

Accommodating New Aspects of Interdisciplinarity in Contemporary Construction Teaching

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construction -
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EAAE
Transactions
on Architectural
Education
no 34

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Maria Voyatzaki

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Transactions on Architectural Education No 34

EAAE-ENHSA Construction Teachers' Network Coordinator, Project Organiser

Dr. Maria Voyatzaki

As. Professor, School of Architecture, Aristotle University of Thessaloniki, Greece

Editor

Dr. Maria Voyatzaki

Transcription and speech adaptation: Laura Koniordos, Janet Koniordos

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Introduction

Accommodating New Aspects of Interdisciplinarity in Contemporary Construction Teaching

Maria Voyatzaki

EAAE-ENHSA Construction Network Coordinator

EAAE Council

As cultural expression or artistic performance, as meaningful practice or creative discipline, Architecture has always been the outcome of a manifold of complex, multifaceted understanding and acting. Whether it is sometimes dominated by aesthetics; while other times by technique, sciences, and even, sometimes by politics or social and cultural aspects of human life and biology itself, it always remains a multi-, trans-, inter-disciplinary domain of knowledge and practice.

It could be argued that the history of Architecture of the last five centuries is the history of aspects of interdisciplinarity, mainly in the way of thinking and creating spatial manifestations of our social and cultural life. Starting from a multidisciplinary expertise possessed by one person in the Renaissance, architecture has progressively passed through the classical period to those aspects of interdisciplinarity of Modernist architecture, defined around the sciences and then to those of Post-Modernism, defined around the humanistic sciences and later on around the new construction technologies of the High-Tech architecture of the 80s.

Nowadays, architectural contemplation and practice are experiencing a shift of interdisciplinarity characterized by the coordinating, articulating, and dominant role of digital technologies. In this new context the collaboration between architects, computer scientists, engineers, nanotechnologists, material scientists, biologists, environmental scientists and mechanical engineers appears to be increasingly necessary a condition. Creative action takes place in a digital environment which affects all aspects of architectural form from the more abstract and conceptual to its pure materiality. New architectural ideas and concepts related to the generation of forms that correspond to new conceptions of human and social life, of space and time, of nature and context, of speed and change, of communication and globalization, of complexity and order, of stability and movement support and sustain this new condition.

In this context the education of architects and, more specifically, construction education, is progressively transforming in order to keep abreast with the incredibly fast development of technological possibilities and infrastructures; more informed about the amazingly wide variety of totally new construction materials and techniques; more aware of the rapid deterioration of the environment and of the imperative necessity for a built environment, less energy-consuming and more sustainable; more attentive to an increasingly unstable labour market and increasingly specialised professional practice; more conscious of the tremendously rapid transformations of the logics and the ideas which generate contemporary architecture; more sensitive to the unbeliev-

ably fast-changing values and attitudes of our contemporary culture; more responsive to the rapid transformations of our every day life; more responsive to the demand for new forms of interdisciplinary collaboration for generating new forms of contemporary architecture.

The emerging question nowadays is how can construction teaching accommodate this new interdisciplinary reality? How can a school of architecture prepare its students to be good active partners, efficient and productive members of a design team that strives for innovation in architectural form and its construction? What must be the competences of graduates which will ensure their capacity to be effectively adapted to this new professional and academic environment? How could the dialogue with specialists of other disciplines become efficient, fruitful and productive? What will the common ground of the dialogue be? How can this ensure, promote, enhance, and develop, research and innovation in building efficiency and material intelligence?

The volume is primarily addressed to construction teachers as well as to all those other specialists with whom architects have to work. Construction teachers present teaching examples where interdisciplinarity is in action. Teachers that run construction design courses along the lines of interdisciplinary teaching share their visions and perspectives. Specialists such as nanotechnologists, material scientists, biologists, environmental scientists, computer engineers, mechanical engineers present cases of collaboration with architects on the design and construction of contemporary buildings.

The volume is organised around the following main themes:

1. Interdisciplinarity - **representation** – construction – construction pedagogy.

The questions tackled are:

How can computer specialists collaborate with architects in order for a file to arrive at a factory? What are the necessary competences of architecture graduates that can enable them to collaborate with specialists and/or can use software to produce working drawings? What is the role of digital environments in modern construction? How can new representation tools and software aid and facilitate the construction of architecture? Does the production of computer drawings change the teaching methods and pedagogy of construction?

Interdisciplinarity in the design process is not a new discussion and has alluded to the strong involvement in the design of novel buildings of structural engineers from the early 70s. However, the issue of representation and its contemporary perceptions is what forces interdisciplinarity to be in action and brings into the design team new specialists that have to bargain for their positions and status. Representation has ceased to stand alone as a mere communication instrument but is part of a whole, the parts of which are inseparable and indistinguishable. The use of 3-D modeling in design imposes the protagonist's involvement of information engineers in the design team, a new but necessary member of the design team. Design and construction teaching as a simulation of real life situations has to involve information engineers in the

teaching team the same way that structural engineers often run design studios with architects while architecture students are taught structures at a basic level. Working also with students from other disciplines has proved to be an interesting exercise to practise interdisciplinarity. Education has to make a shift from cultivating and ensuring only traditional skills of hand sketching and computer representations to computer programming so that at least graduates can follow, if not create computer models and design parametrically.

2. Interdisciplinarity – **simulation/environmental control** – construction – construction pedagogy.

The questions tackled are:

Can architects alone work on the design of sustainable buildings and settlements? What is the necessary knowledge base that architects ought to have for designing intelligent buildings? How can environmental scientists/engineers collaborate with architects and the design team, in general, in order to produce environmentally-controllable buildings? What are the necessary competences of architecture graduates that will enable them to collaborate with environmental scientists/engineers to produce sustainable energy-saving buildings? Does the use of computers change the teaching methods and pedagogy of construction with an emphasis on the environment?

The relationship environment - interdisciplinarity and effectively their impact on construction education brought up once again the questioning of the definition of sustainability itself. To decide which are the specializations and the education of people involved in sustainable design one has to decide if sustainability is about buildings that consume little energy, and/or fit in their context, and/or use local materials and resources, and/or respond to the local climate, and/or use the latest intelligent mechanisms and systems to perform with effectiveness in the way they use energy to serve a building. It was noted that the relevant literature creates similar confusion by interchanging terms such as 'envelope', 'skin', cladding' 'façade' etc. on many occasions not so innocently used, but mostly to connote certain attitudes to sustainability. There was discussion on the aesthetics –an architect's traditional preoccupation- and on sustainability –arguably a way of creating buildings where aesthetics is the least of a priority. It was certainly agreed that architecture students have to be taught attitudes of respecting the environment which will automatically render them to design with energy consciousness as a way of life and contemplation.

3. Interdisciplinarity – **new material(isation)** – construction – construction pedagogy.

The questions tackled are:

What are the necessary competences of architecture graduates that will enable them to collaborate with specialists in order to use new materials? What is the necessary knowledge for that? How can architects play a crucial role in the creation of new materials? How can material scientists collaborate with

architects in order for new materials to be exploited? Can conventional construction methods allow for the incorporation of new materials in design? How can new materials aid and facilitate the construction of contemporary architecture? Does the use of new materials change the teaching methods and pedagogy of construction?

The discussion on the role of new materials in contemporary construction teaching and the need for interdisciplinarity raised once again issues of definitions of what a new material is. Could the fresh and unconventional use of a traditional material be classified as new material? Whether new or old, in whatever definition, architectural education does not tackle the relationship of students with materials and does not encourage experimentation of any sort. However, one could not deny an extreme shift of paradigm, for the time being, a situation where the genetic code of a building is prescribed by the architect. The term 'material design' is extremely evocative and suggests that one of the skills contemporary architectural education has to pursue is architects able to prescribe materials to the building industry. This new approach has further implications in the way design and construction is taught. Namely, the design of a material puts materiality in the forefront of the design process, which is no longer staged and linear, and whose materiality is not considered last or at some stage in the process. The design of a material could be the central and, at times, only important preoccupation of architects; hence their central task could be to prescribe materials of their desire to material scientists and computer specialists.

4. Interdisciplinarity – **morphogenesis** – construction – construction pedagogy.

The questions tackled are:

What are the necessary competences of architecture graduates that will enable them to collaborate with specialists and/or can use software to produce working drawings? Can conventional construction methods allow for the materialization of designs that have been generated through computer software? How can computer specialists collaborate with architects in order for a file to arrive at a factory? How can new representation tools and software aid and facilitate the construction of contemporary architecture? Does the generation of design through computers change the teaching methods and pedagogy of construction?

Although the way the theme was put forward indicated that the genesis of form and its construction belong to two separate worlds it was suggested that parametric design in a continuum erases this artificial distinction. As a consequence the teaching of design and the teaching of construction is not two processes that either follow one another or overlap but are one and the same thing. This point has been raised in past debates among construction teachers, but it has never before been argued so boldly and convincingly. It is interesting to note that traditional construction teachers who are, nevertheless, updated and use computer software in their teaching and practice as engineers see the potential digital tools offer for the exploration of the loading conditions of a preconceived structure; on the contrary studio teachers use digital tools and software to generate form and to explore their constructability without separating the parts from their whole.

All in all, the discussion on interdisciplinarity and its position in construction teaching has brought up many interesting thoughts of adjusting architectural education to accommodate it. In times of the need for specialists in real life, architectural education can no longer promote the profile of the architect *polymath* nor can it support the egotistic and long-held view of the architect as conductor of an orchestra with little knowledge of the role of each musician or instrument. This dated model has to be reconsidered and architects have to come to terms with their new role as yet another instrument player that still needs to know a lot about 'music', its history, advances as well as what the rules and particularities of the other 'instruments' and 'players' in their domain are. The only possible reassessment that gives architects a prestigious but no longer a central position in the design team is that of book editor rather than author; with the editor having to handle enough complexity to still have both of the responsibility but also enjoy the credit. Only if architectural education, in general, and construction education, in particular, educate their students to coordinate information among various professions and trades involved in the production of a building, will they as architects in practice regain their central role.

The currently separate professional realms of architecture, engineering and construction can be integrated into a relatively seamless digital collaborative enterprise, in which architects could play a central role as information master builders, the twenty-first century version of the architects' medieval predecessors.

Branko Kolarevic,

In: Architecture in the Digital Age · Design and Manufacturing, 2003

Opening of the Workshop

Welcome speech by Enzo Siviero,

Director of the Department of Building Construction of the IUAV, Venice, ITALY

It is an honour to host this event. I believe that construction is crucial and that architecture exists only if it is constructible – I will not say constructed. Professor Carnevale was the director of the Department of Design until three weeks ago, so we had many opportunities to work together and during the past three or four years we worked very hard at trying to connect architecture and construction. Therefore, this event is a kind of culmination, if you will allow me to say so, of the work we have done these past few years and it is our sincerest hope that in the future Professor Carnevale, the current Dean of our faculty and I will be able to ensure that this attitude grows more and more widespread.

I would like to translate a few things Professor Carnevale said; he said that the media are now so strong that everything is shown only from the point of view of image. It is a dream – it is not architecture. It is something that belongs more to the realm of the ideal, where the reality of form and structure, form and technology, and other components, have no place. We see the pretty work of artists, which sometimes I refer to as urban sculpture, rather than architectural buildings. And this is a problem, because our students have learned to think that everything is possible, with no regard to cost, with no regard to maintenance, with no regard to constructibility, with no regard to the kinds of materials we use and, finally, with no regard to what the people who live inside the finished buildings feel. I think that it should be compulsory that every publication featuring this kind of construction should be republished after four or five years showing the same buildings, the same architecture, accompanied by interviews with the people who live there and who have to spend extra money for heating, with the people connected with the work, the contractor, etc. And we are talking about sustainability and the acceptable, and vice-versa. This is an ethical problem that we face in our school, and particularly in the School of Architecture. This is the message that we are trying to establish. This is the reason why, when Maria and Dino proposed this meeting to me through our common acquaintance, Professor Malindretos, I agreed and said that this is exactly what we want to show: that we in Venice are thinking in this way and that we wish to confront what is happening in the European Union and elsewhere head on.

To this end, we are constantly searching for all kinds of scientific opportunities to discuss integrity in engineering and architecture. As Torroja (Opera Unica, Tecnica Pluressa), an old and very famous engineer said, the connection between those who construct and those who design should be so stringent that everyone will know that the final goal is a question of ethics. What we produce will remain for many years to come. Sejourné said a century ago, “*il n’est pas permis de faire laid*”, it is not permitted to make ugly things, and that is not restricted to the aesthetic sense of the word. In order not to make ugly things we have to work conscientiously and perhaps that way we will ensure that our work will live on in the future as something good. As it was in the past, so we hope to be in the future.

To make a small parenthesis: I was in China three weeks ago at the UNU/IAS Symposium – an event that I am sure you are familiar with – and I am happy to

announce that next December we will be hosting it here in Venice. The title of the symposium is *Architectural Engineering: For the Future, Looking to the Past*, and I would like to take this opportunity to invite you to participate. I will distribute more precise details afterwards.

In closing, let me sincerely thank you for being here with us in this magnificent room, dedicated to Manfredo Tafuri, former director of the Department of History of Architecture. Unfortunately, the current director is not here so he cannot greet you, but I will do so in his place. Thank you very much, Maria, for initiating this discussion with us.

Professor Giancarlo Carnevale, *Dean of the IUAV School of Architecture, Venice, ITALY*, made his welcome speech in Italian and Professor Siviero summarised it in his speech.

Welcome speech by Per Olaf Fjeld,

President of the European Association for Architectural Education, Oslo, NORWAY

Thank you for giving me the opportunity to welcome everyone to this EAAE-ENHSA Workshop. One of the reasons these workshops are so important is that they give us the opportunity to communicate with each other throughout the year. It is truly wonderful that there are so many of you here – I think this is a new record of attendance. I want to thank our hosts, Professor Giancarlo Carnevale and Professor Enzo Siviero. Some years ago this was a school that I knew very well. Over the years I have spent many summers here, and I thank you very much for that opportunity and for the friendship you extended to me at the time. As always, I also want to call attention to the excellent work Maria Voyatzaki and Constantin Spiridonidis have done for architectural education over the last fifteen years. One may take their work for granted, but their spirit, their professionalism and their generosity are very rare and I want to thank them on behalf of architectural education in general.

As the title of the workshop declares, we find ourselves in the midst of a discussion about change; we are very preoccupied by change and it is as if we sense that change is taking place more and more rapidly than ever before. Maybe this is true, and then again, maybe it is not. What I am certain of is that architecture is somehow the only stable instrument, the only instrument that within itself is the most stable. We realise that we cannot escape change, and we realise that architecture has the capacity to change; but at the same time we know that so far that change has been gradual. I think that within the idea of construction, within the idea of materiality in relation to the capacity of construction to take on the material and so on, within this instrument that we are going to be discussing over the next few days, lies the core of all architecture: given that we cannot get away from the material, so we cannot get away from a structural attitude. And I think that it is important that we realise that this is certainly not a discussion that starts from zero, it is part of a continuous transformation in which we are participating and that is interesting in itself. It is also very important to understand that we are within a framework of transformation that we cannot escape, and this extends to architecture in general.

At the same time, I am sure that we all realise that there is a challenge in relation to the ideal structure at the moment. It is a challenge within which you can find many possibilities, and how to judge these possibilities is a challenge within itself. Because we cannot come away from the fact that architecture is fundamentally related to structure in a way that requires that we are able to find practical applications and solutions that go beyond the idea of concept and design. And I think that this is particularly interesting with respect to the pedagogical attitude we apply in these changing times. For we have grown up in a world where materiality is taken for granted; kids growing up now do not experience the process of bringing an idea to a material form in the way we did in the past and, since architecture is based on material, this understanding of what the material is and what its capacity to take on a focus is, raises an immediate pedagogical challenge.

I do hope that we can touch upon some of these and other questions in the days ahead. I thank you for coming and I wish you a good workshop. Thank you.

Welcome speech by Constantin Spiridonidis,

ENHSA Coordinator (European Network of Heads of Schools of Architecture), Thessaloniki, GREECE

Dear colleagues, dear friends and dear potential friends, for those who have come for the first time to one of the activities jointly organised by the EAAE and the ENHSA. I will take this opportunity to say a few words about our Network and its relations with the EAAE. The EAAE, the European Association for Architectural Education, is an organisation that has been around for some time and that at least some of you know very well – it has already been thirty years since it began developing such initiatives in the domain of architectural education. The European Network of the Heads of Schools of Architecture, on the other hand, is something rather new and rather temporary. It emerged from the activities of the EAAE, but is financed by the European Union under the framework of the SOCRATES Thematic Network Programmes. It is a project that follows the lines that the EAAE developed but, because it is financed by the EU, it has its own particularities. Its main objective is to facilitate and create the conditions for a productive dialogue between schools of architecture. At this time, each one of our schools is faced with a great number of changes in various forms, and what the Network would like to assure is a fruitful and creative debate between all the actors in the educational community, to enable us to deal with the difficulties that lie ahead in this new European reality that we face.

We have structured this project into two big parts: the first deals with the administrative side of academic issues and is mainly addressed to the heads of schools of architecture; the second is addressed to teachers and contains four Sub-Networks – the network of Construction teachers, of Architectural Design teachers, of Urban Design teachers and of Architectural Theory and History teachers. The concept behind these four sub-networks is the following: all schools of architecture have the experience of existing in the midst of various negative dualities that impede the development of architectural education and that appear to be contradictory to each other, for example, construction and architectural design, theory and architectural design, fine arts and architectural design. They appear as if they belong to different worlds, and in some schools those worlds seem to be incompatible. Therefore, the main concept of our Network and of the four Sub-Networks is, as a first step, to provide an opportunity to structure a coherence between the teachers of those particular subject areas, and as a second step, to find ways to reconcile or at least to bring closer all the people around the heart of architectural education and architectural design.

This workshop is organised under the framework of one of the most successful Sub-Networks that we have developed and I may be a little ambitious, but I believe the others will also succeed and I am sure that we will have the opportunity to achieve our objectives very soon, and at the end we will try to evaluate what we managed to get from this continuous effort.

To give some information about future events related to this effort I would like to inform you that in April we are planning to have a workshop similar to this one, directed towards teachers of architectural design, hosted by the Luciada School of Architecture in Lisbon. This may be a possibility for some of us to meet again soon,

since I know that many of the people here are not only construction teachers or, at least, are construction teachers who do not consider that architectural design is another world. A week later, we will be organising another event, which is to take place in Tallinn, Estonia, entitled, "Towards Stronger Creative Disciplines in Europe". It will be organised in cooperation with the European Schools of Fine Arts and of Music, so it will be a kind of common organisation between three creative disciplines; and what we will try to investigate will be the common grounds between these three disciplines concerning education in the creative aspects of our fields. So this will be the event that will enable us to reinvent the position of the disciplines in Europe with regard to education and research, since, as you know, architecture is not a focus of research preoccupation in Europe. And what I would like to do is to prepare a text that will be sent directly to the Ministers' Meeting that will take place in London at the end of the spring, in which we will try to incorporate our bid for a better position of our disciplines in the European policy of education and research.

I sincerely hope that you have a productive time in the workshop and an interesting stay in Venice, and that we will have an opportunity to see one another in the future.

The Work of the Construction Teachers' Network from 2001-2006: An overview

Maria Voyatzaki,

EAAE Council, Coordinator of the EAAE-ENHSA Construction Teachers' Network, Thessaloniki, GREECE

What has become the routine for the first session, the welcome session, is that we start with the progress that we have made each year since the previous workshop. This year, however, things got a bit out of hand, and the smooth progression has been lost. I will be more explicit in a minute. At the first workshop we had only forty-five people, at the second we had fifty-five, at the third sixty-five and then suddenly this year we are nearly ninety. It gives me great pleasure to be able to say that we have reached this number, and that we have representatives of twenty-five countries here today. I have not quite counted the schools of architecture that correspond to those twenty-five countries, but some 40% or 45% of the audience belong to the old Network people – this has nothing to do with age, it simply means that you are senior somehow in this Network. I recognise faces around me; many of you have become friends over the years, and this closeness that we have managed to develop has given rise to different themes. I may bore those of you who have been to the past four workshops, but nevertheless I feel obliged to give a bit of history to the people who are attending for the first time.

In the first such workshop, hosted by Aristotle University of Thessaloniki, which is my home institution, we started off very tentatively, because when you try to set up a network you never know whether the whole thing is going to work out. We were obliged to start from scratch, we had nothing on the table, which in a way was a good thing, but there was this feeling that we did not quite know where we were going and so we did not know where to start from. So, as I said, we started very tentatively, asking very simple but very crucial questions, and these questions were: 1) *What* do we teach? – referring to the content, 2) *How* do we teach? – referring to the teaching methods and the pedagogy of the subject, 3) *Who* teaches construction? – referring to the specialisations and specifications of teachers who teach construction, 4) *When* do we teach construction within the curriculum?, and 5) *To what extent* we do so? At the time it was an experiment. And we set up the experiment and every school of architecture had to present their case by answering these simple questions. What was evident from this first meeting was a need to meet again; but after answering these basic questions there was a demand from people to concentrate on the issue of methodology, teaching methodology, so people returned asking for a second workshop to be organised focused on the "how" question, on the teaching methods employed by construction teachers when they teach construction.

We had to come up with valid questions but we did not know how to pin down this question of methodology and it was Cyrille Simonet then who came up with the idea of presenting the exercises, the essays, the subjects we give to students, through which we try to get something out of the students and through which we try to convey knowledge to the students. The host institution was Les Grands Ateliers de l'Isle d'Abord, whose director, Myriam Olivier, is here today and will be making a presenta-

tion this afternoon. They very kindly hosted the second event, and people presented the exercises they do by means of posters, slides and video presentations, etc.

At every workshop there has always been a demand for a next one. The third one was held by the School of Architecture of the National Technical University of Athens – we have all the representatives of the unit right here: Mr. Raftopoulos, Mr. Tzitzas, Mr. Goulielmos and Mr. Papalexopoulos are all present for the fifth time. The realization at the third meeting was that there is a change going on in the way we comprehend the world, life, architecture, and there must therefore be an impact on the way construction is associated with architecture and thus on the way construction pedagogy is associated with the school curriculum, the teaching methods we adopt and what we foresee when we envisage the future of construction education in a school of architecture.

If I were to draw an artificial line separating the five events, I would say that the first two concentrated on the past, on who we are and what we have been doing, but since the third meeting we have been concentrating more on how we see ourselves in the future of architectural education and of construction education in particular. So in the fourth meeting, hosted by the Valles School of Architecture last year in Barcelona, we concentrated on the digital world and how it affects architectural education and construction education. Ramon Sastre, the director of the school, has very kindly sent us his regards; unfortunately he is at a workshop in Costa Rica at the moment and could not be with us.

There were two things that affected the way we set up this new workshop. The one is anecdotal and has to do with our interpersonal relationships – I will explain what I mean in a minute – and the other is the bibliography, the contemporary bibliography. Interdisciplinarity, as you see from the programme, is the key word of our workshop, in other words, how we, architects, and how we, construction teachers, regard the question of whether there is a need for people to work with other disciplines and more specifically, whether there is a need for us to work with other disciplines in order to create buildable architecture, as well as how interdisciplinarity is transcribed into educational terms.

I will add an anecdote here about what happened last year. Since the first year most of you have sensed that there are two very clear schools of thought: the fundamentalists or traditionalists, if I may call them that, and those that are less so – I will not call them the avant-garde, because it is quite a harsh term for some. So there are two very strong tendencies. The one says that we have to teach students about conventional materials and conventional ways of constructing and that they can find out all the rest for themselves, for the rest is very little percentage-wise, and a school of architecture is not obliged to teach the uncommon. The other school of thought says exactly the opposite: that contemporary architectural teaching has to understand what is going on in the world, how contemporary architecture is created, how contemporary architecture can be buildable, and how this affects our construction methods and teaching methods. There have been clashes. Of course there is an intermediary school of thought that accepts the two realities and tries to find a middle way. But these two tendencies are always evident and apparent. The ‘apocalypse’ began last year after a presentation made by Oliver Fritz, from Liechtenstein. And what started me thinking about this was something Jeremy Gould said about the

presentation, which was basically, “I do not understand anything about computers but I hugely respect what I saw, because I really think that there is something there that we ought to understand whether we like it or not, because it is a reality”. Then, the next thing that happened was that we met Koen van der Vreken from the Antwerp School of Architecture at the airport and he said “I really liked that presentation from that guy from Liechtenstein, and you know I cannot really teach these things myself. I really think that I need to teach what I know, but I really need next to me a guy like this to work with”. So I left thinking that that there is a real need there, and that even people who possess a certain body of knowledge feel the need of other people to work with.

So then I started looking at the bibliography again, and I found that, for example, Antoine Picon, who I am sure that at least the French-speakers among us are familiar with, had argued for interdisciplinarity in an introduction to a book on reinforced concrete. What he said was that this discussion about other people, different people, getting together to create and make architecture is a discussion that has been going on for over two centuries, and it refers to the debate on whether architecture is an art or a science. Contemporary thinking discusses the differences between design and technology; but are there really such boundaries and such clear-cut situations? Can we talk these days about design and materiality? I remember that Boel Hellman from Sweden said last year that it is wrong to start with the assumption that these are two different things, because then we place ourselves on one of the two sides. Only if we stop discussing them as two different things can we start to look at things with a fresh eye. It is true that interdisciplinarity is at stake in the creation of architecture. In the 70s, you all remember from the theory of architecture, participatory architecture demanded the participation of sociologists in the creation of the built environment; then in the 80s, talking about high-tech architecture, you always needed a civil engineer, a construction engineer sitting next to an architect and designing high-tech buildings together. Then we get into the 90s and the present decade, where computer scientists have got into the game and new materials have appeared, and we start looking at things in a whole new way again. I have a suspicion that I would like to put on the table for later discussion that interdisciplinarity has been an issue for the past thirty years at least, if not forever. However, interdisciplinarity thirty years ago could be defined as a coexistence of independent parts that were trying to find their place while retaining their integrity and independence from the rest. My suspicion and my assumption now is that in times of fluidity and seamlessness, where there are no seams, no transition from one thing to the other, interdisciplinarity is more at stake but there are no clear-cut distinctions. Materials scientists have studied architecture, computer scientists have studied architecture, architects have studied theory, and so on and so forth. So these people get together in their different capacities, but cannot really be clearly defined from the others. As I said, it sounds as if it is a certainty; but we do not live in times of certainty – and this is certainly unclear in my head, that is for sure. But I want to leave this on the table, because this is how this theme came about.

The artificial distinction between the four sessions is merely a practical arrangement. The difficulty in putting this programme together was deciding whether, for example, a paper was on morphogenesis or materials. Many people came to me and asked why they had not been assigned to the session they had requested. The reason

was that when I read the abstract I thought it would be more appropriate to another session; but even so I was not certain, because as I said there are no clear distinctions. I had in mind that the people who belong to the session on materials would talk about computers, people in morphogenesis would talk about simulation and environmental control, and so on and so forth; so somehow the distinction is artificial, as I think is true for interdisciplinarity as such. I will not take up more of the time, because we are already running late, but I would like to explain a few things about the format. For those of you who have come for the first time, it is all new; but those who have attended previous meetings will realise that for the first time we have parallel sessions. When we had only forty-five or sixty people, it was easier to have them all in one room. As you know there is no black and white in these things. To have a large number of people is a good thing, because it means that the theme is interesting (although I am sure that Venice was also an attraction), but on the other hand you may somehow lose the opportunity to exchange ideas. This is a danger, and it is up to you, your alertness and your interest, to keep this discussion going, because you know from the past this is not a paper presentation workshop, which is why we do not call it a conference, although this is debatable, but in any case we have always felt that the debate is even more important than the paper presentations.

So the format is as follows: we have Tafuri Room, that we call Room 1 on your programme, and the people on the left side of the programme will be presenting here. Room 2 is left of the reception area, and that is where the people on the right side of the programme will be presenting. The whole point is that we keep to the fifteen minutes of the timetable for each presentation, and afterwards we return to this room and the people who chaired the two sessions give a very brief description of what was discussed and try to warm the atmosphere so that we can start discussing the actual theme. As I said, it is more difficult than staying in the same room, but let us all hope that we will do our best to make it work. I will leave it at that as far as the theme and the practicalities of the format are concerned, and will just thank once again Professor Carnevale, Professor Siviero, Professor Per Olaf Fjeld, Professor Constantin Spiridonidis and of course all of you who made this happen or are making this happen. I hope that you will enjoy the workshop and that we will all get something out of it.

Theme 1

Interdisciplinarity
representation
construction
construction pedagogy

How can computer specialists collaborate with architects in order for a file to arrive at a factory?

What are the necessary competences of architecture graduates that can enable them to collaborate with specialists and/or can use software to produce working drawings?

What is the role of the digital environments in modern construction?

How can new representation tools and software aid and facilitate the construction of architecture?

Does the production of computer drawings change the teaching methods and pedagogy of construction?

Oliver Fritz

**The Teaching and Research
of Design and Construction
at the Information Age**

Liechtenstein University of Applied Sciences

Last year I presented my work as the last speaker as an exotic specialist. This year I would like to draw a bow as the first speaker at this conference "Accommodating new Aspects of Interdisciplinarity in Contemporary Construction Teaching". That's the reason why I will stay more away from the topics "programmed architecture", "parametric design" and "CNC production". So I would like to give you more an overview about collaboration with specialists in a win win situation and about price decline of medias. Finally I would like to present on the basis of a student-project, how we try to integrate interdisciplinarity into everyday teaching at the Liechtenstein University. Sure enough a fact which is very important for a 'specialist' like me.

For all the world to see is that we are living in the Information Age since several years. And this seems to have influence on the design of architecture: But not only the appearance of architecture changes after the change of paradigms - I think that the way we'll work together in the future will be different than in the past.

Traditionally the profession of an architect was working as an integrator

They were able to understand the different special fields essentially and tried to use this knowledge to control the single aspects to get an overall solution. Working as a generalist he / she knew everything important about functions, forces, materials, typologies etc. and was able to conduct the design and construction of a building.

In Industrial Age architects/engineers became specialists and interdisciplinarity became necessary

While in the Renaissance the ideal picture of a designer was an universal genius, in Industrial Age due to the increased mechanization and rationalization a discourse between specialists became necessary - there was the new job of the building-engineer, structural engineer, stress analyst, housing technologist, facility manager ... and the architect as a designer. Because of partial different and sometimes contradicting goals there were often winners and losers. The big fight between the different engineers started and the main goal was to make the disciplinarily as save as possible. Not the best solution was searched but the most secure one. Even though the collaboration



Industrial mass production Ford Model-T

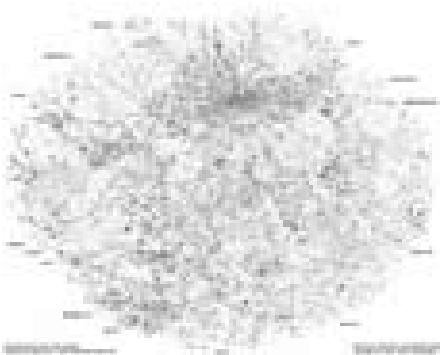


Walter Gropius Dessau Törten

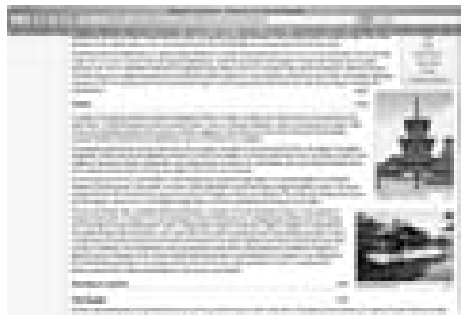
got more difficult, the specialization was important - because buildings became more and more complex. This kind of interdisciplinarity - the co-operation of different special fields leads frequently to a separation between surface and core or picture and structure. The designer has the ambitious task to share the complicated and subjective design process with other engineers. We all learned to "speak" the language of the designer or the engineer in the Industrial Age and to defend our fields of specialization.

In the Information Age interdisciplinarity becomes a new role

In the meantime we've entered the era of Information Age: It is characteristic for this phase, that information becomes of central importance as raw materials and goods. Also the value of information in relation to the goods increases more and more. To be successful it is important to have the competence to inform other people. That is the reason, of the accelerated growth of the Internet - of this giant information-network. It is the germ cell of the all the open source projects and information-platforms like wikipedia. There are thousands of people, which offer their knowledge for free - self-organized - self-adjusted. Phenomena such as Wikipedia show us that (free) provision of information can give us a personal advantage. It's not the problem to get information anymore - but to filter information in the right way.



Internet Mapping



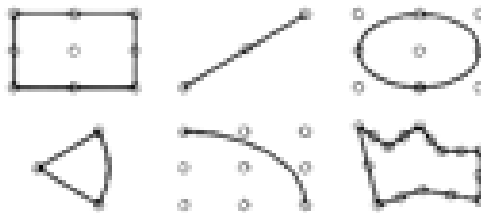
Wikipedia



In the discussion about new interdisciplinarity we have to keep in mind that we are in the Information Age. We have to figure out how to inform the different specialists and how to be informed by them. The Aim is to create with a maximum efficiency a win win situation. Teaching design and construction should consider this fact. Interdisciplinarity seems to be naturally... quality of communication and information will be of rising importance. (Because of its subjective aspects design is difficult to communicate)

**The main (new) tool/media for the (new) Interdisciplinarity is Information
to inform somebody - to be informed by someone**

If we start to discuss the new interdisciplinarity in the Information Age, we also have to discuss the influence of information technology as (new) tools for architects. If we understand computers as support for drawing architecture then it is obvious that a line is a line. Only the cost to produce or duplicate a line with the computer is far smaller than a line drawn by hand. It's the same thing with printing, with rendering - generally with visualizations. The inhibition threshold to draw a stupid line is much smaller than years before, because of the price of a line. And my opinion is that there is a very direct link between the price and the quality of a drawing.



