA London (Typological formations, renewable building types and the city), Jan Jennings at Cornell University (Naming design practices - INTtypes project), Olafur Eliasson (Encyclopedia), Gerhard Richter (Atlas).

Existing classifications in construction technology

To keep track of the technological information, or to keep it comprehendable and usable for the architect/designer in the architectural design process, the existing data is organised using classification methods that create a sense of architectural relevance. An overview of some classification categories is listed below.

These categories are reflected in the organisation of architectural practice and education, in the literature, the industry, buiding practice, etc. and are organised by:

- discipline: architecture, interior architecture, structural engineering, material engineering, mechanical engineering (building physics, acoustics,...), landscape, urbanism, ...
- material: natural stone, brick, earth/adobe, concrete, ceramics, steel, wood, glass, plastics, insulating materials, textiles, plasters, paint, ...

  and related classifications by types and or properties: mineral/vegetal/synthetic, organic/inorganic, structural/non-structural, rough/smooth, ...
- element: façade, roof, wall, floor, window, foundation, balconies, stairs, ...

- process: mostly following the (chronological) phases of the construction process from excavation, foundations, primary structure,... up to finishings.
- typology:
  - by functional typology: housing, office, hotel, shops & retail, museum, industrial, ...
  - by structural typology: form-active, vector-active, surface-active, section-active, ...
  - by scale: single or multi-storey, high-rise, micro-architecture, mega-structures, ...
- morphology: solid, filigree
- performance: cost-effective, energy-efficient, sustainable, simple, sound, ...

These classifications have proven their usefulness and it is certainly not my ambition nor intent to replace them. The question is rather whether the existing ways to organise and represent the technological knowledge in architecture and construction technology has an influence on the ways we use that knowledge (methods) and on the outcome (results) we reach.

Technology - positivism and reduction

Positivism

> *'In order to explain the relationship between technology and form, a positivist model has often been constructed, according to which there exists a direct relationship of cause and effect between innovative technology and the generation of new formal paradigms. ... This is in keeping with a more general idea, the possibility of achieving constant and unlimited development thanks to the evolution of science and, in particular of its more pragmatic component: technology'* [1].

In textbooks and research concerning construction methods and technology, but also in part of the architectural and engineering discourse, the action is more often than not explicitly oriented towards 'novelty': 'new' materials, 'new' construction techniques, 'new' architectural forms, 'new' forms of structure depending on 'new' sets of standards and constraints, 'new' methods, etc. Although based upon the continuity of a knowledge tradition, we have to be cautious about the fact that the process or drive focused primarily on 'new' also has the tendency to judge existing principles and solutions as being outdated or not relevant anymore.

New technologies undoubtedly are (or can be) used to generate new architecture (space and form), as can be seen in parametric design and manufacturing or the integration of new materials and energy-technology in building skins. Both are examples of technological positivism. Hence, we have to be aware that new technology does not change the conditions (sun, wind, rain, hot, cold, ...) in which architecture is materialised, nor does it necessarily alter the basic needs of the user who is still looking for shelter, comfort or a nice and pleasant place to stay. Technology just help us to handle the situation better (or sometimes worse).

The evolution of technological means and methods do not alter the basic principles (gravity stays gravity) and questions, only the solutions evolve or change and the range of possibilities (hopefully) gets larger.

Reduction

Construction technology is essentially instrumental and oriented towards the practice of construction, towards the application. The final goal is the real-life act of building an architectural artefact. For this purpose materials, processes, methods, etc. are researched and extensively documented in disciplinary textbooks and manuals, describing material properties, processes, systems and solutions.

The underlying structure and logic is mainly two-fold. On the one hand there is the rational, scientific backbone (the theory) and on the other, the guides for/to 'good' practice, the 'how to' - the description of the practical solutions and the *'processes of production as an organised sequence of technical operations'*[2].

Although construction technology is essential in the process of transforming ideas into matter, a tension and opposition exists between the practical and physical constraints of construction technology and the conceptual, reflective and explorative nature of the design process. The problem in my view is due to an inherent property of the technological methods based on scientific rationality and proof, and their subsequent translation in rules and regulations describing the 'exact' way to handle problems. The methods and the translations, when implemented in an architectural design context, have a tendency to be very reductive, and this mainly in three different ways.

The first reductive element is one in which a complex problem is decomposed or dissected into simpler subproblems, easier to understand and to handle. It is a method, very popular in engineering and science, used to reduce the variables and can be seen as a (design)strategy oriented towards enhancing the effectiveness to reach a solution. This type of reduction can be regarded as being positive, because it creates a context and the ability for action.

The second one is problematic, because it is not only reductive in nature, but also restrictive. The sets of rules and regulations have the tendency to close off the options, to reduce *'the space of possibilities'*[3].

There are some arguments to support this:

- The focus is directed towards 'problems' to be solved and not 'questions' to be asked.
- The possible answers to the problems are translated into specific solutions or solution-sets which can be applied (with relatively minor formal variations) to all similar problems, i.e. projects, instead of taking general principles into consideration and applying them to generate particular solutions adapted to the specificities of the project.
- The reference to 'good or correct' practice suggests that what is outside of the solution set either is not adequate, or not valuable enough to take into consideration. The 'how to' then evolves towards a 'have to'.

The tension between architectural design in construction technology is particularly noticeable in architectural education, where students, lacking the experience to complement architectural concepts with technological principles, often fail to make the connection between both. This frequently leads to students either turning their backs on construction technology and/or limiting the construction design part to the implementation of predefined solutions without linking with the spirit and design characteristics of the architectural project.

It is therefore imperative to find a format or framework in which the implementation of construction technology in the architectural design can be approached with *'the power of designerly thinking'*[4].

> *'The strange capacity of designerly thinking is that it makes the future as a space of possibilities available for exploration and consideration. Possibilities appear that have not yet been recognised or discovered, as well as all the potential realities that are linked to it. This opens up ...not only the probable, but also the improbable and unexpected'*[5].

Saying this does not imply that this not already happens, but it is situated on the personal level of the designer (architect and engineer) and is dependent on the individual qualities and insights of a designer or design team. It cannot be considered to be structural on a more global level.

The third reductive aspect in my opinion is related to the lack of critical reflection regarding *'the language, methodologies and value systems used within a field of knowledge'* [6].

To clarify this I have to use the following extract from a textbook on constuction methods:

> *'...semi-finished elements are industrially produced building elements manufactured of raw materials. They are system-neutral and can be utilised in a great range of different building systems'* [7].

Based on the conventions of construction technology, the above mentioned sentence is obvious. However, the formulation raises questions. When looked into with more attention, the content becomes intriguing regarding the meanings of the used terminology.

In construction, technology semi-finished elements are elements like beams, plates and blocks which can be used as basic components to make a more elaborate construction. A construction can then be considered as an assembly or combination of a series of those components. The components are in fact finished in themselves because they are ready for use and have specific properties regarding material, geometry, dimension, section, performance, etc, but they are semi-finished in the sense that they gain their relevance or value by being used and in so doing they get finished.

Although the naming in my view is not exactly straightforward, it really gets confusing regarding the claimed property of system-neutrality. The versatility, the ability to be used in different constellations can sometimes be claimed, but the so called semi-finished elements are definitely not (system)-neutral. Rather, on the contrary, much of the available semi-finished elements are all but neutral, due to the fact that they have specific properties that dictate the use.

For example, the geometry of semi-finished elements is often orthogonal and straight. Their use is therefore optimal for the creation of orthogonal geometries but often inadequate or not ideal for other geometries. Building blocks like bricks will almost automatically lead to a massive morphology and a stacking method, whereas linear elements like steel sections will mostly lead to a skeleton-like system with elements and nodes.

The above-mentioned quote formulates a value judgement based on the internal logic of the knowledge field and evolved towards a convention which is never questioned. Other examples of this exist and indicate that in construction technology, and other domains for that matter, we continuously reflect and act on the basis of hidden assumptions.

> *'...The existing language and methods of a technical practice, like any disciplinary culture, runs deeper than we are aware.... To function in the field you have to acquire a range of linguistic forms, habits of thought, established techniques, ritualised work practices, ways of framing questions and answers,.... It is difficult to become aware of the full range of assumptions underneath existing practices, from technical methods to genre conventions to metaphors'* [8].

From idea to action

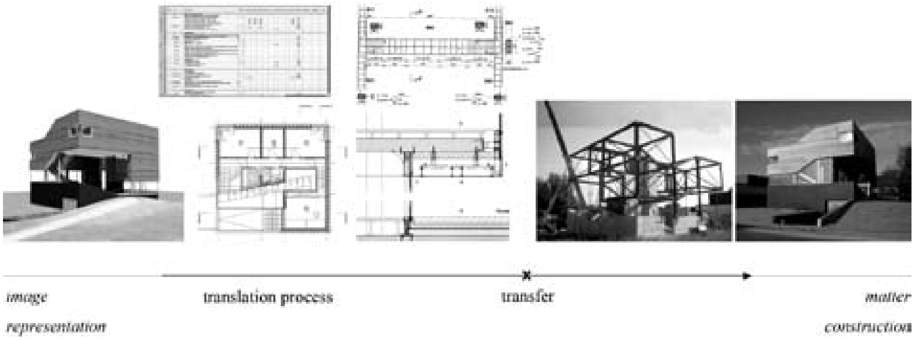
> *'architecture only exists when it is materialised by its construction, before it is image'* [9].


The genesis of an architectural project is a process marked by different stages going from image towards construction, from idea to action, from conception to making, from abstract to concrete, from general to specific, from designer to constructor. The process of going from architectural image to architectural artefact is not new, not specific to our times, but omnipresent in architecture and construction history.

From brief to final design architects, engineers, and other designing parties elaborate the project using different means of representation, from sketch on paper to complex 3D-models, using traditional and/or new tools ranging from pencil to cardboard to computers. Means may differ, but the goal stays the same, that is, turning architectural ideas and concepts into (virtual) representational models or images that illustrate and simulate the result to be achieved.

The architectural model thus created, in order to be realised, has to be translated and transfered from the conceptors to the constructors, or in other words, *'the project must be handed over from those who know what the project is (or has to be) to those who are going to make it'* [10]. The first has to indicate, based on what he knows (idea) what the other has to do (action). To ensure adequate action is undertaken, correct explanations have to be provided. Mostly, those explanations take on the form of an 'exhaustive' description of the project and its compository elements, focused on the 'result' to be achieved.

Either way, in order to be interpreted correctly, the explanations have to be situated both on the level of the 'technological' description, and on the level of the conceptual intentionality of the project.[11]



In this process we constantly have to bear in mind an essential quality of architecture. This is the ability to create an atmosphere, a transient experience, within a physical, tangible reality.

> *'Materials lend their reality to our experience of an architectural idea, but only in so far as they give body to the cognitive model the architects offer up for consideration: what interests us in our projects and buildings,... is modeling, creating an instrument for the perception of reality and our interaction with it'* [12].

This essential quality is also a source of ambiguity, as architecture is not only governed by image and experience. Architecture is conceptual, approximate and arbitrary, but at the same time it is rational, exact and precise. Architecture is determined by will and control over measure, scale, position, orientation, material,... which implies working with quantifiable, repeatable, measurable, controlable data and information. It has to be useful and utilitarian, but it tends to be meaningless without conceptual meaning or '*conceptual intelligence'* [13]. On the other hand, construction principles, methods and actions, whether technologically high-end or based on plain practical common sense are as essential as concepts and ideas to shape the appearance and experience of the architectural artefact.

Architectural projects are sometimes artistic in intention, sometimes technical or engineering and sometimes they shift from the one to the other. In the end they have to be all of it. The architectural design process is a continuous 'wavering' between formal and spatial concepts on the one hand and technical in engineering logic on the other hand, at one moment using rational arguments and a moment later using an intuitive conceptual approach.

Towards an alternative

'I wish to investigate the confluence of technology and human experience' [14].

Staging architectural ideas and concepts in a materialised reality is essential to architecture, but existing models and methods to implement material reality in the architectural design process often remain inadequate or at least imperfect. The application of predefined models and solutions using reason and argument rather than intuition is not very challenging from a designer's point of view and too often generates predictable solutions. The necessity for an alternative model that positions itself 'in between' certainly exists.

As a starting point, I am convinced that an alternative model should conform to following provisional requirements:

- It has to leave space for both rationality and subjective interpretation.
- It has to express multiplicity, diversity and heterogeneity of subject areas, of the field to explore.
- It has to generate and facilitate selection. Selection implies a choice and thus a value judgement to be made.
- It has to be open to modification and alternatives.
- It must faciltate the design and making of something.

An integral and innovative approach regarding the integration and synthesis of architectural construction and design has to be based upon novelty in data-structure, on an alternative classification in which information about technology and material assembly is integrated with architectural concept, morphology typology, appearance, experience, etc.

The goal is to reconnect information and explore relationships and connections between elements that are not visible in other classification schemata and disclose novel and existing or in time forgotten possibilities of creating by opening up architecture's 'wunderkammer'.

Translating this into possible research questions, this becomes:

- Is it possible to enhance the ability of architects/engineers and students to understand the connections between creative design processes used in the studio and in practice and those used in technology and construction by handling the information differently?
- How do we manage the tension between the specificity of the described solutions vs. the general and open design question(s)?
- How do we manage the tension between the generality of the principle vs the specificity of context and project?

(re)classify - proposition, procedure, goals

Proposition

The (re)classify project intends to be both critical and constructive. It aims at formulating an alternative that is trying to draw analogies between disparate activities. It aims at exploring the existing repertoire of technological models and methods regarding construction technology and tries to confront them with the architectural concept and materialised result that is reached with it, or possibly the other way around. It will try to define design strategies. It intends to be about precision and approximation at the same time.

It is definitely not the aim to achieve a radical break with the existing methods, but rather a slight reorientation. For this purpose the intention is to make a compilation that brings the most diverse elements together within a subject field, creating cross-references and revealing relationships that are not legible in the conventional arrangements.

The proposed structure is based on the following elements:

a. An architectural artefact is situated in a CONTEXT

   An architectural artefact is a physical entity situated in a physical reality, on a definite location in the real world. The properties of the location, the natural or created place, condition the requirements and the response. The basis for this category is what is called in the literature the '*context-factors*': water, light / sun, climate, t°, wind, water, landscape-elements like geography and topography.

b. To construct an architectural artefact we work with MATTER

   Materialising architecture implies manipulating matter, following a *'sequence of architectural construction as an additive chain from small to large, a transformation process starting from (raw) materials, transforming them into modules up to elements and structures'* [15].

   Matter/material is natural or created and has properties. Those properties are both existing and assigned (designed). The '*properties*' will be the basis of this category, which explores concepts of for example,

   - thickness / fineness,
   - weight / heavy / light
   - surface / transparency / tactility.

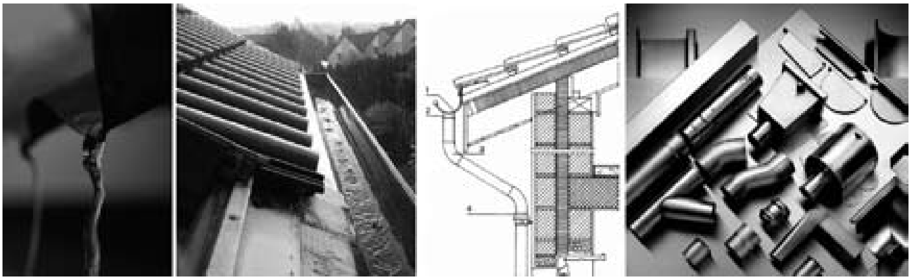
c. To construct an architectural artefact we use METHODS & PROCESSES, a series of actions to reach a goal, to obtain a result, an effect. This category will explore concepts of stacking, layering, pouring, connecting, assembling, excavating, seriability, reproducibility, etc.

I suppose a critical reader might question this list regarding its supposed difference, originality or novelty regarding the already existing classifications. However, the difference does not lie in the subject matters treated, but in the kind of material that is used and the way it subsequently is interrelated. As stated earlier, lots of aspects, like context, for example, are universal and thus recurring in different models.

To shed some light on the particularity of my proposition, I detailed two possible (re)classify-categories. The first is to be situated within context, the second within matter.

(re)classification - category: CONTEXT - water

The elaboration of the group starts from the existing situation,



Example 1

An example of the existing situation, a 'typical' solution for 'collect & evacuate' - it is documented in the textbooks and backed-up by industrial production.

and is subsequently expanded to an as large as possible array of possibilities, available options, strategies and accompanying limitations. The source material is found within architectural practice (design and technology) and history. The question is asked how 'water' is handled as a creative and technical design parameter and which relationships exist or can be imagined between both.

The choice for water as a starting point for this category is based on the fact that water is the most materially tangible environmental element, it is physically present and has sensorial qualities. Moreover, it is fundamentally both ambiguous (essential, positive, poetic and problematic, destructive) and very diverse, multi-layered.

The following (incomplete) list of thematics gives an impression of possible subject matters to be treated:

- aggregation states	
- context & utility	evacuation, collecting (external & internal), buffering, drainage, ...
- comfort & services	clean water supply & delivery, evacuation (sewage systems), humidity, moisture/condensation, sound/acoustics, ...
- materials	absorbance, hygroscopy, porosity, permeability, weathering, erosion, ...
- elements	gutters, rainpipes, soilpipes & connections, gullies, gargoyles, rainscreens, ...
- geometry	topography, typology, building geometry, integration with building structure, ...
- scale	landscape, urban/public spaces/streets/..., buildings, ...

- trajectory guiding, canalising, collecting, dispersing, spraying, draining, ...
- watertightness openings, joints, overlap, sills, copings, layering, deflection, air barriers & ventilation, material assembly, ...
- safety fire proofing, sprinklers, ...
- surface texture / color / reflection
- damage
- atmosphere / experience
- concept
- combinations of the previous.

Example 2

'Collect & evacuate' - formal variations of evacuation elements.

Example 3

'Collect & spray' - formal variations of gargoyles.

Example 4

'Permeability' - scale, material and density variations.

Example 5

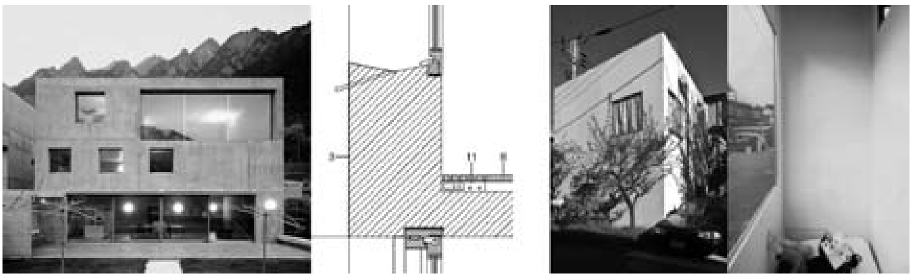
'Weathering' - variations in material and exposure.

(re)classification - category: MATTER - thickness / fineness

Thickness/fineness is a property. This property is not absolute but dependent on the context of use.

This necessitates an evaluation and a value judgement (system). In the case of the property thickness/fineness, it can be related to following aspects which could serve as evaluation criteria:

- strength
- geometry
- scale
- material
- structure
- thermal capacity
- comfort
- massive / filligree / heavy / light
- spatial qualities / perception of space.



Example 6

House in Chur, Switserland - arch. Patrick Gartmann & house in Tokyo, Japan - House in a plum grove, arch. Kazuyo Sejima.

On the basis of the above mentioned criteria we can compare the two houses and evaluate them regarding both formal/spatial design characteristics and technological performance and effectiveness.

Procedure

The proposed (re)classify-procedure is conceived as a sequence of consecutive actions:

- collect material and browse through it

  Besides from aiming at being a classification project, (re)classify is based upon the pleasure of searching, looking for, browsing in architectures treasure boxes and collecting stuff, images, ideas, material and constructional concepts, methods, solutions,.... *'Not in search for the best ..., but everything, the entire business of coming closer, along with all its errors'* [16].
- identify traits
- group / cluster based on the identified features or traits
- describe by text, photograph, drawing, model,...
- name
- contextualise
- use it as a design incentive.

Goals

- create a different knowledge base for the creative application of technology in the architectural design process
- generate a technology-based design-specific vocabulary
- create a project based upon the continuity of an architectural knowledge tradition.

> *'it could not have been so very different in Ur 5000 years ago: the same laboriously fashioned bricks, the same spaces around a courtyard, the same sudden transition from light into darkness, the same coolness after heat, the same starry nights, the same fear, perhaps, the same sleep'* [17].