So the discussion about modeling in parametric CAD-Systems we started last year and continued with the keynote-speaker Marta and Sean makes real sense. You charge a line with interactions, rules, dependencies, constrains ... and so it will regain a value and quality. And I'm sure that in the near future every student will learn parametric design.

It is important for our students to understand, that computers don't produce miracles. You may remember last year, where I have shown the digital chain - we developed at the ETH in Zurich - from the digital design process and parametric design - to the CNC production. Maybe in future some architects will be specialists in the way of parametric design - and the good ones will be able to describe what they are doing there. If this parametric design specialist is capable to inform sophisticated designers, then presumably it will be a great collaboration - if not its probably an expensive fight between design and technic. It is also the same with collaboration between architects and handcrafts eg. carpenters. Most of these craftsmen are working since years with CNC technologies and have a big wealth of experience. In the last year I analyzed the communication channel between architects and carpenters and I found out, that many of the architects don't know how the carpenter produces. If they would talk to each other, redundant design- and production-steps could be avoided.

So we have to organize our teaching in a way, to give our students the necessary vocabulary and knowledge for interdisciplinary work - work in networks... in a constant alteration including the knowledge about architecture, construction, materialization, technology and handcraft.

Projects:

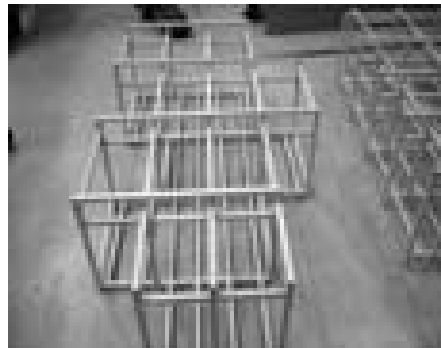
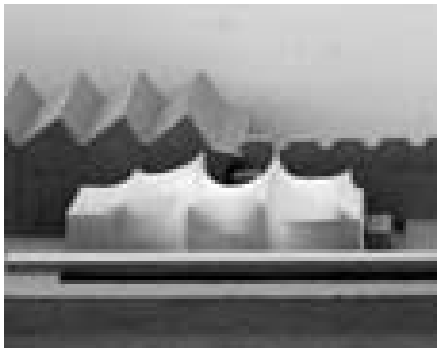
We, in Liechtenstein, believe in teaching interdisciplinary - we integrate different external critics from different disciplines in our workshops. So students have to present their work in an understandable way and in the first years we control very precise which tools they use for the representation. The quality of the architectural results depends more and more in the line of reasoning and argumentation.

Inexperienced students could present their ideas better in a comprehensible world than in a virtual one. So in the design classes, shown in Johannes Käferstein's presentation, it is usually forbidden to work with digital tools. (With exception of the project I will show you next).

Instead the courses are lead by materials, that means they get the material that they have to use for design and representation. Parallel to the design-classes the students learn the basics in digital tools and computer aided design in different lectures. Our aim is after this period in the second year to integrate the digital chain equal to the manual way and the material path into the teaching.

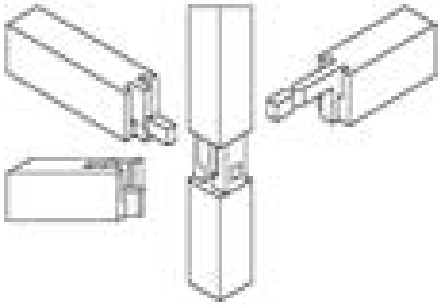
Exemplarily I want to show the design process in a class of the first year which we instructed last semester. The exercise was the expansion of our school with a model-making-workshop about a size of 80 square-meters. The instructor team was formed out of architects, engineers, industrial-designers, carpenters, CAD/CAM-specialists. In the intermediate critics we also invited an artist/art-historian. The result of the course had to be realizable next year in self-construction - together with students. And the idea was also that we want to produce the construction on our CNC-milling-machine.

The outcomes were guided by the procedure of the semester.



Mock ups for representation

Bottom-up the steps of development where differentiated in the construction of the node, of the framework and of the skin. The topic "node" was also divided into a historical view - like the traditional Japanese framework-construction, the process of manufacturing and the possibilities of current modeling and CNC production.

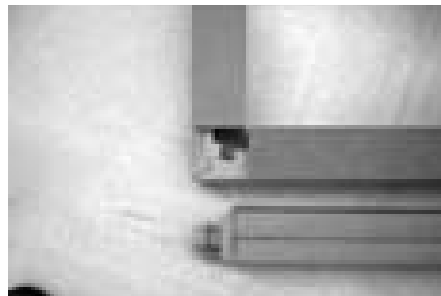
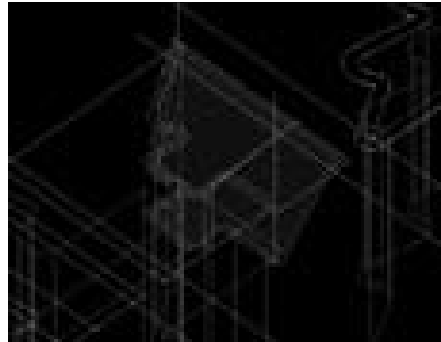


Traditional japanese node

So the students where forced to present in a general-understandable way. They analyzed the nodes with a historical view, they built mock-ups like handcrafts, they translated their construction theoretical for the production (some for industrial, some for cnc / one-of-a-kind), and last but not least they had to design an accurate building, which is constructable. This experimental method seems to be a suitable approach for the first year to learn construction by doing, without copying lines out of specialized construction books.



Students manual skills



CNC millingmachine Liechtenstein University,
Computergenerated millingpath
and the CNC model of the node

Johannes Käferstein

The Material Path

Liechtenstein University of Applied Sciences

"There is a clear RIGHT in our experiments; this is, when it works, when the shelf collapses. Then there is a BEAUTYFUL above the RIGHT; this is when it gets close to the edge, or when the shelf collapses in the way we like it: slowly and complicated – then it collapsed in beauty."

Peter Fischli, David Weiss
speaking about *"Der Lauf der Dinge"*, 1987

The Crisis of Construction

The culture of construction as a basis of all building process has lost its meaning in architecture in the past few decades. Architectural form is not generated through the logic of the building material anymore. Materials are being used in a simplified manner to obtain attractive surfaces covering purely technical structures. To counter this development, possibilities for revitalizing constructive tectonics in architecture and traditional building techniques must be reinterpreted.

Transformation through Fabrication

My first year program at the Liechtenstein University of Applied Science, taught together with Prof. Urs Meister, focuses on the craft of making as a vehicle for the construction of ideas.

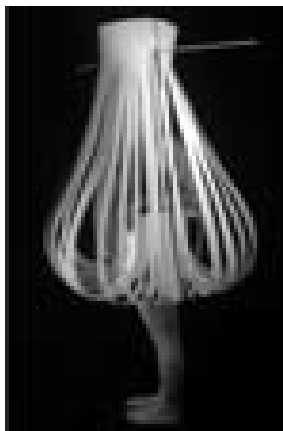
The conceptual approach undergoes formal transformation through fabrication, confronting the laws of quality and character that are part of being material. We work on physical lines of thought and we use a dialectic process of making and unmaking. We create tools to produce new tools that enable us to establish our conceptual path.



Latex Hairy Skin



Leather Belly Corset



Paper Hide Dress



Wood Survival Space

A series of interdependent makes, real and artificial, become our set of personal tools to commute across borders. We consider the making and its unmaking to be the driving force towards architectural articulation, tectonic invention and tactile poetics.

Our experimental approach to material and construction in scale 1:1 articulates an introduction into a field in architecture in which observation and research are more crucial than acquired knowledge and adopted skills. The path of making and fabricating is established from the very start of the first semester. The design process is driven on the inner resistance of the material that causes inventions, transcriptions and raises thematic acquisitions from related fields.

Building Anatomy (The Introduction of Scale in Construction)

The manifold interpretation of human skin and body was the starting point for the design of a second skin, a suit for two students. Not only the relation between pattern and sew, inner lining and jacket or aspects of mobility and the choreography of the performance in pairs played a role. Also the conceptual tension between skin and body, cover and inside, nudity and clothing were subject to intense research.



Dachpappenritter



Gazesumo



Latexanemonen



Goldorak

The students had to decide about their relationship within the second skin. How close does one want to get? How much distance can be held in order to still feel each other? What is a relationship? Where are the physical limitations of one's own body? How do you get dressed? How do you inhabit and give character, identity? The Second Skins were presented on a catwalk for the final review.

The introduction of scale in construction pedagogy is essential. Personally, I believe that beginning students should experience their own scale – the human scale. Therefore we do not build models. The responsibility for one's decisions becomes physical. The consequences are immediate. The student has to include the other in his thoughts and actions. It is essential to understand very early that architects do not work alone. Architects act within community and culture.

Construction and Environment

I am not teaching construction, but all I teach is about construction.

In order to articulate an architectural thought we have to know the tools at our disposition. These tools should be subject to reflection and transformation. The development of our societies throughout history shows that tools have been subject to constant change and not primary building materials. Tools enable us to create our environments.

Environment makes construction specific. Building in the context of the Alps demands a different approach towards material and space then constructing in the context of the Mediterranean Sea.

If we acknowledge this simple observation, sustainable building cultures are being part of a contemporary building education.



Aluminium Tent Ridge



Montechristo Copper Shelter

The Culture of Interdisciplinarity

It seems that the more advanced our technologies become, the more distant we get from what we are actually talking about – material and space. Construction is the joining of materials.

We have been doing this for thousands of years. Though, our tools have changed as well as the needs of our societies. Effectively we are talking about ideas and the joining of these ideas.

The directness and poetics of artefacts – materiality as such and its contextual meaning – are values that we should not neglect, especially at a time of uncontrolled urbanisation of our landscapes and dilution of our cities.

Interdisciplinarity in contextual construction is more than an exchange with specialists. It should be a working culture that inevitably interacts with its environment and society. The culture of construction has to be seen as being part of sustainable, global acting, pulling its specificity from specialised knowledge and its particular surroundings.

Construction is transformation, transportation of content and material – building the material path.

Avraham Mosseri

**The Interface between
free-hand sketches and Computers
in Structural Design**

*Tel Aviv University,
The David Azrieli School of Architecture,
Faculty of Arts,
Israel*

Introduction

The emergence of the computer in the information era brought a lot of benefits to the structural design process as part of the whole architectural design process. In spite of this the free-hand sketches still have many advantages, which can contribute to the integration of many aspects, including the structural aspects, in the architectural creation. This article focuses on the structural design process, as part of the whole architectural design process, in relation to the combination of free-hand sketches and computers. The focus is mainly on specific kinds of projects which are called in this article "archistructure" projects. The term "structural design" is defined here as "the *art and science* of creating structural systems". This definition is especially important when dealing with "archistructure" projects.

The Structural System

The structural aspects are considered to be amongst the most significant aspects in any architectural creation. In general these aspects have a functional role mainly to allow the physical existence of the architectural creation. But, in many cases it is possible to identify architectural projects where the structural aspects have not only a functional importance but also an aesthetic and architectural influence. In this kind of projects, which can be called "archistructure" (architecture and structure), the structural aspects are used to be one of the most important form generators, from the early stages of the design process. In this case it is possible to say that architecture is very influenced by the structure, and that the structural system can not be separated from the visual-architectural system. They are one visual entity.

It is important to stress that the language of "archistructure" is mainly a structural-architectural language and it is only one language between many others, which are not less important in architecture. This language, as any other language, does not have to be used automatically in a dogmatic way in every architectural project, but as an outcome of a responsible and ethical process of context analysis. In general, there are several circumstances, in which there is a rational to use the "archistructure" language:

1. To express a technological image.
2. To create a minimalist design- light structure.
3. To express integrity between structure and architecture.
4. To design a project with a central structural purpose (bridge, etc.).
5. To express an image with association to structures in nature.
6. To solve extreme structural projects (large scale spans etc.).
7. Other reasons.

Examples for projects where the structural aspects have an influence on the architectural language and image (in different levels of influence) can be brought from the works of architects like Santiago Calatrava, Norman Foster, Richard Rogers, Nicholas Grimshaw, Renzo Piano, and others. In addition to these examples from nowadays architecture, it is possible to bring also precedents from early days of the

history of architecture: The Roman Panteon (Berger,1996), the Gothic cathedrals (Brawne,2003:142) and other creations of architects/engineers like Antonio Gaudi, Pier Luigi Nervi, Felix Candela, and others. When the level of influence of the structural aspects is very dominant and it is nearly impossible to separate the architectural language from the structural language it can be called "archistructure".

In many projects of "archistructure", the designer usually gives each (or part) of the structural design variables (the overall geometry, the structural relations between the elements and others, (Mosseri, 2002)), a visual expression in a way that they become a leading visual element in the final architectural language.

Because of this unique connection between the structural aspects and the architectural language in "archistructure", there is a great importance to the design process and its linkage to physics of structures. In this case the design process can be called "archistructural" design (architectural design and structural design). In this process the structural aspects, as leading aspects are "melted" and integrated with other aspects – cultural, sociological, environmental, economical, and others. This issue becomes more critical in the information era, where the computer becomes a more and more influential and vital tool in the design process, and needs a special attention when dealing with architectural education in relation to structures.

The Design Process, Creativity and Structural Design

There are many different ways to design and to relate to different aspects including the structural aspects, but in many cases it is possible to identify a conceptual stage in the design process. This stage is usually characterized by an "open-ended process", which initial target is to create a "wide-span" of creative alternatives and "to open the discussion" in order to expose many directions. In relation to "archistructure" projects - here the purpose is to find the suitable structural-architectural concept between many possibilities, which integrates the structural aspects with other aspects in a way that exposes visually the structural system and uses it as a central element in the architectural language.

In general, the conceptual stage is considered to be creative, non procedural, non linear (each step is not necessarily followed by the other) with insight, associative and imaginative thinking. There are opinions that in this stage people use mainly the right side of the brain. The complementary thinking for this kind of thinking is systematic, rational, logical, and procedural (see De Bono about "lateral thinking" and "vertical thinking", De Bono, 1988).

In the conceptual stage the aspect of "speed of working" (Lawson, 1997:154) is considered to be an important issue, mainly in relation to creativity. The fluent and fast thinking enables the "stream of thinking" to be free and open for many alternatives and for associative thinking. The high velocity enables the creator to deal only with the strategic elements and with the essence of the problem - a fact that reduces cognitive loads during the design process. This aspect of "speed of working" is especially crucial when dealing with "archistructure" projects because the process of integrating physics of structures with architectural language needs a lot of artistic and scientific creativity.

Another aspect which has a special importance in the design process is the visu-

alization - using visual language during the design process. This language enables the integration and fusion of different aspects of knowledge using graphical codes and symbols. It acts as an external memory which holds all the information. When dealing with the structural considerations in "archistructure" this aspect relates to the influence of the physics of structures on the architectural geometry including other considerations - this is the visualization of physics considerations with other considerations.

The fast and fluent process which is visual oriented is strongly connected to free-hand sketches. They have significant contribution to the design process and its structural dimension especially in "archistructure" projects.

Free-hand Sketches, Creativity and the Structural Design Process

Traditionally, in the conceptual stage of the design process designers used to make free-hand sketches with "6B pencil", ink pens, or other hand-drawing tools. The free-hand sketches enable a high speed of working that brings to a fast and fluent process of thinking, which leads to creative ideas. It also enables to concentrate only on the strategic dimensions of the problem and to create schematic-strategic concepts without dealing with details, which can be left to later stages. As an outcome it is possible to scan, in a relatively short time, much more alternatives - a fact that brings to a much more intellectual exposure and to an open dialogue in the design process.

The free-hand sketches also enable the designers to express their ideas visually and to have an integrative tool and an external memory. In relation to "archistructure projects", the sketches are used as an integrative tool to make a fusion between abstract physics and design. In addition to that, the free-hand sketches supply an artistic element to the structural aspects in the design process. This point is especially crucial in "archistructure" language which is "located in the junction" between science and art. It integrates the structural knowledge with the artistic knowledge into a visual solution.

Because of all this the free-hand sketches are considered to be a vital "thinking tool" in the design process especially when dealing with "archistructure" projects.

Computers and the Structural Design Process

The emergence of the computer created many advantages in the design process in architecture, including wider possibilities to integrate the structural aspects in the design process. Nowadays we enjoy a very high level of visual presentation of the architectural creation in different scales, with a high level of accuracy beside many other benefits. In "archistructure" projects, the computer can be used also for structural analysis and for structural simulations from the early stages of the design. In few cases it is possible to find the use of the computer in advanced-technologies approaches like self-organization using parametric-design approach. (For example: Scheurer, 2005).

In this new situation of large-scale utilization of computers, the free-hand sketch-

es are, in many cases left behind because of different reasons. The digital technologies with their graphical simulation abilities tempt many designers "to jump" over the free-hand sketches and to think straight in front of the digital screen. This, in spite of the fact that computers are still not enough suitable for the initial-conceptual stages of the design process. They are still very slow and do not allow speed of working in the initial design as explained above.

In addition to that there is also a relative reduction in the free-hand abilities of designers in the practical world but also of students in the academic world of architecture. Beside this, many teachers for structural design do not have the awareness to develop the student's abilities to draw free-hand structural sketches.

Because of this and other reasons, the fast and fluent process, based on visual language in the conceptual-stage is in many cases more problematic now. This problem is especially critical in the academic stage, where thinking skills, including integration of structural thinking skills, have to be developed as an initial background for the future professional abilities.

In the new reality, in many cases it is possible to see students who prefer to start the design process straight with the computer, focusing mainly on one alternative which is built relatively very slow - "line after line", without lateral and fast scanning of alternatives. When dealing with "archistrukture" the outcome is a reduction in the ability to integrate art and the science of structures in the design process. Similar examples can be brought also from the practical world.

It is important to note that in spite of what is mentioned above, it is possible to identify a group of leading architects who can be a good example for the using the free-hand sketches in addition to computers in the design process – for example Santiago Calatrava, Renzo Piano, Norman Foster, Nicholas Grimshaw (selected examples in: Buchanan Peter. 1993; Jodidio, 1997; Moore Rowan, 1994.) In these free-hand sketches it is possible to identify conceptual and strategic decisions expressed by fluent and fast lines, in a way that integrates the structural aspects with other aspects in an interdisciplinary way. It can be assumed that each one of these architects does not leave the computer and its advantages beside, and many stages in the design process until the detailed result are supported by computers.

It is important to note that even new design methods like parametric design and form generation with computers, do not reduce the necessity and the importance of the free-hand sketches in addition to the computer. In these methods there are still stages in the design process which need visual thinking, spatial integration, fluent and fast thinking expressed by the freehand sketches.

Free-hand Sketches and Computers in Structural Design

According to the facts which were introduced above, different approaches need to be taken especially in schools of architecture in order to create a synthesis between the computers abilities and free-hand sketches in the structural design process. This is especially crucial in relation to "archistrukture" in order to have a more creative and fluent design process, which integrates the structural aspect with other aspects.

For this purpose there is a great necessity to strengthen the abilities of the students to draw free-hand sketches in structural studies (as part of architectural stud-

ies). This should be in addition to the physical-mathematical teaching of structures. Here there is a need to distinguish between the static scheme, which is more suitable to make structural analysis usually when dealing with calculations and the structural sketch, which is more suitable to the initial design stage. The static scheme is an outcome of standard graphical codes, where each structural element - joint, rigid connection, linear component like beam, pile, etc. has its own code. In opposition, the structural sketch, especially in "archistructure" projects, is much more broad and it has to contain the static scheme but also many other aspects related to the overall architectural performances.

It is important to note that the development of the free-hand sketches in the structural field has to be done in parallel to the development of free-hand abilities in other fields of study as a thinking tool for the integration and the fusion of interdisciplinary thinking.

In addition there is a necessity to continue to use methodologies for improving the interface between free-hand sketches and computers. One possible methodology is to use a digitizer pen at the "lateral stage", when searching structural solutions as a "mediator" tool between the free-hand structural sketches and the computer. This can enable a fast and fluent process of working, while in parallel transmitting the free-hand sketches from the working table straight to the computer.

After having several structural alternatives, scanned and organized in the computer, it is possible to develop the conceptual structural sketches into precise and detailed drawings with the help of the computer. This stage is more "vertical" and here the computer can be used much largely.

This methodology can help to have, especially for students, a high quality of documentation of the whole process of the structural design, to classify systematically the final structural solutions and to develop detailed drawings. It is important to note that this way can help to integrate much better the structural aspects with other aspects especially in archistructure projects, where there is a need to cope with a relatively high complexity of integration. With these technologies it will also be possible, especially for students, to deal with the process of the structural design and not only with the final result thanks to a well organized documentation.

Summary and Future Directions

In spite of the fact that computers have many benefits in the structural design process, free-hand sketches still can have an important role, especially for students in structural design studies. These sketches can act as a tool for interdisciplinary thinking in order to integrate the structural aspects with other aspects. In the future it is important to have more research about methodologies for the improvement of the interface between free-hand structural sketches and computers. In parallel, ways should be found to improve the awareness and the abilities of designers, teachers and students to free-hand structural sketches.

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**Vittorio Spigai
Massimiliano Condotta**

**Collaborative e-learning
in Engineering and Architecture:
On-line Design Laboratories**

*University IUAV,
Venice,
Italy*

Introduction

The contribution we are going to tackle in this paper is about a research, and its results, carried out from 2000 to 2006 by the research group, working at the Faculty of Architecture of Venice lead by prof. Vittorio Spigai and its associates. The subjects and the topics dealt with in this essay focus on the transmission of knowledge in Architecture teaching (characterized by a blend of different disciplines and by an high level of multidisciplinary), and on a telematic system for e-learning in architecture.

Four years experience in collaborative e-learning, where practice, experience and developing process, constitute the scientific starting point of the research work that will be illustrated in the following paragraphs.

As a whole, nevertheless, this research is directed to the following sections:

- Protocol analysis for knowledge development sharing.

The study and the development of monitoring systems and protocol analysis of generative processes of the project. Recording and description of the flow of typical and significant concepts that are at the base of the solutions operated by expert teachers. Every flow is connected to a particular problem or objective. Every flow contains in its development multiple references to relevant cases and concepts. This representation can be used as a foundation for comparison and as an element of reference in the valuation of the flow of projects effectively used by students.

- Collaborative e-learning.

The study and the development of e-learning for those disciplines that largely use the technique of "*learning by doing*"¹, the construction of virtual environments with student-teacher interaction, to sum up a system that works as a "*virtual atelier*" where share and store all the practice exercises (the student's tasks and relating teacher's annotation and correction) and where link and relate the whole of the notions grown in this e-learning system with the student's tasks and with the galaxies of theoretical and documentary information which orbit in the web.

Scientific Starting Point

The transmission of knowledge in architecture: a blend of various teaching methods and multidisciplinary.

The research started studying the peculiarity of the knowledge transmission in architecture teaching, since we think that differently from no applied disciplines, in architecture there is a low level of knowledge transmission by traditional teaching methods, instead there is a high level of knowledge transmission with the "*learning by doing*" methodology.

It is well-known, in fact, that students in such fields of study, and in particular in architecture, learn by means of continuous interaction between theoretical knowledge (from lessons) and concepts acquired through examples and advice from experts, and especially through practice on the field (guided with the teacher and/or technical experts).

The main reason behind this different receptivity of the architectural discipline is that even today the didactic transfer methods of theories and design remain assigned principally to a visual-oral tradition (conference with projected images) to practice in the studio (exercises, ex tempore, and workshop) and mainly to the periodically correction of the student's tasks (executed by students individually or in a group at home) by the teachers, correction done one by one but attended by the whole class, in fact, this is one of the most important didactic moment in the teaching of architectural design.

It is easy to affirm that all these transfer methods of the know how of architecture have great difficulty in being established in a unified and shared body of ideas.

In fact, the architectural design creates a moment of great effort of synthesis, in which various knowledge tied to artistic-poetic inclinations (ideas, social and cultural messages of the project) as well as to technical inclinations (functionality, constructibility) but also to knowledge of the different levels of the project (from urban responsibilities, to the choice of materials, of details, of components produced by the industry) are gathered to merge simultaneously since the first layout on the drawing board.

The collaboration and the sharing are afterwards, among the cluster of the knowledge transmission feature, very important and in this field the input of the computing and information technology can be significant. To do this it is necessary to find a way to monitor the multiple experiences and the activity that normally takes place in a didactic room, to record this activity, to select it, use it and make it beneficial in an expert system capable of assisting and monitoring the multiple experiences.

The peculiarity of teaching in applied disciplines resides greatly in the physical support of the student-teacher interaction, which consists of scripts, prototypes, handmade products, or presentations produced by the individual student.

In architecture, the presentation generally consists in an illustrated paper/composition and this composition, marked with suggestions, annotations and notes from the instructor, represents an inalienable moment of synthesis in the teaching and is a very powerful didactic instrument.

Why Teledidactic in Architecture?

It is generally admitted that e-learning represents one of the future universities' opportunities. It could be an essential means for some students categories (workers, invalids, ...etc.) and, furthermore, even today, it may be an important complementary aid instrument to the traditional didactic; but since the previous analysis drops hints, other important opportunities are involved.

The study and the analysis of the knowledge transmission in architecture stressed on the waste of the didactic experience grown in the atelier activity. In fact in the *"learning by doing"* methodology, that is usually played in the atelier activity, a big amount of learning is entrusted to practical exercises conducted with various methods and instruments according to the discipline, characterized by the constant commit-

ment of large amounts of time and energy to every single student to develop his/her personal, individual and specific preparation. Such accumulation of didactic experience generally gets burnt into the training of only a single student.

Teledidactic could be an opportunity to solve this problem and to turn this intrinsic anomaly into an added value, making possible to institute, through a *virtual class*, a permanent exchange community between learner and teachers, and make possible to consult in real time and to record in a knowledge system the collaboration carried out at the design table, collaboration that represents the most demanding didactic work for teachers and students.

To achieve these objective we started to develop a new teaching method based on a telematic system able to:

- reproduce this complex learning process by a distant learning web based teaching system;
- record the knowledge produced in an architectural course and make it reusable in a system capable of share the experiences of the single to all the students of the class and assist the teaching process.

The Virtual Atelier

Storage and sharing of the didactic experience

The educational development passes inevitably through communication of knowledge and operative know how with a relevant flow of ideas and abilities from the expert (teacher) to the student. The complex path of reception and view of papers and their corrections, needs constant references to previous experiences, experimental cases, etc.

The critical interiorization of the ensemble of stratagems carried out is the foundation on which one builds the cultural and technical knowledge of the student. We know that this process is widely destructured and left up to the practice and experience of the teacher. On the other hand, the new interest towards economies of scale caused by the introduction of teaching at a distance in all sectors of education, points out the problem of analyzing and rationalizing these cognitive processes that traditionally happen only in presence.

In such direction, from 2000-2006 the activity of the research group of Venice focused on the following: the construction of an e-learning system based on the idea of a "*virtual atelier*" intended to be used both as a didactic environment (*virtual class*) and as an instruments of student-teacher dialogue for a practice of revision at a distance of the student's design task and papers (Fig. 1).

This system of revision at a distance (the TDraw² system evolved since 2006 in the new and current version named T-Labs³) has been the first operative experiment of exercises online in Italy in the Department of Architecture.

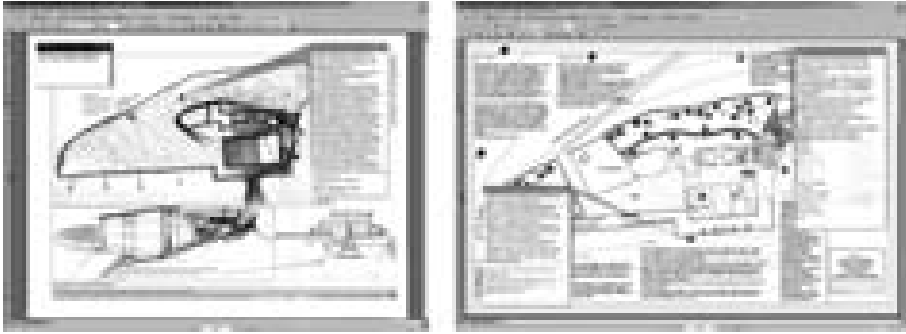


Figure 1
Examples of student's design task with teacher's annotation and correction as exchanged in the "virtual atelier".

The tutorial system: the T-Labs tool

T-Labs is a multimedia asynchronous tool designed to the revision of student's design tasks during architectural design, planning and construction courses. T-labs is structured as a virtual class where students, teachers and tutors, with different rights, share graphic files. This files, that are the students design tasks, are corrected and annotated by the teacher and can be consulted by all the course students.

The main characteristic of this didactic tool, and the basic idea of the whole system is the shift of the atelier activity from the real class in the real world to the *virtual class* in the virtual computer space.

The annotated paper, that is the most important teacher student communication mean, in the T-labs system has been transferred from the paper space to the digital computer space.

The design tasks of the students, theirs drawings, compositions and all sorts of illustrated works, have been converted in *electronic papers* (the corresponding of the real and material paper) in which students can assembly sketches, text, images, photos, cad design, renders and digital elaborations.

In the same way, the activity of the teacher has been transferred from the paper space to the digital space, in fact he corrects the student's design tasks directly on the electronic paper in the virtual space where he can add to the student's design tasks annotations, sketches, images, like writing and sketching on a classical drawing paper.

In our experience we chose to use the pdf as only file format in order to have a standardized database and to allow students to use the design and composition technique they want to perform their design tasks (they have only to convert at the end of the work their composition in Acrobat format).

The student exercises and the revised exercises are stored and exchanged in the virtual class via web (Fig. 2). In this virtual environment all students of the specific course are represented, and in each student box colored icons symbolise the students' design tasks; the different colors indicate if the specific exercise has been revised, or it needs to be revised, or if this exercise is didactically important for all the students and suggests that they should have a look at it.

From the virtual class page, the student can get into his personal page (Fig. 3) and into the single exercise page (Fig. 4). In these sections the student or the teacher may upload or download the files, can check the story of the exercises, and the teacher can check the student's progress. The student find in these pages the files revised by the teacher or by the tutors and the story of a single file recorded in the system (Fig. 5).



Figure 2
Examples of "virtual class page" in the T-Labs system.



Figures 3, 4
Examples of "student personal page" and "exercise page" in the T-Labs system.



Figure 5
The connection between "virtual class page", "student personal page" and "exercise page" in the T-Labs system.

Recording the Activity of the Virtual Atelier

Architectural knowledge decomposition model

During these years of work and teaching, the system has stored a great quantity of students' works files. An enormous quantity of data that presents hints, indications, and suggestions related to the questions pertaining to the project. This material, the recording of the activity of a community of designer-students and a designer-teacher expert, strongly outlined in the pedagogic point-of-view, is presented as very destructured, at first impression, confusing and difficult to consult with. We asked ourselves if and with what methods this wealth of knowledge - in the traditional didactic activity, destined to be erased after use - could be reused and exploited in different contexts; for example, as a new offer within a course.

However, the very nature of the education acquired through studio-practice is nonlinear and this difficult to organize, and carries the risk of reducing it into a list of abstract rules for the project-design or into a manual.

For such reasons, we developed a system that provides the possibility to navigate in a personal manner through the internal contents; a system, who links the exercise to one or more keywords the instructor assigns to the student work.



This indexation motor refers to the decomposition model on a semiotic basis that recaptures the lucid and always valid intuitions of Hjelmslev, revised by Greimas and, in the field of arts and architecture, reworked by F. Thurlemann and A. Levy and our group in Venice since 1980.

Figure 6
Decomposition model for indexation. The colors signal the different categories of concept (orange), typologies (yellow), spatial topologies and other formal structures (blue), and perceptive feature (red).

Conceptual categories of the project generative process

A design course represents, as it has been said, an effort of synthesis in which different abilities and understandings merge together.

The aim that brought to the integration of an indexing system into the virtual atelier, was to understand if and how it is possible to render explicit the tacit form of understanding (which is the know how transmitted at the drawing table in a collaborative interaction between the student and teacher and which is based on the comparison of experiences and imitation) and make the contents and flow of tacit

knowledge useable even to users who are strangers to the process, and even in different locations and time.

Such occurs through concepts that refer to other concepts and which tend to guide and produce the associative process that the student, measuring himself/herself on a projected exercise in the special and stimulating environment of the virtual classroom, puts into action during the brainstorming phase of ideas and solutions to the proposed theme.

In our experience the concepts refer to:

- meaning of the project: significance and profound sense of the project (e.g.: lightness, purity, vivacity, complexity, ambiguity) and socio-functional aspects (e.g.: public, private, representative; hall, living room, court).
- architectonic and constructive typologies: building typologies (e.g.: tower, bi-familiar house, gothic lot), typologies of building parts (e.g.: stairs, bow-window), typologies of constructive elements (bricks, steel; column, wall)
- perceptible qualities: psycho-perceptive proprieties and textural attributes of materials (e.g.: light, transparent, polychrome, smooth).
- syntactic structures: geometries, forms, shapes (e.g.: rectangular, golden section, etc.)
- design actions: operations in the composition and manipulation of the project (e.g.: deformation overlap, include, intersect, divide).
- theoretical concepts: operative categories and consolidated theories in architecture and urban planning (e.g.: land-art, metropolitan area, etc.)
- architectonic, historical and geographical references (e.g.: roman architecture, 1790, S. Geminiano, Chandigard)
- projects tools and design techniques (rhythm, symmetry, proportion)
- recurring errors and didactic advices

Indexation system

In the T-labs system to each conceptual category correspond a keywords category and within a keywords category a list of keywords is recorded relating to the specific concept. Obviously the number and the name of the keywords categories as the number and the names of the single keywords can be set down by the system administrator according to the discipline and course needs.

Going back to the student's personal page, in each exercise page he can find a list of keywords, added by the teacher to his work, related to his design task (for example about the subject of the exercise, or about a typical error or a good solution present in his work). Through this indexation system, the student may find works of other students (recorded in the system memory) that are related to same keywords and consequently and likely regarding the same problems, questions or matters of his design task.

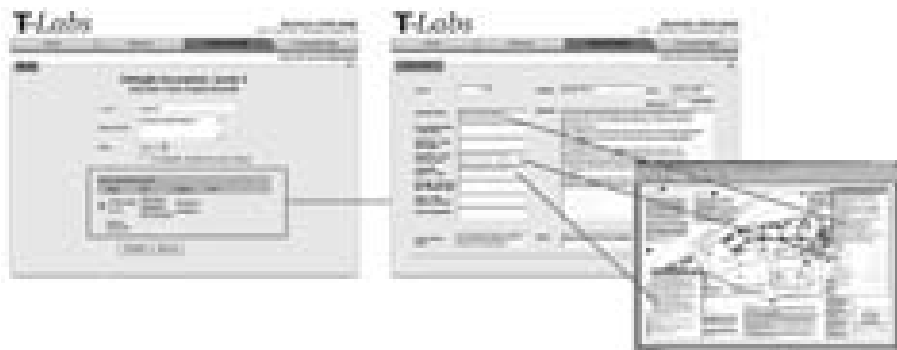


Figure 7

This indexation system is featured by T-Labs and monitors and classifies all the design tasks according to the instruction of the teacher.

Notes

1. Learning-by-doing is a concept of economic theory but it can be used also in a didactic context; in this context it refers to the capability of students to improve their knowledge, skill and training by regularly repeating similar type of exercises or by making errors or finding solutions in their design tasks. The learning process is greater if the student's work result is shared with other students and with the teacher.
2. TDraw, acronym of Telematic Drawing. Cfr. Spigai V. and others (2003), *Didattica dell'architettura in rete*, in *Atti Didamatica 2003* (by A.Andronico, G.Dettori, L.Ferlino, G.Olimpo), Genova, Italia, pp. 247-254.
3. T-Labs, acronym of Telematic Laboratories. Cfr. Spigai V. Condotta M. Stefanelli C., *Collaborative e-learning in engineering and architecture: intelligent systems for knowledge sharing in on-line design laboratories*. Pages 1082-1091 in "Joint International Conference on Computing and Decision Making in Civil and Building Engineering", Conference Proceedings, Editors: H. Rivard, E. Miresco, H. Melhem; June 14-16, 2006 – Montreal, Canada. ISBN 2-921145-58-8 ©2006.

T-Labs software has been developed in 2005/2006 in collaboration with Archeometra s.r.l. (by G. Berti and P. Donà) within the "E-learning and web collaborative design. Implementation systems of tutorial e-learning experiences integrated with systems of corporate knowledge management", project funded by the "Italian Ministry of Education, University and Research" (PRIN National Research Program).

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**Markus Aerni
Boel Hellman**

**Faking the Future -
Creating Interdisciplinarity**

*KTH School of Architecture,
Stockholm,
Sweden*

Introduction

We have been involved in the development of a new interdisciplinary way of teaching for 1st and 2nd year, at KTH Stockholm, during the past 6 years.

By having different teachers of different disciplines present inside the studio, at the desk of the students, a natural interdisciplinary exchange and way of navigating between disciplines, can take place.

In first year teaching, we have separated architecture into different *layers of conception*, in order to be able to think, ask and discuss how each concept is present in the different disciplines.

In second year teaching, we have chosen to add a special focus on studies of different *layers of scales*. This has shown to work as a platform for the need of deepening the student's understanding and interest in finding knowledge and relevant facts, but still be able to work conceptually. This also helps to move easier between abstract and concrete and back again.

This is why we have set the focus of our teaching on conceptualization, communication, collaboration, navigation and presentation within in an interdisciplinary micro world, the studio *-Faking the future*.

Attitude

To learn how to learn

Anything is possible!-You just have to be able to find the appropriate information, communicate with the right people, being able to transform it into your project and have the ability to explain it!



Goal

The teacher as a guide into the unknown future

Today, philosophically, we can't possibly know the details and contents of tomorrow's knowledge. Therefore we should concentrate our efforts on teaching different concrete working methods and creating abstract tools for analyzing and understanding specific facts in an unknown, yet specific context.

Teaching should be like the design process in itself.

-In the beginning, one doesn't know the answers but one knows some methods of getting there without teaching the necessary details and knowledge to everyone-but by showing them how they can find the knowledge themselves.

You need a certain knowledge to know what you don't know.

Means

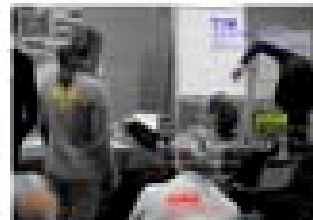
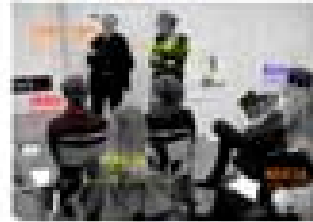
Interdisciplinary teaching in the studio

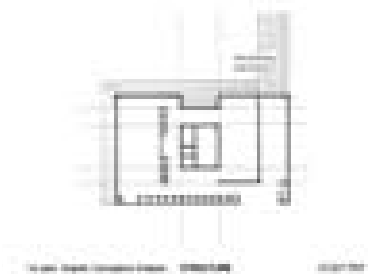
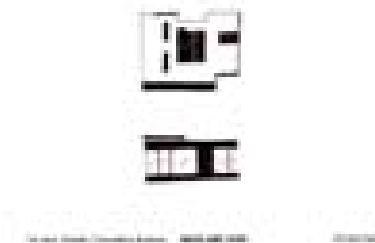
The teaching is based on students working at school on a daily basis, they are organized in studios with 20 persons/unit. This year there were a total of 4 units in second year, which is a good number of competing studios, driving their own idea of specific working method in the studio.

Each unit has its own group of teachers specialised in architecture, art, construction and landscape. The architecture teachers, 2 or 3 are the coordinators of the group but collaborate the whole time with the other disciplines regarding relevant content and strategies of teaching.

We have an alternating schedule with either long interdisciplinary projects with all the teachers involved, or short focus weeks- dedicated to one specific topic and facts of one discipline.

The focus on the common lectures alter-





nates between different disciplines or concrete case studies, by one or a combination of teachers, where a recent project is presented and explained through basic conceptions and through scales. We have found out that a dynamic schedule is very important for the students to prevent getting drained of energy and to keep working at a high speed, producing material.

We think that the first years are very crucial as they create the base of attitude and understanding towards the different disciplines and architecture itself.

This is very important to discuss and to explore in order for students to be able to navigate and develop a relevant communication about their work with all the “actors”.

One day of the week, a practicing construction engineer is involved in the studio teaching. Interdisciplinary tutorials take place every week, a student, an engineer and an architect together discussing a project. This gives the chance to practice very realistic but conceptual ways of developing an architectural project.

The different disciplines can be involved in every phase between abstract and concrete, depending on the different studios set up and believes.

Because all four studios are run at the same time with the same overall theme, the students can easily guide themselves between the different working-methods and get an idea how the set up of a working process and the different disciplines involved can make a difference to the kind and the way architecture is being produced.

Means

Dividing into different layers of concepts and scales

Like a dogma, we have defined 7 basic concepts/layers that we can say architecture always consists of - throughout history and styles. These concepts/words can then form a mutual platform of conceptual understanding within a design process, but reassure that we always are dealing with central aspects of architecture.

All students study the same basic concepts at the same time – for example: structure. By studying one concept at a time, a common understanding and different possibilities of structure are elaborated and discussed by teachers of different disciplines.

1. Structure
2. Mass and Void
3. Light
4. Movement
5. Tactility
6. Place
7. Program

Different courses have different combinations of focus on these central concepts, for example:

Structure + place, or movement + tactility,
or program + light

These concepts/words can be discussed and can be transformed within all different disciplines and into all scales.

1. Structure – How does the structure of mass and void in relation to the load bearing structure of the building?
With the same logic, in a dialog with each other? Why is the structure of the city like that?
How can I use the structure of the material?
2. Mass and Void - The perception of mass/void is made of something, a material or a substance, what?
3. Light - What is the relationship between the load bearing structure and light?



Fig. 1000 Structure/Place

Fig. 1001



Fig. 1002 Structure/Place

Fig. 1003

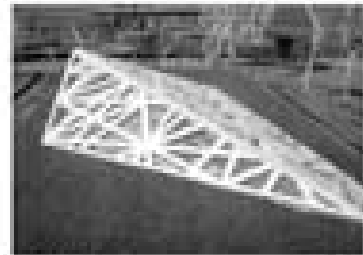


Fig. 1004 Structure/Place

Fig. 1005

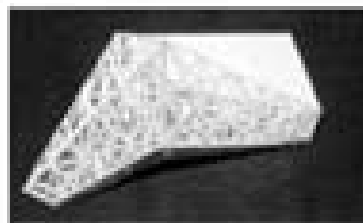


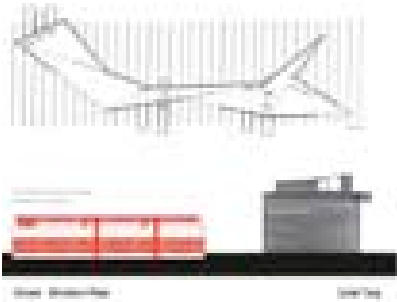
Fig. 1006 Structure/Place

Fig. 1007



Fig. 1008 Structure/Place

Fig. 1009



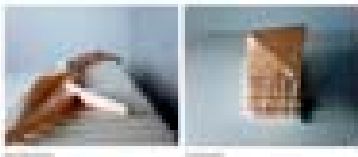
How does the detailing of the openings taking in light affect the light in itself?

4. Movement - how is the movement solved, high tech-elevators, escalators, automatic doors low tech-ramps, stairs, friction on the mass you are moving on? How can a movement be directed by architectural means.
5. Tactility - how are surfaces built up? What is the materiality and the geometrical structure of surface characteristics from nature? What are possible characteristics or properties after a transformation into an architectural surface?
6. Place – how does the geology affect the foundations? How does the local climate affect the layers within a wall construction? Are there specific characteristics of the place to be recorded? Mapping might be a necessary method to find relevant information on site.
7. Program –how can construction transform or make a difference in program? How can you give a program to the construction of the facade? – how “ smart” are your columns, what can they do more than bearing loads?

We have mainly tried 2 different ways of separating the total complexity into smaller parts:

Layers (for example structure + place + light)

In the first year we start to analyse the different layers of disciplines and words of conception in different combination



Scales (for example 1:1000, 1:200, 1:20)

In the second year we introduce the 3 different scales in all the projects in order to deepen the understanding of the need of knowledge to be able to transform abstract thoughts into a concrete solution and the need to understand the different possibilities and restraints into the different scales.



Method

working process

We would ask students to start their design process out of different interests and abstract ideas. Points of departure could be something personal- a fascinating thing or an image together with some aspect from an earlier project, or with an aspect out of our assignments. Asking for different starting points would provoke the students to start producing architectural material from “different points of view” without obvious or with only an intuitive connection. At the same time these individual and possibly personal points of departure guarantee a stimulating and open dialogue.

By analyzing the properties, possibilities and rules of objects or systems –logics can be found and the students can get a set of rules for how to transform a basic concept of architecture into some wanted direction. For the student, the possibility to choose a personal way to proceed gives a great motivation to work further and add depth to the project.

This first phase of a working process would be run as a workshop, always followed by a synthesis week, where all the different layers or scales are put together into a whole. Then we would have an intermediate critic with critics from all different disciplines to get an interesting discussion and to help guiding into the next phase.

In short, an architectural working process would be created by guiding the students through the following working phases:

Workshop

(Learning by investigation and accident)

To study

To transform

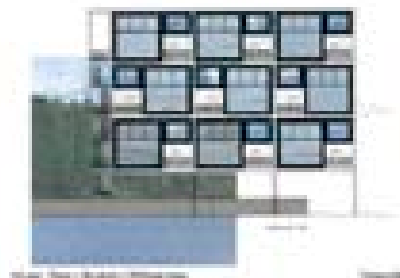
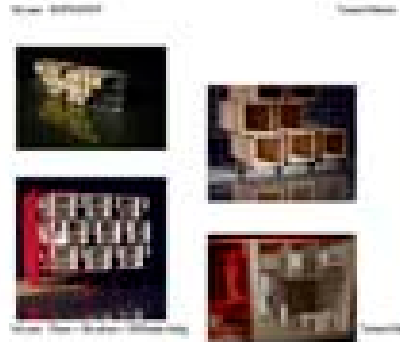
To study

To transform

To study

To transform

Synthesis and intermediate critic





Refine

(Learning by focusing)

To focus

To refine

To make precise

To refine

Synthesis and intermediate critic

Convince

(Learning by showing)

To explain

Why? Where? What? To whom?

To present and represent

How?

Synthesis and final critic

Method

Analysis

To learn how to study your surroundings by being able to de-compose it layer by layer, and scale by scale.

We have two methods of training this: An individual one, that the students always do/ practice when we are on study trips (1 each term), and one in form of a seminar where teachers from different disciplines de-compose the same piece of architecture in front of and in discussion with the students.

Graphic conceptual analysis

The students drawing just one layer of information connected to the basics concepts in different scales,

For example 1:2000, 1:200, 1:20

Context, body and eye/hand are connected by sketching up a basic architectural conception of a project during a study visit or by analyzing an interesting reference project in connection with their own current project in the studio.

Interdisciplinary case studies

Relevant built projects are analyzed by an

engineer, an architect, an artist or a landscape architect in three different scales.

For example 1:2000 1:200 1:20

Context, body and eye/hand are connected by de-constructing a project into basic architectural conceptions and by explaining them.

Method

Representations

We have been exploring different ways of representing architecture by combining different representations of different disciplines in a new way.

The 1:50 or 1:20 cross section in perspective has become a most effective interdisciplinary representation with methodical qualities.

This technical/atmospheric drawing/study in graphic representation has shown to become a splendid tool in the working process as well as in the interdisciplinary teaching.

In an easy way, it generates for the student a direct understanding why he/she has to develop architecture into different scales of concretization, because they have to draw technically into a space. Learning by curiosity and a will to control their drawing gives the students a motivation to learn more about how the construction of a wall really works.

This methodical drawing forces the student to focus on properties of their own projects in order to be able to construct the drawing. These properties are tutored by teachers of different disciplines. The method for understanding and being able to detail a 1:20 - sectional perspective becomes a tool for interdisciplinary teaching.

Conclusion

In order to find appropriate ways of teaching architecture we think one has to force oneself to define what one think architecture is, or should be. We have therefore defined our view



Image: Perspective section and section view

Image: Section view



Image: Perspective section and section view

Image: Section view



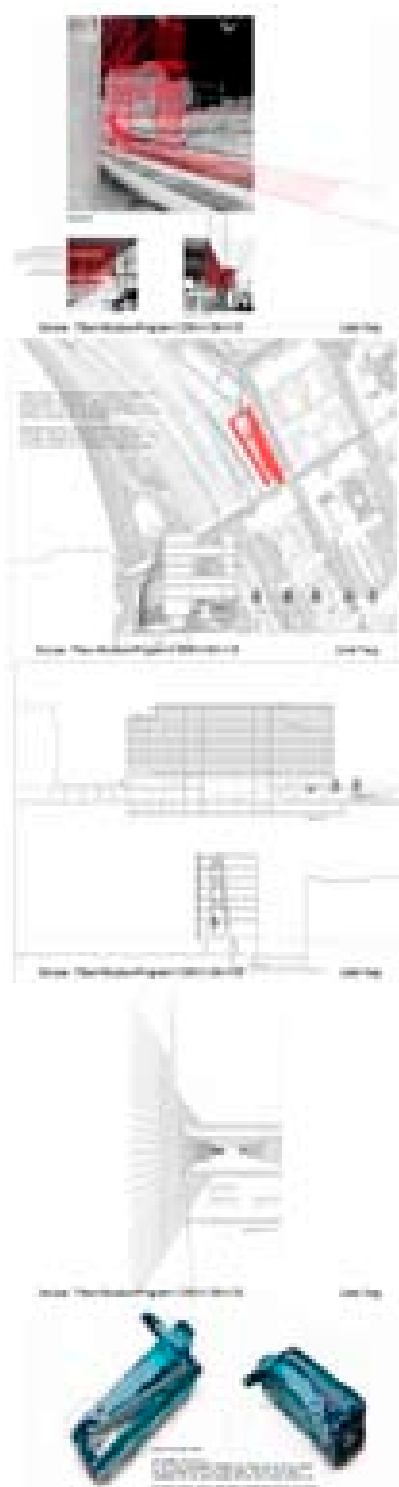
Image: Perspective section and section view

Image: Section view



Image: Perspective section and section view

Image: Section view



and think that “faking the future”-creating interdisciplinary- has helped us guiding our students towards what we believe in.

Creating Architecture is like creating a weave, a meal or maybe even better music- where different layers of disciplines are like instruments that together form the whole piece, with abstract themes or inner logics that order and give rules for relevant possibilities, and constraints, for the shaping of it..

Myriam Olivier

**The Educational Contribution
of Les Grands Ateliers**

*Les Grands Ateliers,
France*

Along the development of a project for a real object, there are different steps to go from the idea to the project, then to the building project, and eventually to the realisation. All these steps make it necessary for representations. They are usually « virtual », looking like drawing, CAD file, form generating software, ... in each case, representation may be considered as a filter that let appear one specific facet of the project, and the final project is a superposition of all of these filters.

During their training period, students learn how to make different types of virtual representations, and what their meanings are.

The Educational Contribution to Teaching at Les Grands Ateliers

In addition to the education given in schools, working at Les Grands Ateliers allows students to approach, in a physical way, the elements of the project elaborated during the courses. The physical experiments realised at Les Grands Ateliers bring other types of representation of the architectural project, quite complementary to the digital or graphic representation currently used.

Through a few examples the unique knowledge and know-how these students have been able to acquire will be illustrated thanks to these trainings which include inter-cultural and physical approaches.

- Learn the *building of material* and the *behaviour of structures*,
- Understand the *know-how of professionals*,
- Become aware of the multiple *possibilities of materials* in the built environment.

As a supplement, Les Grands Ateliers allow educative modes based on the meeting of the cultures of architects and engineers, professors and professionals. The ensuing knowledge is:

- Learn to see their projects through somebody else's eyes
- Understand the importance of putting in common different *abilities which enrich a project*
- Learn to work in a *mixed team*
- Acquire the *building site culture*

Prototypes

Some pedagogical activities imply the *realisation of prototypes* where students make an "experimentation of real life", that is to say that they design, then build projects that fit a concrete and real demand (social or technical). But, simultaneously, they can make work of creativity and invention as these projects are situated outside the markets normally entrusted to the builders.

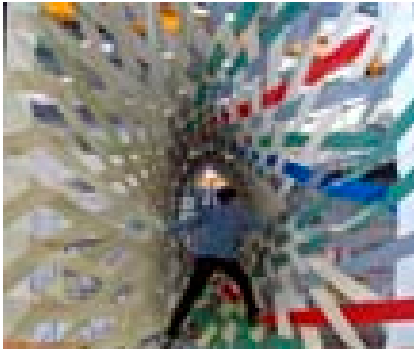
When industrials join together on some of these projects, they bring their knowledge and know-how (new materials, implementation technologies, products adapted to the stakes of sustainable development and still answering the economical imperatives) that enrich the projects by their contact with reality. Their participation allows the

students to a better understanding of the strong interaction that must exist between the actors, both at the level of the design than during the building phase.

The physical representation is therefore situated downstream from the digital execution project and allows confirming its technical feasibility and/or ergonomics. Moreover, when the students have the possibility to act in mixed groups with students coming from other schools, they get further along another step towards the training for the profession of builder, which consists in knowing and understanding the contribution of each type of profession.

Three examples of experiments on prototypes are presented.

- 1) Textile structures / These initial training sessions, designed and organized by Nicolas Pauli, School of Architecture of Montpellier, lead to the manufacture of load bearing structures based on technical textile materials. They are organized in collaboration with the FERRARI Textile Company industries.



- 2) Lighting ambiances / Les Grands Ateliers have organized a competition concerning students of art, architecture and engineer schools whose subject is to propose an urban light installation in the old districts of Lyon. Twelve laureates built their project on site, with the help of Les Grands Ateliers and professionals. Several thousand visitors visited this site in December, 2006.



- 3) Prototype of light habitat / The facilities of Les Grands Ateliers allow the students during their end of studies projects to test the feasibility of the design of light habitats. Several students, of the School of Architecture of Grenoble and St-Etienne, therefore constructed structures out of their plans.



Element of Study

The goal of physical representation may be the understanding of the material characteristics, the study of the properties of a type of structure, or the declination of the realization of one element of the project. These *elements of study* allow the validation of hypothesis elaborated by theory, or go past or integrate the knowledge acquired on the materials.

But the manipulation of materials and elements of structure let it go further than the simple validation of the formulated ideas. The experience of 4 years' functioning of Les Grands Ateliers shows that:

- this step is essential to the understanding of the qualities of the new materials (example: very high performance concrete) or the new building processes (gluing),
- the manipulation of materials is a part of the design phase. Through experimenting materials, students discover by themselves that they can be used differently, create other shapes, be associated with one another, therefore generating new shapes and feeding the design steps.

While manufacturing these objects, be them materials samples, elementary structures or reconstituted environments, students realise a material representation of an idea, that is on the same level of advancement of the project than the one that could be realized with abacus for material composition or shape research software, and complementary to it.

Example:

- 1) Simulation of environments / This two-week original workshop, on the theme of «design of working areas, health and security», conceived by the School of Architecture of Clermont-Ferrand and the University of Technology of Compiègne, in collaboration with the National Institute of Research and Security, is devoted to

student of schools of architecture and engineers. The workshop includes theoretical courses, then the students, in coeducational groups, design and build ergonomic devices for a real site, in a reconstruct environment, answering needs of security. Then they test and verify the operating capacities of these devices.



- 2) foldable structures: experimentation of structures realised from steel tubes, to study the characteristics of the created spaces,



- 3) bridges: realisation of small 1m long bridges, made of wood, strings and glue, in order to learn material resistance and ... have the students practice their creativity.

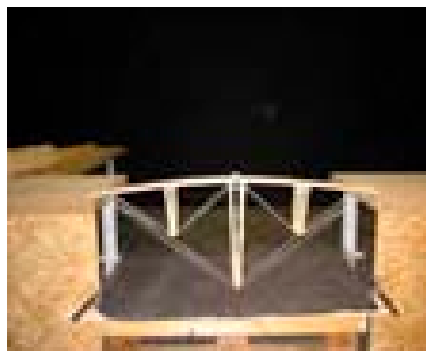
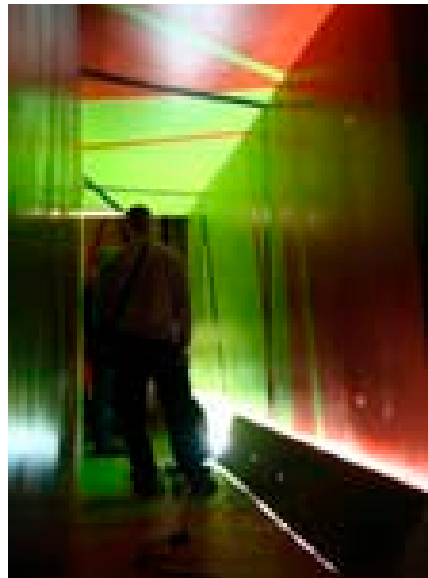


Illustration of a Principle

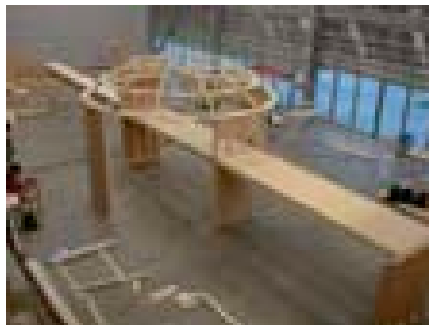
Finally, one last type of object is realized at Les Grands Ateliers. We have called them *illustration of a principle*. These constructions, made by the students, have as a goal the understanding of a principle (structure, materials, aesthetics, space, ambiance...) or the physical translation of a theoretical concept. These objects are educational tools that allow the demonstration of didactical notions mainly for students at the Bachelor level. They are not a representation of an object with an utilitarian function in the domain of architecture, but allow the formalisation of notions of space and shape, ergonomics, light, plastic art, as well as of structural technology.

Example:

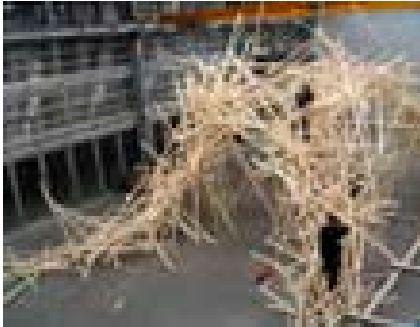
- light and space: full size building of small models used to design environments out of colours and light. The objective is to teach students how to go from the project to real environment.



- wood technology: realisation of a wooden structure implementing different building technologies.



- built environment and art: building of a built environment whose objective is to understand the place of art in architecture.



Branislav Zegarac

Experience in Teaching Studio Architectural Constructions

*University of Belgrade,
Serbia*

Introduction

In 2005/06 at the Faculty of Architecture University of Belgrade a new curriculum started based on ETCS system of credits. The result of this reform is a completely new approach of studies oriented towards a *studio-based* didactic method. This change inevitably reflected on the concept of courses oriented towards problems regarding architectural constructions.

The hierarchy of the reformed curriculum concerns two typical levels of studies:

- *undergraduate* studies lasting three years (180 ECTS),
- *graduate or diploma-master* studies lasting two years (120 ECTS)

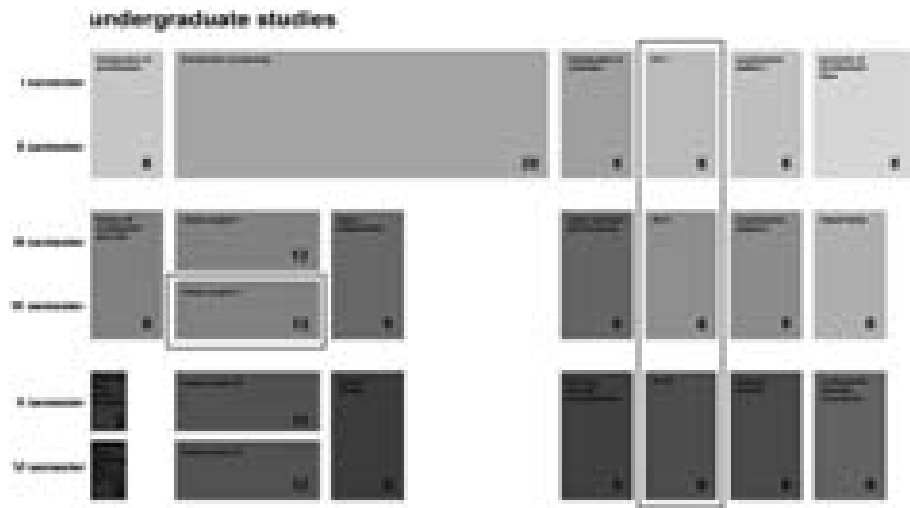


Figure 1
Scheme of a concept of undergraduate studies

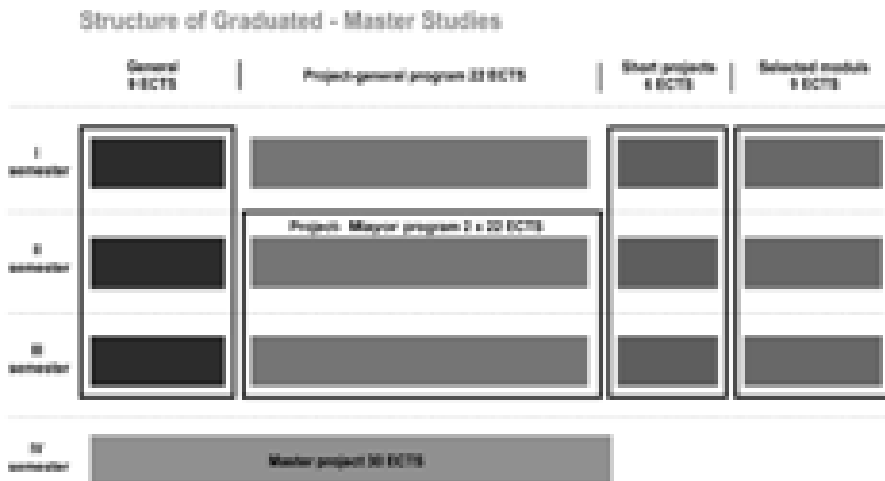


Figure 2
Scheme of a concept of graduate - master studies

After the first generation of students who learned Architectural constructions in studios we have significant results in teaching concerning aspects of interdisciplinarity.

An Interdisciplinary Architectural Construction Studio

Implementation of a studio-based didactic method in the field of architectural constructions starts in the fourth semester. During this semester students are engaged in architectural construction studios on design projects, focused on aspects of construction and materialization of a building.

The topic of the project is a relatively simple building type that combines small and large spans of structure, such as small sport or industrial buildings, car show rooms or similar (approximately 1500m²). This particular design project asks for specific requests from students.

Architectural constructions studios are based on the *interdisciplinary approach* and include four teachers from different disciplines:

- Two architects specialized in architectural constructions (professor and assistant or doctoral studies student)
- One civil engineer (professor or assistant)
- One architect specialized in installations, (professor or assistant)

Also, in the studio specialists in architectural design can be jointed, such as architects and engineers from building industries, producers of building materials.

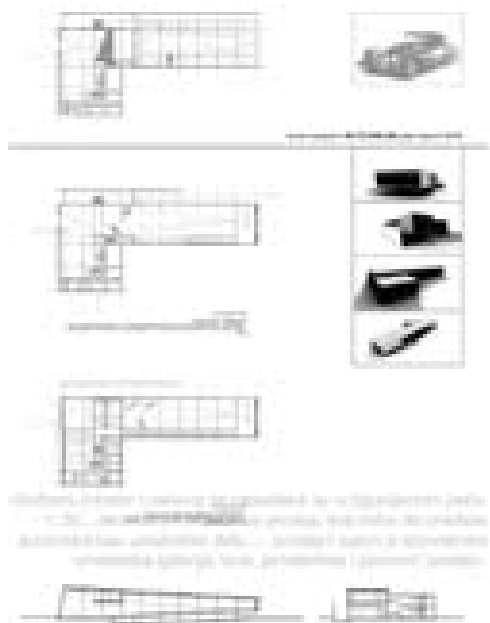


Figure 3
Students'work, 2005/2006: Car Showroom. Preliminary designs: after first four weeks
student: P. Bojovic

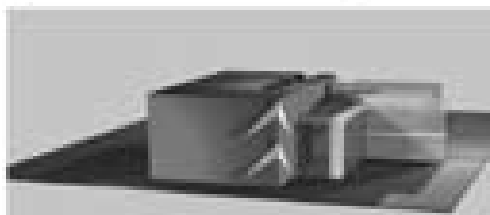
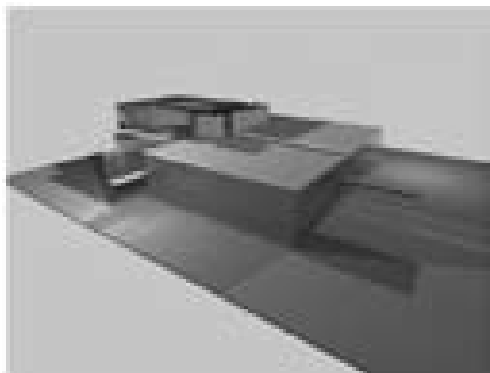
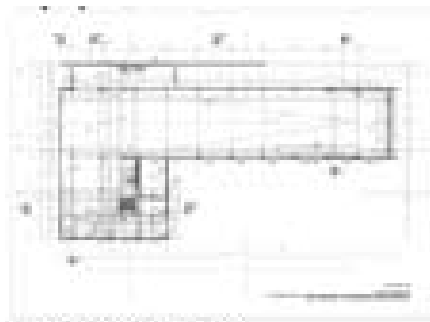
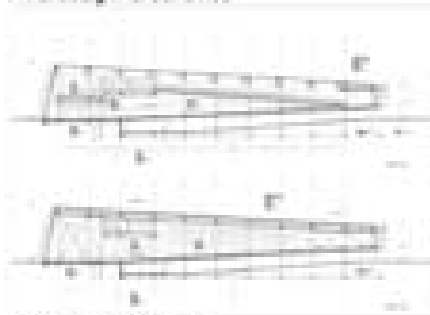


Figure 4
Students'work, 2005/2006: Car Showroom. Preliminary designs: after first four weeks
student: T. Guzina



Final design: Ground floor



Final design: Sections

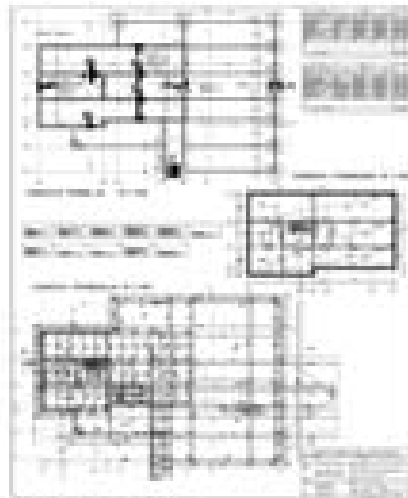


Final design: Elevations

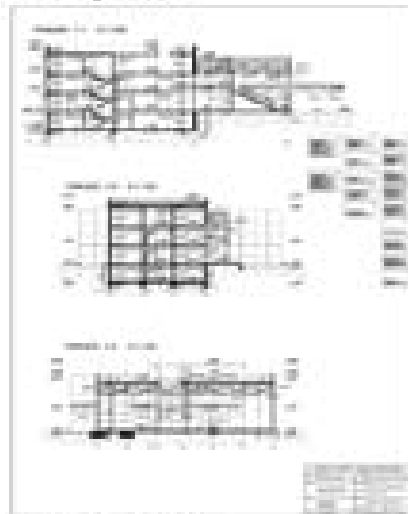


Final design: 3-D model

Figure 5
Students'work, 2005/2006: Car Showroom.
Final design - students: P. Bojovic, R. Salevic,
B. Djordjevic, A. Jokanovic



Final design: Floors



Final design: Sections



Final design: Model

Figure 6
Students'work, 2005/2006: Car Showroom.
Final design - students: T. Guzina, K. Erge-
lasev, B. Zivkovic

Studios are oriented in a problem solving way of teaching. Students learn how to transform a project from the first sketch, through the preliminary architectural design into the final design.