Addendum - RAUW

As an architect, I am a partner in the RAUW architectural firm in Brussels. The firm was founded 10 years ago and consists of Arnaud Hendrickx and myself. RAUW is both a word and an acronym at the same time. RAUW is the Dutch word for 'raw' , while RAUW also stands for 'Realisatie van Al Uw Wensen' (Realisation of All Your Wishes). The name was chosen to be a constant reminder of the task that lay ahead of us when we founded the office. To respond to a duality, a short-term and a long-term view, a problem solving and an explorative approach, a smooth, rational, politically correct side and a rough, 'uncooked' spontaneous side...' [18].

Notes

1 Carlos Ferrater: 2003, *Materiality*, Ed. Torho S.A., p.7-8

2 Joseph Lim: 2009, *Bio-Structural, Analogues in architecture*, BIS Publishers, Amsterdam, pp. 6-8.

3 Nel Janssens, 2008, Designerly thinking & Research, paper in *Reflections* 7, after Bo Dahlbom, ARC Sint-Lucas, p.206.

4 Nel Janssens, 2008, Designerly thinking & Research, paper in *Reflections* 7, ARC Sint-Lucas, p.204

5 Ibid, pp.205-206

6 Philip Agre: 1997, Towards a Crtitical Technical Practice, article in *Bridging the great divide: social science, technical systems, and cooperative work*, Erlbaum

7 Staib, Dörrhöffer, Rosenthal: 2008, *Components and systems - modular construction, Edition Detail*, München, Birkhäuser. p.43

8 Philip Agre: 1997, Towards a Crtitical Technical Practice, article in *Bridging the great divide: social science, technical systems, and cooperative work*, Erlbaum

9 Patrick Bouchain: 2006, *Construire autrement, comment faire*, L'impensé Actes Sud, Arles.

10 Ibid.

11 Construction technology acquires its relevance through the act of constructing, building, making the architectural artefact. It is its basic premise and fundamental goal. Tranposing this to a context of architectural education, we have to be conscious of the fact that students never get into the project phases of transfer and construction.

The mere fact that, for obvious reasons, the architectural finality of the built construction is never reached makes the application of construction technology in the project highly theoretical and virtual. To put it bluntly, in the context of the elaboration of an architectural project in a design studio, a project can be very interesting regarding concept, idea, space, form, etc whilst being complete nonsense from the viewpoint of construction technology. The irony lies in the fact that to certain extent this does not matter, because the project is not intended to be built.

12 Philip Ursprung: 2002/2005, Herzog & De Meuron, *Natural History*, Lars Müller Publishers, Baden/Switserland, p.55

13 Ibid.

14 Philip Agre: 1997, *Computation and human experience*, Cambridge University Press.

15 Andrea Deplazes: 2005, *Constructing architecture - Materials Processes Structures - A Handbook*, Ed. Birkhauser, pp.11-12

16 Philip Ursprung: 2002/2005, Herzog & De Meuron, *Natural History*, Lars Müller Publishers, Baden/Switserland, p.212. Extract from an interview with Gerhard Richter.

17 Herman Hertzberger, Addie van Roijen-Wortmannn, Francis Strauven: 1982, Aldo Van Eyck (quote), *Stichting Wonen*/Van Loghum Slaterus. p.47

18 Arnaud Hendrickx, 2008, Interactive architectural design, slightly modified extract from a paper in *Reflections* 7, ARC Sint-Lucas, p.283

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Area = Integrating Architectural design and teaching of structures

Introduction

Architecture is an useful art, a statement of the physical, through which space is organised and constructed. This is why we say that space is designed and so if we want an architectural project not to be just a mere representation on paper the space has to be constructed.

From an academic point of view, as a general rule, architecture students limit themselves to create virtual or fictitious representations in class of what could be a building. Logically, students have a few years contact with the architectonic fact and, therefore, they do not logically have the experience required to design as professionals. So they are limited to project their architectural intuitions in parallel to the complementary technical disciplines learnt, thus showing serious difficulties when trying to connect these with the project.

On the contrary, the real exercise of architectonic culture always implies limitations and commitments which on many occasions are far from those the architecture student usually faces during his learning period.

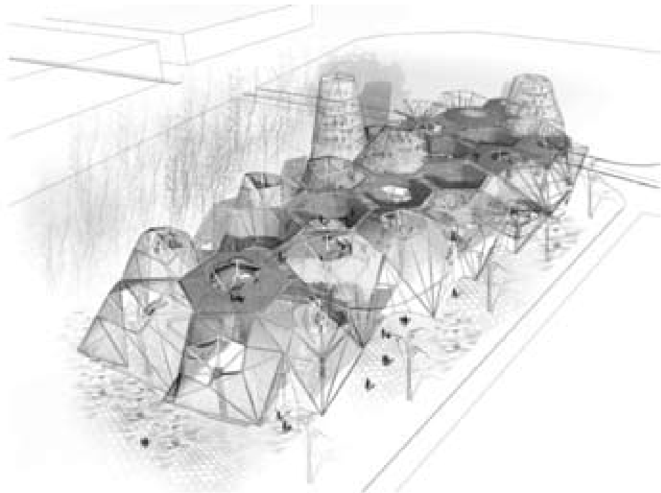

Fig. 1
Team León 11' proposal for Market in San Chinarro competition, 2008 (accesit) (Illustration from internet).

The Experience of Teaching Architecture

From the experience that teaching at the School of Architecture in Valencia brings us, and in particular from our subject Construction I, which is one of the first subjects where the student learns construction in detail, we observe that during the first degree years, the student is generally not aware of the connexion between design and architectonic construction, and so the student usually sees these two disciplines as independent, unconnected and without a relation between them.

During those first years, the student does not even consider the need for a scientific and technologic contribution to their school exercises and does not realise that to be able to build the idea this is a requirement, without which it would be impossible to make the idea of a project became reality.

In other words, pupils study the different subjects of their studies programme as isolated obstacles they have to handle without knowing very well what they are useful for, besides for failing and passing a subject.

It is also common that students in their first courses only see construction as an isolated subject they need to pass to obtain the degree, whereas they usually consider project and design subjects more important and the only subjects they need to be prepared for.

However, the most serious concern is not what the student perceives during the first years, when he has not yet acquired an interest for a global and complete learning. The truly worrying thing is when this happens with students in their last year, which means something has failed in the coordination between different subjects and in particular with architectonic construction and project.

Fig. 2
Exercise for connecting construction and project (Illustration from subject Construction I, School of Architecture in Valencia, Spain, from the Housing in Quinta da Barca, Joao Alvaro Rocha architect).

The Importance of Building´s Nature in Learning

During his learning period, it is made obvious that the student is not aware that the nature of every building, its architectonic quality, not only depends on the project but that it is also linked with the way in which the project is run and based on its construction characteristics.

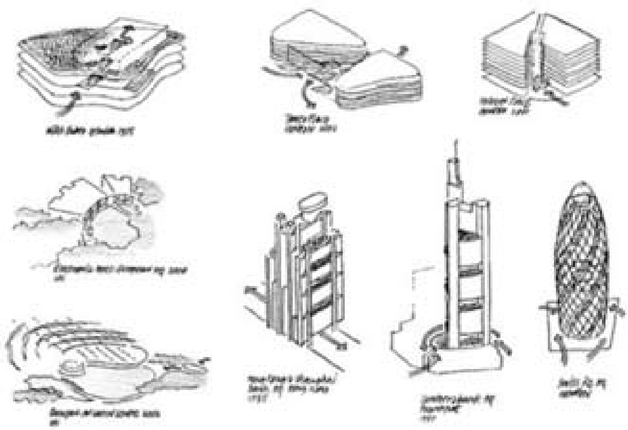

Fig. 3
Complexity in technique, stucture and construction (Illustration from Internet. Norman Foster, architect).

Buildings are very complex in their technique, structure and construction and each historic period has resolved this according to its possibilities. For this reason, the study of structures and construction is essential for any architect´s training.

If we understand architecture as everything an architect builds, from a hut to a skyscraper, we will reach the immediate conclusion that students must prepare themselves for learning the trade, which is mainly to think, design and materialise, building the spaces to be occupied.

The Project and its Materiality

The learning of the architect´s trade must inexcusably go through the early understanding that the architectonic fact is inseparable from materiality and the understanding that the same abstract concepts of composition which belong to other planning and concretion levels are the same in the construction on any element.

In other words, this means that the project cannot be separated from its completion and therefore, from its execution strategies. Amongst other facts, a building must be conceived from the structure that will support it. Any good project must have a clear correspondence between composition structure, formal structure and supporting structure right from the beginning.

History, construction and structure are therefore, from this point of view, interconnected disciplines which are very important for teaching the reality of architecture, and are very helpful for the understanding of composition, space, light, gravity, all the essential elements of any architecture project with which every student dreams of.

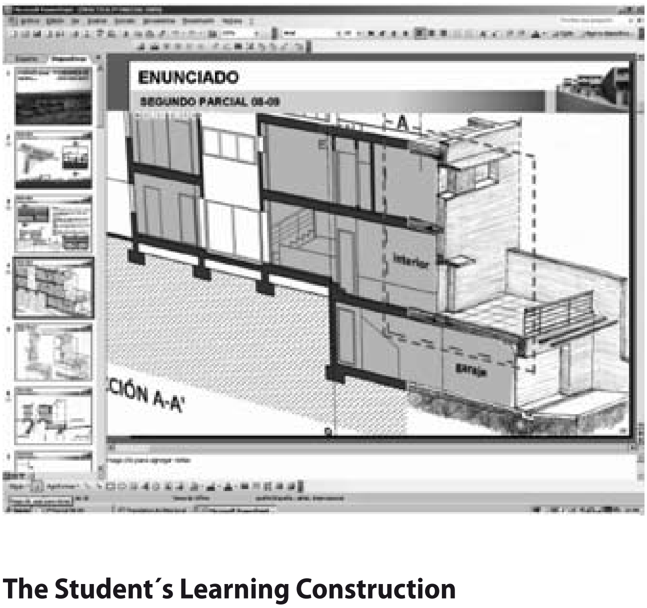

Fig. 4

The project cannot be seperated from its completion and therefore, from its execution strategies (Illustration from subject Construction I, School of Architecture in Valencia, Spain).

The Student´s Learning Construction

However, these problems about linking with the way in which the project is run and based on its construction characteristics are not the only ones. The same happens to the students when learning construction.

Serious difficulties are observed when they have to interrelate learnt theory with practical lessons, mainly due to their tendency to understand the constructive detail as an isolated fact, without analysing the facts leading to superimposing and concatenating elements and without realising or reflecting that each detail forming part of the learning is not an isolated fact but is part of a whole, of a project and that it has to be resolved according to the constructive logic of each project and of each particular situation.

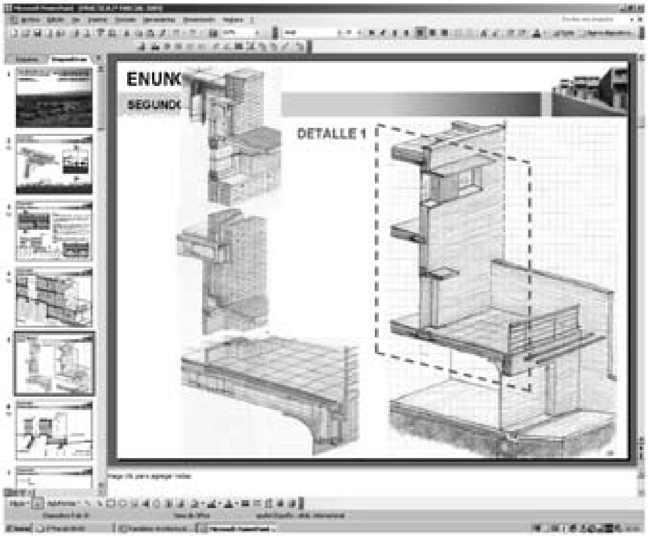

Fig. 5
In subject Construction I, students have to interrelate learnt theory with practical lessons and reflect about that each detail forming part of the learning is not an isolated fact but is part of a whole, of a project (Illustration from subject Construction I, School of Architecture in Valencia, Spain).

The Architect in Ancient Times

Any architect in ancient times knew, even intuitively, how to build so that form and structure were as efficient as possible, and knew perfectly that construction and structural efficiency greatly depended on how the joints were executed, besides from knowing the importance of materials.

Fig. 6
The ancient architect learnt hands on work at the construction site, at the workshop, whereas today's student learns mainly at University (Illustration from teaching in a classroom at School of Architecture in Valencia, Spain).

A good architect is not only one who makes good projects, something totally necessary, but who also knows how to build and why something must be built in a specific way and not another.

According to our discourse, what is the difference between that ancient architect and today´s architecture student? Perhaps the difference is that the ancient architect learnt hands on work at the construction site, at the workshop, whereas today´s student learns at University.

That architect gained an awareness that building depended directly on various parameters such as materials, scientific, technical, technological, and even budgetary, which determined the design significantly.

The Need to Resolve Problems

As hard to believe as it may seem, today´s student is not aware of all of this. This is something he will have to face and realise when he wakes up from the idyllic dream lived through his University years and starts his professional life, meeting with the powerful reasons of the labour market.

The study of history proves that this has always been like this, so it is important to study and understand the history contemplating the materiality of buildings, searching for knowledge, understanding and explanation, and ultimately for the reasons why the architectonic space was built in a particular way according to the techniques and materials available in each time period.

The important thing for the students is to understand that the most simple construction and structure elements resulted out of necessity and not on a whim, as a result of the need to resolve important execution problems of a particular building. More important than knowing whether such temple was roman, Paleochristian, Byzantine, Gothic, Renaissance, Baroque or Neoclassic, although this is obviously important but not as much.

So, this is a constant throughout the history of architecture, nothing is the result of a whim or an insuperable fantasy dream.

Fig. 7

Any good project must have a clear correspondence between composition structure and supporting structure right from the beginning (Illustration from subject Construction I, School of Architecture in Valencia, Spain, from the Housing in Quinta da Barca, Joao Alvaro Rocha architect).

Buildings for Living

All examples of good architecture only confirm the use of techniques and materials offered by the place and moment at the time of building, demonstrating that behind each great architect there has always been a great builder.

Our buildings are made for living, so our lives can be healthy, pleasant, comfortable or just the contrary, depending on them. When architects design, we follow a social purpose. We are responsible for the human habitat and therefore, our duty is to create beautiful objects and at the same time useful ones. This is what makes Architecture different from the rest of Fine Arts.

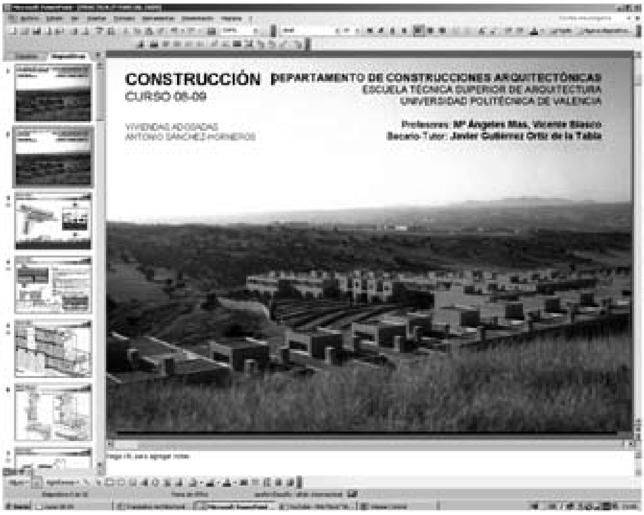

Fig. 8

When architects design, we follow a social purpose. We are responsible for the human habitat (Illustration from subject Constraction I, School of Architecture in Valencia, Spain).

The Architecture as a Physical Problem

However, when architecture is built, regardless of the project and the design, it is always a physical problem needing a solution as a consequence of a series of physical actions coming together in architecture. After all, our profession, whether we want it or not, is purely technical, and we owe it to ourselves to see that.

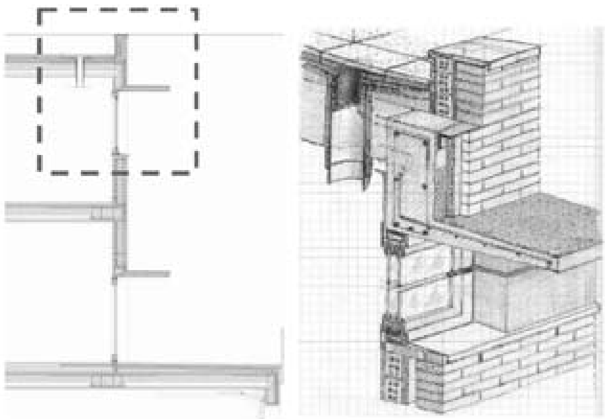

Fig. 9

Direct relation between problem and response. A practical lesson in the subject Construction I (Illustration from subject Constraction I, School of Architecture in Valencia, Spain).

From this point of view, we can be certain that in order to build we must consider the procedure based on physical laws; the stability controlling forces and gravity, the insulation controlling temperature changes, and the leakproofness controlling humidity. These are aspects, amongst others, which should be fulfilled adequately in every project and in every work.

No matter how ambitious the project is or how spectacular our idea is, if we do not give the correct solution to these questions, our architecture will lack sense and will be useless and empty.

For example, when we analyse the structure of a living being, we observe a unit form, characterized by a direct relation between problem and response.

The same lesson can be found in any device or useful tool, like a jar, airplane, ship... Any of these objects are built with a shape as optimal designs, regardless of its design and beauty.

The Adaptation to the Place

This is the same spirit in ancient and modern Architecture. This is the spirit that should underlie in our architecture, being beautiful but at the same time adapted to the place, without superfluous elements, and with economy of means; a modern architecture backed with centuries of tradition.

This is the great challenge of Architecture and we must make an effort to make the students understand the relation between problem and response.

An Architect must know every construction technique. He needs to master gravity and fire behaviour, must control light, water and wind, the space and its sun exposure, the thermal inertia and the insulation, as well as the psychology and the feelings, emotions, perceptions... There are so many elements involved and many things transforming the void into a project...

Fig. 10

A beautiful piece of architecture, but at the same time adapted to the place, without superfluous elements, and with economy of means (Illustration from subject Construction I, School of Architecture in Valencia, Spain).

Practical Exercises from Recent Architecture

Our subject Construction I obtains the models used in practical exercises from the most recent architecture examples published by journals, whether they are in fashion or not. We try to use them as examples of good architecture with the purpose of teaching the student to resolve construction problems, and also in order to make the student reflect on the relation, always existing, between the idea of a project and its solution or solutions.

Construction I subject has a concern for creating interesting spaces, beautiful and long lasting buildings. For this reason, exercises are always based on real cases, explaining and analysing from the start the project criteria and the required strategies for its construction.

With this, our intention is that the student is able to identify materials and the relation between them so he understands the construction situations given in the project, proceeding the other way around to the real approximation when we design.

Additionally, nowadays, the environmental concern requires efficient solutions to avoid the wastefulness of past decades where everything was allowed. Building interesting spaces, beautiful and long lasting buildings are no longer the issue. From now on, we want to build high quality products which satisfy people´s needs with a minimum cost and low energy consumption.

Fig. 11

In our subject Construction I we obtain the models used in practical exercises from the most recent architecture examples published by journals, using them as examples of good architecture with the purpose of teaching the student to resolve construction problems (Illustration from subject Construction I, School of Architecture in Valencia, Spain, from the Housing in Quinta da Barca, Joao Alvaro Rocha architect).

Conclusion

Concluding, architecture and construction, shape and technique must be covered together and as only one problem, as a unit. We do not project and after build. Project and construction must be only one and simultaneous thing.

Therefore, it is necessary to teach the student to think, reason and make him see the inseparable relation existing between architectonic design and construction design, that design and construction share the same purpose, the materialisation of the form which is inseparable from its materiality and that it is intimately linked with its execution process, in order to integrate a coherent group of knowledge for the future Architect.

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Understanding the Unity of Architecture by Analyzing Vernacular Settlements

This paper makes an attempt to show how the study of vernacular settlements can form an experiment for students towards the development of an understanding of the wholeness of architecture.

I will first try to explain briefly why the above approach can contribute to the demand for integration in architectural education, and then I will give you an outline of the joint course we have at the School of Architecture at the National Technical University of Athens.

By measuring, analyzing and evaluating traditional settlements, the Architectural teacher is trying to approach the process of design - from the whole to the unit - in an analytical way, opposite to the usual one followed in the architectural studio. Therefore we are trying through the constructional and morphological analysis of traditional settlements to make our students think of mass, space, volumes, materials, textures, light together with elements as design detail, construction techniques and technology.

Vernacular settlements have acquired a special value as unique areas of equilibrium, variety and human scale in our contemporary technocratic environment, which is for the majority gigantic and monotonous. We still admire the harmonious relationship of traditional settlements with their natural environment. The variations and differences that traditional buildings present from place to place as unities of homogenous buildings are mainly due to the influence of many factors such as climate, ground morphology and availability of building materials, together with the particular social organization, economic situation and laws of tradition.

Vernacular buildings compared with contemporary ones - which are usually the product of Architectural design, calculations and technology - follow a different principle in relation to their functional, morphological and constructional characteristics. They are structures mainly constructed by skilled craftsmen and their slow evolution was primarily based upon successive improvements deriving from the continuous repetition of similar forms, methods and materials. In traditional construction primary and secondary parts, load bearing and non - load bearing elements are not always clearly separated, consisting in most cases of a homogeneous organic whole.

Taking into account what has been briefly explained, but mainly by observing analyzing and recording in-situ the elements and characteristics every specific settlement presents, students are able to conceive better and interpret the architectural character, as well as understand the relation between building, form and construction.

The course presented is a joint course between two departments, that of Architectural Technology and that of Architectural Design. It is a "compulsory" lesson in the 5th semester of studies. The students involved have an adequate level of knowledge in both required fields, having already four semesters with projects in Architectural Design and two in Architectural Technology.

Every year a specific area in Greece with traditional settlements is selected. The area should have an adequate amount of settlements with more or less united character. Students are being separated into groups with their responsible group of teachers - one from each department - and visit the area. The visit usually takes place after the introductory lectures – lasting usually three weeks - that cover as many aspects as possible on history, building technology and analysis of the area.

The examples presented are a selection from different student works from the past two years of study and are actually following the analytical diagram of their work as stated by the Teaching Fellows of the School of Architecture at the National Technical University of Athens.

At first factors related to the understanding of the formation of the settlement are being examined as follows:

- The history of the area with special notice paid to the settlement.
- The social structure of the settlement in connection with the local economy, i.e. civil or agricultural or mixed.
- The geographical placement of the settlement and the possible relationship both to the natural environment or other settlements, villages or even adjacent towns.
- The size with approximate number of inhabitants, of houses and buildings of various categories i.e. shops, warehouses, municipal buildings etc.
- The urban mode of its development i.e. linear, radial or fortified etc. (Fig. 1).
- The division of the whole settlement into sub-units and the possible reasons of this creation. (Fig. 2)
- The analysis of the type and the degree of alteration of the traditional character of the settlement (Fig. 3), i.e. old buildings with no alterations, old with radical alterations or new buildings related to the character of the settlement, etc.

The following chapter is related to the analysis and the character of the open spaces either private or public, where the courtyards, streets and squares are examined and analyzed:

- The courtyards (Fig. 4) are analyzed regarding:
  - Their size, dimensions and proportions.
  - Their arrangement in relation to the buildings and the streets.
  - Their boundaries, whether they are clearly defined or not.
  - Their visual and physical relation to the streets, to each other or to the open spaces in general, whether they are isolated or communicating etc.
- The streets (Fig. 5) are analyzed regarding:
  - The type of the street/road network whether it is regular or irregular and in what degree.
  - The forms of the streets and their main characteristics i.e. whether they are linear or not, whether they are of constant or variant width, whether they have clear boundaries or not.
  - The proportions between the width of the streets and the height of the buildings and the human size and the importance and differences of such sections of the streets.
- The squares and open spaces (Fig. 6) are analyzed regarding:
  - Their location and distribution in the settlement.
  - Their structure and main character. Whether they are random or organized, whether they are un-organized or free spaces, or even enlargement of roads and their characteristic elements in each case.
  - Their importance for the settlement. Whether they are points of reference or not, whether they are important parts of the social life of the settlement or not, whether they are the main elements in the general image of the settlement or not.

Fig. 1
Urban Mode (Linear Development).

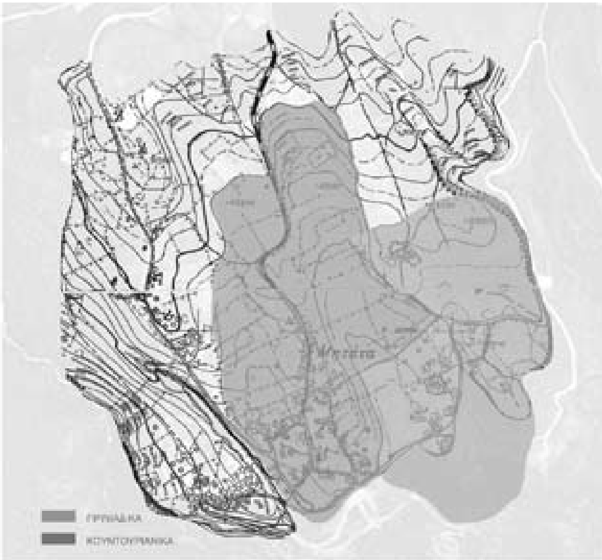

Fig. 2
Division into Sub-Units.

Fig. 3
Alteration of the Traditional Character.

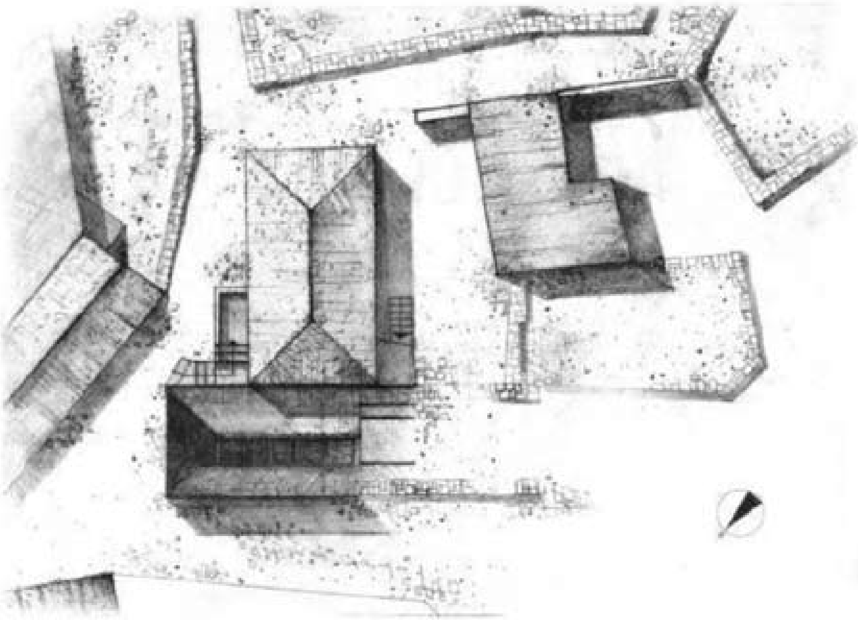

Fig. 4
Private and Public Open Space – Courtyards.

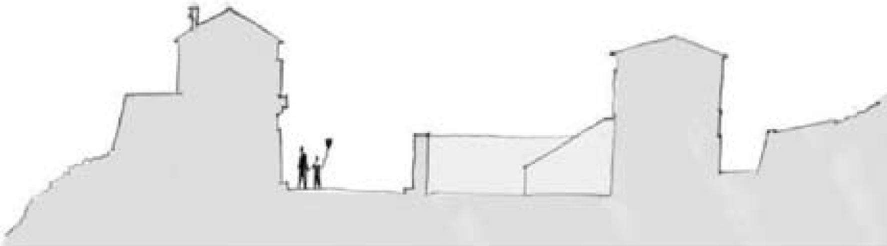

Fig. 5
Private and Public Open Space – Streets.

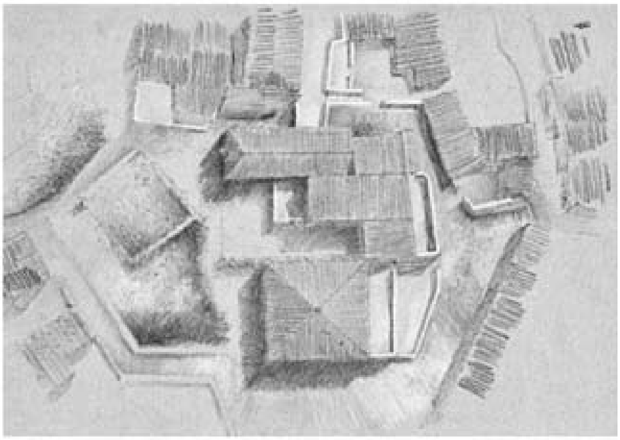

Fig. 6
Private and Public Open Space - Squares.

After the understanding of the settlement as a whole, the analysis focuses on the examination of the buildings both as units and as groups. Regarding the building units the predominant architectural types and building forms are detected and analyzed. Measured drawings and surveys of the most representative types of buildings are completed. The structure of the various types and the arrangement of their function is examined and categorized (Fig. 7). All this is followed by detection and classification of the general morphological features of each type.

Therefore the buildings of the settlement are categorized regarding:

- The general synthesis of their form i.e. simple unified form or composite etc.
- The predominant shapes of their form i.e. regular or irregular, prismatic or free etc
- The predominant proportions of the shapes.

The buildings are also examined as groups (Figure 8) where measured drawings and sketches of groups of buildings and their façades along the streets are created. The predominant modes of composition of the buildings in groups, together with the density of built forms with buildings in distance or in contact are examined. The interchange of built volumes of main and secondary buildings together with the alternations of height and the empty spaces among them as they appear in the street front are analyzed. The importance of the skyline of the building groups is also examined and analyzed.

Finally, the construction analysis of the buildings is made regarding the various construction elements and their importance in the creation of the building as a whole and their relation to the morphological analysis of the buildings. This is done both by making an isometric construction section of a typical building of the settlement (Figure 9, 10) and by making an analysis of as many as possible construction elements of the various buildings. This analysis involves:

- Structural framework, load bearing masonry walls (Fig. 11), floors, & roofs (Fig. 12) etc.
- Elements attached to the walls, floors, roofs i.e. gables, cornices, eaves etc.
- Openings construction analysis and shapes. Windows and doors. (Fig. 13). Construction of lintels, sills and thresholds. Construction of moving parts.
- Balconies, covered balconies and/or closed balconies.
- External staircases.
- Fireplaces, chimneys (Fig. 14), cases.
- The most common buildings – defects & failures (Fig. 15).

This whole process – we believe - helps students to understand the importance of traditional settlements, their morphology and construction analysis, being their first contact with the qualities of vernacular architecture.

Note

All figures presented are selected from different student works from the past two years of study at the School of Architecture, at the National Technical University of Athens.

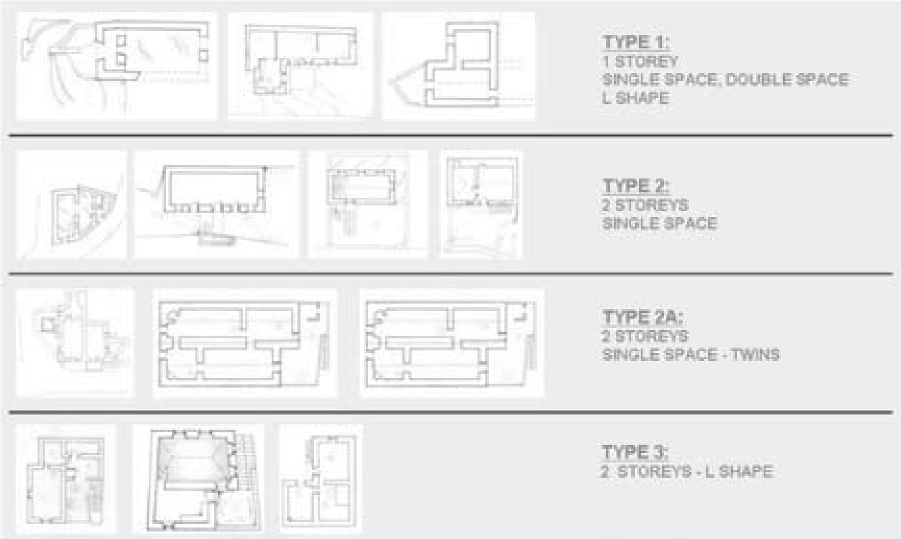

Fig. 7
Building Types.

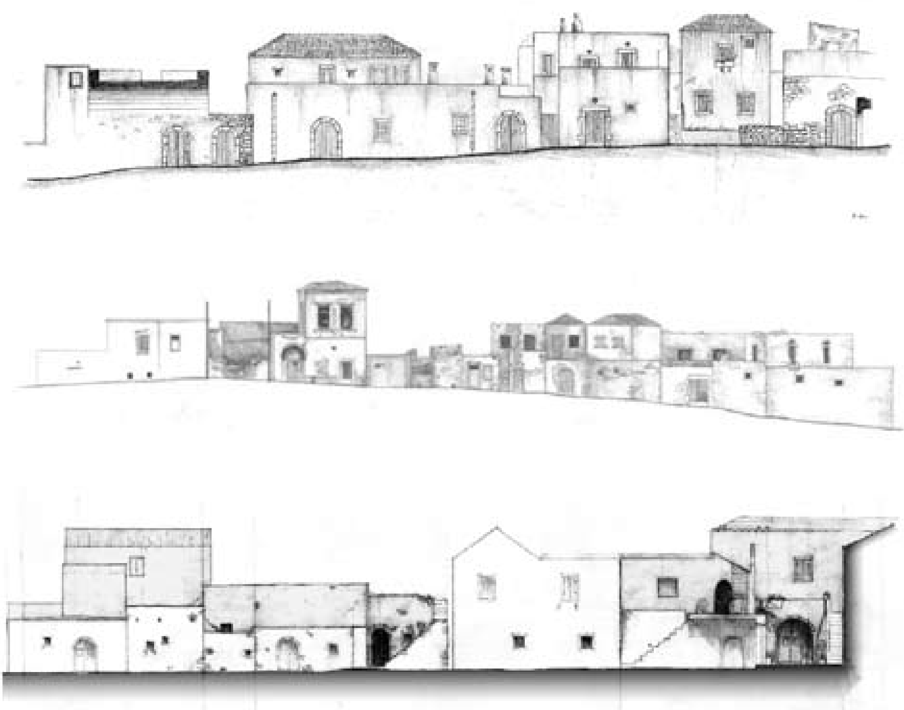

Fig. 8
Building Groups.

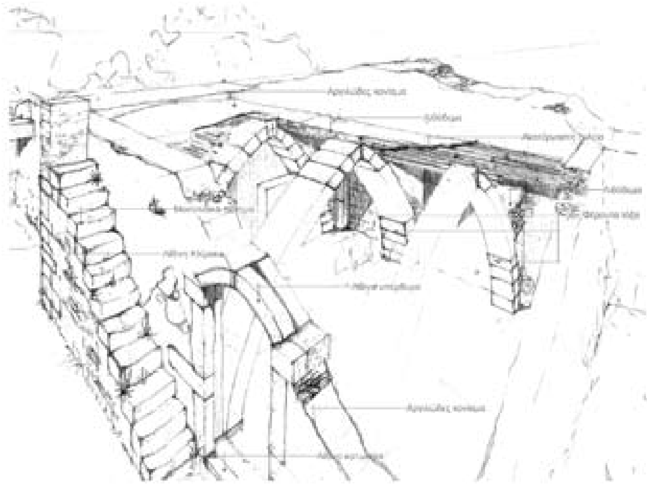

Fig. 9
Construction Analysis
– Isometric Section.

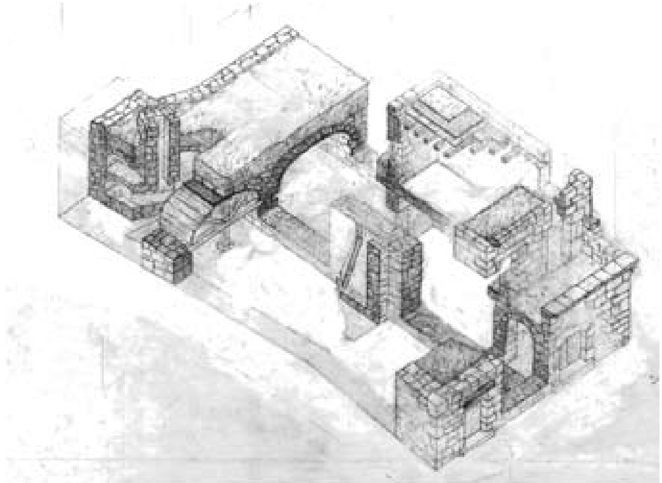

Fig. 10
Construction Analysis
– Isometric Section.

Fig. 11
Construction Analysis -Walls.

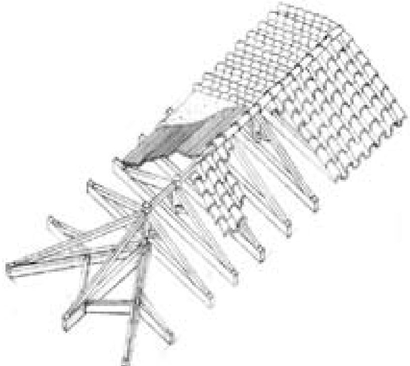

Fig. 12
Construction Analysis –Roofs.

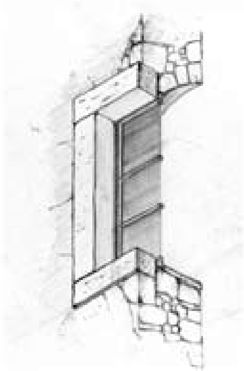

Fig. 13
Construction Analysis –Windows.

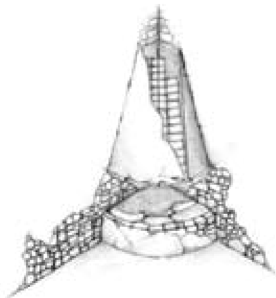

Fig. 14
Construction Analysis –Fireplaces - Chimneys.

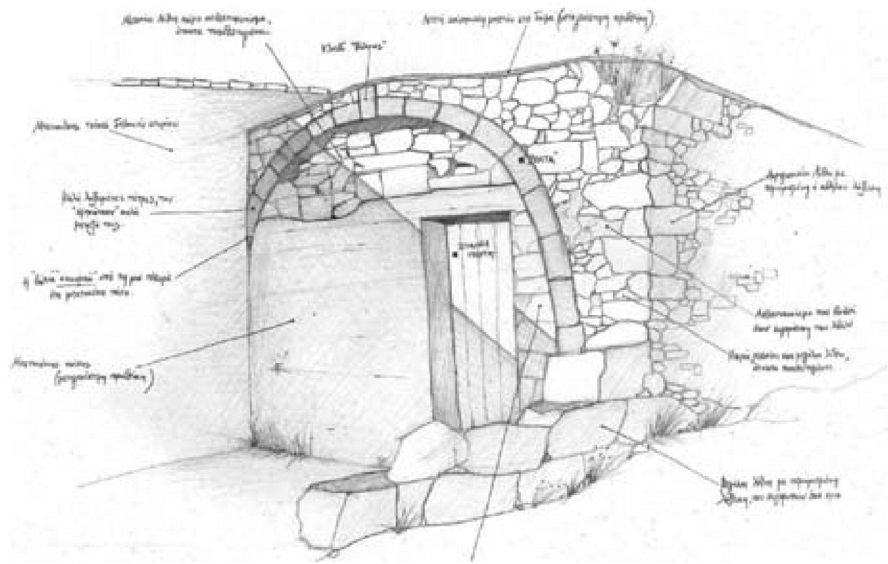

Fig. 15
Buildings Defects and Failures.

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A Pedagogic Experiment: Introduction to Architectural Technology Using 3D Design Tools

Introduction

Students in our school are initiated in construction aspects in a one-semester course entitled "Introduction to Architectural Technology". The module runs in the second semester of the curriculum. The content and the nature of the course act as a pivot for accommodating the more senior years in order to correspond to the recent pedagogical challenges, which derive from the new perceptions of thinking of architectural ideas and ultimately of fabrication methods that transform them into built form in real practice (fig.1).

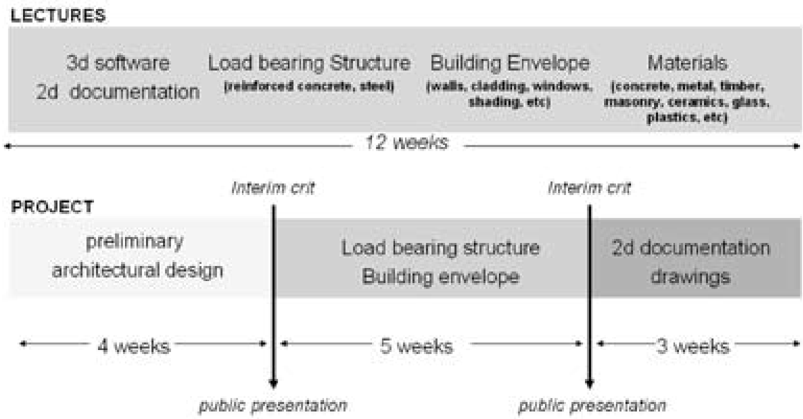


Fig. 1

Typical Course structure timetable

The main objectives of the course are for students to:

- Familiarize themselves with the notion of integration of design and construction
- Develop an understanding of the materiality in a design proposal
- Learn the basics on building construction (foundation for transcending this knowledge later in the curriculum)
- Develop graphic and representation skills towards better communication of architectural concepts.