Students work on preliminary designs during the first four weeks. After the fourth week, teachers make selections and choose 8-10 the best designs for the next step. Students form teams of four colleagues and start with the final design, architectural details, construction, installations and specific technologies of chosen student's works.

The second assignment is how to solve and implement technological knowledge in building (structure, installations, etc.) into a design process. The task is to design and develop a project through plans, sections, elevations and details at 1:200, 1:50 or 1:100 and 1:20 to 1:10 scale. Students also learn to calculate, draw basic elements of static and to draw specific installations. This complex problem requires, above all, participation of teachers of architectural constructions, as well as those of building structures (civil engineers) and installations. Following this course, students become aware of the need for teamwork and accept an integrated knowledge of the design process.

In this way of teaching, students learn that architectural design and architectural constructions are not separate topics, but they represent integral parts in the process of creation.

During the semester students visit building sites related to the project (same type of building, or chosen problem in constructions, facade etc.)

Reperesenatation: The Role of Computers

In my Studio all students use computers - it is not compulsory, but highly recommended. Some students are familiar with AutoCAD and 3-d programs, the others use simple programs, such as Sketch-up, to represent their ideas and project. In the first four weeks the use of the computer is based on representation of ideas and mainly based on 2 and 3-D modeling. In the rest of the semester use of the computer is in function of final designs and architectural detailing.

The use of computer technology definitely changes the teaching methods and pedagogy of construction. The Art of detailing becomes an integral part of design in every step of the design process. Without a computer (in the traditional way of teaching) students draw plans and sections of the whole building and, in second phase, they work on details. Computers disable work on the whole design without knowledge of details.

In comparison with the conventional way of representation, computer tools offer students extra time for creative thinking and designing. 3-D programs offer new possibilities for understanding of constructions and elements of interiors and building skin.

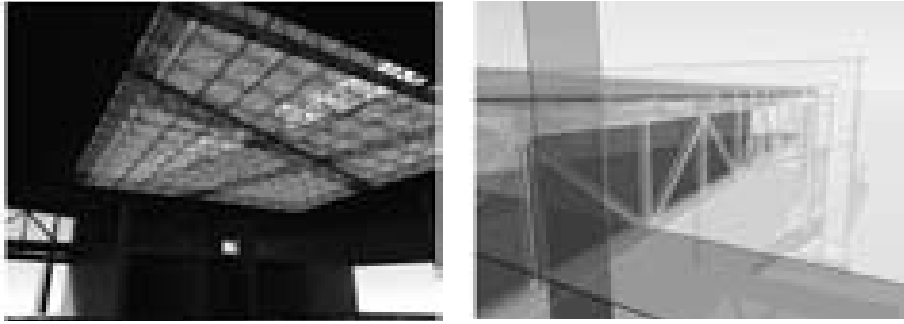


Figure 7
Use of computer in teaching studio architectural constructions (examples of student works, student: N. Brankovic)

New Materials: The Role of the Digital Media

Working on the final project and details in the studio, Internet is a powerful tool. Students design details according to architectural, esthetic and building physics' demands and after that they research for adequate response in building materials, technologies and constructions. Instead of the conventional way of teaching where teachers offer possible solutions, students explore Internet products data bases and details (from web sites of producers) and incorporate (in consultation with teachers) details and products into their projects. New materials, new technologies or creative use of traditional material are the topic of this research. Studio work is based on extensive research of different possibilities and solutions. Teaching process is intended to avoid instant use of computer details (directly from internet data bases) which can produce drawings without knowledge of core concepts.

Research on how new materials generate architectural forms and new approaches in architectural design (connected with new technologies) are a part of the master studies. During the second and third semester of the master studies students can choose project (22 ETC) as well as master project (30 ETC) with topic of architectural constructions and technologies.

Marko Suutarla

**Simulation of the Planning Process
of a Building Project**

*Tampere University of Technology,
Finland*

Introduction

For years we have been discussing whether it would be useful for our students during their studies to do an assignment which included other parties involved in the construction project, such as the party commissioning the building and special planners from other fields. The question is extremely topical since in the modern construction process the number of other parties involved is greater than it used to be, and on the other hand, due to reduced times for degree completion, many students graduate without the strong experience of working life they had in years gone by.

On the initiative of the Institute of Construction Management and Economics of our University of Technology we arranged this year for the first time a course intended for advanced students on which we went through the entire planning process of a construction project in a design group that feels authentic.

The aim of the course entitled “Simulation of the planning of a building project” is

- to develop students’ comprehension of the relationship between the customer, the designers and the party commissioning the work
- to improve the students’ co-operation and interaction skills
- to exploit and explore possibilities of CAD design and especially working process with virtual building model.

Course Participants

A planning group was created from students representing different specialisations:

- Architect group (4 students from the School of Architecture)
- Structural engineer (2 students from the Institute of Structural Engineering)
- Engineer of foundation structures (a student from the Institute of Earth and Foundation Structures)
- Building services designers (2 students from Department of Civil Engineering)
- A Building management consultant (A student from the Institute of Construction Management and Economics)
- Cost Estimator (A student from the Institute of Construction Management and Economics)



The project group also included a future user of the building who was played by a teacher of construction technology from the School of Architecture. The support persons for CAD modelling were researchers from Virtual Building Laboratory. Teachers from the respective institutes also served as support persons for the various designers.

Arrangement of the Course

The entire course including its schedule sought to simulate an authentic construction project: a relatively easy construction target was selected, a new production building for a manufacturer of refrigeration equipment, with 7 months allowed for design from the placing of the order to the completion of the final documents for the investigation of building contract.

The design process progressed according to regular design meetings as in a real project. At the first design meeting the designers got to know each other, the client and the design task. There was a choice of two pieces of land for building on. The group of architects drew up a four different designs for how each of these would be used, on the basis of which the cost estimator made the initial tentative calculation of costs. The teacher from the School of Architecture in the role of client selected one option as a basis for further development.



The first actual architect designs were made. The architectural work was arranged within the group of architecture students, i.e. of the group of four students of architecture on the course one was designated chief planner, or leader in charge of the construction project. This student served as a main coordinator, liaised with the other designers between design meetings, led the architectural planning, drew up the necessary official documents and presented the design at the design meetings. The other group members served as architectural designers, i.e. they made the actual architectural designs. The student acting as engineer of foundation structures lodged a complaint about the plot of land about the foundation research to define the conditions for the erection of a building and the structural designer drew up the first tentative plan for the construction principle of the building.

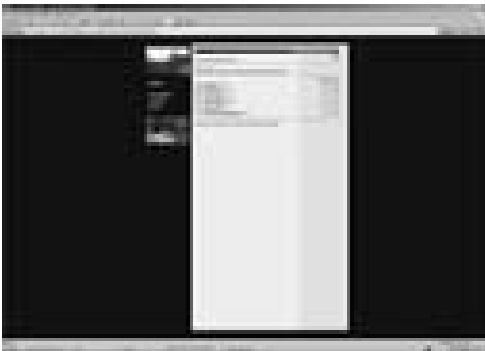


On the basis of the first draft the design was continued, adjusting the plans and design meetings were held as planned at regular intervals. During this process each special designer contributed his/her design information to the plan. The chief planner was responsible for reconciling and coordinating information on different aspects. When the main parts of the construction design were ready the chief designer drew up the official documents for permission together with the other architects. In addition



to the actual drawings this entailed making statements and accounts pertaining to all permission documents. However, this documentation was not completely accomplished; several appendices were merely given a mention so that the amount of work would not assume unreasonable proportions in relation to the amount of time to be used for the course.

Working with CAD



The planning process was fully integrated into computer aided design in different levels. For the transmission of CAD data specific a data bank protected by a password was created in the

net, from which each group member could access all the planning documents such as drawing by various designers, minutes of planning meetings and various reports.

The designs were planned to made throughout as a CAD based production model, although this aim was not ultimately achieved.. The production model is fairly new concept and is undergoing an intense research and development process in various



countries to become standard practice in building design and maintenance in the near future. Many architectural firms produce three-dimensional models, but these are mainly used to visualize the project for the client. Differ from this the building production model concept serves as a common source of information for the various parties involved in the process.

In the production model concept a building is modelled three-dimensionally and this virtual building includes a great quantity of technical and economic attributes. The architect's 3-D model is utilised during the design process

- as a basis for the structural model by a structural engineer
- as a platform for the designs of the various designers, when, for example,
- building services are designed three-dimensionally inside the model during the design for monitoring costs. 70-80 per cent of the quantity data required could be taken direct from the model almost automatically.
- as a basis for the energy and condition simulations. Direct data from production model will make it a lot faster to calculate how much energy will be consumed for heating the building in the winter and air-conditioning in the summer or on how different structural solutions will affect the temperature in different rooms in the building.

The production model is used also as a tool for the actual building process to check plans 3-D in situ. The model moreover remains as a tool for the maintenance of the building after construction.



In pilot projects the chief advantages of modelling have been found to include the integration of plans and reduction of errors with clash detection analysis, faster and more accurate quantity surveying and cost estimating, the clarity of three-dimensional plans, and extracting marketing materials and drawings direct from the model. Clash detection analyses makes it possible to check out, for example, whether the architectural and structural design allows enough space for the necessary building services. Specific software (Solibri Mode Checker) has been developed for this purpose.

One of the key challenges for the product model concept is to make data exchange more fluent. The tool chosen for this was the international data standard, IFC (Industry Foundation Classes), with which all the product models of the various designers could be linked together. In ten years, IFC has become the best-known standard in the building sector. There are already tens of software packages on the market which support it, although there are still many technical problems and restrictions related to the standard. In certain countries, among them the USA, the construction market and the roles and responsibilities of players in the sector are highly fragmented and for this reason adapting a common standard is slower and more difficult than expected. The countries so far most advanced in IFC technology are Finland, Japan, Norway and Singapore.

Experiences of the Course

The Course is a pilot project arranged for the first time, so the experiences gained will be utilised in planning subsequent courses. In light of the discussions held with the architecture students who participated in the course it can be considered that

some of the objectives set were indeed achieved and others, at least for the moment, were not achieved. The course was evaluated as follows:

The aim to develop students' comprehension of the relationship between the customer, the designers and the party commissioning the work was achieved pretty well. A conception of the chain of events of the design process, of the tasks of the various parties and the preparation of documents required at different stages of the process was made real to the students very successfully. The feedback on this part of the course was almost entirely positive.

The aim to improve the students' co-operation and interaction skills was achieved in varying degrees. Firstly the design group was somewhat incomplete as one of the main designers, the designer of electrical work was missing. The reason for this was that our university does not offer teaching in this area. Secondly the motivation in the design group was heterogeneous, likewise the time at participants' disposal for this purpose. Some of the designers were students already professionally active and taking continuing education. Their work limited their opportunities to devote time to internal meetings of the design group. Especially in the initial stages the architectural designers felt that the contact between members was inadequate. The preliminary stages of



the architectural design would have progressed more easily if the border values determining the design had been obtained faster from the other planners. These difficulties explain in part why the points awarded to the students varied such that the work of the architecture group had been estimated to be much greater than the contribution of other planners.

The greatest difficulties were experiences with the aim to exploit and explore the opportunities afforded by CAD design and especially with the work process with the virtual building model. These problems were due in part to the actual CAD software used and the variation in the computer literacy of students and institutes for working with a virtual model. The only designer group capable of producing a virtual model was the architectural designers. In other planner groups the familiarity with the necessary design programmes was weaker and no resources were found for teaching these in the time available. There was also room for improvement in the design software acquired by other institutions and in teaching its use. For this reason the other planners, in spite of good intentions, completed their own design the traditional way in 2-D form. Only true application of model was made by cost estimator who used architect's model as a source for her examinations.

There were also difficulties in information transfer. The institutional design software (ArchiCad) used by the architectural designers generated old type IFC data, and transferring this to other software caused problems. However, this problem was later solved.

The problems concerning the CAD design mentioned above are the same as those encountered in real-life design processes. In that sense the project simulation was very real indeed.

Where do we go from here?

As can be deduced from the feedback outlined above it would be worthwhile to develop the Course further in the future. The future challenges will be:

- How can the co-operation among students be improved?
- How should the group members be recruited so that they have the appropriate skills for working with a virtual model?
- Can the skills for working with virtual models of students other than architecture students be improved in general during studies?
- The compatibility of the design software to be used should be tested before work begins
- Working with a virtual model necessitates an expert support person from outside the group so as to derive maximum benefit from the model
- Could the course be developed in such a way that the teachers' resources would be sufficient for more and more students to participate on the course?
- Could a comparable process be applied when approaching targets which are architecturally more demanding and therefore more complex?

The positive feedback obtained on the course serves as encouragement to arrange the course again next year. If it is possible to resolve the issues mentioned above the Course has big chance of developing into a Course which serves all parties concerned, and which is popular and motivating.

**Marcel Heistercamp
Martine Valembois**

**In Search of Interdisciplinary
Integrated Designing**

*Sint-Lucas,
Brussels-Gent,
Belgium*

In a sense, 'interdisciplinary' involves attacking a subject from various angles and methods. Here belongs the word 'user' and 'end-user' to indicate that people central state. Frequently however the technical system – the computer – take the central place and we are only a derivative. For this reason a designer – and certainly a student – must have a grip concerning essential basic concepts, methods, techniques, theories and design methods.

Design

Design is not considered within the world of software-engineering as a science. Designs can be better called no science. We must realise that design for a large part is a subjective (intuitive) event. The eventual form or chosen solution is directly dependent or liable to taste, vogue and subjective estimations. However, designs have much to do – but not everything – with science. Each product, contains knowledge which has been collected by scientists (and others).

A good definition of design – in this context is:

Design is a repeating reason process reason process where as much as possibly uses scientifically founded and (empirically examined and tested) knowledge from other disciplines. Design objects in practice requires a combination of knowledge, scientific knowledge, creativity and craft at the same time.¹

Designing is an attitude

...Designing is not a science. Designing implicates an attitude which is a kind of exploration. It results among other things in an expansion from logical to associative coherence. The effect is to investigate design. Attitude formation is the result... So in fact before designing, becoming the just attitude to design is a must.

Many methods have been experienced to get the just attitude.

Folding

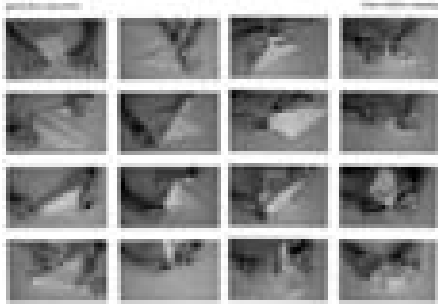
One of them is "Folding" .

Folding evokes a challenge, and is more important for the developing of methods to arrive at a new architecture, than it is for the development of an individual architectural form. Folding leads to great possibilities and looking for possibilities is the key to fertilize the design process.

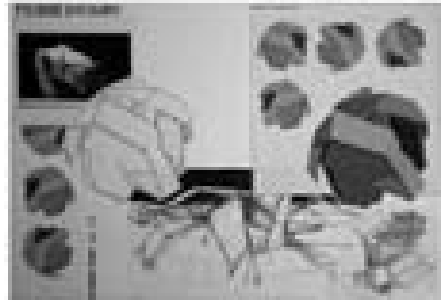
..." Opening a fold in a surface creates spaces, which in our minds are filled with volumes. The advantage is inherent: the technique makes it possible to re-appraise every step. Each step is laden with potential. Folding and the associating development of hand-eye coordination liberates the design thought-process from preconceptions and removes any existing architectonic images. The limitation that the technique of folding brings with it sharpens the mind and stimulates creativity. Folding also implicitly allows accidental and unknown end-results for a relatively long period of the design process..." (Sophia Vyzoviti " Folding Architecture" Spatial, Structural and Organization Diagrams)²

After using the folding method, the designer has to make a choice. The scope, suitability and significance of these will be a subject for discussion.

...“The way of folding doesn’t include narrative elements. Folding is a sort of affectionate space. More than just reason, meaning and function are involved here.”...“the fold alerts the traditional viewpoint. The incisions are no longer concerned with aesthetics or meaning but with a different type of order. “...(Sophia Vyzoviti “Folding Architecture” Spatial, Structural and Organization Diagrams)²



Sophia Vyzoviti “Folding Architecture” Spatial, Structural and Organization Diagrams



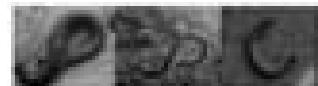
De Bruyn Floris (student 2nd year St. Lucas Ghent)



Frank Gehry, Hotel in Elciego Spain.

Conceptual Thinking

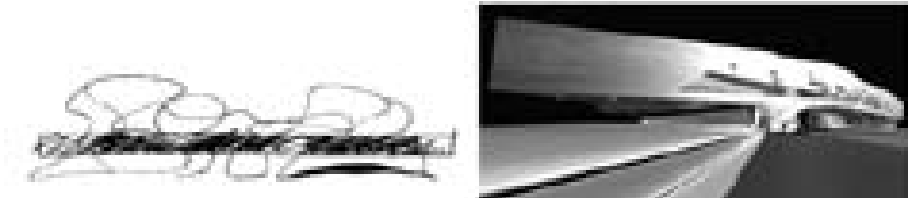
The method of “conceptual thinking” is an analogue method. Several domains can offer different starting points for projects. Nature, arts, poetry, philosophy ...can offer grateful points of contact for creativity.



Pieter Uyttenhove – Myass Sys
(students 2nd year St. Lucas Ghent)

Digital Architecture

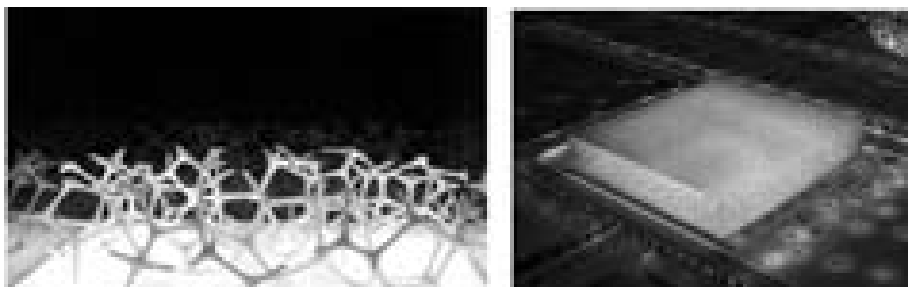
The new digital approaches to architectural design (*digital architectures*) are based on computational concepts such as topological space (*topological architectures*), isomorphic surfaces (*isomorphic architectures*), motion kinematics and dynamics (*animate architectures*), keyshape animation (*metamorphic architectures*), parametric design (*parametric architectures*), and genetic algorithms (*evolutionary architectures*) as discussed in 'Kolarevic 2000'. New categories could be added to this taxonomy as new processes become introduced based on emerging computational approaches. For example, new methods could emerge based on performance-based (structural, acoustical, environmental, etc.) generation and transformation of forms.³ For example: three digitally designed and built buildings.



Zaha Hadid, Phaeno science center, Wolfsburg.



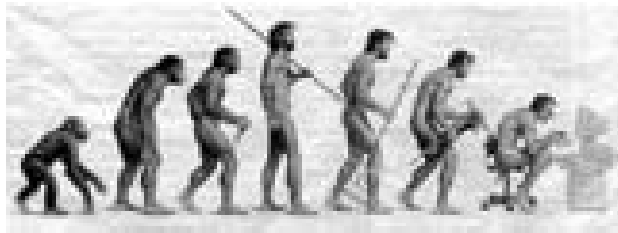
Bernhard Franken –ABB architekten, BMW pavilion.



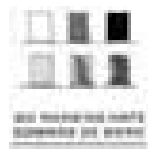
PTW, National swimming center, Beijing, China.

So, the promising development in the world of design is on-line designs using tools such as CAD/CAM systems. Nevertheless a lot of disadvantages have been linked with direct use of a computer tool. It has been remarked especially at the beginning of a design career that designers, and particularly students, do not seize to a tool but that they firstly reflect concerning what they want to design in fact.¹ There is a double

danger in digital architecture: over-development of the feeling with respect to the reason and over-development of the reason with respect of the feeling. If we do not pay attention, perhaps we create the evolution like on an image like the one below.



Our task is to formulate 'design guidelines' for the students. The intention of design guidelines and design philosophies is not to make dogmas, but to produce the flexibility to leave an idea for better ideas to become a new empirical research. Lateral thinking is the message. It is to stimulate questions themselves. (See: Edward de Bono, Six Thinking Hats, 2000 and The Six Value Medals, 2005.)



White:	information
Red:	emotions
Black:	bad points
Yellow:	good points
Green:	creativity
Blue:	organisation of thinking



Design and construction pedagogy: we need a laboratory learning environment with a full range of media for exploration and decision-making – sketching and drawing, model making and computer modelling. We have to merge the art of design with sciences and technology – a multi-disciplinary endeavour that other fields are just discovering. This integrated design education must have the mission to identify sustainable design (green design), to dedicate to expending students understanding of and contributions to the development of advanced building materials, assemblies, and integrated systems.

We have to exert tireless efforts by conducting numerous educational and training programs about integrated the design process. Design teams will often include: architects and designers; engineers (mechanical, electrical, structural); etc.

The digital age has radically reconfigured the relationship between conception and production, creating a direct link between what can be conceived and what can be built through 'file-to-factory' processes of computer numerically controlled (CNC) fabrication (*Branko Kolarevic*).

So the key component is integrated design-build system. Throughout the entire process, all of team experts at every phase work as a team sharing the same goal of creating a building to the exact needs and specifications of the client.

Integrated design is a technique that engages the design team early in the decision making process to identify systems that can be integrated to achieve short and long-term cost saving, resource efficiency, and an all-around better building. The goal is not to build a building; rather it is to build a building that is functional, efficient, appealing, and valuable long into the future. Integrated design ensures that all these goals are met in the most cost-effective way.

Poeta Nascitur – Orator Fit

People are entirety, they are a being with a judgement, a will and an internal life. When these elements are in balance, people reach to absolute. Beside reason (ratio) we see that architecture also is related to intuition, myth, feeling, expression, in other words 'mystic'. In that entirety many things are irrational and do not explain with reason. In all what people do is reasonableness (the solution of what). The way in which (how) is at the artist unique! The problem is therefore that architecture is immediately the work of the reason and feeling. In going together with reason and feeling, architecture must be then an expression in which life becomes experience in its unmasked entirety, in other words 'spiritualisation'. The expression of the 'mentally think', can be employed in three part in human creativity: humour, science, filial simplicity. Game is a manner of life, a life attitude. It signifies a climate of freedom, filial simplicity and spontaneity.

Finally:

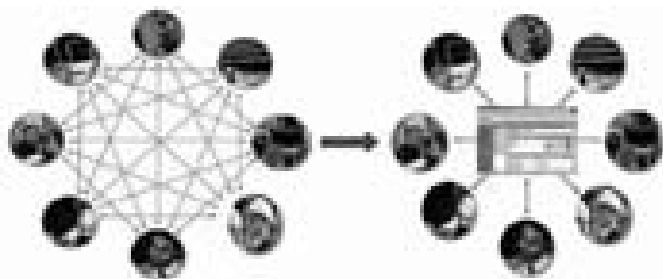
'Perfect design leads to moving beauty'.

Some Objections

Interdisciplinarity – representation – construction – construction pedagogy

- 1 *How can computer specialists collaborate with architects in order for a file to arrive at a factory?*

They can assist in providing FTP-space of a Groupware application on the web, but also in "educating" the architects about the best way to use such facilities on the web (e.g. : see <http://www.buzzsaw.be>).



2 *What are the necessary competences of architecture graduates that can enable them to collaborate with specialists and/or can use software to produce working drawings?*

Good knowledge of a CAD-system (to create, modify , presentate ... drawings), preferably a “standard” CAD-system.

3 *What is the role of the digital environments in modern construction?*

Increasingly big... .

4 *How can new representation tools and software aid and facilitate the construction of architecture?*

- Better quality and much faster (=cheaper, less time...) results.
- Better notion of the design and construction with the newest BIM systems (like Revit – see <http://www.revit.be>) , with less errors in the drawing documentation.
- Ability to extract a lot of building data out of the virtual building model.



5 *Does the production of computer drawings change the teaching methods and pedagogy of construction?*

The switch from “CAD” as Computer Aided Drafting” to “Computer Aided Design” and software-applications like BIM (Building Information Modelling, e.g. Revit instead of AutoCAD) demands a huge change in the working/thinking methods of the designers and has surely a large impact on the teaching methods and pedagogy of construction.

Interdisciplinarity – simulation/environmental control - construction – construction pedagogy

1 *Can architects alone work on the design of sustainable buildings and settlements?*

Some architects have a clear focus on specific domains, e.g. sustainable design. Of course that specialist on this domain can help ...

The architect is the first designer whereupon there are a lot of designers who under its inspiring control specify the project.

2 *What is the necessary knowledge base that architects ought to have for designing intelligent buildings?*

The need of (more) intelligent Architects?

A broad academic preliminary training is an absolute condition for a ‘digital’ architect. People must be at the centre of a project. An architect must control

three skills. He must be able to think purely and to structure. He must be able to imagine oneself in someone else's situation and he must have sufficient sense of construction. The architect has not only necessarily a holistic look and structuring qualities but he must have still a great degree of creativity. Here on top he must have still strongly analytical and conceptual qualities. He can structure matter and incorporate it (style, function and design). He can bring things back to the essential and communicate about them in a practical way.

Three aspects in architecture are important: 'utilitas', 'firmitas' and 'venustas', f.e. the use value, the perception value and the future value. If we translate this to the digital world we have: the functionalities and their mutual coherence; the used components, technologies and integration techniques; external behaviour, the users perception. Not all the artefacts within the digital world answer to that.

3 How can environmental scientists/engineers collaborate with architects and the design team, in general, in order to produce environmentally-controllable buildings?

Provide a better sense in order to have a better notion of the different aspects, what is really important and how buildings can better respond to different environmental parameters.

4 What are the necessary competences of architecture graduates that will enable them to collaborate with environmental scientists/engineers to produce sustainable energy-saving buildings?

A basic knowledge of building physics; aspects of water, energy, building materials (energy-aspects), ...

5 Does the use of computers change the teaching methods and pedagogy of construction with an emphasis on the environment?

With the suitable software, of course.

Interdisciplinarity – morphogenesis - construction – construction pedagogy

1 What are the necessary competences of architecture graduates that will enable them to collaborate with specialists and/or can use software to produce working drawings?

Good knowledge of a CAD-system (to create, modify , presentate ... drawings), preferably a "standard" CAD-system.

2 Can conventional construction methods allow for the materialization of designs that have been generated through computer software?

On the 'construction' aspect we must ask earlier 'with which technologies?' New technologies offer possibilities for sophisticated designs. The commitment of technology must have a serving role and must be the inspiration source for the architect.. He must apply eventually the new technologies that promote effectiveness, efficiency and the innovative capacity of architecture.

3 *How can computer specialists collaborate with architects in order for a file to arrive at a factory?*

They can assist in providing FTP-space of a Groupware application on the web, but also in "educating" the architects about the best way to use such facilities on the web.

4 *How can new representation tools and software aid and facilitate the construction of contemporary architecture?*

- Better quality and much faster (=cheaper, less time...) results.
- Better notion of the design and construction with the newest BIM systems (like Revit, see <http://www.revit.be>), with less errors in the drawing documentation.
- Ability to extract a lot of building data out of the virtual building model.

5 *Does the generation of design through computers change the teaching methods and pedagogy of construction?*

The switch from "CAD" as Computer Aided Drafting" to "Computer Aided Design" and software-applications like BIM (Building Information Modelling, e.g. Revit instead of AutoCAD) demands a huge change in the working/thinking methods of the designers and has surely a large impact on the teaching methods and pedagogy of construction.

Interdisciplinarity – new material(isation) - construction – construction pedagogy

1 *What are the necessary competences of architecture graduates that will enable them to collaborate with specialists in order to use new materials?*

A basic knowledge of building physics ; building materials (energy-aspects), ...

2 *What is the necessary knowledge for that?*

A good education ?, ...

3 *How can architects play a crucial role in the creation of new materials?*

Design and development of new materials is not a stand-alone goal. New materials stem from new desires.

E.g.: Comparison with the medical world. As a result of the close and persistent interdisciplinary cooperation between micro-surgeons and engineers, new medical operations can be performed. On the one hand surgeons express their requirement whereas on the other hand, engineers come up with solutions.

On the other hand, new materials will generate new expressions and forms.

E.g.: The development of silicon and more in particular: its elasticity and binding capacities, resulted in enormous architectural changes. This is especially the case for glass. Window frames are not compulsory any more when it comes to constructing glass volumes.

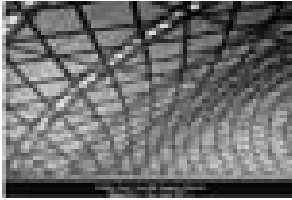
4 *How can material scientists collaborate with architects in order for new materials to be exploited?*

Design and realize good architectural projects with those new materials as examples.

5 *Can conventional construction methods allow for the incorporation of new materials in design?*

Why not ?

The conventional construction methods will fulfill the needs that are required from materials, e.g. elasticity, waterproof,... Once these conditions are met, the remainder of the assignment will become part of architectural art.



Shigeru Ban / Hannover / Japan Pavillion (paper tubes)

6 *How can new materials aid and facilitate the construction of contemporary architecture?*

This depends on the material: some better than others?

7 *Does the use of new materials change the teaching methods and pedagogy of construction?*

A building is designed as a sustainable structure with a relatively temporary wrapping (frontage). The idea pertains that after 10 to 15 years, this building will undergo a new facelift and simultaneously will have to be able to perform a new function. Sustainability get a new dimension. The advantage is adaptability in time. The charisma of the building can thus immediately meet new and trendy dimensions. Renovation facilities are integrated in the initial concept.



Laban Dance theater London Arch.
Herzog & De Meuron

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Discussion on the Presentations of Theme 1

Chairs:

**Maria Voyatzaki
Dimitris Papalexopoulos**

Maria Voyatzaki, Thessaloniki, GREECE

Dimitris Papalexopoulos and I will begin by summing up the sessions we chaired and by putting forward some provocative points that we think might generate some discussion. This is the first time we have tried this, and I know that the last thing we need to do is to paraphrase what has been said; but I would like to make a few points as a kind of comparative study of what has been presented. In the session I chaired, we had four presentations. When I introduced the presentations, I said that we would be seeing three presentations, because the first two people were from the same school; but I now regret having said that, because in fact they were complementary groups with very different characteristics, very different identities.

To begin with, no one labelled themselves as construction teachers, design teachers, computer people, or whatever, which in a way proves the point I made at the start, that there are no clear-cut distinctions between specialists. Then, I would say that interdisciplinarity was implied rather than explicitly explained. What was apparent from the four presentations is that people try these days to strike a balance between thinking, hand sketching and computers. The word representation did not appear at all in our discussion, and I think that this is something that we need to discuss, because if there is one thing that we need to put on the table from the four issues that we have put together in the four sessions, that is how representation is one way that makes us think about the need for interdisciplinarity in teaching construction.

Dimitris Papalexopoulos will also try to put a few things forward from the discussion in Room 2, and then we will take it from there. I do not know whether by representation we make ourselves clear to all of you. I do not know whether the term representation means many things, or means the same thing to all of you. It could be mixed up in several things as a mechanistic tool or as a way of looking at something and just projecting it one way or the other. I think that it is more than that, but let us leave that for the discussion.

Dimitris Papalexopoulos, Athens, GREECE

Thank you, Maria. I will do my best to summarise the four presentations. I think they show four things, mostly about interdisciplinarity, less about representation. With regard to interdisciplinarity, I wanted to say that maybe you have to open the discussion in a place where interdisciplinarity actually exists, and I mean a concrete, physical place, like l' Isle d'Abeau. It was said that you have to think about interdisciplinarity as part of a course, a design course, a construction course, or in relation to such courses. Another presentation depicted interdisciplinarity as a tool or a catalyst in the teaching process. In the third intervention, the 3-D model was clearly portrayed as a place where interdisciplinarity is mapped, is exercised. And that is a different aspect – disciplines have to bargain their positions. Someone else said that we have also to cultivate an interdisciplinary attitude. The fourth intervention, that is, showed that interdisciplinarity is not seen as a predefined tool for solving design problems but as a way of inventing new things, open and very risky.

To summarise, here we have four things: the need of a place, the structure of a course, the construction of a tool, and an attitude.

Maria Voyatzaki, Thessaloniki, GREECE

After hearing what Dimitri said about the parallel session, I want to put the following questions: Are there new perceptions of representation? If there are old and new ways, or contemporary and not so contemporary ways of perceiving and understanding representation, do they affect the way that we think of construction when we teach our students? It is quite a complex issue, so I think that we should start from how representation is perceived. When we say representation, what do we actually mean? And do the different tools that Dimitris Papalexopoulos mentioned (hand sketches or computer design tools) affect the way we understand representation? Are these the different perceptions of representation? What is representation? How is it related to interdisciplinarity? Do we need different specialists to teach our students the different types of representation?

Dimitris Papalexopoulos, Athens, GREECE

We have just begun, and of course it is too early to set down what may turn out to be one of the main questions encountered in this workshop. I will in a way pre-describe the problem by referring my question to computer engineers: Do architects need to learn a code, do they need to learn how to programme? Because there we have a very strong problem that arises out of interdisciplinarity in a very, very practical way. We have certainly accepted that we have to sit down with civil engineers, we have certainly accepted that we have to sit down with artists, with dancers, with painters, to try and solve problems and to learn from them; and this applies mainly to construction courses; but how can we sit down in a course with information engineers? I think that this is going to be the problem for the next few years, and it has to do with whether we accept the information engineer as a professional participant in the design team; and then, if we accept that, we will be obliged to sit with information engineers in the construction course like we sit down and work with civil engineers. To put it more clearly, there is one type of engineer that is at present missing from the team.

Antonino Saggio, Rome, ITALY

To begin with, I want to say that I like the format of the meeting, and I think that it is important to start talking, just to break the ice, even if to start with we are not going to be saying very important things. The title this year comes very close to the way I approach many things these days, and I think that just before attempting to answer the questions – I will not answer the specific questions Maria posed – it is important to point out that the word "representation" is very important in that it implies different paradigms of thinking, teaching and everything else, so I think that it is important to point out in some way the different paradigms that the word gives rise to in my mind at least. I think Maria touched on this point, and I certainly agree with her. I will give you a simple example. My generation was very strongly educated in a process that was exactly the opposite of interdisciplinarity. As soon as we entered the school of architecture, basically we were very strongly pressed to cut out all the interests that we had in high school. Some of us were very interested in philosophy, for example, others in art or music or dance; but the school of architecture was almost scientifically structured – at least my school was – to cut out all those

years. These schools approached our education as one subject within itself in a way that was exactly the opposite of interdisciplinarity. The main reason for this was that it was assumed that the kind of rationalistic approach behind the industrial paradigm and the functionalistic architecture was a kind of subject that needed a rationalistic, specialistic approach. Now we are completely in the opposite paradigm of thinking and of making things, and this is mainly because of information technology. The greatest architects, philosophers, scientists, whatever their field, always think in the opposite way: they start from the whole and from the whole they go down and verify the hypothesis. This is the way of thinking today. So I just wanted to show that there really is a shift of thinking; and of course we have to readapt many things, change our own minds, and particularly try to understand how to cope with the many of us that did not completely accept this idea because they have to find what they are, and they are not made in that way. So it is a big struggle and a big discussion, and I think that it will be very interesting.

Johannes Käferstein, Vaduz, LIECHTENSTEIN

I will try to take a shot at the question of representation. I think we did not talk about it precisely because it is so important. It is something that has to do with communication, if we are talking about representation of a project, and I think that Oliver and I discussed our work before; it is a craft that is inside content or inside the project, so it is a way of communicating a project, but not on a formal level. It is something that has to come out of the content, out of the architecture, the construction.

Donal Hickey, Dublin, IRELAND

I am not necessarily responding to the questions that have been asked so far, I am responding to the presentation made by our two colleagues from Liechtenstein. What I am interested in, in terms of the foundation course, is that representation became reality; and I think that when you think about representation it takes on many forms, and the forms that it takes are relative to the stage and the process, the process of making an idea real; and what I find interesting about the work that both of our colleagues are suggesting is that at an early stage students learn the implications of their ideas, and I think that that is critically important. Representation is only a means to an end, but it is the clarity of the process that they engage with that I think is particularly interesting, and the fact that that process would give them the ability, where the intent becomes more complex, to realise they have the ability to make it real and to find both places to represent it and ways and means of achieving it.

Miltiadis Tzitzas, Athens, GREECE

I am one of the old-timers you mentioned earlier. We are still at the very beginning and trying to get the discussion going, and it is difficult because this year things are not so well defined, not so clear, so they are rather more difficult to understand. To that end, I want to attempt to clarify some things. I just want ask Dimitris Papalexopoulos something that confuses me. You said, Dimitri, that an engineer is missing. The mechanical engineer is there, the structural engineer is there when you are talking about architecture, a building for instance, and you say that the information

engineer is missing. Before we come to understand where he is missing in teaching architecture and in teaching construction, I would like to ask you where he is missing in the building itself, so I can understand what role he plays, and then where to incorporate him in the teaching of architecture. This is not a direct question, but you know what I mean – you have known me too long not to understand. I just want you to clarify some things for me.

Dimitris Papalexopoulos, Athens, GREECE

From a very practical and non-philosophical point of view, when we are dealing with construction we are dealing with mechanical engineers, but there are many, many parts of a building that we have to talk about with an information engineer and not a mechanical engineer. For instance, we were talking about intelligent environments. It is wrong to say that in the practice we have to deal with mechanical engineers only, we also have to deal with information engineers and incorporate them in our teams. Otherwise, we will end up playing the role of the information engineer, wrongly, as sometimes we play the role of the structural engineer, wrongly again. But if you deal with intelligent environments, even if it is only plugs or air-conditioning, you deal with traditional mechanical engineers that have some knowledge of intelligent systems.

We are just at the beginning of our discussion of this subject, and it is a huge issue; but it is something that we have begun to feel in everyday practice, and if we start feeling it in everyday practice, because construction is a very practical thing, then we are going to start feeling it in the courses we teach.

Markus Aerni, Stockholm, SWEDEN

I want to make a comment from our experience with representation and interdisciplinarity related to teaching in the first and second years. In our experience, interdisciplinarity is something like a happening, so it is hard to put down on paper sometimes, but it is a very strong tool. We practice it in joint seminars or joint tutorials with students; and I think that that might be a difficulty with representation, which is sometimes quite linear. So that was what I wanted to say, that interdisciplinarity can be used as a method, and in our experience it works.

Boel Hellman, Stockholm, SWEDEN

If I may intervene, I wanted to say that it is very crucial, of course, how you divide things. If I add on to this discussion about starting at school, I am starting from the whole. In my school, too, the programme was divided into different subjects, so you had first architecture, then art, and so on. But what we try to do in the teaching structure in interdisciplinarity is to divide the actual topics more layer by layer – a structure taken from the computer world, actually. I had the opportunity to learn about computers very early, and I got into that logical thinking very early, although I use it for developing my architecture rather than using it on computer. But talking about layer by layer, another way of thinking about it is that all the disciplines can be present in a certain layer. For us, layer by layer is the first year and scale by scale the second year, and then of course a certain topic is also introduced in a kind of dynamic schedule in these interdisciplinary courses.

Per Olaf Fjeld, Oslo, NORWAY

I would like to argue a minute around representation because it covers quite a wide range of fields and has many side issues. One can say; “I like that representation” or “That was a good representation” or “That was a rather lousy representation”. This means that the very idea of representation is a personal attitude, and that implies that it can be interpreted in many different ways. And if I am going to go deeper into this discussion, I think one has to differentiate between the idea of the content of what we represent and the tool that has the capacity to represent it. The representation tool has always been different and has always been changing, and that includes the most recent transformation, which is computers. Within the idea of understanding representation one has to understand the way in which this new tool has its own capacity for representation. In other words, by all means we must use the tool’s capacity for representation, possibly as an inspiration, but we have to be able to differentiate between the content of what one tries to represent and the capacity of the tool.

Nikos Panagiotopoulos, Thessaloniki, GREECE

To the earlier question, about where a computer engineer fits into the process, I would like to add that we are entering a new era in which the whole process of building enters a phase that involves not only design and construction but also management. Furthermore, nowadays we are facing the notion of ‘the living building’, where change is relative to rapidly shifting needs, so that when we talk about the management of a building we must understand that it does not end at the construction stage, but continues throughout the life of the building, and this is where computer technology is indispensable in order to predict and to make models. So to me it is very plausible that a computer engineer is needed in this process, and what is more we should not be surprised if we begin to see many other disciplines gradually entering the building process: for instance, in twenty years we may very well need water managers, and so on.

Mario Sassone, Torino, ITALY

I think that there is a strong relationship between the tool you use for representation and the possibility for a stronger interdisciplinarity. I think that the use of computers in 3-D modelling is a kind of revolution in our field. All representations are made in the same environment, the 3-D model can be used either for rendering a structural model or as a source of data for evaluating cost, or all sorts of things. It is a unique representation of the project in which you find a lot of data, informatics data, that can be used in different disciplines. The important difference with respect to the past is that drawings use a different language. There is a huge difference between free hand sketching and technical drawing. In the 3-D model, you can even use the 2-D model for a rendering or for an explanation of the project or to extract surfaces or data about the cost or the quantity of materials, and so on.

Henk de Weijer, Amsterdam, NETHERLANDS

Maria said something that really struck me: that the distinctions between disciplines and ways of thinking are very unclear. Representation, I think, is very important to

the whole interdisciplinary and to the vision of the designer, who in his representation is trying to produce something to be worked on. Because sometimes the design is so clear that all the other participants would like to share that vision; but if the vision of the design is strong, but the vision is not broadminded the influence of the other participants might be much stronger and the representation of strong participants in this interdisciplinary discussion of total presentation might overrule the vision of the designer. So it really depends on the designer himself. If a designer has a very broadminded vision and a wide perspective then everybody who is taking part in that process might give up his own identity a little to contribute to that basic proceeding, and then if in such a process everybody is listening to each other and is contributing to a very clear process, then you too will accept that other people might step on your own ground, your own field, and you allow other people to join in. That is why I think representation also depends on interaction between people, and if we look very carefully, then the whole flow of the process depends on representation and presentation.

Gligor Liviu, Bucharest, ROMANIA

Coming back to practical things, I think we have to try to stimulate personal representation as well as teach practical representation. Because building starts from the concept, and in building architecture, I think, there is a single language for the builders – and this is important also. It is a gradual process, starting from how you represent your own idea and ending at the moment when you have to represent it officially in a way that is capable of being constructed. And in this, I think, computers are very important, because they give you the language to do it with and generally facilitate this process.

Maria Voyatzaki, Thessaloniki, GREECE

May I ask a naïve question? Before the computer age we taught design and construction in certain ways. Of course there were different schools of thought – I see Donal already wants to answer and I have not even put the question yet. Let us assume that, even though there were different schools of thought, we still had crystallised in some way how we teach design and construction. Now that we have a different means, even if we see it just as a tool, do we have the same pedagogy of construction or do we have to rethink it? A very simple question.

Donal Hickey, Dublin, IRELAND

I am going to tell a story that may help answer the question.

Maria Voyatzaki, Thessaloniki, GREECE

I saw you knew the question before I asked it.

Donal Hickey, Dublin, IRELAND

Well, I kind of suspected it would come up. I met a Norwegian architect called Jan Olaf Jensen some years ago, who obviously comes from a culture that has the capacity to represent in a multiplicity of ways. As a student he went to India to work on a

project for an orphanage, where the only means he had at his disposal were a pencil and some paper. He still used his faculties as an architect to represent his ideas in a clear way, that was describable and buildable, which is to some extent the reverse of what we normally expect when there is a dearth of processes available to us. Why I think it is interesting is that maybe sometimes a simplicity in terms of representation and capabilities is an interesting starting point, and you can introduce more complex ways of representing later, when the process from the idea to realisation is understood.

Luca Fabris, Milan, ITALY

I wanted to begin with what you called your naïve question. It is my opinion that it is not only the computer that has changed our vision or our kind of building, because this is only an expansion of what we can do. I mean that there is a lot of good architecture, just simple buildings, mainly old or ancient ones, that are incredible to us now because they were made before the use of computers. I think that it is clear that we are now at a stage where we can do what we want, and that maybe we need a kind of super engineer for the calculation of some things. I have one project in mind: the Mercedes-Benz Museum by Ben van Berkel which was done with the input of informatics engineers.

The other side of this is us, the teachers. I teach in the fifth year, which is the last one in Italy, and I have difficulties in teaching people who know only how to use a computer, because for four years they have only used a computer: they barely know what a pencil is, let alone how use it to design something. Then, on the other hand, the students often have something in mind that they cannot realise because all the tools and sketches they need are in the computer. And I always ask them what they will do if they find themselves in the Metro or somewhere and someone asks them to draw a project for them on the spot for one million euros. It is so crazy not to be able to make a design, or find a solution with simple ideas and a pencil and paper, because you do not have your computer with you. For me an architect is someone who is in the middle and who has to be a director of a lot of other things – this for me is the traditional architect.

Maria Voyatzaki, Thessaloniki, GREECE

If there is no one waiting to speak, I would like to ask another naïve question. Suppose we give our students an assignment to design something and to find ways of constructing it. We ask the same students to generate a form working with a pencil, and then we ask them to generate a form using a computer programme, but specifying that they are to collaborate, to work with the computer and not simply to use it as a representation tool. My question is, do we explore constructibility in the same way on both occasions, or not? How do we teach that?

Dimitris Papalexopoulos, Athens, GREECE

I never understood why we have to choose. Choosing may be a modern way of thinking, but it is not a new way of thinking. On the other hand, accepting that in a building you can have traditional, industrial and digital or intelligent elements, is a digital way of thinking. It is not a digital way of thinking to cut out everything

traditional and to look only forward. I clearly say to my students that they have to have a physical model of the construction as well as a digital model, because we need both. There is no reason for us to choose. A digital model gives you in a minute many alternatives, and this is both useful and necessary. On the other hand, with a physical model you have to be careful, either because materials costs money or because there is a danger of cutting yourself, but this makes you slow down and when you slow down you think. But as far as I am concerned this poses no contradiction. You need both. If a third alternative comes up, I will use that too. Thank you.

Maria Voyatzaki, Thessaloniki, GREECE

I think I have made my point.

Dimitris Papalexopoulos, Athens, GREECE

We were hoping that the key-note speakers would tell us something more about the question of representation, because one possible answer is that the representation question is a false one or one without an answer. In my opinion, we cannot deal with the question of representation per se. When we have a continuum from file to factory or, as our colleague from Torino said, a 3-D model where you can elaborate on many representations and not just one, then the whole representation question seems to be a question of the past.

Boel Hellman, Stockholm, SWEDEN

I just wanted to say something more about computers. I studied in Norway, and I was already working with a computer in 1992 or thereabouts, where I began to use it because I thought of it as a way of developing a project in different layers, and then I understood that the computer is actually the tool of layers. It was just the right tool for the right kind of inner logic that my project had, and that was my sole motivation for using a computer at all. Although this enabled me to work at a famous architectural firm, I still did not really know anything about computers, except that it seemed a good way to structure a project, putting one layer on another and then combine them, and I was able to use all the different disciplines to help me with my layers. And of course there was no discipline that I was not happy to include, because I had a lot of problems with my layers. So I just wanted to say that computer representation is still not the most interesting aspect of computers; it is in the thinking and the layer structure that have helped me the most.

Markus Aerni, Stockholm, SWEDEN

My comment has more to do with the belief expressed in a total 3-D model. If you look at what happens in a studio, then it is cool. But, for example, when you use it to develop a project in a school, it is an instrument that is too complicated for the students; they get hopelessly stuck and cannot finish their projects. They sit there all day but the project does not get finished because it is not all in the computer. Therefore, I agree with what Mr. Papalexopoulos, that students need to know how to do physical models, sketches, everything.

Mario Sassone, Turin, ITALY

I would like to try to answer Maria's last question. Starting from the structural engineering point of view, because that is my field, if I design a structure by using a pencil I can only do that by referring to established typologies, such as reinforced concrete frames or better steel trusses or simply better supported schemes, from which I can obtain a lot of information and a lot of help for my design. On the other hand, if I use a computer, I have the possibility of examining even free form shapes or non-traditional shapes; and I may find a completely new solution, because the computer representation can be easily transformed into the finite element model, for instance, so it can perform structural analyses without the help of our own knowledge. I can do research for the best solution with the help of the computer. So I think that it makes a difference not only in terms of the tool we use for representation but even in the way we think about design structure.

Antonino Saggio, Rome, ITALY

Since a second round of interventions has been opened I would like to add something more. To rephrase what I said earlier, we have come from an old inductive model to a deductive model. So, the question, since we are mainly in a pedagogical circle here, where we deal mainly with how to teach these things and not so much with how we do it ourselves when we are working at the drawing table, the question, then, or rather the motto, the crucial motto, is that you must imagine it first. Imagine it first: this is the basic approach of a deductive approach in science, in art, in architecture. This is one aspect. Following on from that, the really interesting question to me is how we develop a teaching that is quite different from what we were used to, that is able to address and develop all this. Also, a very crucial ethical question, that we have to address at some point in the conference, is that the real question when you are dealing with education is whether interdisciplinarity is for all. Talking with Dimitri earlier, we said that we are used to having 12000 students in a school of architecture. In Italy the numbers are a little smaller now, but you understand what I mean about whether interdisciplinarity is for all. Are we going to graduate 2000 people per year that will in some way have the possibility to operate in the world within this deductive approach? This is a really tough question.

Maria Voyatzaki, Thessaloniki, GREECE

Is this taking us back to the discussion of specialists versus generalists?

Antonino Saggio, Rome, ITALY

No, because that changed again. The best way to put it – sorry, Maria, I must be very direct – is that we should start thinking of the people that are really able to pose the important questions and have a kind of studied answer for those that are really only able to search for them. Basically, because we are in a world of knowledge that is huge today, this means that whereas before the whole education process was addressed to giving people knowledge, today, in the new paradigm, the key theme is to teach people how to look for knowledge. We are in a world where basically everything is

there at our disposal, as long as we are able to look for it; and this is very different to previous times and previous generations. So a way to re-paraphrase your question would be to say, not specialists and non-specialists, but people who are able to pose crucial questions and to find answers and people who are looking for knowledge and are able to look for and to capture knowledge. This is a very different way of posing it, because it goes with a different paradigm.

Then I wanted to say one thing to my Italian colleague from Milan. Earlier I mentioned my educational experience. I came from Carnegie-Mellon, where in 1969 the PhD in computer science was founded by Chuck Eastman; and his dream back then already was exactly this idea of having a 3-D database that covered the complexity of the building so easily, precisely as Boel Hellman described, and the reality which we have today is that this approach is implemented, it is already in place. All the large firms use it. I came from a conference where Fraser showed one of these incredible databases which he used in his buildings in Shanghai. Another colleague pointed out that this database brings his life over in the management, etc., of a building, and I absolutely agree with that. On the other hand, I do not agree with the point raised in the second intervention about the difference between a traditional approach, that somehow constrains you within certain ways, and the computer, that allows for a freer approach. I think that the problem should be addressed as I said before, and this is exactly where I would apply my motto: you must imagine first.

Maria Voyatzaki, Thessaloniki, GREECE

Your motto is registered for the proceedings.

Myriam Olivier, Villefontaine, FRANCE

I will give another kind of interpretation from my experience in Les Grands Ateliers. From what I see, representation seems to be an intermediate step between the original idea you have of a building, a place, something, and of the construction itself. Representation seems to work as a sort of filter which will be used differently depending on whether you are an architect, an engineer, or an artist, so that you will have different sorts of representation for the same building; however, all of these representations have to be linked together in an utterly coherent manner, because in the end only one building will be built. What I mean, then, is that interdisciplinarity is the way to mix these different representations and incorporate them in a kind of summing up that will be the final building. And we have been talking mostly about computer representation, but physical representation is also a tool for transforming the idea into a reality.

Per Olaf Fjeld, Oslo, NORWAY

I think what my colleague talked about is very interesting in the sense that our capacity to read the different types of representation is important. With that I mean that a bad idea, if I want to put a moral value on it, might have a fantastic representation, but if one does not have the capacity in some way to read the representation in a pedagogical way, I think that the final result or what one goes on with will be different.

Maria Voyatzaki, Thessaloniki, GREECE

How is that related to construction?

Per Olaf Fjeld, Oslo, NORWAY

I think that it is related to construction in the same way that it is related to any type of creative approach.

Mike Fedeski, Cardiff, UNITED KINGDOM

I just want to say something about representation and interdisciplinarity before the process of construction, during the process of drawing a design. I have been working with students in an environmental design course for long enough to have seen the use of the computer arrive, and I still do not think that it has matured; but before it came along, what was fairly evident was that representation was a skill, a facility, which belonged with the architect. It is this way of thinking through pencils so that your ideas appear on paper. It is a skill which takes time to learn, and it is something that architecture students had and something that I think students of other disciplines find very difficult, and that was one of the problems we had to encounter – I will be telling you more about this tomorrow. But when the computer began being used more by students, students were arriving who already had the ability to draw with the computer, and I think there was a lessening of this difference between the disciplines.

The second thing has to do with some research I did a while back, looking at design going on in an office and trying to find out how ideas about the environment became incorporated into the building through the design process. One of the things that emerged from this research, which surprised me, was that a lot of the information, even about construction, before we even got to environment, was tacit in the drawings being produced by designers in the office. And I knew this to be the case because sketches which apparently said very little about how the building was to be constructed were passed on to technicians, and I listened to the explanations that were being given to the technicians which did not contain much information about construction, and the result was that working drawings were produced, production drawings that could be given to contractors who would produce this building, which seemed to be precisely what the designers had in mind. There was tacit information that was being shared by the people who were working in the practice, and there was a turnover of people, new people who came already bearing this shared understanding.

I think that this is very interesting in terms of interdisciplinarity, because where would this shared understanding be at this stage of design if people were coming from different disciplines? Also the tacit information was in drawings of the first kind that I was talking about, coming from the pencil of designers who were thinking through the drawings, and the information that was going into the drawings was information that you could not entirely see unless you knew the language. And the question is, if you do this through a computer, how do you do it? If a number of disciplines come together and work through a computer, in many respects things become easier, I think, but I do wonder where the tacit information is going to abide.

Dimitris Papalexopoulos, Athens, GREECE

I want to say something more about the 3-D model. I think that we are going to enter an era where interdisciplinarity is needed to build the concept of such a model, but then interdisciplinarity will be put away because, of course, with a 3-D model managing the databases the problem arises of who controls the whole construction process and for what reason. And as the whole story of Fraser and his partnership with Gehry at Gehry Architects clearly shows, as we progress, the question will arise whether we need another engineer who will be the construction manager and what are the ethics of such a model and whether its purpose is for controlling the construction or for producing new ideas. At the moment we need interdisciplinarity to build a model, to build the notion of the 3-D model, and for the moment no one questions who will control it, but I think that this is only temporary. We have to wait and see in the next two or three years how things are going to evolve, and if this will happen.

Thomas Jeffries, Manchester, UNITED KINGDOM

I just have a general comment. I guess the interesting thing about computers is that they allow everybody to make stuff that looks good, and maybe that is the designer's role – to make stuff look good. An economist does not have to think about making the building look good, because he has his spreadsheets, his calculations. The structural engineer can make the building look good because he has the structure worked out for him and he can have his P.I. cover any indemnity if the thing does fall down, and the architects hand the design over to the contractors without having to design any of the details, and the constructor can make it look good because he does know how to design the details to the view that the architect produces in his rendering – and maybe this is the kind of world we are moving into, where looking good is the primary role of the computer, without any more of these flawed discussions about authenticity or whether one method is correct and another is incorrect. You know, whenever you play a computer game you exist inside some form of environment that has been designed; and there is an interesting slippage, I think, between these beautifully designed environments inside your computer and the designed environments outside the computer.

Maria Voyatzaki, Thessaloniki, GREECE

I see that Henk de Weijer has something more to say, and then we will have the keynote speech.

Henk de Weijer, Amsterdam, NETHERLANDS

I am thinking that maybe all the interdisciplinary implementations can be located in two places. One could be the programme of demands for a certain project, where all the databases, all the necessary information or what is thought to be necessary information, could be implemented. And the second would be when a designer synthesises all the information laid out in a programme and lays it out in a form. After the second stage, different disciplines or different people, mechanical engineers or physics engineers or structural engineers, whose function is primarily to serve, will tend, especially if it is of a scientific nature, to support the division that has been

laid out and will say that this design has a full and total vision, which implements all the requirements that have been laid out in the programme of demands. So the second stage is much more fluid and subservient in nature, and the representations of the different disciplines have a completely different form and a completely different approach.

Maria Voyatzaki, Thessaloniki, GREECE

I am delighted to present our first keynote speaker, Marta Malé-Alemany, who has come to us from Barcelona. You have all received short biographies of the keynote speakers in your delegate's pack, so I will not repeat it. I would like to say that we have slightly changed the sequence of the keynote speeches to match the availability of the speakers, so although this session has been centred on representation it would be quite unfair as well as confusing to let you think that Marta only has to do with representation –Marta is about much more than representation.

I will give her the floor and you will find out for yourselves what she is about, but in my opinion she is one of the most fitting people for what we are discussing here.

Thank you for accepting our invitation, Marta.

Keynote lecture

Marta Malé-Alemany

**Parametric Constructions:
An Exploration on "Virtual Standardization"**

*Institut d' Arquitectura Avançada de Catalunya,
Spain*

Marta Malé-Alemaný

Marta Malé-Alemaný is the director of the new Postgraduate Program 'Digital Tectonics' at IAAC (Institute of Advanced Architecture of Catalonia). She is a licensed architect, graduated from ETSAB-UPC (Barcelona, 96) and holds a Master in Advanced Architectural Design from Columbia University (New York, 97). She is currently doing her PhD in the department of Visual Communication in Architecture and Design at the ETSAB-UPC (Barcelona). She has been involved in academics since 1997. She has taught architectural design in US and European institutions (UCLA, SCI-ARC, U.PENN, ESARQ, IAAC and others), exploring the conceptual and material opportunities that emerge from the use of parametric design and digital fabrication technologies for the production of Architecture.

In practice, Marta Malé-Alemaný co-directs an architectural office called ReD with Portuguese architect José Pedro Sousa. ReD is a Research and Design Studio in Architecture and Digital Production, which specializes in implementing cutting-edge digital technologies to assist design conception, engineering and fabrication. With built projects in USA, Austria, Italy, Spain and Portugal, ReD's work has been presented in lectures, exhibitions and international publications. In 2006, ReD received the International FEIDAD Award that recognizes excellence in the application of new technologies in Architecture, and won the Portuguese prize in Ephemeral Architecture 'Outros Mercados'.

The advent of digital technologies has challenged most of the 20th century settings of production. Given totally new cultural conditions and market demands, their interference on design and fabrication offers a scenario with alternative opportunities. After standardization has been the dominating paradigm for decades, today's technological reality also embraces variation as a plausible aspect of industrial production.

Intro / Theme

The work presented here is the result of the Elective Seminar ARCH632 on Parametric Design, held at the University of Pennsylvania in 2005¹. The seminar investigated the role of the computer in architecture with a particular emphasis in its capability to defy established production paradigms. It considered the theme of 'Virtual Standardization'² as a theoretical basis to examine how the specifics of computation may assist in combining formal creativity and constructive efficiency, offering new ways of facing architectural design problems. 'Virtual Standardization'² is a concept associated with design strategies that explore principles of differentiation. Lying between the logics of *standardization* (the repetition of the same) and *non-standardization* (production of singularities), it relies on the mathematical power of the computer to calculate multiple possible variations from a singular original design idea. In architectural production, this approach can be applied equally at the level of the whole architectural object or at the lower scale of its components. In both cases, the resulting design solutions present shared family traits and logics, because they are different actualizations of a latent original one –the virtual standard- that is defined by a set of procedures, variables and constraints.

Tools

To support a *praxis* that embraces 'Virtual Standardization', the seminar used a fully parametric and associative CAD-CAM software (TopSolid³) originally conceived for mechanical engineering. Like Catia, Solidworks, Unigraphics and other similar platforms, this software offers remarkable conditions to resolve an architectural project -from conception to construction- through principles of variation and adaptability. In these advanced modeling environments, objects are defined by numeric and geometric parameters. Their dimensions are not static or fixed, because the designer can modify their value at any time. Simultaneously, these parametric objects retain their original associativity to other objects, such that the alteration of one of them automatically affects all others that are geometrically related with it. With this powerful tool, design changes can be made at any moment, their effects can be perceived in real-time and the consequent adjustments are simultaneously propagated through all other associated design files. Moreover, these advanced CAD-CAM tools collapse different modes of representation in a unique digital three-dimensional model, such that drafting, modeling and fabrication become interactively linked. By offering ways to assimilate and manipulate different types of data and merging aspects that are normally disconnected in traditional design processes (i.e. design and manufacturing), associative parametric CAD-CAM tools provide a convergent, multi-dimensional approach to design⁴; one that flows from design con-

ception to representation and technical description, extending to include fabrication programming to manufacture prototypes at real scale.

Challenge

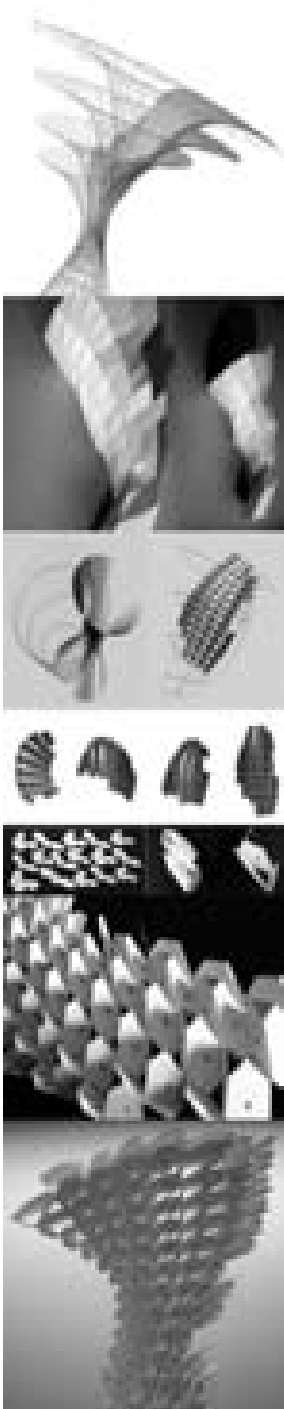
The seminar's research interests were deployed through the design and materialization of an umbrella-like hyperbolic form, which was treated as an abstract exercise for resolving any non-planar architectural surface. Given the complex geometry of the *umbrella* its resolution would naturally imply variable building logics. The challenge was to develop a material "constructions" that had the ability to index multiple sets of information and mediate between different conditions, collapsing functional qualities with more formal or ornamental aspirations. In other words: investigating a design solution that *orchestrated* the relationship between form and performance while achieving specific and desired aesthetics effects. Following variation and adaptation strategies, each student would study a "virtual standard" component and develop a "prototypical" method for its assemblage with self similar components, such that the overall construction would be produced as an aggregate of smaller parts. Furthermore, the seminar pushed the computational power of the computer to reconfigure and recalculate these assemblies, allowing for the generation of any alternative version of the proposal. In parallel, the CNC manufacturing equipment of the school (laser cut) was used to fabricate real prototypes of these constructions, in order to test the material and tectonic implications of the designs.