What gave rise to the course

In a context of re-considering our school curriculum, the teaching group responsible for the construction pedagogy in the school proposed this re-consideration to be founded on the profile of the architect graduate our school wishes to generate[1]. The competences and skills in relation to construction pedagogy necessary to fit this profile were:

- understanding of the integration of design and construction
- thinking of an architectural idea and its materiality simultaneously
- learning the fundamentals of building construction

in order, later on in the curriculum, to be able to:

- transcend building and construction traditions
- learn the potential of new materials and new construction methods
- invent new construction methods that can enhance architectural ideas
- integrate environmental issues of energy conscious design and sustainability of their proposals.

The above competences identified -to form the profile of the architect in relation to our teaching- were translated by our teaching group into a series of interconnected modules:

- The course the present paper will present
- A two-semester double-weighted module ran primarily in the design studio and supported by lectures on certain subject areas on the integration between design and construction
- A one-semester module on energy conscious design on the fundamentals of the subject area
- A one-semester module on the theoretical background and the design of sustainable contemporary building skins.

One of the key decisions we made was that we needed to teach technology on a design project and in the studio. That was not only for reasons of symbolism, but also because we felt that only hands-on experience on a design project could be an effective vehicle to grasp the integration of design and building technology. In any case, this was one of the core suggestions made from relevant encounters of construction and design teachers from various schools of architecture across Europe[2,3].

The premise of the course was also founded on problems observed in the pedagogy of construction and in a sense in design education as a whole. As contemporary architecture has a strong third dimension that often does not even emerge from Cartesian logic, to evolve design and its materiality in 2D, aided by a bibliography that also portrays construction details and working drawings in 2D, is a contradiction in terms.

Another difficulty that was to be encountered was the perception of some senior staff members that architectural design and construction are two separate domains and have to be taught as such. This perception preserves the myth that construction constraints control the potentially frivolous freedom of architectural visions.

With underdeveloped specialized technical knowledge the inhibition of freshers' initiatives encountering construction problems is inevitable.

In this context architectural technology taught conventionally becomes unattractive to students of architecture who refuse to engage with the technical aspects of their architectural propositions.

Course features

The cohort of our first year students that join us in the second semester have the ability to do free-hand sketching, to do basic technical drawings using computer software and the ability to make physical models. However, their use of computer software is limited to 2D drawing and is exploited only for representation. They have no knowledge of basic concepts of structure, materials and their properties. They can operate at scales between 1:200-1:50. They ignore the operational value of the drawings of a construction detail and they do not know how to draw one.

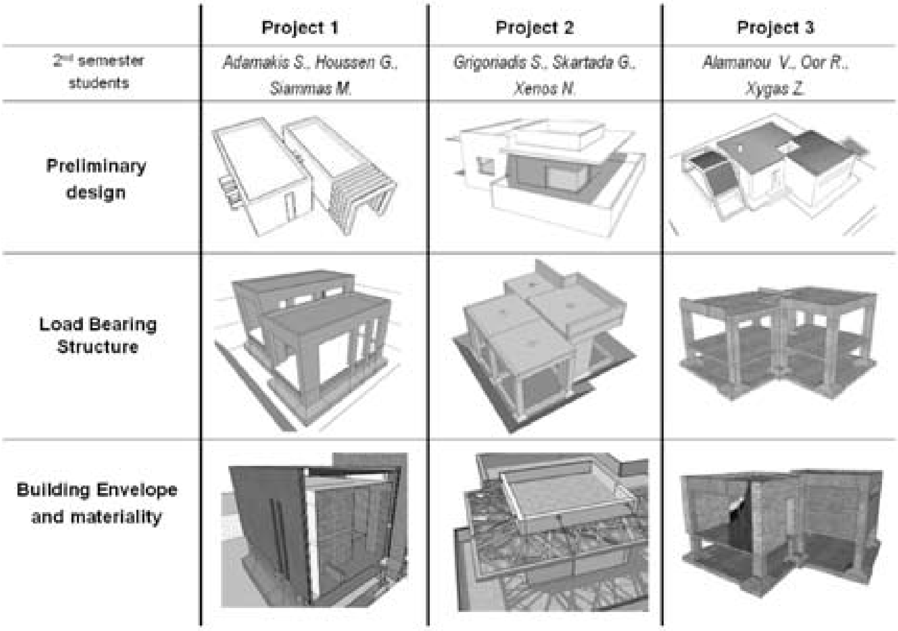


Fig. 2
Representative students' projects

3D design software

The important element for this experiment is the choice of software, which enables fast learning and familiarisation of students with simple representation techniques to communicate their design in conjunction with its fundamental construction elements. These representations are aimed at replacing or complementing hand sketches and working models, and at enabling perceptions of the structural performance under various loading conditions of the designs they propose and the effective improvements necessary towards structural stability with the least compromise of their initial proposals.

The software that has been selected is Google Sketchup, a suitable 3D tool for students in the lower school. In contrast with other types of "traditional" 3D software, it is easy to learn, has a friendlier interface and does not require long training and complicated manuals. Moreover, it has free access and provides a variety of free online tutorials.

Part A: Preliminary design

In this phase students explore the volumetrics of their ideas, testing relationships of spaces and scale. The 3d tool allows them to rotate their model to get a better sense of its various aspects, changing and adapting according to what they eventually wish to achieve (fig. 3, 4).

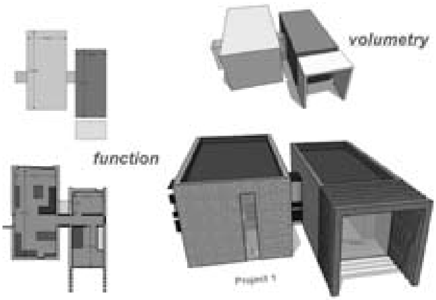


Fig. 3

Part A: Preliminary design

Part B: Load bearing structure and building envelope

In this phase students attempt to define a dialogue between the building envelope and its materiality alongside the structural system that will support it. They learn to distinguish the parts of a typical and conventional structure. The adventurous students are already experimenting with deviations of the basic and formal structural rules (fig. 5, 6, 7, 8).

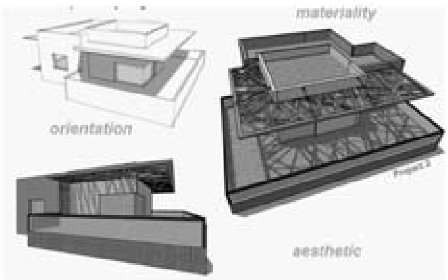


Fig. 4

Part A: Preliminary design

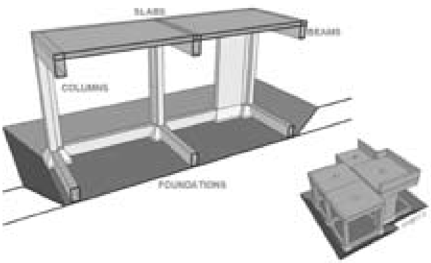


Fig. 5

Part B: Load bearing structure by reinforced concrete

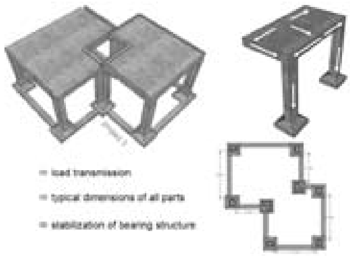


Fig. 6

Part B: Load bearing structure by reinforced concrete

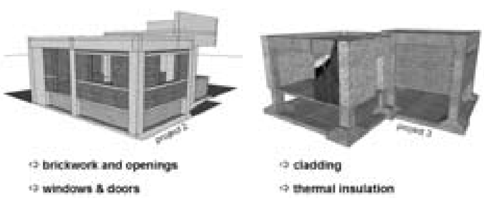


Fig. 7

Part B: Building envelope

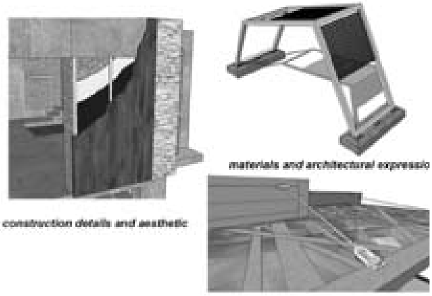
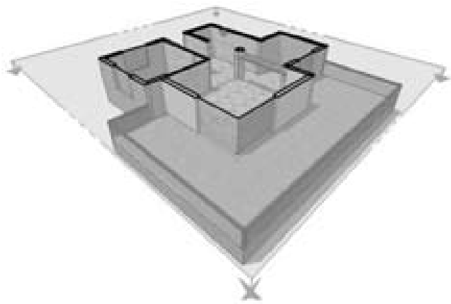


Fig. 8

Part B: Building envelope



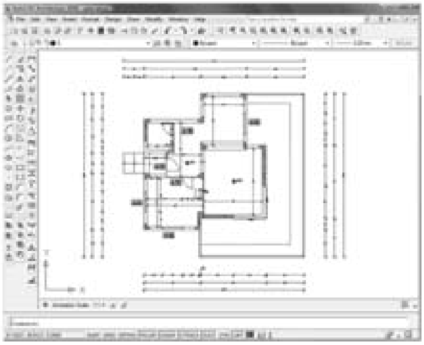


Fig. 9
Part C: 2D drawings

Part C: 2D drawings

In the last part of the project students have to exploit the 3D model they have made in order to produce the appropriate 2D drawings. This software gives them the opportunity to export drawings to other CAD types of software by cutting the model when necessary (fig. 9).

Their final hand-in includes plans, sections and elevations alongside the 3D models they have worked on throughout the project.

Conclusions

The benefits are twofold: both for students and teachers.

Benefits for the students

With this pedagogic experiment first year students enter the "world" of 3D design with an easy and friendly software. With more tactile drawings and models their perception of construction aspects increases.

They realize the impact of materiality on their architectural expression and learn how to manage a higher and complex degree of information.

They become more articulate in explaining more explicitly their formal and structural decisions. Last but not least, they conceptualize the continuum of design and construction.

Benefits for the teachers

Teachers integrate to the teaching process a wider spectrum of aspects, especially those of construction without having to separate them from design itself. They are in a better position to explain in a more efficient way the structural parts and construction details. They whet students' appetite for further knowledge on the making of design ideas. They can make architectural technology more attractive, integrated and interconnected with design reinstating their misunderstood role as rescuers of fixed but impossible design decisions offering to the world of architecture competent individuals both in design and construction.

Notes

1 This was a suggestion and a well-established practice in a number if schools of architecture across Europe that are restructuring their curricula in the light of the Bologna process. In: C. Spiridonidis, M. Voyatzaki (Eds) (2003). 'Shaping the European Higher Architectural Education Area'. EAAE Transactions in Architectural Education No 18, ISBN 2-93031-14-7 pages 295.

2 M. Voyatzaki, (2003) *Construction Teaching Methods: The Exercise(s) in the Teaching of Construction*, Conference Proceedings. Subject: Construction Teaching Methods: The Exercise(s) in the Teaching of Construction, European Association for Architectural Education, ENHSA (European Network of Heads of Schools of Architecture) Grands Ateliers de l'Isle d'Abeau, 15-17 May, France, pp. 14-19, ISBN 2-930301-13-9.

3 ibid pp. 98-105.

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YTU Architectural Final Project as a Design Studio

One of the most effective tools of architectural education is the architectural project with respect to developing the design system intellect. Architectural education aims to provide the students with the ability to overcome the problems that may be faced in their professional life by means of combining and blending the various information throughout the educational process.

Within this context, architectural education has to have the quality to equip the new architects with a vision to evaluate the built environment socially and culturally, translate the architectural forms and spatial organizations with regards to function – form - environment relationships both socially and physically.

The USIS program that started in the Faculty of Architecture in Yildiz Technical University gave its first graduates in the 2007-2008 academic calendar. This program aims to update the education and to prepare for a national or international accreditation process. Within the scope of this four-year education program, Architectural Design Studio 7 constitutes the final project (the diploma project)

The USIS program consists of one year of mandatory English prep and four years of bachelor degree with a total of 224 hours / 180 credits and 240 ECTS.

The distribution of courses is,

18% of general issues,

12% of history, human behaviors and environment issues,

32% of design,

20% of technical systems,

3% of application issues,

15 % of elective courses.

The program consists of 52 compulsory courses (42 architectural + 10 social)
74 elective courses.

The Architectural Design Studio 7 is conducted with approximately one hundred 4^{th} grade students in 3–5 groups including one core jury, a minimum of three professors of different fields of specialization (building design, restoration, urban design, construction techniques, material etc). The credit of the studio is 9 ECTS and 8 hours a week, one full day, but students have the opportunity to continue studying after studio hours. In addition to this jury, practicing architects that work professionally at their offices are invited to derive benefit from their experience.

The aim of the Design studio 7 is to integrate the urban and environmental planning with the architectural and constructional scale and discuss and create alternative solutions to realize transformation in urban centers utilizing rehabilitation, conservation, revitalization with construction techniques in urban preserved areas.

In this context, the subjects of the projects are assigned from both urban and suburban samples at a minimum of 5000 m^2 (and to include the 1/2000, 1/1000, 1/500 and 1/200 scales) and with Details 1/50.

Within the context of this paper, the final project where the students complete the 4 years of academic education will be openly discussed and evaluated with regards to the objectives, scope, acquisition of material, structure and the ability to integrate them in the design process, together with the experiences of the studio based on the results of questionnaires done with the students.

Methodology

There are different methods for forming the structure of the final studio.

The first one is the "Hands-off" method, in which the student develop his/ her project by his/her own free will. Second method is "Hands on" method.The students are guided by their professors with routine critics to develop their projects.

Yildiz Technical University is doing something more like in-between these two methods and the professors are trying to combine both of these methods. The general approach is to integrate the theoretical courses into design courses. The professors and lecturers give the students some seminars about thematic issues and the seminars concern structures, technical equipment, design etc.); these courses are presented by professors, practicing architects and other known people that are experienced in the relevant fields together with two midterm juries and one final jury at the end.

The major expectation of the students from the final project is to be able to integrate all the knowledge and the skills gained throughout their education.

Specificially:

- to be able to make multidimensional analysis (environmental, social, cultural, urban, structural analyses etc.)
- develop their design concepts by the use of the analysis
- to be able to improve their design skills from macro level (environmental planning level) to micro level (spatial level) like building materials, construction technologies etc.

Another thing that is expected from the students is that they present their projects, expressing the design process and their architectural ideas by the use of representation techniques, digital models and models.

Fig. 1
Photo midterm Jury.

Students have eight hours studio practice for one day of the week. Beyond these hours they can practice in groups in other studios organized for free practice.

The aim of the studio and the studio practise is to discuss and create alternative solutions to realize transformation in urban centers utilizing rehabilitation, conservation, revitalization with construction techniques in urban preserved areas.

Fig. 2
Photo midterm Jury.

The students are also expected to take an active role in design discussions, to develop their abilities in expressing themselves effectively and to improve their decision making skill from complex problems.

Fig. 3
Studio Discussion.

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Simple Experiments to Improve the Teaching of Structural Mechanics: a first experience

Teaching Structural Mechanics in the Schools of Architecture asks us to face the fundamental aspects of the equilibrium and deformation of structures through a didactic path which can be usefully improved by coupling standard lectures with experiments on models. Even though the authors believe, with Truesdell, that "Experiment is a necessary adjunct to a physical theory; but it is an adjunct, not the master" (C. Truesdell, *The classical field theories*, Handbuch der Physik, vol.III/1. Berlin, Springer, 1960, p. 229), it may be often instructive to 'test' the results of mechanical theories.

The representation of real structures through mechanical models is based on a procedure of abstraction of the physical system in terms of mechanical language. Structural analysis then uses the fundamental principles of equilibrium and deformation specialized to the considered structural problems. Finally, the didactic process ends with the application of these methodologies to meaningful examples that refer to single structural elements or whole constructions.

A critical element in teaching structural mechanics concerns the process of abstraction of the physical system in a mechanical model adequately simplified. In order to make this phase more comprehensible it is important to work with simple models, representative of structural components. Through the presentation of simplified physical models and by carrying out proper experiments, the student may grasp the basic questions of structural behaviour and realize the meaning of the formulas that translate these questions in the language of mechanics. In this way it becomes easier to establish a direct correspondence between physical reality and structural model.

With this aim, some teaching experiences have been developed in the courses of Structural Mechanics at the School of Architecture of Genoa. They concern the setting up of simple models and experiments to be carried out in the classroom without refined systems of measure. The experiments deal with mechanical problems of two categories. The first one concerns equilibrium problems that can be analysed under the hypothesis of rigid body such as the funicular polygon, the equilibrium of bodies in the presence of unilateral contact, the stability of voussoir arches, the role of struts and ties in simple statically determined trusses. The second one concerns deformable systems in order to introduce the fundamentals of elastic behaviour: in this sense, the elastic constitutive model (Hooke's law) and the concept of reversible deformations are illustrated through simple experiments of uniaxial traction on samples of foam rubber of different sizes. Moreover, the deflection of elastic bars is shown through simple experiments on beams of polyurethane, the identification of the elastic modulus is experimentally obtained and the effects due to loads and restraint location is evaluated and compared with the theoretical prediction. Finally, a simple uniaxial compression experiment on slender wooden rods is described, from which it is easily possible to draw experimental results that are shown to agree with those obtained by Euler's theory on buckling of columns.

Funicular equilibrium

Threads, ropes, chains and cables are structural systems with a common mechanical feature: they can resist only tensile forces and for this reason they are often called 'tension structures'. This feature does not depend on the mechanical properties of the material and is essentially due to the peculiar geometry of these systems which is characterized by a great length l with respect to the diameter d of the cross section.

These systems are then perfectly flexible and they naturally adapt their form to the load. This means that a thread (of negligible self weight) fixed at two points A and B and bearing a load P at point C takes the only possible configuration of (stable) equilibrium shown in Fig.1 in which the thread is subjected to tensile forces. Thus the geometrical configuration of the thread – the so-called funicular polygon - corresponds to the static equilibrium in the sense that the load P is balanced by reactive forces acting along the side CA and CB of the polygon and measured by means of the parallelogram rule. By adding a second load P at point D the thread immediately changes its form in order to find a new equilibrium configuration.

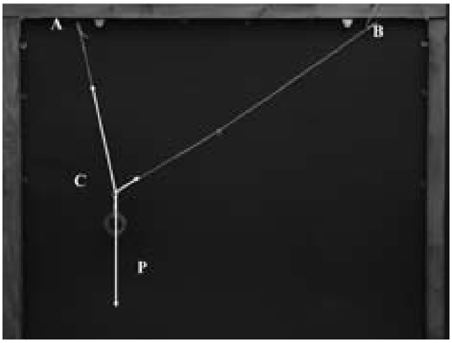

Fig. 1

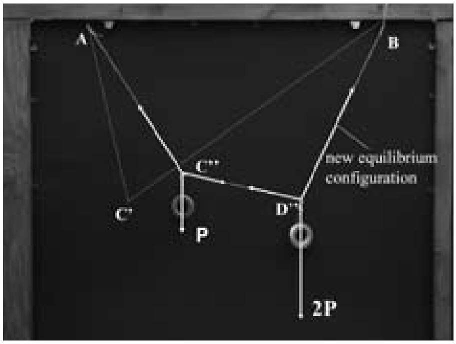

Fig. 2

Equilibrium in the presence of unilateral contact

When a body rests on a plane without any 'glue' between its base and the plane itself one speaks of equilibrium in the presence of unilateral contact. Unilaterality is then characterized by the absence of tensile resistance at the contact surface. The sequence in Fig. 3 shows that, as long as the direction of the load - for instance the self weight W - falls inside the base, equilibrium is always guaranteed; on the contrary, the body necessarily turns about an edge as equilibrium would require tensile resistance.

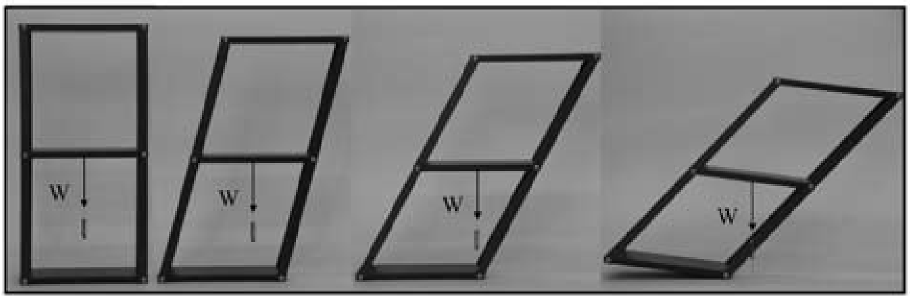

Fig. 3

Arches and catenaries

When a thread is subjected to distributed loads, for instance the self weight, it takes a curvilinear configuration of *stable* equilibrium which is called catenary and is the equivalent of the funicular polygon for distributed loads. Thus the catenary is nothing other than the configuration that a system resisting only tensile forces necessarily assumes to balance the external load (Fig. 4b).

Since the 17th century, scholars of applied mechanics have realized that a strict analogy exists between the equilibrium of a thread and that of an arch subjected to the same load. They expressed this intuition with the statement that "As hangs the flexible line, so but inverted will stand the rigid arch" (Hooke). Obviously, the change in the sign of the curvature when passing from the catenary to the arch under the same load implies a change in the sign of the reactive forces, that is, an inverted catenary is an arch resisting only compressive forces (Fig. 4a). There exists, however, a fundamental difference between the two structural systems as the inverted catenary is a configuration of *unstable* equilibrium and cannot be taken in practice. For this reason the voussoir arch – that is the arch made of voussoirs subjected to unilateral contacts at the joints - must be provided with a 'certain' thickness to stand without collapsing. This aspect was clearly understood by the ancient scholars and expressed with the statement that "When an arch of any figure is supported, it is because in its thickness some catenaria is included" (Gregory, 1697). If this is not the case, equilibrium becomes impossible and the arch necessarily collapses by rotational mechanism: Fig. 5 shows the beginning of the arch collapse where the opening of the rupture joints can be easily seen.

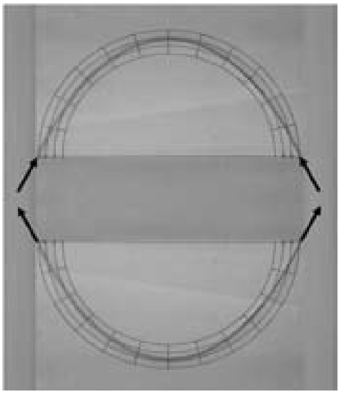

Fig. 4

Fig. 5

Trusses

Trusses are structural systems resisting both tensile and compressive forces, provided that external loads are applied at the pinned joints and that self weight is negligible.

The first real structure presented to the students is the simplest one: a truss composed of three elements. The experimental model is, at first, made with three pinned wooden bars. Then, the question "*Which elements of the truss can be substituted by cables?*" allows the student to grasp in a very intuitive manner the role of ties and struts (Fig. 6). The subsequent mechanical model, deduced from the real structure, will be easier understood more easily and solved both with graphical and analytical methods.

Another very simple experiment is useful to explain the role of slender braces in real trusses. An articulated parallelogram has been built with four wooden bars connected by pinned joints (Fig. 7a): a horizontal load, applied at one of the upper joints, shows that this system has one degree of freedom: it is then *geometrically indetermined* and, in general, *statically impossible* (Fig 7b). By adding a diagonal cable the truss becomes geometrically and statically determined only if the cable works as a tie (Fig 7c): by adding two cables forming a St. Andrew's cross, the truss appears to be *geometrically predetermined*; nevertheless, under the same load condition the experiment shows that the cable in tension is working while the other one does not work (Fig. 7d).

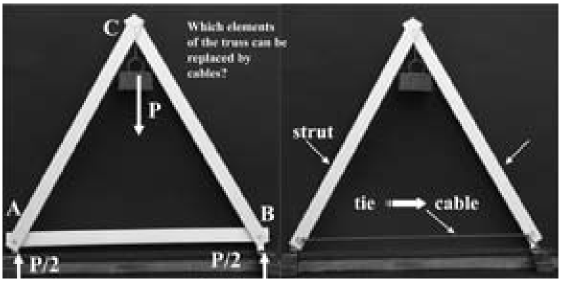

Fig. 6

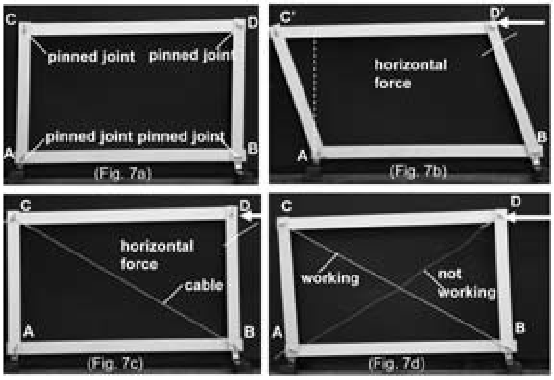

Fig. 7

Internal Actions

One of the most difficult concepts to be explained in the first course of Structural Mechanics is that of internal actions acting inside a body. Differently from displacements and external forces, which can be directly measured, internal actions cannot be 'seen'.

A rough but effective way for introducing experimentally the concept of internal actions has been achieved by building a prismatic beam made of two pieces connected by means of Velcro stripes glued at the adjacent cross sections of the pieces. Supposing the beam in equilibrium under a pointed load P and the external reactions (Fig. 8), the role of the Velcro connection is pointed out by observing that each one of the two pieces, for instance the right one taken apart, cannot be in equilibrium unless internal actions are conceived to be acting at the cross section (Fig. 9). The actual distribution of these actions – called stresses - at each point of the cross section is a delicate question but their resultants in terms of normal force, shear force and bending moment can be easily identified by means of the equilibrium equations.

Elastic tests

The previous experiments have been carried out without taking into account the deformable properties of the materials. As a matter of fact, they concern equilibrium problems that can be analysed under the hypothesis of rigid body. Starting from the present section a new series of experiments will be presented in which some basic features of structural systems are investigated by considering the elasticity of materials.

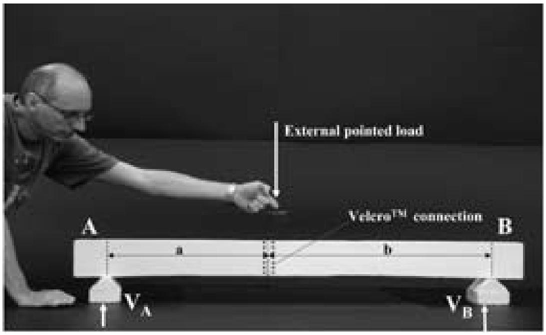

Fig. 8

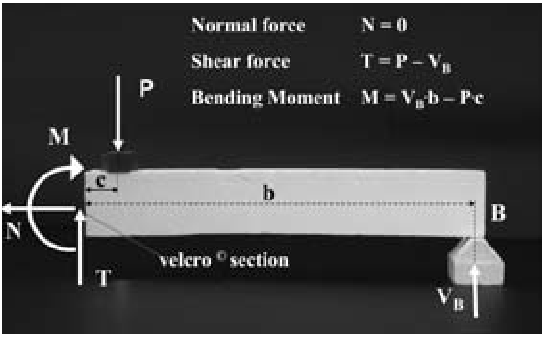

Fig. 9

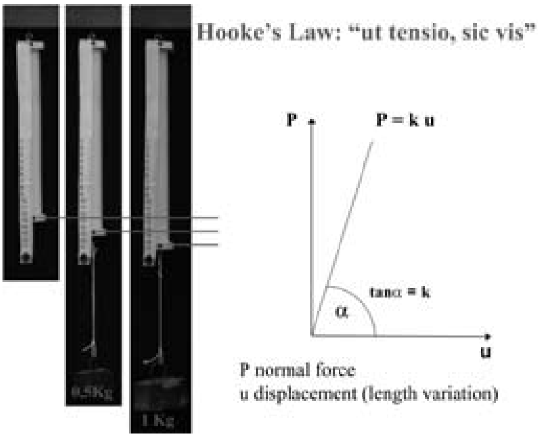

Fig. 10

The first experiment concerns the fundamental of elastic analysis, that is, the so-called Hooke's law. A prismatic sample of foam rubber with given length l and cross section A has been pulled by different weights P and the corresponding elongations u have been measured. These tests show that the elongation is sensibly proportional to the applied weight as for materials obeying Hooke's law $P=k\cdot u$, where the constant k is the stiffness of the sample (Fig. 10).

Other tests have been done in order to realize that the relation between applied forces and corresponding elongations is directly proportional to the length of the sample and inversely proportional to the area of its cross section. This suggests the opportunity of introducing the two new measures of normal stress $\sigma=P/A$ (reasonably supposed to be uniformly distributed at each cross section of the sample) and linear strain $\varepsilon=u/l$, so that Hooke's law takes the form $\sigma=E\cdot\varepsilon$ where the constant $E=k\cdot l/A$, called Young's modulus, is the stiffness of the material and can be experimentally determined.

The Elastica

The elastic behaviour of a real beam can be qualitatively described by means of a very cheap experimental model consisting of a polyurethane prismatic bar resting on two supports as shown in Fig. 11, where also the longitudinal axis and the cross sections have been directly drawn on the body on the lateral side of the beam. The application of a load at the midpoint of the beam highlights the most important aspects of its elastic behaviour, that is, the deflection of the axis and the rotation of the cross sections (Fig. 12). Moreover, a quantitative analysis of the deflection can also be easily carried out and put in connection with the theoretical analysis based on Euler's Elastica. In a first step, a comparison between the displacement measured on the model and that given by the solution of Euler's differential equation of the Elastica offers an indirect way to identify Young's modulus of the material. Then, on the basis of the obtained modulus the correspondence between the theoretical and experimental results can be investigated for other restraint and load conditions.

Stability of Equilibrium

A scale and a slender wooden rod with circular cross section can simply be tools to introduce the problem of equilibrium stability: the rod is supported on the scale and axially charged by hand at the upper edge, simulating a simply supported beam (Fig.13). The experiment shows that, by increasing the compressive load, the rod leaves the straight fundamental configuration and assumes a curvilinear buckled configuration of

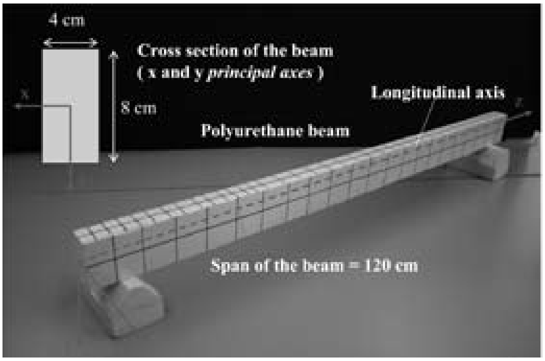

Fig. 11

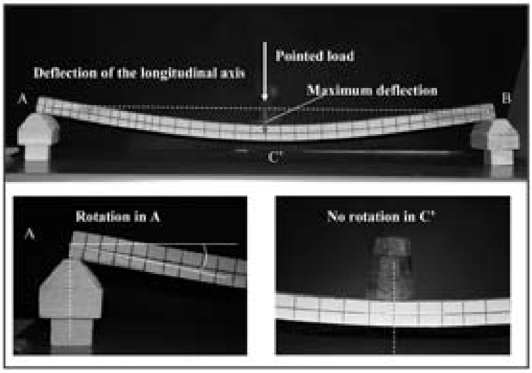

Fig. 12

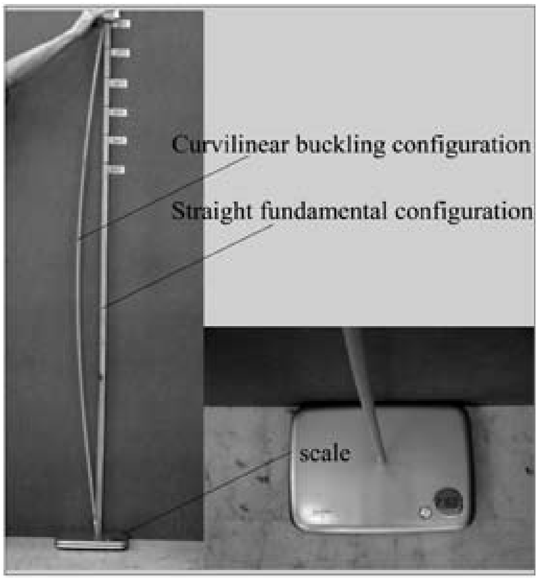

Fig. 13

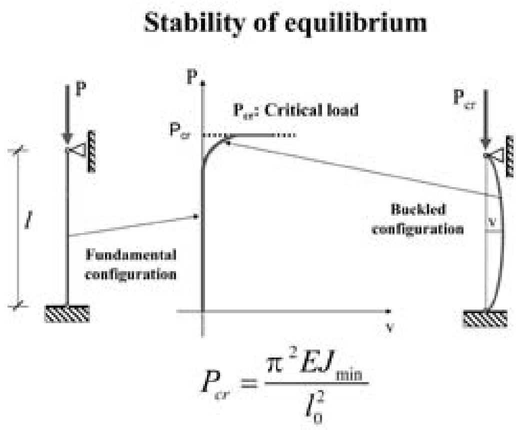

Fig. 14

equilibrium. In correspondence with this buckled configuration, the scale shows small variations in the value of the compressive load P^* which is very close to the theoretical critical load P_{cr} of the rod, taking into account the unavoidable imperfections of the test condition (Fig.14).

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Re-defining the Studio: Integration in Architectural Education

Introduction

The definition of the architectural profession and the expectations from the profession is changing rapidly. Yet, the architectural students' learning experience is pretty much the same as if not taking into consideration the developments in the profession itself. We usually discuss the profession and the education as if they are separate issues. In the United States NAAB and in Europe UIA define the competencies of architects by 37 criteria and 11 criteria respectively, which determines the skills and the knowledge level in the profession but leaves it to the academy how the curriculum meet these criteria. So far the outcome is in the most conventional way as if the profession has not evolved a bit with the exception of few. Architectural school curricula try to meet these competencies by courses either theoretical or design studios as if they are separate entities and expect students to see the "big picture" and integrate these skills and knowledge.

So the main question is, "is it realistic to expect this integration from the student?" and "has it worked so far?" It is hard to say yes to both aspects. The architectural school curricula are composed of course work (in a variety of subjects including construction) and the design studio which is supposedly be the synthesis of the skills and knowledge gained in these separate courses. However, both in the course work and in the design studio the instructors declare their own independence and without being willing to lose that own autonomy, we talk about the architectural education and the development of the curricula, how realistic is that? We expect architectural students to integrate the skills and the knowledge from this highly fragmented frame.

Therefore the aim of this study is to determine the underlying reasons of disintegration between construction courses and the design studios from the students' perspective. A Focus group study is selected as a tool of methodology.

The participants' of the focus group were the students' of Yildiz Technical University (YTU). Undergraduate education is four years at YTU Architectural Faculty and provides a Bachelors Degree in Architecture. Furthermore, graduate education is two years and provides a Masters Degree in various specialties. The architectural department is composed of four departments: building science, design, architectural history, restoration and preservation. These departments are also composed of units. In this case, the building science department is composed of four units: construction elements and materials, building production and housing management, structure and building physics. Only two of the building science unit faculty members teach design studio besides construction courses.

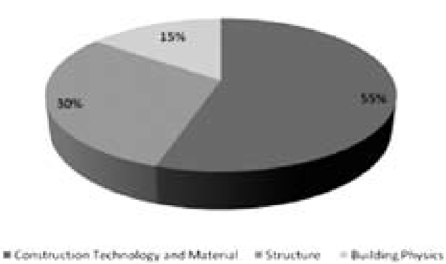

Fig. 1

General Dispersion of Construction Courses.

Undergraduate education is composed of 240 ECTS and 220 hrs course work including design studio. Undergraduate education is composed of seven design studios and two application projects. Compulsory Construction courses accounts for 22% of the whole undergraduate education. Construction courses are composed of three sections: construction technology and material, structure, and building physics. Figure 1 shows the dispersion of these sections.

Methodology

Focus groups interviews were born out of necessity in the late 1930's. Researchers had doubts about the accuracy of traditional survey methods where the respondent was limited by the choices offered and therefore the findings could be unintentionally influenced by the interviewer by oversight or omission. The open-ended approaches allow the subject ample opportunity to comment, explain and to share experiences and attitudes as opposed to the structured and directive interview that is lead by the interviewer.

Focus group studies tap into human tendencies. Attitudes and perceptions relating to concepts, products, services or programs are developed in part by the interaction with other people. We are a product of our environment and are influenced by people around us. People do not form their opinions in isolation. People may need to listen to opinions of others before they form their own personal viewpoints. Although some opinions may be developed quickly and held with absolute certainty, other opinions are malleable and dynamic. Evidence from focus group interviews suggests that people do influence each other with their comments and in the course of discussion the opinions of individual might shift.

A focus group is established by the participation of seven architectural students. The general demographic characteristics are displayed in Table 1. The average age of the focus group participant is 25 and their entrance year is 2003. The ratio of the gender of the participants also reflects the general population characteristics of the school. The participants of the focus group reflect the average level of students (Table 1 General Average Grade, Design Studio Grade, and Construction Course Grade).

Table 1

Demographic Characteristics of the Focus Group.

Student	Gender	Age	University Entrance Date	GPA	Design Studio GPA	Construction Course GPA
A	M	23	2004	2.93 (B-)	B+	B-
B	F	25	2003	2.65 (C+)	B	C
C	F	23	2004	2.78 (B-)	B-	C+
D	F	26	2002	2.90 (B-)	B+	B
E	M	26	2002	2.20 (C)	B-	C
F	M	26	2003	3.20 (B)	A-	B+
G	M	24	2003	2.50 (C+)	B+	C

During the focus group study, the aim of the study was explained briefly and the ground rules were set for the discussion. The whole discussion took 3.5 hours which was recorded digitally. The discussion topics were composed of four rounds and presented as phrases rather than formal questions. The students' opinions, experiences and observations on construction courses were discussed in the first round of the discussion. Construction courses and design studio relation was discussed in the following round. Application project and the theoretical coursework relation and the theoretical courses and design studio relation were discussed in the following rounds.

Reliability of the method was accomplished with the final question as to whether the phrases or my interventions anyway led them in any way to certain directions. It was rejected unanimously.

Discussion

In the first round of the discussion was the students' perception of the construction courses, their general opinions and experiences about the courses and the instructors. The following are some of the remarks which reflect their general opinion about the courses:

> *..."For me the construction course is just a course, that is why I don't think it is a gain professionally"...*

> *..."It is one of the courses that I draw details as I am expected to –though I have no knowledge how it is to be in reality- and pass the course, leave it behind me"...*

> *..."It is taught in an old fashioned way. They don't use the advantages of technology in presentations. I think this course is very important. Actually when we look at a wall we should be seeing everything beyond that wall. But they teach us in such a weird way that we cannot perceive it three-dimensionally. Only the students who have done their site training can understand what they teach. Teachers and students confirm that by nodding to each other"...*

> *..."this is a course where teachers try to teach details in a hangar size classroom and you try to see the visuals among the raising heads"...*

> *..."I passed the construction courses with high grades because I memorized the details practiced to draw them completely in a short time of period and made a good guess about the questions"*

> *..."I am one of the old version program students and I realize that even though the course hours have been increased in the new version, the level of knowledge has not changed at all"...*

> *...,"construction technology, structure and building physics units' courses do not complement each other, it is almost impossible to synchronize these units because they don't interact with each other... it is chaos"...*

In the second round of the discussion participants were invited to discuss their opinions on the Application Project and its integration into construction courses. There are two application projects in the curriculum. The first one is placed in the fourth semester of the curriculum and the second one is placed in the seventh semester of the curriculum. Both projects are the development of the application projects of design studio 2 (for the application project 1) and design studio 5 (for the application project 2) respectively. The followings are the remarks regarding the application projects in general:

> *..."when I leave the construction courses or the application project I feel like I am free falling... when I leave the design studio I feel I will become something completely different. I feel like an architect"...*
>
> > *Researcher asked: Don't you think the image of an architect in your mind needs this knowledge?*
>
> *"No I don't need to know them. I don't have clear image of an "architect" but I know what to become… I would like to work on sustainability, not the details of frames"…*
>
> > *Researcher asked: Do you think that they are irrelevant?*
>
> *"No, but I think others may get the picture as an interdisciplinary workgroup"*

The integration issue between the construction courses and the design studio was the major discussion topic and the participants elaborated on the issue on many levels. The following are some of the remarks on that topic:

> *..."They don't teach the process and they don't look at the issues as design problems... fragmented solutions are presented"*
>
> *..."They force us to see problems or issues from the same perspective"*
>
> *..."teachers develop the courses according to fragmented building pieces like walls, slabs, chimney etc. However, today they are the integral parts of buildings. Teachers try to split these elements, therefore they can't help your problems. They want to see the chimney as a chimney, nothing else. Construction teachers do not necessarily have a design approach to problems"...*
>
> *..."they say that they are teaching us the foundation of the issues. What foundation? They are so outdated that they don't inspire us to try something different"...*
>
> *..."I learn the profession from the design studio because the process is important there and they have you under close observation"*
>
> *..."I was an Erasmus student so I can compare the studio with other universities. Design studio is the most effective and interactive course. Though there is no standard in the studio as well. Who will be the design instructor all depends on which project you take. It is good though that every project and unit has different problems that they take into consideration"...*

..."It is good for me that they do not have a unique definition of architecture."