Process

The work was developed in a series of phases to facilitate the learning process, strengthen the level of design resolution and reach the seminar's research goals. The projects would (a) explore associative parametric modeling to control the *generation of variations* from a unique design idea; (b) investigate how these capabilities can also be extended to a greater level of architectural detail with interactive models that collapse multiple, discrete representations; (c) develop associative parametric components and assemblies; and finally (d) examine how these assemblies can address specific design goals related to architectural performance.

a) Construction of a 3D parametric model

The work began with the elaboration of a parametric model of the *umbrella*, by abstracting and re-adopting specific formal qualities from found examples in nature and other disciplines (flowers, shells, trumpets, etc.). In order to have a wider variety of proposals, this exploration was not limited to the geometry of hyperboloids but included comparable curved surfaces. Each case-study offered clues about its geometric properties, thus suggesting what kind of 'data' ought to be considered to (re)produce it using parametric modeling. The act of drawing in this advanced digital environment, required students to select the parameters that influenced each shape or figure, which would simultaneously facilitate its future manipulation and reconfiguration. Consid-



Work of student
Hormuz Batliboi

ering that each geometric element (i.e. line, curve or other) could be associatively linked to others, the process required a design methodology where -rather than drawn- the overall model had to be 'constructed'. Given all its associative relationships, the parametric model became not only a representation of the final shape, but also an interface for its formal manipulation with 'real-time' interactivity. To test its potential as a design tool, the first stage of the project culminated with the creation of multiple versions of the original umbrella, by altering the values of its parameters and manipulating the spatial configuration of its underlying geometry.

b) Associative subdivision, unfolding and fabrication patterns

Taking into account its parametric generative elements (i.e. ellipses, circles, splines.) and constructive rationale (relationships and constraints), each umbrella surface model presented an inherent topological logic that helped informing how to subdivide it. Its isoparametric curves provided an 'associated' wireframe, used as scaffolding to model a simplified polygonal version of the original smooth surface, with individual planar facets. Considering that both the support curves and the resulting triangulated geometry remained associated to the original surface, their dimensions automatically registered the spatial transformations of the overall model. In other words: any morphological change of the original *umbrella* would interactively regenerate its corresponding triangulation. To test the models in physical form, a duplicate of each facet was unfolded onto an orthographic plane and used as cutting pattern for the CNC laser cut machine. In that manner, the model simultaneously preformed different tasks: it provided a global geometry that was subject to change; it had the ability to recalculate its associated triangulation for any given configuration; and also facilitated an immediate translation into material form by updating its corresponding flatten parts and revising its contour cutting patterns in real-time. This phase of development concluded with the physical construction of 4 triangulated versions from the same parametric model, which were understood as 4 materialized configurations of an infinite array of possibilities.

c) The parametric component and its assembly

The third phase of the project was dedicated to re-examine

the construction of these variable surfaces with a greater level of detail: instead of using mere triangular facets, the umbrellas would be resolved with an assembly of much more intricate building components. This was achieved through the development of a 'virtual standard' component, created in an independent design file, without any preoccupation to scale or specific configuration. Instead, its design focused on determining its internal rules of construction, its parametrically controlled morphological behavior and its insertion key points. Unlike a fixed traditional CAD block, this 'virtual standard' component acted as a *smart* block that could routinely adapt its dimensions to fit local topological variations, when 'inserted' onto specific points of the surface. The disposition of the scaffolding curves was thus fundamental, because they ultimately manifested the topology of the surface, thus informing the components' actualization. Repeating this operation all over the surface generated a field of distributed components, all of which were interrelated with each other. As a whole, this varied aggregation had the ability to: react to global changes if any modification affected the overall surface; and recalculate all its parts (as a registration of local variations) if specific design changes took place at the level of its 'virtual standard' building component. In order to solve its fabrication –given the increased complexity of the constructions–, each component was designed with an associated flattened copy onto an orthographic plane. In that manner each time one placed a new component in 3D, it would come in the model with its corresponding 2D contour for laser-cut. What resulted was a field of flattened components that would interactively adjust according to the global model transformations.

d) Form and Performance

The last phase of the project called for a closer examination of these assemblies, addressing specific design goals related to architectural performance. Considering options like creating openings, studying its thickness, decorative detailing or other, the design of the component was revised to further explore its possible performative qualities. At large, all final constructions managed to do several things at the same time: beyond a clear demonstration of structural stability, they also succeed in revealing variations that responded to other concerns.

For instance, one of the models⁵ produced an



Work of student
Jennifer Cramm

environmentally responsive surface by orienting its pyramidal building components according to the vector of a hypothetical solar orientation. Another⁶ revealed how the thickness of its components could be locally differentiated, such that what was a formally symmetrical structure had the possibility to function asymmetrically as well (to respond to external wind loads, for example). In the end the final outcome of this exploration presented a wide range of design solutions for non-regular forms, which were perfectly resolved as cardboard physical constructions. All of them were put together without using any glue, just by means of folding tabs, corresponding slots or special joints with metal clips.

Conclusion

As a research and design ensemble, the work of the seminar produced a collection of models that succeeded in synchronizing form and performance, while producing spectacular compositions. Parametric and associative CAD-CAM software proved to be a unique digital environment to develop an integrated and interactive design process from conception to construction. The complexity of the design problem –to resolve any non-planar *architectural surface*– was overcome by the students, who demonstrated a total control of their projects throughout the whole process. At any given moment their designs could be measured and examined in detail, changed and adapted to new configurations, and immediately tested with the construction of a material prototype. Parametric design provided students with a sort of hyper-experience of the architectural project that allowed them to merge design creativity, the study of performance and new fabrication possibilities. In this manner, the work revealed how the theme of ‘Virtual Standardization’ offers fruitful ways of developing an architectural *praxis* that takes advantage of the computer as a design partner in the production of variations.

Notes

- 1 The Seminar ARCH632 on Parametric Design was taught by Marta Malé-Alemany at the School of Design (University of Pennsylvania) in the 2005 spring semester. It involved the following people: Students: Hormuz Batliboi, Lang Cheng, Jennifer Cramm, Adam Davis, Jason Dougherty, Andrew Evans, David Friedman, Cristopher Junkin, Jane Kim, Linda Montanile, Stephen Pitman, Todd Shapiro and Nicholas Wallin / Invited Critics: Peter McCleary, Lindsay Falk, Axel Killian, Branko Kolarevic, Detlef Mertins and José Pedro Sousa.
- 2 The theme “Virtual Standardization” was developed by architects Marta Malé-Alemany and José Pedro Sousa (ReD) and presented in the context of the “Non-Standard Praxis” Conference, held at MIT in November 2004. The article ‘Virtual Standardization’ is included in the Conference Proceedings, to be published by MIT Press.
- 3 TopSolid is developed by the company MISSLER. It belongs to the family of advanced CAD-CAM packages that are normally used in mechanical engineering, automotive, aerospace and other industries, and offers precise surface modeling capabilities that are not found in traditional architectural software.
- 4 For further information on how these advanced tools do affect the architectural design process, see article by Marta Malé-Alemany and José Pedro Sousa “A Research on Parametric Modeling as a Technique of Convergence”, published in the Proceedings of the 8th CAADRIA Conference (Thailand, 2003)
- 5 See the work of student Hormuz Batliboi
- 6 See the work of student Jennifer Cramm

**Discussion on the keynote lecture
by Marta Malé-Alemaný**

Chairs:

Maria Voyatzaki

Dimitris Papalexopoulos

Maria Voyatzaki, Thessaloniki, GREECE

Thank you so much, Marta, for a fascinating lecture. It could not have been better. It was absolutely spot-on with what we are discussing and what we are trying to do here.

Nesil Baytin, Gazimagusa, Northern Cyprus

Fabulous work! I would like to ask who developed this programme. Architects? Engineers? Was it a joint effort?

Marta Malé-Alemaný, Barcelona, SPAIN

That is a perfect question, because I meant to tell you who developed it, but it slipped my mind. Basically the majority of these projects have been done using mechanical engineering software. The software is called Topsolid, and it is very similar to CATIA. Its philosophy is pretty much the same but it costs some twenty times less. After many years of working with computers I have realised that there is no architectural software that can give us the flexibility that we would want to have in order to do this kind of work and to really explore the potential of computation, but I think that lately things are changing, because a lot of traditional architectural software has begun incorporating parametric tools, and I am positive that this will be generalised in no time. Perhaps you do not get the capacity – somebody was talking about capacity earlier – of a mechanical engineering tool in an architectural software, simply because they are different disciplines, but nonetheless you would have the possibility of developing the project parametrically in an architectural software. And the thing with mechanical engineering software is that when you put together an engine you have to be very, very precise, because you have to make sure that all the parts fit with one another, and if you move one of the parts you have to adapt the others to the change. So there is a certain intelligence built into the software that I think is very important for us.

Dimitris Papalexopoulos, Athens, GREECE

I have a simple question. How do you make a judgement on a parametric model?

Marta Malé-Alemaný, Barcelona, SPAIN

What kind of judgement?

Dimitris Papalexopoulos, Athens, GREECE

Any kind. I will put it more simply. How do you judge a student's work?

Marta Malé-Alemaný, Barcelona, SPAIN

Well, I think that first of all I judge them by their capacity to understand that they are working with more than one solution at the same time. I think this is very important for them to know, because in my opinion architects are in a completely different situation from before, basically because of our society. Let me rephrase this, or rather, I will tell you what I say to the students so that they understand what they should be doing.

I say: "Let's imagine that you are designing a house for a guy that has all his money in stocks. How do you design a house for such a person? You do not know how much money he is going to have by the end of the process, right? You do not know whether or not he is going to be able to build it all at once, and so on and so forth."

This is a very real problem and I think that an architect has to be ready for these kinds of challenges. I can give you another example. We just finished a project in our practice for an exhibition designer in Graz. It was a huge exhibition with thirty contemporary artists. The curator gave us the list of all the works of art he thought would be included, because the museum does not have its own collection so all the works of art needed to be brought in from other galleries and other museums to mount the exhibition. The curator would request some works, but then we were not sure whether or not they would be available or else we were not sure whether the transport could get them there on time, and so we spent two months with a list of works that was constantly changing. And then some of the works were especially difficult: for example, there was an architectural model that was 8 by 4 meters, and a project is very different if you have to allocate a space for something of that size, than if you do not. So there were times everything was so crazy and we would do the project once, then have to go back, do it again, then go back, and so on and so forth. The programme changed day by day, so we ended up having to create a script in which we could put the different variables. For instance, we were working on the ceiling, and in the end we developed a script with which we could re-calculate the ceiling in five minutes and which would enable us to have all the re-fabrication files for that ceiling. We spent a long time programming it but at the end of the two months we had the possibility to change the project in five minutes. For us that was amazing, especially since the day before we were supposed to send the fabrication files to the company we were informed of some new changes to the programme. We were told by the curator that two of the works were not going to be there, and we changed the project the day before we sent in the files!

So going back to your question, I think that there is of course an aesthetic judgement, but you have that in any kind of architectural project. You can say, "I look at those surfaces and I find them very beautiful", and this is one type of judgement. Or you could make a structural judgement. For example, you could say that based on a whole tradition in architecture by Mr. X, instance, that a structure made out of parts that collaborate with one another may actually be more efficient than other kinds of structures, and so maybe if the model was informed, or if the components were designed following a structural reasoning, then you could have the model informed structurally and you could judge it based on structure. Or else, you could judge it based on cost. You could say that this configuration is more expensive than the other. That would also be a judgement. But the point is that you would have all solutions at once.

Donal Hickey, Dublin, IRELAND

Obviously the parametric models that you present at the moment are reliant upon the manufacturing process to make them viable. In terms of physical manufacture I can see how parametrics would be a very interesting tool to utilise. Is there a difference

between the time lapse of manufacturing capability and the possibilities in terms of what is available as part of a design process in terms of parametrics?

Marta Malé-Alemaný, Barcelona, SPAIN

That is also a very good question. I was hoping that someone would bring it up and perhaps answer it. In Spain I bet that 90% or more of carpenters either have a CNC machine or have access to one, and that is interesting to us because we work a lot with carpenters. I mean, carpenters have the technology but we are not using it, so, hey, we have a problem!

What I try to say to my students is that it is true that maybe ten or fifteen years ago this was a very exclusive type of approach, but today we are so terribly behind that it is ridiculous. All the industry already has such machines; it costs them the same to cut a piece that is irregular as one that is regular. For example, in the case of carpenters, I think that it is ridiculous that 90% of the carpenters in Spain have CNC machines, but they use them to cut doors that are all the same. So they have a problem too. I think that there is an opportunity for collaboration, because you can go to carpenters and tell them that their machine can cut pieces that are not regular and by doing so you open for them a whole new field that they were not exploring before, while at the same time you have opened up for yourself a field of possibilities that you did not have before either. And it is the same in every single field of activity that has to do with construction – I mention carpenters as just one example.

Henk de Weijer, Amsterdam, NETHERLANDS

I think it seems to be a fascinating approach to design a scheme, but I was wondering if you have ever used this approach to design inhabitable forms.

Marta Malé-Alemaný, Barcelona, SPAIN

Yes. I did not show you some of the projects from my practice, because this is basically work that is done in a research environment – it is academic, it is research-based. So what I am saying is that every single studio and every single seminar is an opportunity for developing things with this research edge, but for me it is also very important that the students understand that what they are doing in the seminar and what they are doing in the studio is actually the reality in the street, because that is the way it is. So they are learning about tools, they are learning techniques, they are learning thinking processes that are being applied in practices in real life.

Antonino Saggio, Rome, ITALY

I think it all sounds fascinating and your course certainly sounds like one I would like to take. And although I am very interested in where all this is going I will change direction or side a bit and start questioning things from a different point of view. Since this conference has to do with education I will try to think about these things from a pedagogical point of view. Now the big question that comes from what you were saying about the carpenters and the kind of general thinking you mentioned, is that we were still used to the old meaning of the word modularity while we are clearly in another paradigm now. Therefore what we have to do now is think

very carefully about what could be the real keyword of today with which we would replace the word modularity. Then returning to your course, which as I said before sounds fantastic, we have to ask ourselves how all this will affect our pedagogy. To illustrate what I mean I will use a metaphor. Imagine a spreadsheet – what you have been doing is taking one cell of the spreadsheet and putting within that cell several parameters that you can change parametrically. What I see as the real strength of your approach is that these different parameters are related, in construction and in programming and in doing geometrical things. But I would like to go back to the idea of the spreadsheet, the cell, that incorporates changing parameters. This, I believe, is its strength and it is a strength that I am bringing into construction; and, as you showed, the result can be beautiful. But this is further down the line, of course, so what is next? I think that there are two ways to proceed. One way would be to add more parameters, issues of the function of interior spaces for instance, so that the cell we created becomes more and more complex. That is one way, but it is not my way. My way goes in another direction, and all my thinking for the past twenty years goes in this other direction. I will look at the other cells of the spreadsheet and then I will make connections between the cells of the spreadsheet. This is the concept of instantiation, which means that there are different parts of the system that are not connected parametrically, but are connected through instantiation.

All this goes back to the idea of what we change as the other element of modularity, looking on this as modularity versus continuity. However, the real issue is probably not modularity versus continuity, but modularity towards ‘remixability’, which is one way to say it, or modularity towards instantiation, which is the other way to say it.

Marta Malé-Aleman, Barcelona, SPAIN

Well, obviously for me it is important to be here today so that you help and suggest ways in which one could continue this; because I do what I can, but of course I have limits like everybody else. What I am thinking and what my objective would be is based on the fact that I see a real possibility for interdisciplinarity, which for the time being is only a theoretical possibility that has not yet been materialised. However, what is clear is that you can create a series of relationships between elements, but, in relation to the judgement question, you can inform them differently. And I think that again this is a very different situation from before, and probably the people who could best inform us of it are people that have a lot of experience in their field, who are probably people from a different generation to mine. Not that I am young, but they may be no more five years older than I am, maybe even people who have never used computers before, and I think that would be a very interesting collaboration.

Also, we are talking about interdisciplinarity, but as Dimitris Papalexopoulos said earlier, if we had a parametric model and we had various specialists all saying what it should be like, how are the decisions taken and how does the collaboration process work? That is, of course, a question mark for me. Because I think that in parametric modelling what you have is a very powerful tool that you can use in different degrees, to do very simple things or very complex things. So for me it is not so much about augmenting the number of parameters but about exploring its potential, and it does not necessarily mean that the model gets more complicated as a result.

Lucien Denissen, Antwerp, BELGIUM

All those shapes and forms that you showed are wonderful, and they seem easy to imagine. Personally, I do not think that it is so easy, but let us say that you could teach us. However, after some time the shapes will have to actually be calculated, and at that moment I suppose another person, for instance, a civil engineer, will be called in who will have maybe the same programme or a connected one. So it is a great idea that schools of architecture should integrate this way of thinking, but at the moment we need someone who can play with it like you do, and maybe there are just a few people like that in Europe, I do not know.

Marta Malé-Alemany, Barcelona, SPAIN

There are many, actually.

Lucien Denissen, Antwerp, BELGIUM

You think that there are many?

Marta Malé-Alemany, Barcelona, SPAIN

Yes, definitely.

Lucien Denissen, Antwerp, BELGIUM

Then maybe afterwards we will need a civil engineer, because it will be without control and I am afraid that there is a danger that it is only shapes, only forms, which certainly look beautiful, but they have to be built, they have to be made into something. As a second phase, maybe we need to look at that kind of control. So I do not think that schools will begin integrating that kind of exercise very soon.

Marta Malé-Alemany, Barcelona, SPAIN

Well, let us say that there are two sides to your question, or to your comment. I think that one is clear – these type of models put a question mark right in front of our face with regard to the next step, which I think we agree is that we will have to work with a civil engineer or a structural engineer, some sort of engineer that knows more about this than we do. How we are going to work with him is, I think, a clear question that arises from this; and how I see it is that a person with a lot of experience would be able to constrain or control the model. If you see the work with the spoons, my hope is that the same thing would happen as with the spoons. So that means that by constraining the model for engineering reasons, you are opening up new configurations that you did not anticipate. That is my hope, and I admit that I see such a collaboration with an engineer as a potential for creativity and not as something that would constrain me.

The other point is about whether or not we can do it without engineering, without collaborating with specialists. To be frank, I was hoping that by the end of my lecture you would see that it is not only about shape and not only about form, and that the fact that we are building these prototypes allows us to test these things physically, so we could follow the Frei Otto kind of approach and build models and learn from them. We could build them, test their resistance and go back to the computer and

adjust the parametric model and try again. But it is important to understand that we would not be remodelling the project, we would only be making adjustments. And I think that in what I showed you it is also clear that the digital fabrication equipment allows us to fabricate immediately, so it is not something that would take a year and then leave you to go back to your model, etc. It is an instant process, which I think gives us the possibility to go back to a kind of intuitive engineering, in the sense that there is a relationship between what we create in the computer and the physical world that I think was lost in the 90s, when computers were first being used in design, and personally that did not make me happy. I am much more happy when I see the things built, when I can touch them and when I get dust all over me, because I am there with the machine, I like that feeling.

Lucien Denissen, Antwerp, BELGIUM

I have a second question, if I may. You started with a circle in a point, and when we draw the circle the point follows or does not follow, and you ended by saying that this could be the basis for digital design. And we saw folded structures and hyperbolic structures, but you say digital design can also be used for simpler structures.

Marta Malé-Alemany, Barcelona, SPAIN

Yes, of course.

Lucien Denissen, Antwerp, BELGIUM

And we can create tectonic metals with digital design, it does not end with this kind of three-dimensional structures; we can also compare different solutions to a project in, say, 'usable' buildings.

Marta Malé-Alemany, Barcelona, SPAIN

Yes. And actually I think that you can work parametrically without working with parametric software, because it is all in your head. It is all about you and your approach to design. That means that you are designing a part or a piece or a building or whatever you think can have all those configurations due to anything, the stock problem, weather conditions, etc. You could design a pavilion for a site, even if your client has not yet bought the site and you would have the possibility to adjust it depending on what site he buys. There are twenty thousand possibilities you could be confronted with, and this variation is part of the design process for any architect. Otherwise, you can do it by hand and commit in a way to the prospect that you will be doing it again and again and again, each time you learn something new; but I think that we do not need to do this – we do not need to because now we have tools that allow us to work in a different way.

Mario Sassone, Turin, ITALY

With regard to the problem of bringing in a mechanical engineer, I think that one answer could be the automation of the structural analysis of these kinds of structures related to parametric design. That is the work we are doing in Turin. It means the automation of the building of structural models and it means using finite element

models, starting from geometrical models. This kind of analysis can be performed in a very short time, like what you said about manufacturing.

You talk about scripting as a tool that facilitates parametric design, and I wanted to ask, who develops the scripts? The students, or do you have some support by informatics engineers?

Marta Malé-Alemaný, Barcelona, SPAIN

Well, I talk about scripting because I know that scripting would be doing that, but I have not yet taught a scripting class. I hope I have the chance at some point. Our office used scripting when we were doing the Graz project to model the ceiling, and we mainly used AutoLISP, a programming language which is twenty or thirty years old, and basically we learned how to do it as we went along. In the beginning we learned how to script one line, so if we gave it ten points it would do ten lines, and that in itself was a big success. The next thing was to do those ten lines and extrude them off, so immediately we had ten surfaces extruded off. We proceeded step by step, real baby steps, until we got our programme together and, as I said before, it took us two months to develop our programme because it ended up quite complex. We were doing geometric work, mathematical work, fabrication work all together in a language made up of letters and numbers that was completely foreign to us, we are more visual or spatial people, and that was also interesting. It was quite fascinating. When you write a script you can immediately test it, because it is like writing a set of instructions, you tell it to take a line for five meters and then extrude it for three meters, for instance, and then you have to test it to see whether or not your script is working. So, in fact, it continues to be visual, but you also need to be very analytical in the way that you approach design. I think that it is less intuitive than parametric design, that is my feeling, but it is really, really useful. I think that there was a discussion earlier about whether or not architects should know how to programme and learn codes, and I am positive that they should, because even if they are not able to do very complex scripting they will at least have a minimal understanding of what scripting is so that they will be able to talk to information engineers; otherwise they will have no language in common. And I think that it is not only a question of our willingness to talk to information engineers or include them in the process, as you discussed earlier, but of whether or not we speak the same language – I could be willing to talk to a Japanese man but if I do not speak his language, I could be talking for a week and he could be talking for a week and we still would not understand each other.

Nikolaos Panagiotopoulos, Thessaloniki, GREECE

A very interesting idea came to me while I was listening to your presentation. Lately architects and schools of architecture are besieged by all this ultra-heavy, ultra-cumbersome building information modelling software, that claims to be capable of monitoring every single process in the building, from cost to thermal performance, you name it; and then I saw what you showed us and I asked myself, what if we had a much simpler tool, much simpler software, less expensive, less cumbersome, less demanding, where we would be able to set the parameters that are required for a specific project ourselves? It is an idea that seems very interesting, and this brings

me to the question of what limits we can put to the parameters we can set. Can we set religion as a parameter of design, or the wind, for example? Can we integrate such things in this kind of programme? Because I saw that the sun was a parameter in one of the designs you showed.

Marta Malé-Alemaný, Barcelona, SPAIN

As I see it you have brought up two issues. The first is the software and whether or not the software can be simpler, less troublesome and cheaper. This is somewhat subjective. For instance, I do not think that AutoCad is cheap, or simple for a beginner, and personally I find it very troublesome, but there are other options. Take a software like Rhino, Rhinoceros, for example, for which an educational licence costs 200 euros and which, when the students graduate, turns into a professional licence without paying anything extra. I think that is unbeatable. And not only that, but Rhino supports a programming language called is rhinoscript and also I think that it allows you to build families of shapes using nerve surfaces and solids. I would say that it is a very complete programme. You could do orthogonal things with Rhino, or curvy things, but it is a tool that is basically easy to use, it is intuitive, it can support all sorts of advanced developments with scripting and stuff like that. From that point of view, it is definitely my choice for students.

Then in terms of what you are saying about the parameters and whether the wind could be a parameter or not, what I showed you were some examples of what you could do. In my example the sun was a parameter, but it could be anything. The idea is that there is a point in space that is external to the model that affects it. It creates a kind of privileged vector so that all the components of the model will actually be adapting or recalculating themselves in relation to that privileged vector, which could be the wind, the view, the sun, or anything else you want.

Nikolaos Panagiotopoulos, Thessaloniki, GREECE

Can we import these things from Rhino to AutoCad?

Marta Malé-Alemaný, Barcelona, SPAIN

The things I showed you were not done with Rhino. These are parametric models and Rhino is not a mechanical engineering software, it is not parametric and associative; but, yes, you can do anything in Rhino and export it to any other software. However, the Rhino model does not give you the possibility of adapting or adjusting it, except the latest version of Rhino, which incorporates a lot of parametric tools. But this is true for any software: parametric tools are on their way in. For example, I think in AutoCad now you can draw a circle and you can click on the circle and change the radius, so that is an example of a parametric tool; and you have parametric tools in most of the new software, but what they do not have is associativity. This means, to continue with the example of the circle, that you have the possibility to change the radius of the circle, but if another circle was right next to it, the change in the first would not affected the other, because they are not connected, they are not associated to one another. To be more explicit, say I have a segment of 10cm and I draw two circles on it, each with a radius of 5, in an associative parametric environment if you informed the model that the line is 10cm and then you modified one to have

a radius of 3, the other would automatically change to a radius of 7, because both of them together have to be 10. You cannot do this with AutoCad.

Nesil Baytin, Gazimagusa, Northern Cyprus

I hope I will not sound too traditional, so I do not want you to think that I do not appreciate what you have shown us, but I would like to ask you some questions just so that I understand it better and perhaps so that I can explain to my colleagues. Your presentation gave me the impression that the process emphasises the form, and following from that I understood that by saying creativity you directly refer to form. So beginning with a search for forms and then inserting some criteria, such as sun orientation or wind load or whatever, some contextual parameters, and then the changes and the variations that are created with them seem to me very much like the same forms. It somehow seemed to me like sticking to the same form but trying to solve or trying to bring in some variations, or trying to see some variations created by the software on the very same form. In my context, in my faculty, I teach both design and construction courses, and I am trying to coordinate both kinds of information into the projects, so I find this very interesting and I would like to understand it better.

I also have a question. I am not referring to the cost of the programme, the cost of the software at all, but I am asking what type of building project this software can be utilised in?

Marta Malé-Alemany, Barcelona, SPAIN

In relation to the limitations of parametric modelling, I think that again it is a question that has different answers, because in this case the models are somehow limited by their topological or geometrical description, in the sense that if you model a torus then you stay within the idea of a torus and you do not go to a sphere, because topologically a sphere and a torus have nothing to do with each other. And that is why the spoons project is very important, because when you do your curatorial work you decide which eight will be your spoons and then you reflect on how you are going to build them, so in fact you are deciding on the topological nature of your model, and that is of course at the top of your construction tree. And these kinds of software are hierarchical in the sense that the construction tree dictates how our model will have the capacity to react or not. It is like the human body in this, for instance, I can twist my arm this much but not more, because the relationship between my bones is dictated already, I do not have free movement in all my bones, and I think that it is exactly the same in parametric modelling. But there are parametric softwares, like GC, Generative Components, in which you can modify the construction tree, so that the topology of the model is not restrictive. That is of course a different kind of approach to modelling, but it is there, it is available. Already on the market you can find software that will give numerous possibilities to do things differently and not necessarily in the same way I have. For example, you could also script conditions: you could say "If A then B, if not then something else", and right there you have a bifurcation.

Now in relation to the second part of your comment, about where such software can be utilised, my answer would be in any kind of construction. Personally, and this

is my architectural agenda, I do not think that everybody should live in the same kind of house and on the other extreme, I do not think that everybody should hire an architect and pay an architect's fee to design a single unique house. I do not agree with these extremes and, in a way, that is exactly what I was saying earlier: on the one hand you have this repetition of houses that are all the same and on the other you have the exclusive expression of an architect's idea, but for one single client. In between is everything you can imagine and I think that implies variation. So I am somewhere there, in the middle.

Thomas Jefferies, Manchester, UNITED KINGDOM

In the 13th century a master mason pointed at a site of a cathedral and spoke to his masons and said, "I want one there, please. Off you go, boys, and make it the biggest one in Europe", and Salisbury Cathedral gets built. And what you have really shown today is that an architect can get very close to his parametric software and produce a myriad different varieties of something that you are not quite sure what it will be, but you think it will be good. So my question is: is parametric design the new Gothic?

Marta Malé-Alemany, Barcelona, SPAIN

Well, the thing is that you are talking about a stylistic thing, and in that sense I take full responsibility for any aesthetic choice that has been implemented by my students, otherwise they have the responsibility because it is their project and not mine, in terms of aesthetics. From a construction point of view I think yes, in a sense. Maybe I do not know enough, so assume I might make some historical mistakes in my answer, but I think there is definitely something about having the possibility to have models, parts that collaborate with one another, so in that sense these are constructions that are not so classical in a way.

Maria Voyatzaki, Thessaloniki, GREECE

I think that by Gothic, Thomas probably means something that will stay in the history of architecture as a masterpiece. Is this what you are implying Thomas?

Thomas Jefferies, Manchester, UNITED KINGDOM

I think it is interesting that you move out of the Roman period, classicism is dead and buried, into the Gothic period, which is about structure, expression of forces, a kind of organic, evolutionary view of architecture, then you move back into the classical period, which has continued through modernism really, so the question is whether we are now in this potential position, beyond Fordism, beyond Taylorism, in a kind of much more open, everything-is-possible, situation – and is that a kind of re-statement, analogous obviously?

Marta Malé-Alemany, Barcelona, SPAIN

I think, yes. I did not understand your question correctly before. In that sense, I think, yes – radically yes. However, that has nothing to do with parametric modelling in the sense that if you look around and see what is being produced today in

competitions and everything. And I think that computation has a role, in that computation has radically changed the way we produce things, has radically changed our opportunities for form-making; but I think that parametric design is only one way of operating within computation. I am thinking for example of Toyo Ito's designing with algorithms, which is parametric, but it is not necessarily done with parametric software; and there are many more examples like this. I mean, take any major representative buildings of our era and you will see that there are very few that are not exploring these kinds of issues in one way or another.

Maria Voyatzaki, Thessaloniki, GREECE

Thank you very much, Marta.

Marta Malé-Alemany, Barcelona, SPAIN

Thank you.

Theme 2

Interdisciplinarity
simulation/environmental
control
construction
construction pedagogy

Can architects alone work on the design of sustainable buildings and statements?

What is the necessary knowledge base that architects ought to have for designing intelligent buildings?

How can environment scientists/engineers collaborate with architects and the design team, in general, in order to produce environmentally-controllable buildings?

What are the necessary competences of architecture graduates that will enable them to collaborate with environmental scientists/engineers to produce sustainable energy-saving buildings?

Does the use of computers change the teaching methods and pedagogy of construction with an emphasis on the environment?

Keynote lecture

Mike Fedeski

**A Postgraduate Course
Teaching Environmental Design
Across Construction Disciplines**

*Welsh School of Architecture,
Cardiff,
United Kingdom*

Mike Fedeski

Mike Fedeski is an architect whose persistent interest in the interface between architecture and the physical sciences has steered him through changing currents of public enthusiasm through the years for energy conservation, bio-climatic design, and sustainability. He began his voyage in architectural practice but, seeking a higher level of expertise in these matters, he took a masters course in environmental engineering, was deflected by the lure of academia, and eventually came ashore as a member of staff at the Welsh School of Architecture.

There he has been running an MSc in the Environmental Design of Buildings since 1993. This opened the doors of the WSA for the first time to students from other disciplines, and though never as numerous as their architectural colleagues, they continue to arrive. Some remain at a distance, studying on the new on-line version. The environmental design course has since spawned two further masters on architectural science subjects, one taking a more general view of the Theory and Practice of Sustainable Design, and the other a more focused look at Building Energy and Environmental Performance Modelling.

His research interests have centred on the process of design, on climate change, and more recently on urban soundscape.

The masters' course in the Environmental Design of Buildings at the Welsh School of Architecture opened in 1993. Over the years since then it has matured under the guidance of the module leaders from the research and teaching staff at the School. As the course leader during this time, I have been invited to give an account of the present state of the course to the conference.

Its relevance to this conference is that, although it is taught at an architectural school, it is open to any student who finds it of benefit, whatever his or her previous discipline. As it is a postgraduate course, most students have had previous undergraduate training at some stage in their life. The student cohort is thus truly interdisciplinary.

The invitation to give this paper is an opportunity to reflect on the problems and rewards of interdisciplinary teaching, and to address some questions about why we do it and how we are doing it.

The Course

Subject and structure

First let me describe the course, what we teach on it and how it is delivered. The subject matter of the course derives from the School's research strength in environmental design which dates back to the blossoming interest in environmental science in UK architectural schools in the 1960s, was absorbed into the national programme to promote energy conservation which began in the 1970s, and has been rejuvenated by the more recent international broadening of the research issue into design for a sustainable planet.

Although we investigated the market for such a course before we launched it, it is interesting to note that the original impetus came not from market research but from our own expertise in the subject. In some respect, the priorities of the School's research were ahead of those commonly found in practice. The School, due in part to Government initiative in research funding, was responding earlier to the same drivers that would affect practice later. When we began, any advice we offered prospective students about career prospects was at best vague. Nevertheless, students joined the course, inspired by the very same burning priorities that drove our research. This tradition of student aspiration for a better future continues, with many students from abroad joining the course to learn from the experience of practice in the United Kingdom skills they can take back to their own countries.

This was the first masters' course to be run at the Welsh School of Architecture. It was the first course that took the School's teaching beyond preparing students for architectural careers, and it was decided at the outset that it would not be just for architects. Nevertheless, the architectural tradition of training students through project work in studio was considered to be a virtue worth introducing to non-architects. Whilst the course is not studio-based, in the sense that the School's undergraduate course is centred on design programmes in the studio, learning by project work is given a prominent role.

The subject was divided between modules, as required by University and national teaching policy, each with a different leader, but they were never conceived as independent. Another early decision was not to organise the teaching of environmental design around the obvious technical schema of heating, lighting and acoustics, but to devise a more integrated programme sympathetic to the needs of building design. The original module subjects have almost all been changed over the years, but this principle remains, as will be seen later.

Since 1993, the course has been subject to continuous review and redesign. Major changes accompanied the University's programme of modularisation, which altered the number of modules and entailed a major re-structuring, and the development of a version of the course for distance learning, which required systematic on-line capture of all the taught material, with its consequences for the delivery of the local version. A version of the course has been transferred to the British University in Dubai, and transfer of another version to a university in China is under negotiation currently. Two new masters' courses have been developed in the wake of this one, about which more later.

The present course has six modules, which can be characterised with reference to figure 1. The Ambient Environment module is concerned with the environment found at the site, ways of presenting it to assist in design, and of modifying it in preparation for building. This is counter-balanced by the Building Environment module, which considers the environment to be established within the building after the intervention of the designer. The linking module is Skins and Spaces, which studies the building fabric's influence on the passage of air and light through it, following the dictum that the fabric functions in part as a climatic filter. These three modules are the analytical basis for the Passive Design module, which looks at strategies for designing buildings to maximise the contribution that the ambient environment can make to the building environment, and reduce the load on the building plant. Its corollary is the Efficient Building Services module, which shows how the building plant can be designed to meet this load in an efficient way that minimises consumption of energy. The wider context within which environmental design is conducted, which governs the ethical stance of the course, is portrayed in the Frameworks for Sustainable Design module. It is an unfortunate fact that a comfortable and healthy environment in buildings is often attained at the expense of the wider environment outside, and so to the detriment of the global environment. This module gives an overview of this situation and how to avoid it.