..."It is a good thing to bounce to completely different instructors"...

The focus group participants discussed the integration/disintegration phenomena in various dimensions. The following points can be considered as the general outcome of the discussion:

- The classes are over-crowded.
- There are some problems with the teaching skills; not inspiring.
- The syllabuses either do not express objectives, knowledge and abilities to be gained in the courses clearly or do not meet them at all.
- The content of the courses is outdated.
- The knowledge gained in construction courses is not transferred to abilities in design studios.
- Construction courses are highly fragmented, which is a clear reflection of the construction units' disintegration.
- Inefficient and/or lack of use of laboratories.
- Design studio projects are structurally tenuous.

Conclusion

The general outcome of this study is a major need for change of perspective on architectural education methodology. The study also indicates that "space" may have a great effect on students' level of perception. Both construction teachers or design studio teachers need a change in their attitudes. Academics should not be afraid to lose autonomy on their own turf "classrooms/studios" and to collaborate more in every level.

It is believed that the problem of disintegration in architectural education can be overcome. Instead of defining the design studios as the synthesis of knowledge and skills gained in the coursework, we can redefine the design studio as the space where the skills and the knowledge is gained and applied at the same time. This can be realized by multi-instructed module-based studio practices. In this way, the status quo can be eliminated, architectural students will embrace the new knowledge because they will apply it to their own work and it will be more permanent knowledge for the student; the students will be able to experience the collaboration through the instructors and finally, as the instructors, we will be able to start communicating between each other where the real issue takes place.

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Integration by Experience and Cooperation

I have compressed my title into two words, Experience and Cooperation. I think they describe the aims quite well. The exercise and education methods have developed during a long period of time and in constant interaction with students and the working life.

Helsinki University of Technology TKK has recently merged with the Helsinki School of Economics and the University of Fine Arts, forming the new Aalto University. What this merger means to our education and cooperation will be seen later. Hopes are high.

In our department, teaching of Building Construction is divided into two chairs: Building Technology with professor Antti-Matti Siikala (architect), and Building Techniques with professor Tor-Ulf Weck (civil engineer). There is also a Wood Construction chair for advanced students, including the Wood Program for international students.

The chair of Building Techniques is responsible for teaching exact calculations and measurements, and we in the Building Technology chair concentrate on using materials and constructions in architecture. This is one of the reasons we require an artistic touch in our exercises. The courses in these chairs have been integrated into each other to create the whole picture of construction in the student's mind.

Basic courses, which students are doing at the same time within other chairs, can be added to this integration; first of all Basics of Architecture which alternates in periods with our basic courses. You would think that influences from different courses ignore course limits.

We believe that the experiences and opinions you get in the very early phase of your studies are extremely important for your development as an architect. Personal working with real materials is the first step. Our workshop is an excellent tool for that kind of education. We have four craftsmen helping students; we also have a well-equipped wood and metal workshop. Our tutors are practising architects, direct from working life.

Our university requires pedagogic studies for teachers. Today pedagogical studies are offered by the university; it is possible to get to know about new teaching methods, as well as to meet other teachers from other departments. I have found all this very fruitful.

First year studies in the chair of Building Technology

The course, Basics of Building Technology 1, is mandatory for all first year students. The students have a short introduction course on how to use circular saws etc, and then they design and build, in groups of 5 students, a wooden bridge max 2 kilos. String and hanging constructions are allowed. In the durability test, students walk over the bridge and they increase the number of students until the bridge collapses. Almost every year one group succeeds in building an unbreakable bridge.

The reason for the bridge collapse is then visually estimated. The aim is to develop a general understanding of how to build, understanding of the materials and the construction.

The next assignment is a suspended canopy of fabric. The site is a model of the court yard of our own department. Students need to know how to use a sewing machine. Students are able to weld the metal parts in our workshop. The aim is here to understand, what happens to the structure when you tighten the cables.

Education is supported by our own textbooks of different building materials (Brick, Concrete and Steel). They are edited by me, and sponsored by the industry of building materials. Specialized tutors take part in education, and excursions are organized to industrial plants. The same books are used in all the Finnish architectural schools in order to integrate education in our country. Every student gets his/her own copy of the books; the books are available on our website.

According to Finnish tradition, the site is always a very important starting point in architectural planning. In the concrete pavilion exercise, students choose and visit their site in the wild. They then have to convert their feelings and the atmosphere of the chosen site into concrete. Different surfaces are studied with experimental concrete mixtures, moulds and treatments. As the task is about architecture, students have to study functions and space as well. The scale of the work is 1:10.

The Finnish magazine ″Betoni″ (Concrete) publishes the works of our students every year. Cement manufacturers provide us with the necessary materials. The brick industry has provided us with miniature bricks, and sponsored the textbook. Integration between education and the building industry works well. In the brick exercise overlapping and compression will be studied. Each student group designs a part of a brick façade. The bricks are easy to re-use every year as only clay is used.

During the first year, our education method uses experiments and understanding. We believe in "learning by doing" and we use real materials in model working. The lectures, given by our professors, support the exercises. At the end of the course, there is a small written exam just to test the level of understanding. Among the exam papers we include a feedback form which almost all of our students fill in. This gives us guidelines to develop our courses further.

Second year studies

During the second year the course Basics of Building Technology 2 approaches the real architect's work. Students learn about the use of steel, glass and wood and their characteristic constructions and structural elements. They take the first steps in detail planning and basics of Computer Aided design. The course is mandatory for those who want to specialize in Building Design. A separate course regarding building specifications is taught later.

The first task is to design a new entrance in the gable of our workshop building, made of steel and glass. The steel task also contains designing a staircase. Again we have the privilege of a sponsored textbook.

In the spring the task is to design a wooden sauna, in groups of two students. The site is given to the students and it is somewhere along the Helsinki coastline. The construction is a frame structure. The total area is about 30 m^2. The holiness and the rituals that we associate with the sauna are essential to the Finnish people. The focus is not only on details, but also on building physics: the course of the water drop is studied carefully, from the roof to the ground and through the wall.

Advanced studies

Our students are usually working in architectural offices during their study years. This is one reason why studies last at least nine years or even more. On the other hand, stu-

Fig. 1

Learning by doing.

Fig. 2

Test walk.

Fig. 3

Canopy over the department yard model.

Tuula Virtanen, Tuula Mäkiniemi-Hassinen, Marko Ahola, Nikolai Bobrov

Fig. 4

Tension and compression.

Liinu Kivioja, Niina Paajanen

Fig. 5

Pavilion for all senses.

Vilma Pyykkö, Mikael Thylin, Jonas Löfroos, Miina Ant-Vuorinen, Hanne Klipper, Tommi Rainio

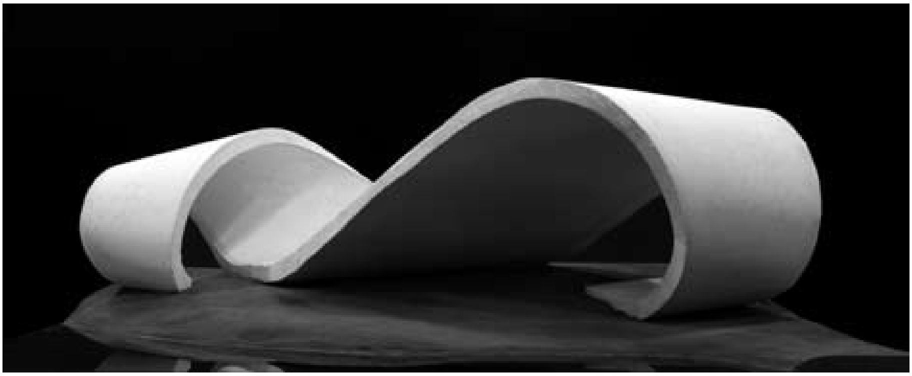

Fig. 6

Curves of concrete.

Aku Jokinen, Anna Nyyssönen, Marko Ahola, Heini Saari, Teresa Winter

Fig. 7

Concrete pavilion theme every year.

Fig. 8

Façade of miniature bricks.

Laura Eerikäinen, Tarmo Juhola, Kaisa Junkkonen, Annukka Leino, Katja Virta

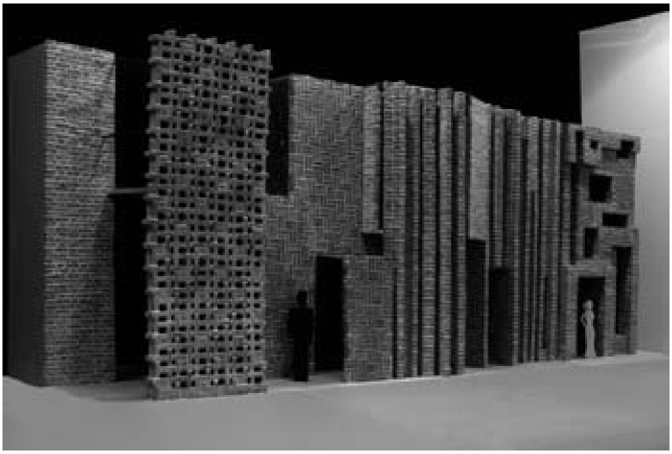

Fig. 9

Row house of brick façades.

Course 2007

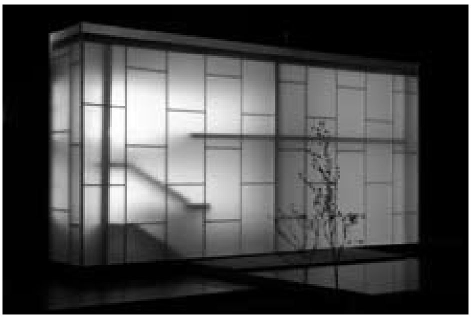

Fig. 10

Workshop entrance of steel and glass.

Jyri Jernström, Noora Lehtovaara, Annimaija Tarkkanen, Jussi Ukkonen

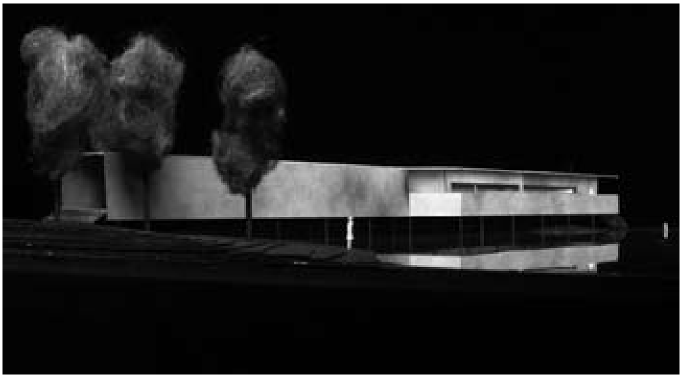

Fig. 11

Private sauna.

Maarit Vilander, Milja Lindberg

Fig. 12

Public sauna.

Joakim Breitenstein, Ilkka Ala-Fossi

Fig. 13

Renovation of an institute into a hotel.

Petja Hyttinen

dents develop their skills through constant interaction with real life during their studies. After graduation they already have the knowledge and skill of an architect that has been working for several years. That is why requirements to graduate after only five years of studies cannot be seen only from a positive point of view. Compressing studies into only a few years do not give the space that is needed to become a good architect. It would mean that contact with working life would be lacking.

Renovation Studio

The Renovation Studio is meant for advanced students who already have participated in many courses and who have experience of working life. As the studio is often given before the diploma work, it summarizes all the previous learning.

The course has its own budget. The owner of the building gives us a certain amount of money. With this amount we are able to employ top architects and civil engineers as our tutors direct from working life. We make a contract between the owner and the students stating that the results of the studio can only be used for marketing the building. Copyrights and contracts have been made for several years in cooperation with the Innovation Centre in our university.

We look for buildings that are in need of new use. The building and the task is different every year. Sometimes the students can suggest a building; sometimes the owner of the building gives us the assignment. This year the building was an old institution, owned by the Helsinki City Real Estate Department. In previous years we have been dealing with water towers, storage buildings, harbour magazines, a cotton factory, horse stables, military barracks etc. Examples of earlier renovation studios can be found in the Gallery on our website.

In the Renovation Studio, the method is to simulate a real architect's work, as far as it is possible. Feedback from our students has always been good. They feel this is one of the most useful courses in our department, and no wonder: today the most common task for an architect is the renovation of an old building. The reality of our course seems to match quite well with these kinds of demands. The course is also open for international students.

The Renovation Studio clearly states that it is necessary to minimize unnecessary mechanical work. For example, the bigger the target building, the more lines to draw, but the educational effect does not improve. However, there is a danger that the extra work removes attention from the architectural design. In my opinion it would be beneficial, every now and then, to zoom in on other courses as well, and to determine if minimizing and integration could keep the students' working load within optimal limits.

For many years we used to cooperate with the departments of Civil Engineering. The students formed planning groups, the way it is done in real life. This seems to be a perfect way of cooperating and when you succeed it is also very educational, but it has certain challenges. The schedules have to match; everybody's targets have to be the same, the level and enthusiasm of the students is also extremely important. Time is also needed because of different phases in the planning process: waiting for the plans of others, overlapping tasks etc. Because of the Bologna Process a return to earlier cooperation would be even more challenging, due to shorter courses with less content, compressed into the tight limits of the terms.

Fig. 14
Kalasatama town plan with the winning entry.
Erica Österlund, assisted by Jussi Vuori

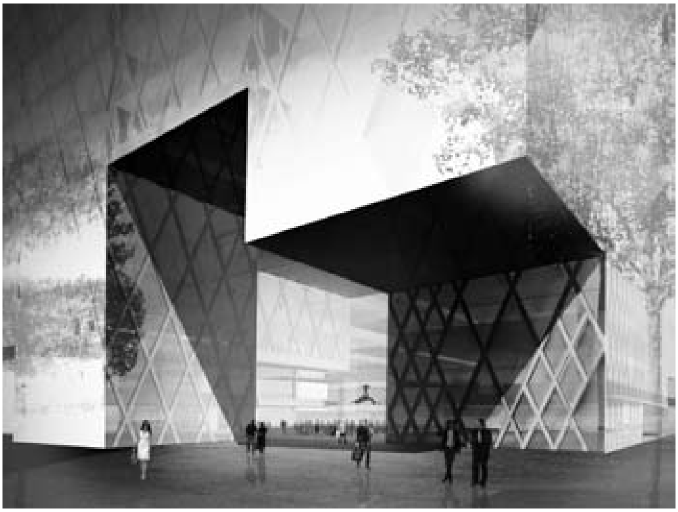

Fig. 15
Entrance of the Kalasatama gate –building.
Erica Österlund, assisted by Jussi Vuori

Product Design Studio

The Product Design Studio is a varying course with a different content. The recent Steel Studio was arranged in cooperation with several partners. The steel company Ruukki acted as our sponsor. The Helsinki City Planning Department gave us the site and the exhibition place. Students from all three Finnish architectural schools were able to participate in the steel studios that were held separately in each school in the autumn, and in the common student competition in the spring.

The site Kalasatama is an old harbour area in the eastern part of Helsinki that will be altered into an office and housing area. The task was to study possibilities of using steel in high rise buildings, as well as to create a captivating landmark for the Kalasatama area. A total of 34 entries from all schools participated in the competition.

The works were diverse and evolved from different starting points. One of the reasons was due to different course demands. In Otaniemi and in Tampere the course was on building technology, in Oulu it was on contemporary architecture. However, the differences between the best entries remained relatively small. Maybe this is an indication of the similarity of the educational targets in all three schools.

Although small deficiencies in the details were allowed, it was important that the entry did not contain too many unsolved matters. The winning entry even exceeded the requirements of a student competition. The jury liked the way the building was integrated into the cityscape. For a steel construction it was innovative and cost-effective.

The competition results were presented in an exhibition place called Laituri, owned by Helsinki City, in the city centre. The media gave quite a lot of space to this event.

Conclusion

As a conclusion I would like to list some of the means that we have tried to apply in our education:

Working with real materials

A well equipped workshop + craftsmen tutors

Group work

Own textbooks

Visiting tutors direct from working life

Connections with other departments and schools

Sponsors from the building materials industry, Helsinki City, building owners, etc.

Learning by doing

Simulation

Course control: feedback, core competencies, straining calculations

Publicity, and public discussions.

Note

Photos 1-12: Anne Kinnunen, Aalto University School of Science and Technology, Department of Architecture

Closing Session

Maria Voyatzaki

I would like to start by quoting a metaphor used by Cristiano Ceccato on the first day. He mentioned the difference between conceiving a child and bringing it up. We are in a situation now where the child is there, after three days. We spent a long time giving birth to it and after we sent it off to you; now we are in a situation to criticize the upbringing of this child. It is good that we have an intimate relationship with many of you after many years of interaction and of the operation of our Network. It is intimate and friendly enough to be open to criticism and to receive criticism. It is difficult to be self-critical when you are close to a situation, but we talked about it amongst ourselves. We also had many of you commenting upon things such as, Where is integration? Where is design? Where is construction? It is a fair criticism to say there were things missing. It is true that while we were thinking of the title of this conference, we thought first about the word "experimenting". "Experimenting" is what teaching is about, as teaching is an intuitive process that we do without having been educated to teach: we have been educated to be architects but we have not been educated to be educators. We are in a continuous and ongoing process of experimenting. Thus when we wrote down the word "experimenting", we looked at each other and admitted that this is tautology as teaching is synonymous with experimenting. Nevertheless, we wanted to put the emphasis on this word, because this is really what we are about, not only as teachers but as coordinators of the two Networks. So this - and do not take this as an insult - was an experiment, to put two networks together. We could not easily say that we have succeeded; in fact, we feel quite the opposite in the sense that, according to some of your criticism, the design has not been quite so distinct and in some cases construction has dominated. Yet the experiment is valid in itself because it has given rise to questions. In contemporary times, when answers are complex, multiple and multi-faceted, perhaps just to come up with a set of valid questions is just as important as it is just to answer a very few questions. From that point of view, we would like to ask for your understanding. Integration, throughout the sessions and the papers that we received, is undoubtedly a question that had and has to be tackled. As with all other networks that we have experienced in the past, there are two extremes of the polarity and then there are things in-between which is the majority of the cases. In drawing your attention to the two ends of the spectrum, however, maybe we can then draw a map of the state of the art as to where we stand when we teach design and construction and how integrated those two things are. The two distinct schools of thought that I could put on the table for discussion depend on different understandings of the design process; namely, the linear versus the seamless. In the linear process, schools perceive integration by increasing complexity of projects that students are first asked to design and then resolve in terms of their detailing, materiality and structures. This is opposed to the second school, which thinks that complexity lies within, no matter what the level and what the actual subject is. In the former case, it runs throughout the curriculum, whereas in the latter case it is -irrespective of the time it happens- in the school curriculum. There was a lot of discussion between hands-on and hands-off, but in the former case, there seems to be a tendency to prepare people for work, to be competent and informative professional architects that can draw well, as opposed to the latter case where employability is not a question. Here, what is important is to create architects that are imaginative and that happens in terms of the process with hands-on material, hands-on prototypes. Criticism of the two approaches could penalize the former as inhibitive of creativity and the latter as misleadingly and deceptively liberating. It is important to return to the core of the matter. The way we speak about it, it seems almost impossible to divide topics, which was the theme of the first day; this rendered it difficult to divide papers into distinct sessions because they seemed to me to belong to different categories. These distinctions are mostly invented for operational and practical reasons. Given this, to talk about integration and yet to split the presentations and respective debates into subject areas is a contradiction in terms. I would like to finish my reflections on the past three days and on the experience of receiving and selecting papers with a word that we architects dislike, which is compromise. I think if we wanted to put a word between design and construction, a word that sits in the middle of an architect's head, it would be the word 'compromise'. This is because to transform an idea into a built form, knowing and understanding less of the real issues and knowing and using mostly efficiently the means, the tools and the processes available to get from the one to the other means that we have to compromise between what we think and what we would like to achieve or what we actually produce. In my opinion, this is an issue we have to transfer to the students. Here I would like to mention what Plasma said about competitions. Testing is an ongoing and real issue nowadays in design. As a result, if we want the list of compromises to be lessened by achieving a built form that is not far from our original ideas, integration is certainly an issue that leaves open questions on how to achieve it. This is what we have been here for. Allow me to leave the floor to other people's reflections and hopefully with this concluding session we will have some ideas on how we can tackle this issue of integration.