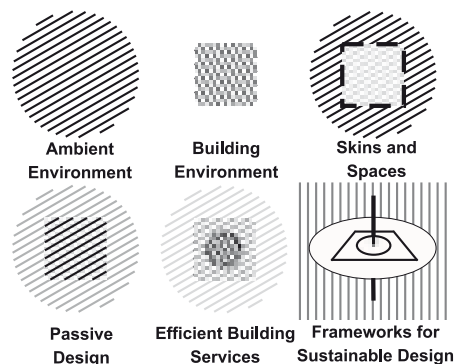


Figure 1

Student project work

The programme of teaching could be explained in greater detail, of course, but little would be gained from presenting the syllabus in this paper. Reference can be made to the School's web site for this. Some idea of what students do with the knowledge they gain can be illustrated by showing some of their project work. Students show their work in posters for exhibition or in slide presentations. Although graphical presentation is preferred, this work has a strong narrative thread in which the process of development and analysis is explained. As this aspect of the students' work cannot be shown here without a lengthy description of each project, only an impression can be given. The kind of work undertaken will be illustrated with just one sheet from a student presentation for each of three modules.

In the Skins and Spaces project, students are asked to examine and explain the environmental performance of an existing building of their own choice. It is an exercise in understanding how buildings work, usually buildings noted for their environmental qualities. Figure 2 is one of four sheets looking at the Wessex Water Operations Centre at Bath, UK, which focuses on the detailing of the facade, the pattern of natural ventilation in the building as a whole, internal cooling loads and thermal performance.

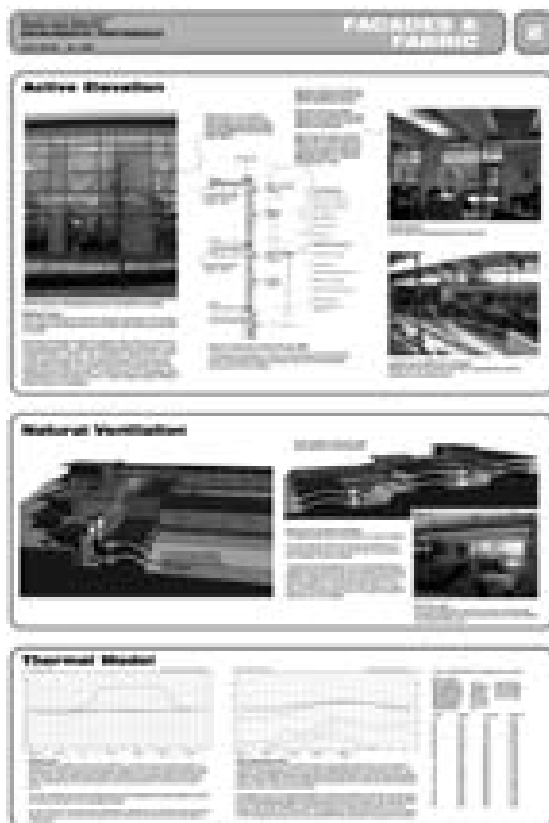


Figure 2

The Passive Design Project requires students to make proposals of their own for a building following a brief which they again decide for themselves. The sheet shown in figure 3 is one of six presenting a public boarding school for boys in Putrajaya, Malaysia, which illustrates the strategies adopted for cooling, and assesses the expected ventilation and lighting performance.

Whereas the emphasis in Passive Design is on the fabric, the Efficient Building Services project asks students to make proposals for the services of a building. Although the type of building is their own choice, in this project the envelope in which the building must go is always the same, to preclude any pre-occupation with the design of building form. We see in figure 4 a sheet from



Figure 3

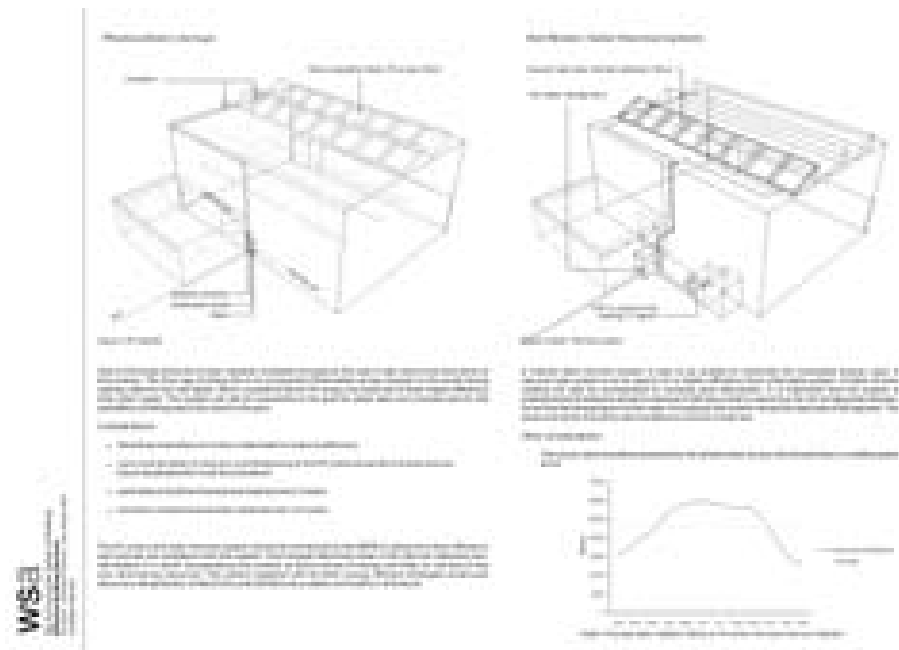


Figure 4

seven presenting a fitness centre for Las Vegas, Nevada, and it outlines proposals for a photovoltaic array and a hot water system using solar thermal collectors geared to the loads expected for this building in this climate.

In looking at these examples, one should bear in mind that the nature of work presented by students is influenced, as it should be, by the criteria by which it is assessed. This is a course concerned ultimately with the environmental performance of the ideas put forward. As performance is difficult to assess from normal architectural renderings, there is a strong requirement for argument, analysis and modelling. The presentations give emphasis, therefore, to the technical aspects of the work. The assessment criteria do not mention explicitly aspects of design normally given high priority in architectural work, such as visual aesthetics or spatial planning. A good architectural student will find it impossible to ignore these aspects, but opportunities for exercising skill in them are minimised in the project briefs.

New courses

In the last two years, the Environmental Design of Buildings course has been supplemented by two others, one of which takes a broader, more comprehensive, view of the subject, and the other a more specific view of a particular aspect. This nested interpretation of the courses' viewpoints is presented in figure 5. The broader course is the Theory and Practice of Sustainable Design. This is a more comprehensive view of the issues involved in the design of sustainable built environments, from product selection to planetary impacts, and it includes a double module in which opportunities for sustainable practice are investigated in a live project in a local practice. The design of building environments is considered in this course, but not in the detail in which it is treated in the Environmental Design of Buildings course. The shading in the figure is intended to show this aspect of the Theory and Practice course highlighted and

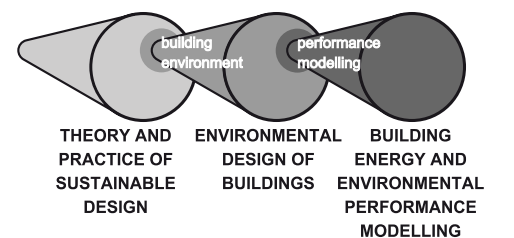


Figure 5

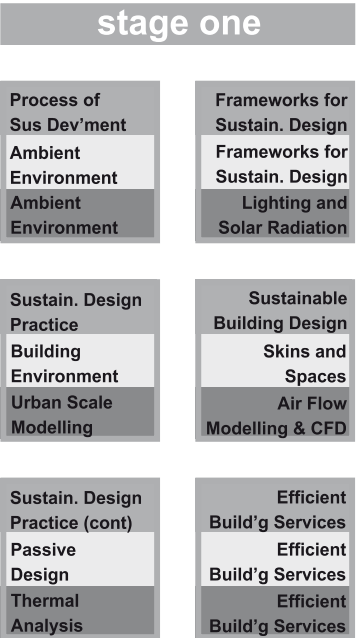


Figure 6

amplified into a course specifically on environmental design, taking with it such other aspects of the subject of sustainability as are needed in support. One aspect of this next, Environmental Design of Buildings, course is modelling environmental performance to find out whether proposed building designs meet the requirements set for them. Modelling is becoming an increasingly specialist activity, and this aspect is in turn amplified and taken as the subject of the next course, Building Energy and Environmental Performance Modelling. This gives students practical training at greater length in the safe use of the major types of performance modelling tools.

The teaching structure for these courses is the same (figure 6). In this diagram the sequence in which the modules are taken runs from top to bottom. As with most taught masters' courses in the United Kingdom, there are two stages, one for the taught modules and another for a research, or dissertation, module in which students report on an investigation that they have conducted into a research question that interests them. In the taught stage, there are six modules, and students take two at a time, few enough to allow project work to be undertaken for the duration of the modules. In the diagram, the yellow background is for the modules described earlier for the Environmental Design of Buildings course, whilst the green is for the ones taken by students on the Theory and Practice of Sustainable Design course, and the red for those taken for the Building Energy and Environmental Performance Modelling course. As can be seen, some modules of common interest are shared, but otherwise the modules in a group are lectured at different times so that students can sit in on modules from other courses if they wish to do so.

The Mix of Disciplines

Student numbers

The decision to open this postgraduate course to non-architectural students is one that has influenced our approach to teaching the subject. Instead of being able to build on the common knowledge and skill that a group of architectural students would have had, we have had to find a new basis common to an interdisciplinary cohort. I would like to discuss how we have done this, and consider some of the problems for the students as they face aspects of learning which are new to them and the challenges for the tutors in defining appropriate standards.

Let us look at the mix that we have had since 1993. The table in figure 7 shows the background disciplines of all the students to date who have taken this and the two new related courses. Of a total of 244, 127 have studied architecture, 30 architectural subjects including architectural engineering, and 2 architecture with another discipline. Thus, the majority of students,

	127	architecture
	23	architectural engineering
	7	architectural technology
	1	architecture + env management
159	1	architecture + planning
	1	interior design
	2	interior architecture
	2	three-d design
6	1	design
	2	environmental engineering
	3	environmental science
	1	environmental science + biotechnology
7	1	environmental technology
	5	building surveying
	2	building technology
	1	building studies
10	2	construction management
	25	engineering
	12	civil engineering
	2	civil engineering + architecture
	1	civil engineering + philosophy
	3	building services engineering
	1	building engineering
	1	mechanical engineering technology
50	5	mechanical engineering
	1	urban design
	1	built environment
3	1	laboriculture + building
	1	human life science
	1	biology/chemistry/design
	1	geology
	1	economics
	1	mathematics
	2	physics
8	1	leisure resource management
1	1	none

Figure 7

159, have had training in architectural disciplines. However, if it is granted that a course in architectural engineering gives its students some knowledge of engineering methods, another way of looking at this is that 117 students, almost half, have come to the course with training in disciplines other than architecture (including one who came without a degree but with several decades of relevant experience). That is, about half of the students have been able to bring to the course and share with others skills learned outside the formal discipline of architecture as it is taught in the UK. The graph in figure 8 shows how the mix has varied from year to year, with annual numbers of architects, students with mixed disciplines, and those with no architecture.

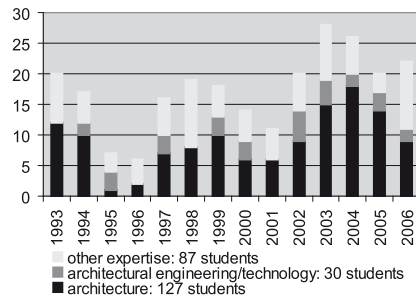


Figure 8

There has been an attempt in figure 7 to group loosely related disciplines, and it is interesting to note that the course has attracted some students whose background has not been related to the building industry at all. Although we have not done a statistical analysis of the grades awarded to students from different backgrounds, our impression is that students in this category have done as well as others, and some have done very well indeed.

Perhaps it should be said, although not relevant to the theme of this paper, that the students come from all over the world. There are only a few, if any, students from the United Kingdom among the student cohort each year.

Differences in starting skills

Ideally a student should be an all-rounder, good at both design and technology. Architecture has traditionally attracted students who have had a dual interest in the arts and sciences, but our experience with undergraduates at Cardiff has been that the student body as a whole is resistant to the level of technical discourse that engineers would relate to. They are more interested in getting on with applying their creative talents to the design of buildings. The masters' course steers a path between these two extremes.

It regards technology as a means to the end of designing buildings. The environmental science needed for this end is taught in principle, without a detailed mathematical treatment. The need for complex mathematical analysis has been eroded in practice by the availability of computer programs that carry out performance analysis more accurately and faster than would be possible by manual methods. However, because this software can give misleading results, it is of the greatest importance to be able to check its output manually. Fortunately the calculations needed to make sure that the results are realistic require only simple linear algebra, and this determines the level of mathematical ability required of students. The same techniques are also suf-

ficient for them to gain an early indication that their design proposals are proceeding in the right direction before resorting to computer models. This makes life easier for students without a strong technical background.

Equally, we recognise that students without the several years of studio experience that architectural students have had will not gain the same design skills during the course. As can be seen from the few examples presented above, only some of the projects involve the students in design. For these, the project briefs encourage simple design problems that do not demand difficult spatial planning, construction detailing, or aesthetic choice. The students are guided by their tutors in selecting problems that are within their capability. Most importantly, non-architects are invited to see themselves in the role of an advisor to the design team, not producing the designs themselves, but proposing to the team the approach that they should take to the environmental problem and suggesting to them how this might influence the building design.

The technical and design abilities required of students when they embark on the course are thus low key. Most students will exceed these requirements in one aspect or another, but are likely to be at a lower level in others. There is thus an imbalance in their abilities to which they will need to adjust in the early months. At the beginning we run a two week induction course in which, among other things, we introduce students to the common level that the course assumes, tell them what they should know and should be able to do, and guide them in how to bring themselves up to standard.

Subsequently, students are presented with project briefs that are flexible, in that they involve a high degree of self-choice in the subject and the problem. For example, the Passive Design project brief does not specify a building type, and can be located in any place in the world, so the physical problem to be solved may take different forms. This allows the students, within the overall objectives, to shape the project to suit their areas of skill. In the example in figure 9, an architectural student has indulged in tight spatial planning on a small scale for a wildlife observation hide in Africa, whilst in figure 10, a physicist grappled (in calculations not shown) with the thermal, acoustic and lighting problems of a simple underground “hardened aircraft shell” he designed for air defence in Saudi Arabia.



Figure 9

Nevertheless, to meet the overall objectives of the projects, students are still sometimes obliged to work outside their area of skill. Even so, some students have shown how they can find an approach in these more challenging areas by bending their own particular interests. In figure 11 for example, a civil engineer takes the need for

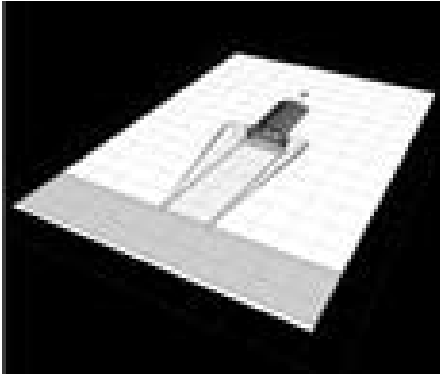


Figure 10



Figure 11

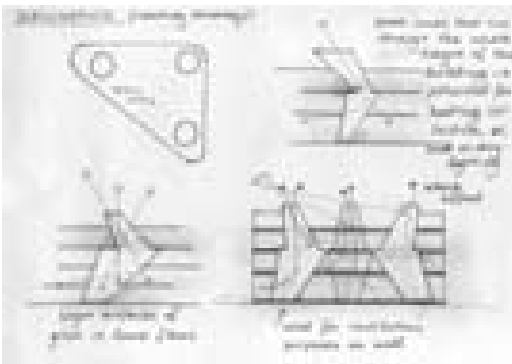


Figure 12

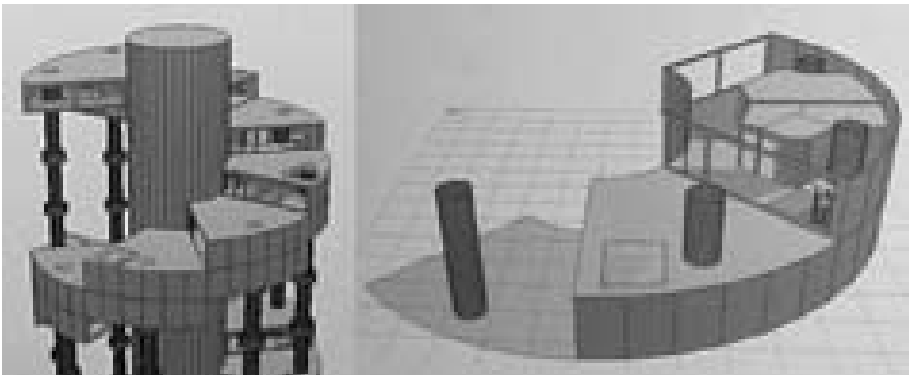


Figure 13

high volumes of fresh air in a studio for reconstructing Mayan masterpieces in the Yucatan Peninsula as the basis for his design. For the office building in Munich in figure 12, an interior designer has used the drive for interior lighting in a deep site to shape unusual light wells. The bizarre residential tower in figure 13 was designed by a physicist as luxury apartments for Reykjavik, and dominated by the need to admit the maximum solar gain throughout the year. Figure 14 shows a thermal bath

in Edinburgh, designed by an engineer to make the most of both solar and geothermal heat for bathing.

These designs can be faulted in architectural terms, and this could pose a problem in assessment. But the view taken is that what matters is whether the designs make sense environmentally. Of course, some account must be taken of their structural and constructional plausibility, but this is secondary. Missing from the drawings here is the rest of the presentation that made the argument for the designs. The environmental logic can in some cases be rigorous but over-focussed, with the result that the whole is flawed. But these are non-architects, who in practice would be working with architects in design teams. What is perhaps surprising is that the students reached this level at all, and this is probably due to the power of a guiding idea.

The next figure, 15, shows an architect using his own skills to work with technical issues. These are sketches of lighting studies for a skyscraper in New York, and the overall presentation from which they come is a good illustration of how technical analysis can be used to guide design.

What is interesting is that there is little difference in principle between this student's approach to the problem and that of the non-architects whose work has just been shown. Among the best of the students, the work merges into a common approach, to the extent that it is often easy to forget from what background students come.

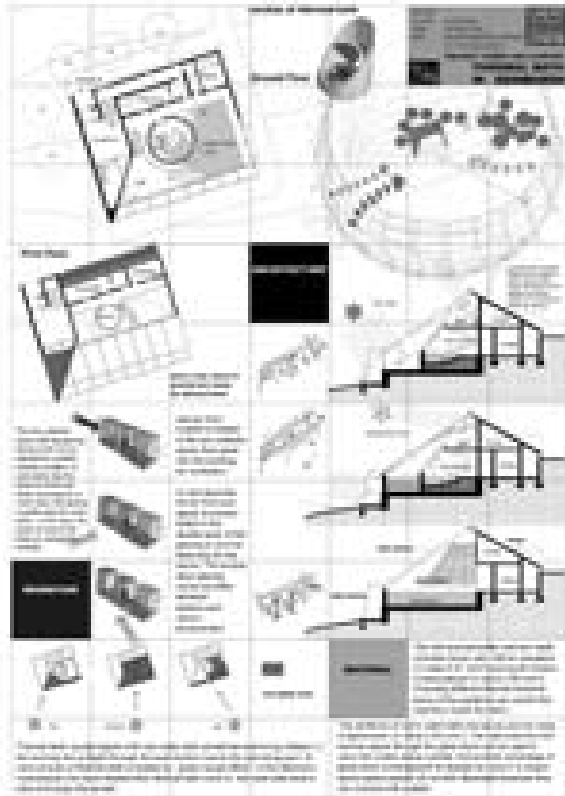


Figure 14

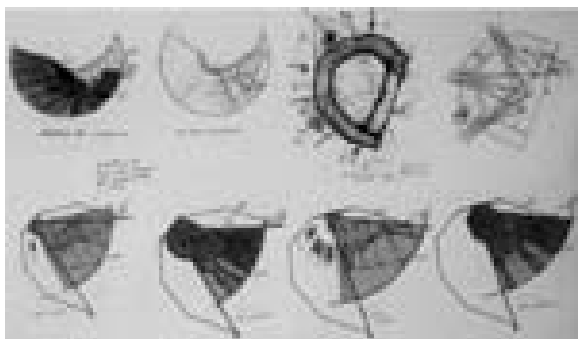


Figure 15

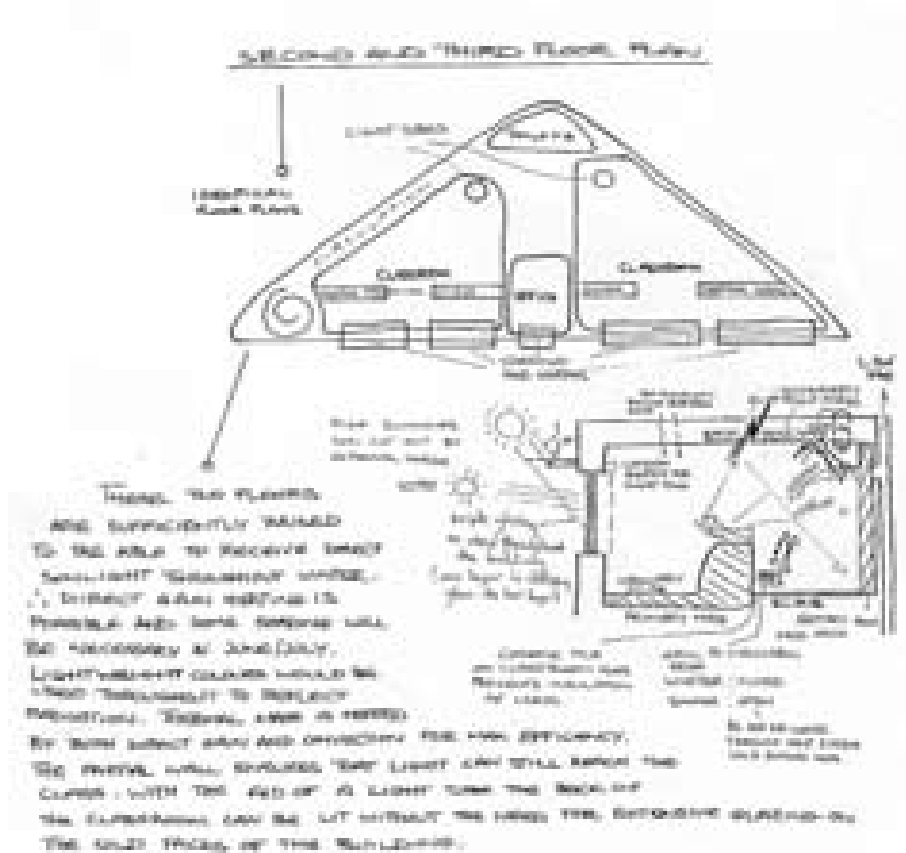


Figure 16

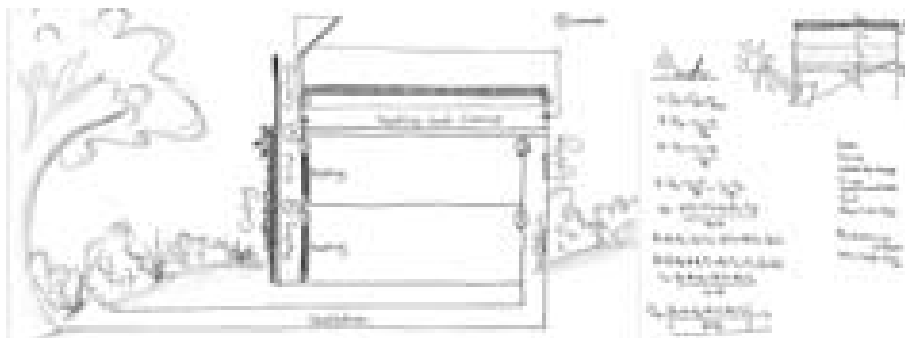


Figure 17

Perhaps one of the most obvious signs of the difference in background is in the students' drawing skills. Many students from non-architectural backgrounds produce drawings at a lower level of presentation than is generally seen in an architectural school, and certainly lower than would be expected at postgraduate level. In the early

years, there was a tendency for non-architects to try to imitate architectural drawings, as though this was expected of them. The result was unconvincing in terms of both drawing and design style, and posed a problem for the course. Students over the years have found several techniques that they can use to overcome this problem. An important one is illustrated in figure 16, which is one of a series of sketches of an office in a blind corner site by a physics student in which she presents advice to the design team without presuming to design the building beyond the boundaries of this advice. Another example in figure 17 of teaching facilities for Tel-Hai University, Israel by an environmental scientist, takes the design one step further and shows that simple sketches can be presented with conviction. Again there are many design issues irrelevant to the problem at hand which are passed over in these sketches for others to deal with.

Physical models can be used by some students to present ideas that would be difficult to draw. The model of an open-air island theatre shown in figure 18 was made by a leisure resource manager, who had some experience of building models of theatre sets as a stage manager in amateur theatre. Figure 19 shows ideas for building a comfortable camping site in mountainous terrain in a hot humid climate which were developed through physical modelling by another environmental scientist.

Computer-aided drawing is increasingly used by non-architects, particularly as it is now relatively easy to learn as an adjunct to environmental modelling software. In fact, the use of computers for graphic presentation has created a more even playing field between architects and non-architects. There was a sudden and significant change in the students' collective ability to assemble graphic elements on a page using computer publishing software about three years ago. Up to that time many students prepared boards for presentation by pasting paper cut-outs onto them. This was in part a reflection of the many different types of output that had to be brought together in a presentation, such as text, analysis results, tables, graphs, drawings, and sketches, much of it being output from separate computer packages. For many years it proved beyond the capabilities of many students unpractised in design to

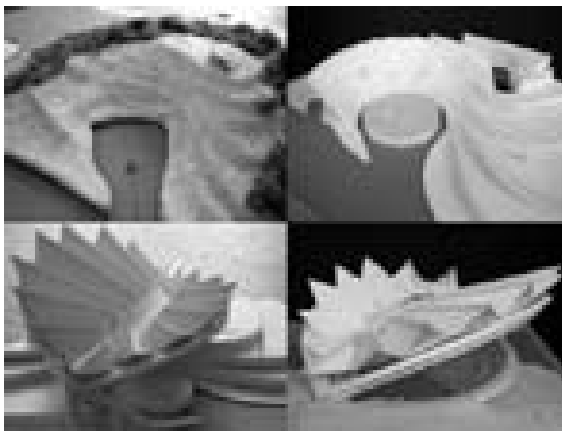


Figure 18

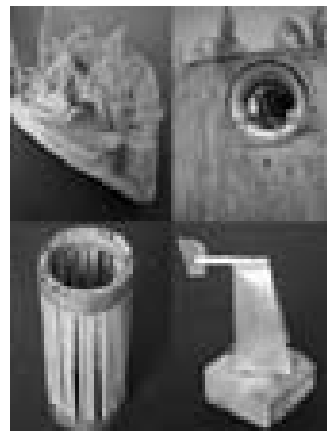


Figure 19

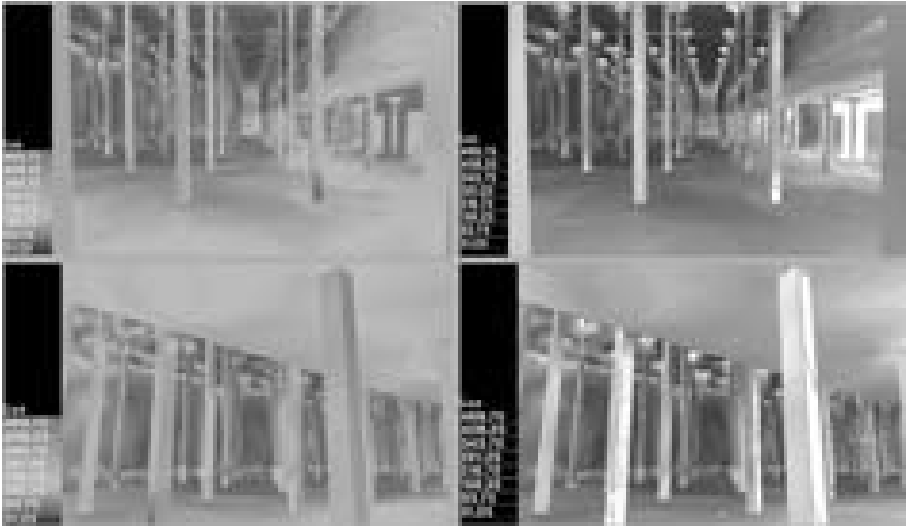


Figure 20

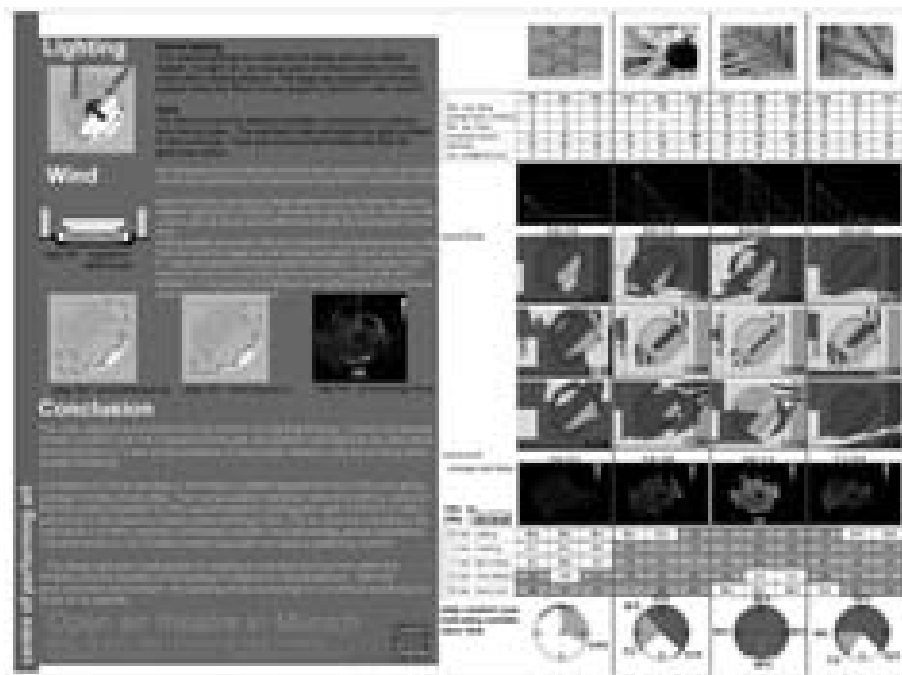


Figure 21

make a montage that related these elements intelligently. Now that they can use a computer instead of glue, more of them realise that they can experiment with the sheet as a forum for bringing ideas together, and standards have improved.

Needless to say, computers also help the non-technical with their calculations. Advances in software available since the course started make it possible for students to do relatively easily what they would never have attempted before, such as the light study in figure 20. This once again promotes a more level playing field than we had at the outset. However, not only do computer packages reduce the calculation demanded of students, they can also appear to the weaker students to remove the need for thought. An ability to take thinking beyond computer output, giving greater insight into the problem at hand, is as likely to be seen in design-minded students as technically-minded (figure 21).

In summary, the challenge for the tutors is to provide a course in common to the students from these varied backgrounds that they can all understand and engage with fruitfully. Our experience is that, although there are difficulties in teaching this subject at postgraduate level to mixed disciplines, it is possible and it is getting easier. We are helped greatly by the commitment of most of the students to the value of the subject.

Shared aspirations

Every year we ask the new students when they arrive why they are taking the course and what they hope to get out of it. Most refer to the un-sustainability of current building practice in their own countries. For some it is a career move, as the professional path on which they are embarked requires them to have a masters' degree. But for most it is a desire to change things (hardly a safe formula for career development). Their approach to this is first to change themselves and so the way that they practice.

There have been a few students for whom personal development has been the whole objective. One student, for example, had already retired from being a senior partner in a large practice. Another student chose not to complete the whole course, just studying those aspects that he wanted to know more about. But nevertheless, the course is on the whole vocational.

Many students undertake the study because of a feeling of responsibility towards the environment and the future. There is a strong common view among them that there is a problem to be overcome. Not all of them share this view, but enough to make it a focus for discussion. They also are all working with the same basic material – buildings – about which almost all of them have some professional knowledge. Consequently, there does not seem to be a serious difficulty in fostering a meaningful dialogue between students in relation to the subject matter of the course and its practice. That they are from different disciplines is an aid to this dialogue.

Whether the training we supply in common to the students from these differing backgrounds is useful to them in practice is more difficult to say, but on the whole they believe that it will be.

Interdisciplinary Practice

Dialogue or independence

The subject of the course, the environmental design of buildings, is anchored in practice. The various matters of which it treats contribute to the common task of designing the environment in and around buildings sustainably. The thesis underlying its teaching is that this is a matter that has fallen into neglect in modern times, and that there is a current need of action in this field to address the dangers facing the global environment. There is research consensus that action can be effective, and many governments are introducing legislation and guidance to change the situation.

We have, then, a course to train students for a role in practice that is necessary and for which there is a demand, and which also attracts students from different professional backgrounds. A question that I would like to discuss now is whether the need in practice is for a specialist discipline or whether it is for greater co-operation and understanding from the various disciplines that currently contribute to the design of building environments.