Constantin Spiridonidis

I would like to say that the first conclusion that someone could draw from this conference is that things change very fast; faster than we expect, faster than we can keep up with. I was having a discussion during lunch with our friend Jean Marie Bleuss, who is one of the pioneers of this construction network. We were talking about the fact that in the first meeting that we had in Thessaloniki in 2001, the main discussion that developed among the construction teachers during this event was around the issue of whether in the construction courses someone has to teach calculations, to teach the principles and rules of construction. After eight years there is an agreement that out of these two functions, the one design and construction and the other just construction, the second one appears to be undisputedly dominant. This means that we have entered into a new conception of this world of the teaching of construction and design. It means also that we are already in a new conception of how we have to work as teachers in our schools of architecture. In the previous events, in Lisbon and Venice, there was a very dense discussion about the fact that we are experiencing a new paradigm both in conceiving and in thinking about architecture. We agreed that the way that we teach corresponds to the way that we think about architecture. If we really experience a paradigm, then we have to understand what it is about and to adapt our educational practices and approaches in order for it to be relevant to our students. This is why the term "integration" appeared as a key word in our conception with Maria. We put it in the title of this event because we considered that the term integration reflected the ideas that we have developed over all these years in the different activities of the network; in this way the debate regarding the new conditions that we have to deal with teaching architecture could emerge. What we expected was to invite teachers from different schools of architecture in order to discuss this issue of integration. Our project was to investigate how the different schools of architecture around Europe conceive this new condition of bringing together these new aspects of architecture in order to produce a new discourse, a new course of educational environment, bolder than the one we have previously experienced. The method for this project was to call all teachers teaching either construction or architectural design and to give them the floor in order to present their ideas focusing particularly on the question of integration. That was the method. We did not want to eliminate any school. The fact that it was very open made some people unhappy, while the same thing also made many people happy, because there was no kind of limitation. The question was to open the ideas and open up the possibility of different views and conceptions of what this issue was. Now we drawing to a close, the question is whether we managed to define the main question that this conference raised: what integration is. If someone tried to make a recording of this, they could say that there were many versions of the conception of integration. Integration like amalgamation: we have many cases presenting integration in this concept. There is also integration as merging construction and design or blending the two subject areas. There is also consolidating, or fusing, or mixing, or incorporating the one with the other. There is also the possibility of unifying or assimilating or homogenising the subject; there are so many conceptions of integration that it is very interesting to consider what integration is. I have spoken about the changes of paradigms and I'm sure Antonino Saggio will take the opportunity to speak a little about that, but I feel that we did not answer the hidden question that was behind the definition of this question, which was the following: Are we ready in our institutions to teach our students on the basis of the conceptions of the new paradigms emerging from architectural practice and the development of our society? For me, this is the question. Do we have the means and the educational methods to do so? How we can teach now in today's dominating conception of architecture? Are we able to teach according to this conception? What may be observed from the debates and the presentations heard here is that what we are trying to do is to move experiences and conceptions from an old paradigm to a new condition. What I mean by the old paradigm is something based upon a conception of reality and of complexity. We always knew that they were complex, but we have a completely different strategy against complexity and reality. The old paradigm, the modernistic, conceives structure as something which is a structure with distinct load bearing and non-load bearing elements and what we have to do is to split these realities into smaller pieces, to define the relationship between these pieces and after to reconstruct reality in new terms. This is exactly the way that we have been teaching up to now. We consider architectural knowledge as something, which is a block that we split into many small pieces; we define these small pieces as different subject areas and we organise a curriculum based upon the teaching of construction, of architectural design, of history, of mathematics and so forth. What is different in the new paradigm is that this relationship between these small pieces is not stable but changeable. We no longer speak about space, but about fluid spaces, dynamics fields, unstable and changeable forces. All of this urges us to rethink the curriculum, the structure of architectural knowledge, the whole structure of our educational system. Certainly we do not yet have the answer. I am certain, however, that with this type of exchange, the answer will emerge, through exchange, through collaboration, through all the views heard. This conference has made a small step forward in what we need to redefine what we are doing and why we are doing it. Thank you very much.

Antonino Saggio

I have a great deal of admiration for these conferences and in particular for the work of Dino and Maria; I try very hard to learn from them and to help as much as I can. I think we have to concentrate on the fact that we, as human beings and as teachers and architects, do not move in a linear fashion. We move in very different ways, in spirals, we jump, we go back and forth; to arrive at a certain point, we make a very long, incredible tour. It is very important to understand this, otherwise we get frustrated because we assume that changing our way of thinking is a journey that goes from A to B, and in trying to organise things, you expect something to happen immediately. Instead, it is actually about creating a field of forces among ourselves, using our opportunities, ideas, visions, experiments, criticism - which is fundamental - to create a field as series of magnetic forces to move. These occasions are the point at which these forces of transformation are more evident and urge actions.

The actual scope of this series of conferences and thinking is not only to share each other's knowledge and experiences, to understand the network of possibilities, which are important, but also to start thinking how these important new ideas can be implemented and can shape our design pedagogy.

Now for years all approach to teaching was derived by an idea of analytical separation. Not only our teaching but practically all of Western science was based on this idea of separation. Equally, a large part of our advancements came from this idea of separation. So logically our teaching was based on this idea too. Hundreds of centuries have shown exactly that dividing was a way to make progress, by chopping the problem into parts, in dividing, for example, religion and science, dividing maths and literature and then sub-dividing all of that, even cutting our body into pieces in order to understand how it works. Now we are at a time where there are two factors that show us that we can do much more. It is a time in which a holistic way of thinking can come together again and push us no longer to think in terms of "analytical separation" but in terms of "systematic integration". There are two main forces behind this. One is information technology because it creates a real environment of integration, of hypotheses and of interconnection. We have, in other words, a real instrument that allows us to go into a real complex integrated domain. The second reason depends on a real historic reason. The problem is that the model of integration, as well as the model of separation, are not only models of thinking, are models of being in the world. The whole idea is separation implies the fact that we can exploit resources, as if they were separate one from the other! It is the idea that we can always expand, go beyond. Nowadays, however, we are in a position where we see that the opposite is true. If we do not pay very close attention to how processes are "integrated" with each other, to how our whole cycles have to refocus on themselves in some way. If we do not use the sources in an integrated way, a cyclical way, we are going to die. It is that simple. The biosphere is a complex neurology of forces that interact with each other. There is no such thing as a human being and then environment: that is one of those typically horrible ideas. Instead there is a inner system of forces in which culture and geology, air and nature, man and architecture are all together. With this horizon in front of us, there is on the one hand the paradigm shift in technology. Technology is not only information technology per se, it is what is happening between the information technology, the product and the material. In Venice there was a very interesting talk on nanotechnology that shows exactly that: the material is not something separate from information technology but they can be combined. So there is this on the one hand, on the other there is the need to go back to an integrated process of doing everything, including of course designing things. The problem is that all of us, not only in terms of the individual mind, but in terms of infrastructure, that is, the system of power, is organised exactly so that there is the opposite system: it is organised around analytica separation. But the transformation has to be started and many things must be done.

Giovanna Franca

I am here in my capacity as chairwoman and I would like to express my appreciation of the session I coordinated because we tried to answer some questions that Constantin Spiridonidis posed. I am pleased because despite the fact that we come from different countries, my feeling is that we have a common way of thinking. So the first thing is that we ask ourselves some questions in the following order of importance: why, what and how. How the instruments and tools operate comes after. First of all, the question of why we teach this. Why do we integrate? In this case, as Jacques Ferrier said yesterday, sustainability and the environment is just an issue, not the main point of architecture. Architecture is architecture in its complexity. This is a very important topic of our session. Sustainability again comes later. The first talk was architecture, and then we confront ourselves on how we can teach, how we can integrate. Here, the very interesting thing is that different countries try to integrate different disciplines from the beginning. This is extremely important. To make the students able to understand the complexities from their first year and to make them aware that architecture in its quality is really the focus of our teaching. Although I teach construction, or construction technology, as we say in Italy, other people teach something different so it is very important to do this. The question of "what" is very important too because we understand that there are different objects: the new architecture and the existing ones. I am very proud to see that in other countries too, conservation of old architecture is important. It is also important that new architecture is reconsidered and revisited from the environmental point of view. The third question is "how". It depends on different levels of course and we very well know that certain sophisticated digital tools are used for the upper level but we also have other intuitive tools and these are at the base. Last but not least, I would like to express my appreciation to the speakers of the session I chaired. Thank you very much.

Katherine Keane

First of all I would like to apologise. Not having been involved with this group before, I am not familiar with what has or has not been done, but when I saw this design and construction come up and then the idea of integration, I became extremely excited.

For me, the practice of architecture is on the point of changing and it has to change to survive. Some sorts of things were echoed by Marco Verde's presentation and even illustrated a little by Plasma. In their work it was shown that what has historically been a linear process is moving into a systemic process. I describe it to my students by saying, the architect in the big black cloak does the sketch, passes it on to another person, who passes it on to the engineer and eventually it ends up on the site in construction and they do not know which side is up! That is changing. I feel it is now systemic right from the beginning; everybody should be sitting around the table, client, construction manager, structural engineer and so forth. They are all involved in the design. This "baby" is like Cyclops: it has many heads; it is a very complex being. This integrated practice is therefore critical; this integrating of construction and design is an offshoot of that. We need to examine the systemic quality of design education. In the session I chaired, there were very many examples of systemic teaching being used, a lot of workshops putting it all together. One thing I noticed going around all the conferences, speaking to different people from different countries, hearing about different courses of structural education, for five, six, ten years, even two or three years, whether in an academy or university, was that there was so much diversity. Yet I think we are focused on the same things. We come from diverse backgrounds but I think there is that recognition and we are all pulling together. For me then, the critical thing is that we are moving towards this systemic teaching, this systemic way of operating in practice and I think that should feed into the architecture. The idea of fabrication, and of the process of fabrication is especially important nowadays. It is no longer the case that you just erect your beams; it is the making process itself that is critical and the student or the architect that is truly conversant with the process of fabrication and the like is going to excel in design.

Spyros Ratopoulos

Having joined most of the sessions that we had earlier, I would like to go back a little in time and say that when we started discussing integration, it was at a point when we realised that fragmentation of knowledge in architecture was creating problems for the students that we were trying to educate. Generally, we found that students were compartmentalising, they were learning things in sections and they very rarely managed to draw together all this knowledge when they tried to produce the final product. In that sense, we started discussing integration; just pointing out that the target is to educate young people to appreciate what architecture is and how they would be educated to be architects and professionals. I don't think that anybody in the academic world thought that we were trying to educate super architects that were going to be able to do everything by saying that they're going to be taught design and structure together and history of architecture all together and construction and possibly energy efficiency. We're not trying to make them experts in everything. What we're trying to do by integrating this knowledge is to have architects that can appreciate each discipline and can collaborate with each other. Something that we felt during these sessions is that each school interprets integration in a different manner and this is understandable. There are several reasons for this. In many cases, it may be due to the preconceived ideas of the professors. In other cases, it may be due to the different characteristics of each school and also the different traditions of each school. There are schools that started operating a few years ago, there are schools that have been operating for almost a hundred years where there are traditions and it is always very difficult to adapt the curriculum and try to introduce new approaches. We must also take into account the size of the school and the number of students. Therefore, some schools emphasise design and try to correlate or support this with other subjects or try to amalgamate the subjects. Other schools concentrate more on the structural part: they may emphasise energy efficiency and try to add this to the design process. We have heard about a number of approaches. We found that some of the schools would set the design project in a general context, by putting it in a city district, in a block building and the apartment dwelling in an urban setting. Other schools would activate design by interrelation of concepts and properties. It is also interesting to see how other schools explore the body of the person, the human being and trying to educate the students with the movements and trying to adapt the design to that afterwards. Everything is a possibility. Yet we can see that in all these different examples there is one aim, that is, to try to educate the students of architecture in a different manner. In other cases, we see a whole integration, a holistic approach, where structure and design, the history of architecture and architectural design are one totality. This is a very interesting approach: we have not only structure and design or energy efficiency and design but the history of architecture, which is something that has to be examined. The history of architecture can teach people how buildings were built in previous times, thus trying to cultivate the minds of young architects in the way they should be thinking once they start approaching a new problem. Some other people, that is, people who made presentations during these sessions, were more conventional. In other cases, there is an emphasis on the integration of design and structure and the application physical model. This is something that nowadays that we are talking about: computers and the digital approach, architects, especially the young architects should also be able to use things that they can build by hand. The digital approach is very vague; it is a two dimensional thing and as it has been pointed out, there is a danger that people might end up being very theoretical. It's very important, especially when trying to educate young people, and in particular those that have come from the last year of High School and are starting their studies, to teach them that they must be able to use their fingers, to see the 3D element or the 3D model in a physical sense. Some people feel that this is very important. In other cases there is the interrelation of morphology, an anglicised Greek word that is the term for the appearance of architecture in relation to the construction, energy efficiency and the structures as well. What I would like to say in closing this summary of the presentations which was entitled "Integration as a Teaching Practice" is that it is interesting to see all the different approaches. We all learn things, what sort of systems we are applying and whether we can adopt some of these ideas and improve the process that we are currently applying in our schools.

Karl Christiansen

The session I chaired was a good one; we were fortunate because during the discussion we disagreed so I'll refer a little to the discussion. It was quite short but we can continue the discussion here. It took its tone from a nice presentation from Cyprus about scale and the human body. It was an investigation of spaces with the human body and the authors showed very nice projects. Such investigations are very good because they never go out of date in that the human body is never out of date; thus here we are going back to basics, which is perhaps something that we need. The result and structuralism could be discussed but the question was whether we should teach our students trends. It was thought that we should perhaps teach what was going on in the world around, in the academic world but perhaps not teach trends directly. So we discussed the relation between the academic world and practice; the presentation was about the first step from education to practice. My belief is that we should absolutely not teach trends. I think that we should not tell the students to do things in this or that way; they have to find their own way and we have to teach them much more basic principles. One of the colleagues in our discussion put it very well when she said, "Don't think of the roof, think of the rain". I think it's important to say such a thing because if you teach the students what rain really is, then you have the chance to have as many roofs as you have students, and that truly is individuality. We also talked a little about whether we should teach mass education or whether it should be differentiated education. Once again, I think we should teach differentiated education because repetition does not particularly suit architecture. Here I must confess that I see architecture as an art. The discussion stopped here but some of us continued it outside. Some people missed some of the kind of basic discussions about what architecture is. Instead of ingesting all these digital possibilities that we see, it was about basics. Then it came to me yesterday evening: I asked myself, have we gone totally mad and gone so far away from our own basic concepts and become so fascinated by other things now that we have created this computer, this powerful calculator? Are we thus on our way to forgetting the human activity of architecture? I think it is important that we discuss this. We are sitting here in Genoa, in a country which has such a culture, one that goes hundreds and thousands of years back, and is so rich, in a workshop which is done by Greeks which have a culture that is even richer and then Frank is sitting in the middle of Disneyland thinking of this form. He is thinking: you have to build this form no matter what it takes and it takes a lot, it takes a Guggenheim fortune to build such a form. Then you go and look at that form in Bilbao and it's only a form, it has no structure! It is just a form; it has no structure, there is no cladding. If you go inside that museum, you can see a sculpture called "Snake". It is much better architecture than the house! I think somebody has to say it: this is very bad architecture, this is not architecture to me at all. It is the same thing with the Disney Concert Hall. In Bejing, I looked at the Bird's Nest and I was very disappointed when I found out that it is not a chaotic system. You do not need a computer to make such a building: it is conventional. It is just some steel frames put together. Anybody who can count to two hundred and has a pencil is able to draw the steel frame to make such a building. It is not that I do not like the computer - we have just seen an incredible example of how to use the computer in creating architecture - but on the other hand we can walk just a few hundred meters from here and we can see an incredible piece of architecture. Every bolt, every column, every beam, everything there has meaning. It has its own meaning. This to me is architecture.

Ramon Sastre

The day before coming here my school had a long meeting for hours about the changes that have to be imposed in the studios of our school. The discussion was about the studios because we have been using integrated studios for sixteen years. Naturally, when you change them, you have to see what you have done in the sixteen years, what you are going to retain and what you're going to improve. I came here with great expectations because I felt that all the discussions would be valuable in many ways; I have heard only half of the conference and the workshops because I am unable to be everywhere at the same time. The things I heard have helped me to understand how we can improve things in our school and what we can all do in our own schools. The sessions today were about structures, which is one of the subjects contained in the area of construction which is a much wider field, so I was not surprised to see how different all the presentations were. They touched on many different things, and so it may be easier for me to group them together in some ways to show what has been said. I've seen that some of the presentations included empirical exercises that demonstrate that the theory of feeling, of touching is something that, it seems, is still valued. Many exercises consisted of constructing things and seeing how they work. I will return to this later. We have also seen that there is great background of preparation: people try to think a great deal about how they are going to teach and how they are going to integrate things. It does not seem based on improvisation, which is interesting. But even very well prepared things are never the same for everybody because, as mentioned before, conditions are different, backgrounds are different as are old schools and new schools which is important in order to create a way to teach and to learn which is what we emphasize nowadays. One of the things I have noticed is that at the moment there is no use of software to learn structures, maybe because it does not exist. Yet we are very used to learning to calculate structures with software. It was one of the first uses of software because it concerns numbers and mathematics. However, there is not much software that is thought to teach structures. I say this because making models is one way but making digital models is another one and these type of models are, as we know, easier, faster and cheaper to do, but you do not touch things. You do not touch things because you do not simulate touching things. It could be done; it must be done. It is not that I imagine putting on a helmet and then something on your fingers but maybe you could touch and prepare things. We did a file-to-factory workshop in my school and the students were eager to use these programs. We showed this software where you use a sliding bar and you change things completely. It was fascinating. At the moment, we are only using it to change geometry, but probably with time we could change other things: the price, the value, the structures, many other things. This is the new way that was mentioned before, a way of seeing things as a whole. You touch something and everything moves: something that up till now was just geometry now moves. Another problem that has not been mentioned is the way to teach integration, that is, with only one teacher or with a group of teachers. It is not only just a question of the number of teachers or of whether you have enough teachers. If you have a number of teachers in a studio and each one represents something in particular, then you are integrating but you are separating at the same time. However, if you only have one, then he has to teach everything at the same time. These are ways that are not being taught and that I had hoped to hear. In conclusion, the things I have heard and seen are quite positive and integration is more present in the schools than I had thought.

Dieter Geissbühler

A lot of things have been said and there are some questions that remain for me as well as this is the first time I have been here. The first thing is a paradox: we talk about the design process and we talk about integration. Isn't the design process the process of integration per se? Hasn't it always been the process of integration? Did something happen between the end of the nineteenth century and today so that we now have a problem in seeing that the design process is the process of integration? There is no closed answer to this question, but it is a question that remains an important part of the discussion. I am hired as a teacher for Baukonstruktion, which in German does not quite mean design and construction but all my colleagues are hired under those terms so we have to teach design and construction which is how it translates literally into English, even if in German it does not mean exactly the same thing. Thus for us it is also a unity in teaching also and that leads to the structure of education, which, if you think about integration, has to be divided between the part that is knowledge and the part which I would call handling, the mechanics of how you do something. I think for the two areas the idea of integration means different things. The third question that we talk a lot about is changes. There seems to be a lot of phenomenal architects that are changing our future. This is what we talk about. If you look at modernity, it might lead to an interesting discussion about what is sustainable; is it the first strata of moderns or is it the second strata such as Schumacher? There are many people, especially in the north or even in Switzerland where there is a very strong second strata whose work today has, in my opinion, more quality and brings more to today's cities and today's life than the work of some of the first strata of the moderns. That raises the question of whether we should not concentrate again more on stable conditions, something that retains its gravity. It's quite simple: it will always be there; as long as we are there, it is there. Some of these phenomena are so strong that we have to concentrate on the changes, that is, the changes in education. Should we not concentrate more on stable conditions, on traditions, on slow changes, which probably deliver and always have delivered a stronger truth than the faster changes? Another point to consider is whether the needs of the human really changed as fast as we always think they have. Are they not a lot more stable if we are not talking about architects but about human beings as an entity? Isn't the reality that we have to deal with out there more stable? Aren't the changes a lot slower than we tend to think they are? Another point being considered in Germany is "immobilien", that is, immobile things. Buildings are immobile: they are stable, they are set on ground, they have their place, they have their relationship to the ground, to the context, so I do not think they are as dynamic even as some of today's lectures try to show. That also leads to the question of how much we can learn from China at the present time. I ask you only to look at the 100 houses. Look at what the result is and its quite ridiculous. I am very aware the way the architect was also very aware when he set this exercise up that the result would come to exactly what it has come to, which is a complete clash of western architecture in this field of 100 houses. On the other hand, we had a very nice session today that raises some key questions. There was the first question of the classification in the field of building technology. It means we find a new set or a new order of criteria to classify the phenomena and the solutions in building technology or in the aspect of dealing with the macro architecture on that level, in order to understand exactly what the tradition brings us today and so what it means to understand what macro architecture is about. That leads to the important question raised of whom are we offering our education to. I firmly accept the plurality of schools and that not all schools should do the same thing. I feel that most of the schools should work for the average architect who is doing average buildings out there, normal houses. This is also in the tradition of a person who built in Genova, Aldo Rossi, and of his distinction between architettura minore and architettura maggiore. Most architects are not going to build monuments, they are going to build very normal houses and if the quality of those normal houses can be just a little bit higher through the education we do, I think we would be very happy in our surroundings.

Maria Voyatzaki

Thank you for the reflections on the last two and half days. I would like to invite comments from the rest of the people around the room who may disagree with what has been raised.

Tilo Einert

It has been interesting over the past three days. It's good to see how different schools approach their teaching, how they like to integrate and what they like to mix. We have seen different mixtures. We talk about change, we talk about the increasing amount of knowledge we have got, about new materials, and new styles and it does not really change just now. We still talk about 4+1, about 3+2, and there is one thing that we would actually need, which is more time to teach all that and it's just not possible. The other point is that I am trying to make a link with Marko Verde's presentation. He looks at the structure itself and tries to make it as efficient as possible with less material, to slim it down and have a sort of slim version. To link it to education, we talk a lot about architecture and about us as teachers but what we actually do not talk about is the student himself, it is still the student that must take whatever comes. However, the issue is that we still follow a type of beaux-arts model in education that is hundreds of years old. Now the students themselves have changed. They have grown up in a consumer society and the way they take knowledge on has changed. To make the system far more efficient I would hope in the next workshop that we get down to the basics of talking about what the student actually needs from us in order to learn. Because we can teach until we are tired and old: if the student does not learn, our job is not fulfilled.

Unidentified speaker

To return to the question of integration, for me it is a question of parallels in discussion. There is a question we did not answer which is what are we teaching? Are we teaching architecture or architectural design? It is a different question. If we are teaching architecture, what I hope is the language or the discipline, then we teach that by the project or by the design If we say that then I think that integration is a question of capitalisation between each experience of architectural design. I think we cannot teach architectural design. It is down to the creativity of each student.

Stefano Musso

Just listening to the discussions over the past few days and thinking of my experience as an architect and as a teacher I just want to raise some points for consideration. I teach restoration and conservation, which includes transformation, as there is no conversation without transformation. The problem is the quantity and the quality of transformation. I cannot divide the result of a design process and the structure because I am in front of a building that already exists and the two or three or four aspects of architecture already exist. So thinking today of the Dome of Brunellesci, I do not think there have been any drawings that we know of but there has been a design process and the result is before everyone's eyes; but apart from this dome, there were the houses around it, there was the town. So I think that first of all we have to educate our students to be cultivated people, without imposing our culture on them but asking them, listening to them, helping them to be thoughtful people, thinking people because there is a dialectic and contradictory, conflicting relationship between individuality and generality. Architects do not think and realise architecture for themselves, or at least they should not. If we think about the area of roofs, we could have a lot of diverse and different roofs. The problem is that, is what is possible, necessary? Is it so important to have a series of architects design a different roof? Ideally, yes it is, because all experimentation brings a result, but then experimentation, diversity and individuality have to find a balance point, which is reality, a common interest in creating a town, a landscape, and a way to live in a sustainable way because we are consuming the resources of our planet. Are we really sure that in this way we are enhancing the creative capability of our students, because in some way if you look at the historic centre of Genoa with four materials: stone, plaster, a little bit of wood, and a very little glass high up, they have been able to create a very huge diversity but one belonging to a common sense, a common language although with a lot of contrasts, because it is a real city. On the contrary, I sometimes see we are producing five, six, seven fashions / points because things are very similar. This raises another point, that of the computer, modelling, digitalising: these instruments are tools, so they are not good or bad. I am happy to have a computer: it helps me in my work, depending on how I can use it. Sometimes the problem is to decide whether the result of my work is the result of thinking, thoughtful, prudent work able to be compared with others in terms of quality, or if it's simply the result of a good application of the tools which are used in themselves. I am not saying we have to abandon anything, we have to experiment, we have to try because only in this way can we merge all the aspects of architecture. The real question is why we are doing this, thinking of our students, but not only of our students. I think we can decide how to teach - there is not only one way or what to teach - we have to teach our student to be a citizen of the world: open, curious, interested in experimenting but able to stop, not to keep following the process because in the end, we give to our followers a terrible, unlimited world.

Antonino Saggio

I don't agree. I feel this is a great statement to start with, thinking about our discussion last night where we were talking about the seventies and open discussions about different missions of architecture and how to confront different visions and all the different possibilities around openly. I started with 'I don't agree' because I think it is much better to be up front with all these complications and different ideas than just to agree on everything. I wrote a book on Guggenheim stating just the contrary of what my friend just said and I said I do not agree. All my effort was to show exactly the opposite. I do not know if I understood well but the issue is that it is not geometry that we are moving, but we are moving in this highly integrated modeling system in which all the parameters of the building are moving together. This is not regarding the cost or the structural strategies, but as a tendency of the behaviour of people and buildings. These are completely different things. So I learnt to say no, I definitely don't agree. As for Bilbao, it is interesting to discuss this a little, because Bilbao is really one example of a system of thinking that optimises parallel conditions of a building at a level that was never achieved in the previous century. Bilbao is probably the most efficient museum ever built; I am not saying something original; it was said by the director of the museum and the director of the city foundation. It is one of the most interesting kinds of interaction in terms of a building that fits the dilapidated, abandoned landscape and is able to create new forces and takes a completely different strategy into consideration. It is a building that takes the form of shapes and it is also able at the same time to create an open space for public use as well as a whole kind of tactic so that the building functions well from many points of view, from the protective point of view to the interweaving of different spaces. Then we consider construction. Construction is a nightmare. Everybody knows that! It is a nightmare, however, because it is the best one, that is very interesting, Guggenheim didn't care about construction because he was concerned with other issues. However, the best bit was building it in that terrifying way, but it was actually the most cost effective way. It was just as simple as that. So what this building shows is an optimisation of parallel sub-systems of design, including the functional and the formative. It is a system able to be optimised in a parallel thinking that was allowed also because of the technology. If you think of Frank Lloyd Wright's Guggenheim Museum in New York, although we all love it, it shows a very anarchist way of thinking. There is a function, there is a form that applies to that function, there is a construction that applies to that form. So it's a very anarchical way of thinking that goes with that project and here we see a parallel of that. The reason why this interests me is that I agree that construction-wise it is pretty terrible, but it is interesting that even in construction there are interesting advances in that how do you really build? That is an interesting issue. In this case there was a triangulated system that had been tried in other ways. Here I agree that the Nest by Herzog and De Meuron in Beijing is not that exciting from the point of view of construction. However, the other advance is that incredibly enough in Italy we have done the worst and the best in this sub-field. The worst are the church by Richard Meier and the MAXXI museum by Hadid in Rome. Why are they the worst from the point of view of construction? Because these are forms that have been thought out as live, dynamic, free, and anti-tectonic forms. We built them instead in solid, pre-stressed reinforced concrete with the result that they cost ten times more.

The best is a recent work by a very talented Italian architect in his seventies called Alessandro Anselmi who has been around since the sixties and is a very traditional type of architect. Despite that, there are a series of other influences on the church that he has built, which is very beautiful. What he was able to invent was an extremely interesting way of building with twisted pieces of solid steel so the actual structure of the church, it is economical, and beautiful and thus well worth seeing.

So it important to say sometimes that we do not agree; if I say after seeing a film, I don't agree, it doesn't mean that the film is of no interest. Having been in Switzerland, I understand the principle of the last statement that we have to teach our students how to build beautiful but ordinary little houses. The problem is our students do not want to. It is the students themselves who feel that there are prizes in front of them and there are opportunities and they have to start to understand how to think and start experimenting in order to face these new challenges. So I think that it is the students themselves who are looking for people who try to put the knowledge in front of them so they can find new ways of doing things. This is at least what I hope for.

Spyros Ratopoulos

I would very much like to make some comments. I would like to start with a couple of examples. In the 1920s, Le Corbusier visited Athens during the CIAM conference, the Congrès International d'Architecture Mondiale. He visited neo-classical buildings and when he saw them he made the following comment: "Look at that beautiful building! Everything is in its correct position: you could never move any element of it, for if you did that, you would destroy the whole building." My second point: ten years ago, I met Oscar Niemeyer in his beautiful office in Rio de Janeiro on the seventh floor above the Copa Cabana. He gave us a perfect presentation, even though he was already ninety years old. He made us the presentation by sketching some of his projects; they were beautiful sketches. He was describing his inspirations and how he thought about everything without trying to explain anything about his project. In a way, I accepted that, because he was a designer. I was not expecting him to try to justify his designs. A third point: when we criticise a project done by the students, the first thing that we ask them is, explain what you are doing and justify your design. Tell us what ideas you have behind your design and try to explain it and try to be rational about it. The reason why I'm giving these three short examples is that when I see some of these examples that Karl mentioned as well as some of the other examples that we have seen, what is the rationale behind some of those? Using some tools, they create forms. We did not see any plans, any sections; we did not see any functional elements of the buildings, the circulation in these buildings; we did not see anything related to the way these buildings operate. People are going to use these buildings. They were forms; what difference does it make if a form is shaped to go one way or another way? Why is one form justified and the other not? Is it created by the human mind, or is it created by a tool, which is a piece of software in a computer? I do not wish to sound old-fashioned, even though I am close to retirement age, but nevertheless I think, when we teach our students, we have to ask them first to learn the basics of architecture. If they have the talent, if they have the potential, if they have the means, they will be able to create fireworks, they can do anything, but they firstly have to learn the basics. We see from architecture that they can be taught a lot about these basics. Digital technology is something that all the new generation will live with, it is the way they are going to use this that is important and I have a feeling that in some cases, it is taking a rather dangerous course.

Marko Verde

Although I was not planning to enter into this discussion, this is my field of interest. I can understand why you still feel it is necessary to have two dimensional plans today. However, I want to refer to what was said earlier about computational systems or software not being interesting because this is a two dimensional world. Computation is different, it is just the opposite because here you can simulate a four dimensional world. Through software application it is possible to create four dimensional worlds where time is the fourth dimension. When it is said that software and computational systems are producing two-dimensional representations or two dimensional outcomes, I can understand why two dimensional drawings are still needed. But today UN studio is quite an interesting example of a process that starts with a computational input and tries to bring to real scale something that also has real qualities. We did not see so much of the structural qualities of this project but I could see that it was something more than a shape, more than a form and this was one of the few examples today of this type. For there is a lot of distortion, there is a tendency to generate almost hysteric forms, that is, forms without any structural integrity. Very often you see an architect propose something or win a competition with a very exotic shape but then, when it is being discussed later, he may admit that a certain part will not be done because it is not possible or because it is expensive and this shape is awkward and the structure at the end will be a non-standard system. Thus I agree that sometimes there is distortion and it is not always clear how we can take advantage of computation. Yet you cannot ignore the fact that today we are immersed in this computation: everybody has an i-phone, a laptop, the very microphone I'm using is based on technology. Some people are worried about technology but we are immersed in it. The worry about whether my results are coming from my brain or from my computer was mentioned, but the computer is an instrument but behind the instrument is also a designer who makes decisions. If we are talking about evolutionary computations, which is a field of Artificial Intelligence, they are specific tools that have a specific brain, a specific engine that is able to generate possible worlds. I use it to simulate a biological world, to simulate the evolution of biological systems. But our designers are also tools with genetic engines that produce something that you can drive in a certain direction. When as a designer you understand the logic of the tool, you can start to interact with the tool so you get feedback. But in those tools - evolutionary computations - there are very interesting parts of the outcome you cannot control. You get into a field where you are starting to interact with the computations so it is not only user and tool, which is something commonly used in traditional practice. As I have tried to point out, the computer is only a tool to make something faster. So a computer is not just to make two-dimensional plans, as we used to make on the technical drawing board a few years ago. When I started, some colleagues were still using such tools. Today is different. If you truly get into the logic of computational systems, you have no need to show two-dimensional drawings to a client and you have no need of drawings to demonstrate your designs because through simulation you can offer a clear vision of your project. If you approach certain kind of geometries, which are different from the octagonal optimised way of thinking coming from modern architecture, how you can hope to explain certain kinds of complexities by using two-dimensional plans? They are two different languages. Therefore, understanding computational language and understanding the logic behind computation is very important.

Issaias Dimitris

The problem is not the computer-aided design; the problem is when we shift the discussion from using terms such as 'building' to be using terms such as 'project'. There is a big difference that lies in the fact that a building talks about the life of people whereas when we talk about the project we derive it from life. Let's face it, architecture is about life.

Nesil Baytin

I would like to emphasize that the problem is not when talking about computers or computer design, but when the discussion is shifted from talking about buildings to talking about projects, it is a change in expression that is created by a generation gap. We used to talk about buildings, whereas now I hear a lot about projects. There is a big difference. The difference is that there is a shift in the discussion from seeing the building as a part of the life of people who are living in and walking around the building. When we talk about a project, we look at the building as something exterior to life. Architecture is about life: this is the point.

I think the use of software has become an example for our students. The problem that we face is our students. It is their life, their future life, their future profession, and as was just said by Spyros Raftopoulos, architecture is life. It is their life, respecting, reflecting but respecting the human being as the user. It is irrelevant whether the user is anonymous, the task of the architect is still to create a habitable environment. Buildings started from this framework. As a teacher, I believe that these software programs should be taught to our students. The problem is that we have to raise the quality of our students to a level where they can be selective because the diversity of knowledge, the diversity of the software available - which has become a commercial market - makes them unable to choose which one is good for them concerning a course, a user, certain preferences, or the locality. I think that we as teachers, whether as teachers of design or of structure, we first of all have to know ourselves how we can deliver the knowledge in order to make them people capable of selecting, because architecture is a profession of decision making and we have a very great responsibility: we decide about the built environment that the future generation are going to live in. I hope we will leave them a habitable world, and not only the forms that we like.

Maria Voyatzaki

I would have been very disappointed if I had left without being able to put some of the pieces of the jigsaw puzzle together. Thankfully, I think I know where the problem is. I think that integration is not happening not because we feel it is not necessary, but because we have different perceptions of it. This is why at the beginning I said that we have two typologies that are at two extremes and we try to define the two. This is the situation at the moment. A third element, or parameter, since we are in the time of parametric design, is the student. I have a lot of respect for the people that spoke before me, especially for Spyros Ratopoulos, who is a very renowned Greek professor, who asked: What is the rationale of the work? Rationalise your work. This is because to Spyros and in the system of values of his generation, in their world, rationality is the top priority. But in our students' world, in their system of values, there is no such word.

So we teach people, the great majority of whom think of a certain set of values that has nothing to do with the certain set of values of our students. The way many of us understand integration has nothing to do with the way our students understand integration. I think this is somehow starting to untie the knot. Exactly because we have different understandings and different perceptions of the word integration, we are in situations like this where we even become too playful to lose our social responsibility when we talk to our students about examples. This is because we try to see buildings like the "Nest" or the "Snake" through our own system of values but when these people created what they did, they came from a different angle. To criticise them using measuring sticks that come from a different world becomes totally irrelevant. On top of that, integration is about contextualization. If we de-contextualize what gave birth to certain things, then we miss the point. Computers have alienated people that cannot follow what's going on in parametric design. This alienated certain people because our students use this every day and they feel the potential danger, which is real and it is lurking just round the corner: people who create things that are not dense with content, values and realities. But I think the same danger was around the corner when they just used a pencil. The way you create something has to do with how you are educated, to have a global understanding of contemporary contexts that give birth to contemporary architecture. When Frei Otto in the 60s and 70s used nature and Calatrava in the 80s and 90s used nature as a reference point, we didn't have the same reactions that we have nowadays that the people at the DRL or the MTec of the AA are doing architecture by observing biology and nature because these people are using computers. However, complexity has in some way to be managed, with tools that allow us to do this management. If, for example, I don't use my phone to do different things, to arrange different things, then I cannot deal with the everyday complexities that dominate my life. I think we have to demystify these phobias around us and understand that we teach people, so we are responsible for looking at things not in a real way. Our responsibility is not to say "I don't like this", rather, we have to see that Bilbao was put on the map after the Guggenheim building was built in it, it was clear socio-economic and cultural phenomenon. To say that we like or we dislike it is a dangerous statement for a professor to make. In the same way, it is difficult to say, that is not the complex "Nest" we set out to build, but it became something simpler. Cristiano Ceccato's lecture made exactly this point. You may have a dream, but that was the case with many so-called modern movement projects. They started out being much more ambitious, but they ended up being much simpler, for economic or maybe social reasons, in order to fit into that context. Therefore, I think that if we want to achieve integration, we have to look at it not in the way that Spyros Raftopoulos is looking at it, but in the way that our students are looking at it. We have to put things into perspective, the life that senior educators and I are living is not the life our students perceive as being their ideal life. We have to bridge the gap, the generation gap between them and us to find a way of understanding it, because they are the future.

Constantin Spiridonidis

I do not wish to repeat things that have already been said, just to close with a few comments. In Greek, the first component of the word "architecture" is "archi" which means "principle". The second is "tecture", or "tectoniki", meaning "construction", so we could say that architecture is the construction of principles. If we accept this definition, then we have to accept that principles are closely related to culture, to life, to ideas and to values. Being related to such things, they are not stable, they are transformable over the years and every architectural production is based on different principles and values so things are changeable over the years. This is the first point. The second point is that there are two types of people nowadays. There are those who consider that when someone observes changes, s/he must concentrate on the state of things, which do not change from one period to the other. There is also a second type of people, those who prefer to look at the changes, to consider them and more significantly, in the transformation of change. Those people may say, for example, the fact that all those people are sleeping, is not significant enough in comparison with the fact that someone is sleeping on the grass, and someone is sleeping in a very luxurious bed. This difference is much more significant than the fact that they are both sleeping. We are experiencing completely different conceptions about things that are changing all the time. The question is what we have to do as teachers. My understanding is that our obligation as schools of architecture and as teachers is, when something new appears on the horizon, to open the door in order to bring this new thing to the table and to try to understand why it has appeared, from where it has come and what it represents. On the contrary, what we observe in our schools - especially in the old schools of architecture - is that, from the moment that something new appears, we close the doors and the windows and try to say that this new thing is dangerous, it is bad, it does not correspond to what we were expecting and we try to protect our students from this incoming danger. Unfortunately, if we observe all these kinds of experiences, we will see that this bad, dangerous thing from outside is coming in from under the door, it is coming from other sources, from our students' computers, or from reviews. Our students bring this new thing into our schools and this is terrible for our schools. It is not just for the students to bring innovation; we also have to be the people who open their minds to innovations, whether we agree with them or not. Our obligation is to explain what this new thing means, where it has come from, and what system of values is accompanying it. For me, as a teacher, this is a moral issue. As we are moving towards a more individualistic society where the individual appears to structure a completely new system of values, we have to understand that we do not share the same system of values with our students. We will never do in the future. So the most important thing for us is to try to understand the students' system of values, even if we do not agree with it, and to try to teach them how they can produce architecture by mobilising and creating something on the basis of the system of their own values. This is just one way of thinking; there are many others. It is very significant and very important that different ideologies appear around the table, that we have the opportunity to think about and to reflect on what we are doing and how, and about which method we can use to do it.

Jean-Marie Bleuss

I appreciate what has been said and I would like to add some things. I think it is simplifying the point to say that students are different from us. With time we can see that the students can be for the group one day and individualistic / idealistic the next. So students show that they are neither individualistic nor community-based, but that they are both. One day they are one thing and the next day they are the other. The complex issue is to understand these complex waves in the way of human thinking.

Tilo Einert

Trying to put the pieces together in my head, I am constantly returning to the idea of bringing up a child. I think that everybody who has children will agree that if you tell a child not to do something, they will want it even more. The learning process is the same with students, even though they are older. I think the secret is motivation; why that young person wants to do it. If we can capture the essence of how can we get the student truly to want to do something that will solve many of our problems.

Maria Voyatzaki

Thank you all for your patience. I think we will close it here. Thank you all for your patience. Thanks in particular to Giovanna Franco and Stefano Musso for being such perfect hosts.

Constantin Spiridonidis

I would also like to express our sincere thanks to the keynote speakers who accepted our invitation to participate in this discussion. We are also thinking about the next event; there was a bilateral proposal from the School of Architecture in Istanbul to organise the next event there. We have to think about the details of this new project in order to invite everyone again to another session and to continue this discussion. We will be sending you an invitation to submit your papers because we are obliged by the European Union to produce something for this event which is also in your academic interests. We look forward to future events and thank for your support and for your contribution to this event.

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