By way of background, figure 22 is a time line portraying the growth of specialisation in the building industry through the course of civilisation, intended as a metaphor rather than as an accurate account of history. The growth of specialist trades is often cited as a characteristic of economic advance in civilisation. Doubtless there was a time when everyone erected their own dwellings but, with the growth of city life, leaving this to specialist builders must have been an early trend. The need for professionals to separately design buildings is less obvious, but the wealthy are likely to have wanted to employ others to express their status through buildings, particularly as the scale and public exposure of buildings in cities increased. These professionals were masters of all the knowledge that was required to erect large and magnificent buildings.

As the required knowledge grew, particularly with the contributions that science could make to structural engineering and mechanisation to the design of building

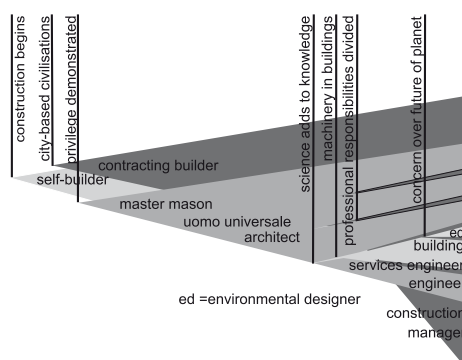


Figure 22

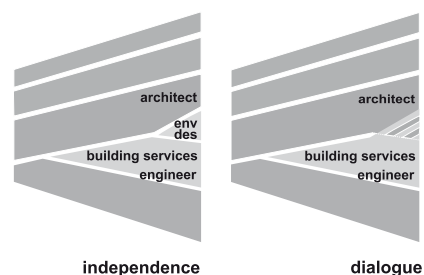


Figure 23

services, there was a need for greater specialisation. It became impossible for any one professional to know everything that was needed to the level of accomplishment that was demanded. This led to a growing division of expertise, which in the diagram is presented as a tree (in which only the branches leading to environmental design have been labelled). These divisions began to be formalised in the mid to late 19th century as professions formed institutions to vouchsafe the quality of their work and protect their interests. But more specialists have emerged since, dealing for example with acoustics, electrical engineering, and facade design. Long since, people have forgotten how to build their own houses. More recently, it would seem, architects have forgotten how to design comfortable buildings.

The design of a building is now in the hands of a team, each member with specialist training, and with responsibility for a particular part of the job. This has greatly increased the expertise that is brought to the design of buildings, and should be a strong guarantee of their fitness to purpose. However, the corollary is that all members of the team have a limited knowledge of the whole job. The specialist focus, which was intended to increase the knowledge brought to a project, has also fragmented that knowledge and, as importantly, fragmented responsibilities. The consequent danger is that some knowledge falls into the gaps between disciplines with no-one recognising their loss. This history of progressive division is now turning into a need for greater integration.

An example of this need is provided by environmental design. The design of the environments of buildings has fallen between the architect and the building services engineer. At its most basic, the former designs the fabric that filters the climate and the latter designs the plant that modifies the result. However badly the architect does the first job, the engineer has the means of correcting it. The greater the need for correction, the greater is the consumption of energy and the impact on the global environment. This is a trend evidenced by the spread of standard western commercial building types to parts of the world whose climates are unsuitable for them, with the consequence that they consume greater amounts of energy than traditional buildings in those parts do.

The reverse is of course also true. The more attention that is given to the design of the building form and fabric, the lower is the load on the building plant, and the less energy is consumed. A persistent application of this idea can result in buildings that consume less energy than traditional buildings.

This is the arena into which the Environmental Design of Buildings course belongs. Seen in this way, the object of the course is to repair a harmful schism that has grown up between the architect and the building services engineer. There are two models for the way this can be done. In figure 22 the environmental designer was placed between the architect and the building services engineer as though he belongs to a new discipline. This position is repeated on the left of figure 23, as the “independence” model. The alternative is to train members of both the existing professions for a better dialogue, as illustrated to the right in figure 23, the “dialogue” model.

In fact, most of the students on our course follow the second, dialogue, model. They return to their original professions better equipped to contribute to a dialogue on environmental design. If they are architects they know how to design the building fabric appropriately and how to integrate this with the building services. If they are engineers, they understand what to expect from the building fabric and know the most efficient way of responding to it mechanically. Very few have attempted straight away to set up on their own account as independent advisers in environmental design. There are few openings advertised for professionals with this specific qualification. There are, however, several large practices that have specialist divisions within them to consider the design of the building environment holistically, and some of our students have found places in these. This is a particularly appropriate role for those students who are neither architects nor building services engineers.

Whatever the best option for environmental design, there is in general an advantage in the dialogue model as a way of overcoming the problems of fragmentation. If the various specialists can learn one another's language well enough to understand the underlying problem that they share, it is easier for them to be alert to gaps. It is not just a matter of their sharing knowledge. They also have to share objectives and a common sense of responsibility. As was emphasised earlier, these are characteristics that are evident among students on the environmental design course.

Widening responsibilities

The issue of responsibility has a wider context in the process by which the built environment is designed and constructed. By and large it proceeds piecemeal, building by building. The economic forces that govern building construction tend to generate activity around single buildings over short time periods. The various members of the team that will be making decisions about what is constructed are brought together typically for just this short period of design and construction, as illustrated in figure 24. They have to be experts in getting the building up on time during that period in a satisfactory state.

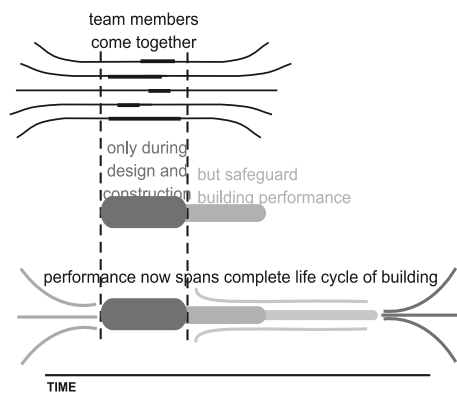


Figure 24

During this period, there is no opportunity to observe or control first hand such matters as the social and political forces that gave rise to the brief, the manufacture of the components that are brought to the site, the way the building will be used by its occupants, any conversion of the building into another use, and the building's demolition. To take these into account the team members have to invoke knowledge of the past and the future.

However, the paymasters do expect the building to continue performing satisfactorily well beyond the design and construction period, for as long as they continue to own it. This is reflected in the division of responsibility between the construction team and the design team, as it is the latter who are mainly responsible for ensuring that the building performs well during use. There is a natural extension of this responsibility to include the period of use beyond its first ownership, but this weakens with the building's age and adaptation.

It is now recognised that this is a severely diminished view of the responsibilities involved in erecting a building. If the complete life cycle of the building is included in the perspective, then the sourcing of the materials, the energy and materials required to maintain the building during its use, and the final disposal have to be considered as well. The continuing health and safety of the building's occupants and of the environment in which it sits are also increasingly seen as important issues. This expansion of the field of responsibility involves a concomitant expansion in the need for expertise, in the knowledge required of the design team, and in the continuing generation of specialisms. Moreover, when the building is seen in the context of the continuing growth and evolution of a whole city, the perspective changes again and involves many other design teams working in practice independently.

The expansion of knowledge demanded by this change of perspective has a direct impact on the material being taught at universities and, to a lesser extent, on the number of specialist postgraduate and CPD courses involved. The subject area of environmental design is affected particularly. We need to arm our students with the expertise they require to engage with environmental design in this way and to do so as members of these ad hoc short-lived design teams.

The question remains as to whether they join the teams as independent environmental design consultants or not. This is probably something that will be decided over time by economic pressures. There is a limit to the size of the team that can be supported economically in a building programme. An existing member who has taken on additional specialisms will be at an advantage. But a professional practice that is large enough would be able to support specialist groupings within it, since this would give its team membership both increased expertise and flexibility.

Design teams

There is a great number of specialist disciplines that contribute to the process of environmental design itself. There are the obvious ones of architecture and building services engineering, but there are also such disciplines as psychology, human physiology, environmental science, component manufacture, energy generation, building economics, facade design, climatology, mechanics, computer programming, waste disposal, land development, and so on, and as we have just seen, their number is growing. But this should not be confused with the number of specialist professional careers required. There is certainly no need for specialists representing all these disciplines to be engaged in the design team.

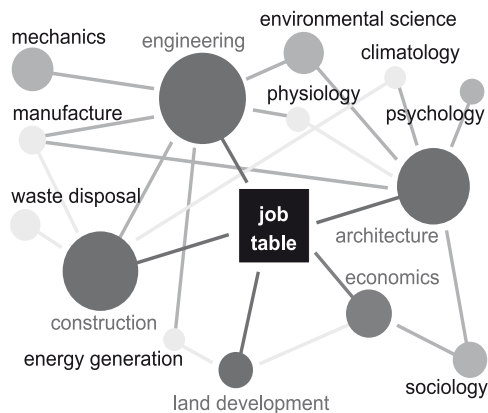


Figure 25

core team members and advisers bring with them a wealth of expertise gained beforehand, in part from similar encounters of this kind on earlier jobs, and in part from reading and formal education. This is the grey transfer, whose extent is severely underestimated in this diagram.

The diagram illustrates that of the many disciplines that contribute expertise to the process of environmental design, only a few of them need contribute specialists during the design and construction period for a job. Also, only some of those specialists need be seen at the job table as core members taking responsibility for decisions. There is thus a distinction between the patterns of responsibility and of expertise, which can itself help to guard against design considerations falling into the fissures between disciplines.

This diagram emphasises disciplines that contribute to environmental design, but does not include environmental design itself, the subject having been assumed to be the responsibility of other professions. It is how the “dialogue” model works in practice. A separate professional discipline for environmental design has been included in the more rationalised and parsimonious network of figure 26, which shows the “independence” model in the context of a job design team. It could be said that the responsibility for environmental design is now clearer. The question has been left open as to whether the environmental designer is a member of the core team or an adviser. But if the role

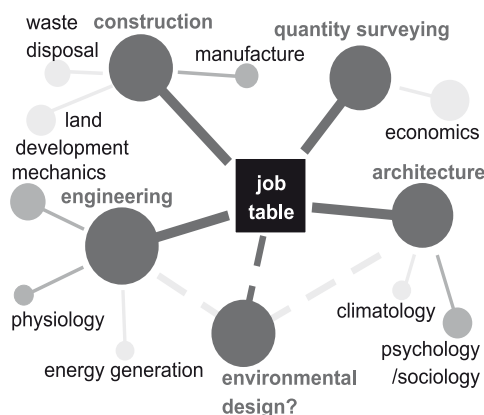


Figure 26

is that of an independent adviser, the advice will affect the decisions of both the architect and the services engineer, so in effect there has to be a mini-team of these three professionals.

Missing from both diagrams is an overall leader for the core team. Although environmental design has a champion in the second diagram, responsibility for the overall picture has been left divided. It seems clear that there should be someone responsible not just for management of the team but for controlling the quality of the final building. It is not the purpose of this paper to suggest who should take this role, but in an extension of the argument that has been made with respect to the environmental designer, it needs to be someone who has been trained to talk the language of the other consultants in enough detail to be able to understand the problems and recognise good solutions. It has been argued elsewhere in the conference that the architect's training is the broadest in this respect. However, the level of understanding required to fulfil the role well cannot be superficial, and would justify additional postgraduate training along the lines of our environmental or sustainable design courses but covering broader ground. The object of training across disciplines in this case would be not so much to create a new expertise as to equip experts for communication with other experts. It is education intended to enable true interdisciplinary practice.

In summary, although there is a growing demand for professionals equipped to give greater attention to environmental concerns, it is by no means clear in this practical context how the discipline of environmental design should map into the design team. There are students from our course and others like it who do practice solely as environmental designers and others who are enhancing their own profession with their expertise in this subject. It need not affect the way that we teach. If the core team can find a place for an environmental designer, our course trains people with the necessary qualifications. If specialist advice is needed, our graduates can provide that also. What is important is that environmental design should find a place in the decision-making process of building design, and it is up to the graduates to find a way of securing this among these diverse ways.

Spreading the message

There has been an emphasis in this discussion on responsibility. This comes from the view that the building industry has a wide responsibility for its effects on the global environment and global resources and from the view that this responsibility with respect to environmental design has in the recent past slipped into a gap between architects and services engineers. It is this that has given rise to the renewed interest in environmental design and its capabilities.

It was stated earlier that many students join the course because of their own feeling of responsibility. They join the course feeling "I want to do something", and leave with the confidence to believe "I can do something". Unfortunately, a common experience after taking these ideas into practice is that, despite a broad realisation that something needs to be done, the pressures of practice push the issue aside. This

makes it clear that it is not sufficient for someone involved in the design process to take on responsibility for environmental design; the issue has to be given a high enough priority by the other members of the team. This may come from legislation, and increasingly does in this country, or from the beliefs of the core members themselves. There has to be an understanding between the team members, including the paymaster, that just as there is no question that it is their duty to make *buildings* safe and healthy for their occupants despite conflicting economic pressures, so it should be without dispute that they have a duty to make the *planet* safe and healthy.

This leads us to the final advantage to flow from having postgraduate courses in environmental and sustainable design. They are part of the means by which a better informed message about the need for change is propagated through the professions that subscribe to it. We are pleased in this respect to be addressing an interdisciplinary student body, which will filter this back to so many professions.

Thomas Jefferies

**Connections and Disconnections:
Sampling and Critical Theory
in Construction Design Pedagogy**

*Manchester School of Architecture,
United Kingdom*

Context + Method

- Over the past 3 years I have asked over 100 student architects “Who is wearing something hand made today?” Not one student has answered, “Yes”; everyone had chosen their clothes off the peg, personally composing their wardrobe from readymades.
- In 1979 The Sugarhill Gang recorded ‘Rapper’s Delight’, spawning a musical genre that relies on recontextualised sampled material.

I cite the above as positional statements in the current discourse on pedagogic approaches to teaching architectural construction. Contemporary culture has absorbed the Duchamp’s readymade as a typical condition. Entire genres of cultural production exploit the idea of sampling readymade and found material. Is our concern primarily about technological performance within a context or is it about cultural contextualisation of pre-existent elements to produce new types of performance and situations?

The approach adopted by the Masters in Architecture + Urbanism and the College of Landscape + Urbanism at Manchester School of Architecture develops a sampling methodology to empower students whilst confirming the validity of inter-disciplinary collaboration. When asked ‘Can architects alone work on the design of sustainable buildings and settlements?’ we say ‘No’. When faced with a plural context at all scales and in all areas, design must move away from unified formal and technical approaches towards an inclusive and open critical discourse. This implies that there is no simple correlation between concept, formal realisation, technical delivery and functional use. A disconnective scenario emerges where dynamic equilibrium between elements is achieved rather than static linear connectivity.

Sampling depends on the ability to be able to dynamically recontextualise material within a critical framework. This correlates with the increasing individualisation of sophisticated late capitalist consumer society. *‘21st century design will fight against the boundaries imposed by artistic “isms”’*¹. Architectural ‘isms’ are traditionally manifested by the relationship of form to programme and ideology. The issue that now faces architecture is to design within an open and malleable omni-ism context. This paper will present a critique of methodological approaches based on projects undertaken at postgraduate and undergraduate levels (MA, Bachelor of Architecture, and BA(Hons)) in Manchester School of Architecture.

This paper sets out three approaches to design method each of which is responsive to the nature of the questions being asked and the context of enquiry. The methods address contexts where there is a differing degree of openness to architectural questions. They can be used to define a scope of enquiry (connective method), establish synergies between apparently disparate conditions (additive method) or open up apparently closed scenarios (disconnective method).

1. Connections

Context

In a situation where there is a lack of obvious formal and programmatic starting points it is necessary to develop an approach to the design of a project that establishes a dialectic framework for action. Every situation has a context; the critical objective of a connective approach is to identify key drivers within a context, and then to explore how these drivers engage to form a ground for action.

The understanding that *the building is not a self contained system* informs all our work. A wider systematic reading of context allows sustainability to be explored at a deeper level. The study of a whole urban area as a system enables redefinitions of the relative technical and cultural performance of its components, changing the perception of where the architectural design problems lie². Trans-scalar and trans-disciplinary synergies emerge and can then be developed to deepen the understanding of the question of sustainability. Disciplinary collaboration between Planners, Ecologists, Contractors, Developers, NGO's and Architects underpins this process.

In a connective scenario the architectural project is used as a vehicle to reveal aspects of a system and release potential programmatic possibilities. We promote the operation of a non-formally constrained architectural methodology where form, space and technology are viewed as interrelated factors, each having no value without systematic interaction. Extensive analysis of the context (of a scheme) is undertaken to establish potential causality. Typically this is viewed as a process to allow maximisation of potential. Technological realisation therefore occurs at all scales simultaneously, but is not linearly deterministic. It is possible to produce numerous formal and technical solutions to the same question within the same scheme, all of which are valid.

Construction

The intention of this approach is to identify synergies within a context that are critical. This testing of context exposes the nature of the context and enables the formation of a potential constructible architectural response, if appropriate. Importantly, this method does not seek to formally define a given outcome; its intention is to provide a framework for action, a project merely being one of a number of possible iterations.

Example 1: Particleboard Factory, Manchester: Helen Webster.

Issues

Questions of scale continue to inform discourse relating to the limits of architecture. This project sought to develop an idea of a loosely formally related urban and built form strategy, exploring the representation of material at different levels of finish as a means of identifying an urban space. The project deliberately set out to engage a variety of scales to set up legible synergies between the materiality of large and small elements, and raw and refined material conditions.

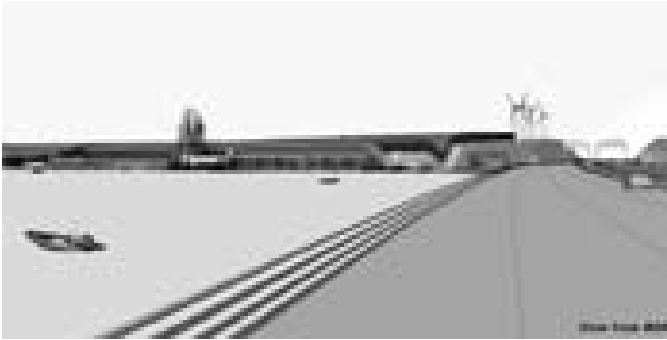


Figure 1
Particleboard Factory,
Manchester: Helen
Webster: View over
new reservoir from
M60 eastbound.

Project Description

The de-industrialisation of the North West of England has left large tracts of urban space empty, their value reduced due to pollution and urban shrinkage. The primary aim of this project was to reintegrate surplus urban space into a productive system. Through the transformation of wasteland into managed forest a new resource is created. The project uses the concept of added value, formally articulated through the reservoir, the forest, the factory, the workshop, the design studio and the showroom. The idea of construction as an act can be extended at all scales, from the city to building detail and manufactured product.

The relationship between a refined, manufactured product and the space from which it emerged was explored as a means of exposing underlying causality. The question 'how far can a coherent reading of the process of construction extend?' was explored at the level of the city, district, building, detail and product. Critical to the development of a constructible final proposal was an understanding that formal connective structures (typically defined in urban terms through the use of proportion and alignment and codified by Lynch) are unable to address very fluid urban conditions. It therefore follows that an architecture developed from a purely formal reading of urban space will be incapable of responding effectively non-formally defined situations.

Construction

The project explores the idea of construction as a process defined issue. At what point does construction, as a conceptual tool, become irrelevant in an architectural proposal? By nesting the scheme in scalar terms so that it proposes a radical, programmatically oriented reorganisation of its urban context, simultaneously with the scheme producing the material for its construction, and using the space it defines for manufacture based on its material context, the architect poses the question 'at what scale does this scheme end?'

The scale of construction as an architectural issue is critical here; plantations of trees are as important to the overall theoretical proposition as the detail of its buildings. However, the scheme does not set up to produce a completely internally consistent answer. It acknowledges that elements or scales of the scheme could change or even be omitted entirely, and it does not set out to produce a singular formal solution to a

potential constructed reality. What is proposed is the idea that through identification of process, form can adapt, and that process can be engaged with a numerous scales to adjust performance, whether at the scale of a city or a built detail.

Shared Themes

The extensivity of architecture is questioned in Connective scenarios. If construction and architecture meet through the manipulation of material then the question of the status of that material is critical. If a project engages with the treatment and processing of material as its basis, at what point does the architecture stop (or start)? Implicit in this discussion is the understanding that architecture cannot exist as a stand-alone object, devoid of context; it exists as a means of articulating a dialectic between different factors of a system. The reconnection between space and value (as part of a productive system) is explored at a wide range of scales.

2. Additions

Context

An additive approach takes pre-existent programmes and constructive technologies and explores how these can combine to form unique design combinations³. Critical to our pedagogic approach is the demystification of all primary elements of design. Additive scenario share the following characteristics; functional briefs, ideally written by a third party, a fully guaranteed constructive system that meets and exceeds all current standards, and sites chosen for their typical character, not their peculiarity. The method allows rigorous exploration of the limits of interaction of each of these elements to develop new forms and configurations of architecture.

The Additive method is the closest to conventional architectural design project based methods, but with some important differences; it is not a craft biased method, it is not a place based method, it is not a formally based method. Removing unnecessary choice is used as a means of empowering the student, allowing them to develop proposals that can fundamentally question the nature of architectural production through radical investigation of the possibilities of programme.

Construction

Contemporary building procurement relies on the interrelationship of many design professionals and sub contractors. The Additive method models the procurement procedure in the application normative solutions. By being forced to use a proprietary system the student is able to understand the limits of a construction method, and the importance of choice as a design approach⁴. The work is partially assessed by a referenced application of standard details. This replicates the situation in professional practice where liability would move from the manufacturer to the architect if an architect modified detail solution was used and subsequently failed. An awareness of potential litigious situations forms part of the professional educational context. This sits within a wider aim of exploring evidence based approaches to design. We

look for objective indicators of performance as critical design drivers and use these as a means of omitting unnecessary design activity. This prioritisation of time enables students to fully explore issues that are under their control through enabling them technologically.

Example 2: B&Q Big Shed Competition, Paula Rial/Will Bates/Rob Hyde+Dan Vedder⁶

Issues

The intention of this project was to test and question the generic retail shed as a type and as a manifestation of a system of production and consumption. The programme broke down into a number of linked but identifiable stages, acting as a means of quickly synthesising valid architectural responses to the question 'what is the contemporary retail shed?'

Questions included; is the shed the ubiquitous urban type? How does built form mediate between global and local? How does programme become manifest? How does a ubiquitous type gain meaning?

Areas of investigation included: *Site Organization*: Lorry movements, car access, active times etc. *Partii*: Typological examination of retail shed with precedents and antecedents. *Energy and Servicing*: Audit energy use of building and of a typical shopping trip- what are the issues of sustainability? *Internal Space Planning*: Organisation and flexibility of retail space. *Marketing and Image*: Graphics and advertised presence. *Construction and Commissioning*: Site construction phasing, streamlined delivery and turnkey operations.

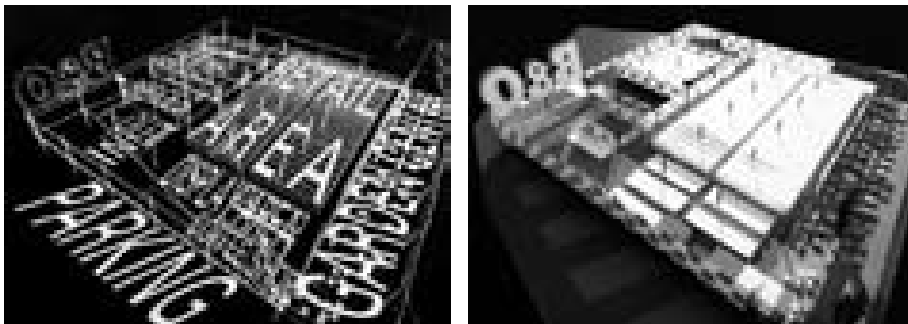


Figure 2

B&Q Big Shed Competition: Paula Rial: Aerial views showing layout and functions

Project Description

Taking a set brief for 9000 m² of retail space plus associated parking, and using a standardised building system from CA Building Products, a major UK cladding supplier, architecture was developed as a critique of programme and space, freed of the necessity of stressing constructive ingenuity. Technical issues were deemed to satisfy through application of the English Building Regulations and the requirement

to only use the wide range of performance guaranteed standard details and systems provided by the cladding company. This adjusted the designer's role in the production of an architectural project, consciously allowing detailed design decisions (and liabilities) to be undertaken by another party. A requirement of the final presentation was documentation identifying and listing where standard details had been applied, referencing these to technical manuals and published literature. Discussion between the supplier and the architect formed a critical element of the design process. The choice of site, which sloped and was slightly too small for a conventional arrangement of shed in a sea of surface car parking, called for a degree of spatial ingenuity in organising a building on the site.

Variation developed by interpretation

By removing the requirement for structural and constructive ingenuity students were able to fully explore the possibilities of the programme. This included developing functional efficiency with the spatial distribution on site, taking into account certain requirements in the brief for some functions to be adjacent. It also exposed new areas of design not explicitly defined in the brief; new retail models (building trades academy), built form branding, and spatial models (store as containerised system or as new public urban space). It also enabled the exploration of hybrid real/virtual spatial solutions where real spatial structures and web based store structures mapped onto each other.

3. Disconnections

Context

Within the current UK building context, which stresses a high degree of regulation and standardisation in terms of performance, and increasingly, design quality, a strategy needs to be adopted that tests and identifies the limits of policy and guidance that informs regulation.

A major problem with policy (from a designer's viewpoint) is that it is often perceived to be prescriptive and limiting. A major problem with policy from a design control / town planner's perception is that it does not deliver the results it was framed for. The disconnective method that we adopt is intended to identify possible spatial and formal manifestations of policy and also allow qualitative and quantitative testing of modifications to policy. The intention is to remove wilful design decisions from the design process to produce 'pure' manifestations of policy. It is with this information that policy can, if necessary, be challenged and manipulated, empowering the architect and designer by giving them the critical tools to actually test a policy context.

Construction

The definition and exploration of limit states within a given system allows ultimate definitions of programme to be established. A critical element in the framing limit state testing is a document or documents against which design decisions can be

made. Performance criteria based documents e.g. Housing Quality Indicators (HQI)⁶ are ideal, as are statistically based indices and reports as produced by CABE. The objective of the design process is to attempt to define where the ultimate limit state of a set of design criteria lies. All the constraints are considered during the design process. Projects explore the possibilities inherent with highly defined and complex sets of interrelated criteria. The critical aspect of the methodology used is that all the relative components are interlinked within a matrix of causality but individual components are internally driven by performance specifications. The limit state testing of any given scenario allows the designer to identify critical points where shifts in the design paradigm are possible.

Example 3: The Guaranteed Successful House, Rob Hyde

Issues

The project set out to design the form of housing that was most guaranteed to be successful within the current UK housing market by spatially representing current guidance and policy to the maximum possible extent. The ideal solution would achieve maximum scores on all available indices and be rated excellent in terms of its design performance and user desirability. Design decisions were informed by overt reference to standards and guidance notes produced by official and government approved or recognised agencies. These included the Housing Quality Indicators (HQI), Planning Policy Guidance Note 3 (PPG3), all relevant CABE design guidance documents⁷ and the Housing Market Renewal Initiative (HMRI).

The objective behind the project is to explore where 'design' operates within the architectural process. By rigorously operating within an objective system the application of subjective design choices itself becomes objectified. The nature of the programme includes the full range of scales and disciplines, intending to produce defined perfection at scales ranging from the urban to the detail.



Figure 3
The Guaranteed Successful House: Rob Hyde: CABE approved public space and housing.

Project Description

Taking the current context for housing in the UK the design intended to produce a guaranteed successful solution where the correct mix of functionalism and economics, romanticism and nostalgia, sustainability and ecology, whilst meeting or exceeding all current design guidance and policy.

The contemporary UK housing market is unusual in that it is almost entirely driven by the private market, with social housing now primarily delivered by housing associations, central government having divested itself of responsibility for housing provision. Another notable factor in the market is the low percentage of housing designed by qualified architects. These factors have combined to produce a context where until recently, architect designed Modernism was identified with social housing, and default condition 'Neo Traditional' design characterised the bulk of private sector housing.

By devolving design decisions to the relevant policy and advisory guidance the opportunity to design an ideal, quantifiably testable, housing solution was realised. Subjective areas e.g. the design of the facade were identified and placed within a statistically defined 'objective' context. By using market research, the ideal housing form, heritage front - modern back, was developed, supported by appropriate sustainability and longevity arguments. This became concretised in a design solution for an individual dwelling that could be arranged in numerous configurations (detached, semi-detached and terraced) and sizes 50m²-150m². The question of the ideal urban form in which to place the ideal house was the result of concretising current guidance whilst acknowledging sustainability arguments. This led to a form where an overlooked public space fronted the dwellings, viewed across a traffic calmed road where residents park on street in front of their own houses. Mature trees in the public space finish off this CABI and PPG3 approved idyll, adding all-important value and purifying the atmosphere.

Teaching Methods

Typical group sizes are as follows BA(Hons) 30-40, BArch 15-20, and MA 10-15. The programme is delivered through a mixture of modes. Student lead seminars provide a theoretical grounding based on a wide-ranging reader. Design work is developed in studio, discussed at weekly or bi-weekly staff and peer reviews. Programme lengths vary between one academic session (16 weeks) for BA(Hons), two academic sessions (32 weeks) for BArch and three academic sessions (48 weeks) for MA.

Conclusion

Sustainability is an issue that contextualises current architectural debate. As a global issue it seems apparent that architecture must sit within this wider context. The work seeks to identify sustainable approaches within a wider systematic context. Issues including policy, climate, landform and use, procurement methods, prevalent and emergent technologies and spatial organisation are considered at all scales. Rather than architecture informing a wider model, we see it as a component within a system, where architectural design method can be used to reveal synergies between different scales and fields of activity.

Our objective is Guaranteed Success; maximised performance on all indices. Our pedagogic method empowers students through allowing them to engage with necessary specialisms within a coherent critical framework, utilising analogue and digital methods to analyse, visualise and communicate within and across disciplinary boundaries.

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5. *The Big B&Q Challenge in The Architects Journal* pp51-57 28.07.05
6. <http://www.communities.gov.uk/index.asp?id=1152812>
 HQI assesses the performance of housing based on the following criteria that are tabulated in spreadsheet form to arrive at a final 'score'.
 HQI Performance Criteria Indicators:
 1. Location
 2. Site - visual impact, layout and landscaping
 3. Site - open space
 4. Site - routes and movement
 5. Unit - size
 6. Unit - layout
 7. Unit - noise, light and services
 8. Unit - accessibility
 9. Unit - energy, green and sustainability issues
 10. Performance in use
 The average score for schemes in the UK is 55% and the maximum score achieved prior to this project was 77% awarded to Westlea Homes for the 'Integer House'. Steve Smith of Manchester School of Architecture produced a design for a 100% scoring house in 2003. This was the model for the Guaranteed Successful House.
7. CABE (Commission for Architecture and the Built Environment):
Building for Life Standard: A Better Place to Live CABE 2005
What home buyers want: attitudes and decision making among consumers 2005
Does money grow on trees? 2005
Design coding: testing its use in England 2005
Creating successful neighbourhoods: lessons and actions for housing market renewal 2005
The home buyer's guide: what to look and ask for when buying a new home 2004
Shaping future homes: issue 3 2004
Building sustainable communities: actions for housing market renewal 2003
The value of housing design and layout 2003
Building for Life: manifesto 2002

**Maria Isabella Amirante
Mariachiara Catani
Rossella Franchino
Antonella Violano**

**Teaching the Environmental Control:
the Case of an Urban Disused Area**

*Second University of Napoli,
Italy*

The didactic experience, carried out within the Integrated Course of Construction (I year), the Design Construction of Architecture Laboratory (II year) and the Integrated Course of Environmental System Design (IV year) at the Second University of Naples - Faculty of Architecture - brought out the importance within the architecture design to realize objects such as: sustainable use of natural resources, energy waste reduction and quality of life.

The Technological area courses structure of Academic Year 2005/2006 is:

Course year	Architecture Sciences (<i>junior architects</i>)	European Union (EU) (<i>senior architects</i>)
I	Architectural Technology	Integrated course in Architectural Technology (Culture of Design / Materials and Design of building elements)
II	Laboratory of Architectural Construction I	Laboratory of Architectural Construction Building Systems Design (Construction of architectural works within the Laboratory of Architectural Construction II)
III	Laboratory of Technological Design and Building	
IV		Integrated course in Environmental Systems Design - Environmental Design / Technologies for Architectural and Environmental Hygiene Executive Architecture Design (within the Laboratory of Architectural Design IV)
V		Final Summary Lab Technological Disciplines for Architecture and Building

The Integrated Course in Environmental System Design (Environmental Design / Technologies for Architectural and Environmental Hygiene, IV year) integrated the following formative objectives:

- Environmental Design means providing students with the tools allowing them to rule, from an ecosustainable point of view, the environmental and building requalification design process through the following phases: analysis, design, realization and construction of the managing model,
- Technologies for Architectural and Environmental Hygiene means wakening and making technically aware students about the problems and technologies existing in environmental and building requalification process to improve both internal and external environment through more and more high standards.

The Integrated Course of Environmental System Design brought out the importance within the architecture design to realize objects as:

- sustainable use of natural resources
- energy waste reduction
- quality of life.

In the light of the above considerations, the external environment and the natural resources must become component parts of architectural design.

The principal topics of this course are the role of natural resources (sun, wind, rain, climate, vegetation...) and the exploitation of environmental context in the requalification project.

The specific theme is the ecological recovery of a dismissed industrial site in the East- Naples area, precisely the sub-ambit 12 E “Feltrinelli”, so as defined in the Variation to the Master Plan for Eastern Naples (Figure 1).

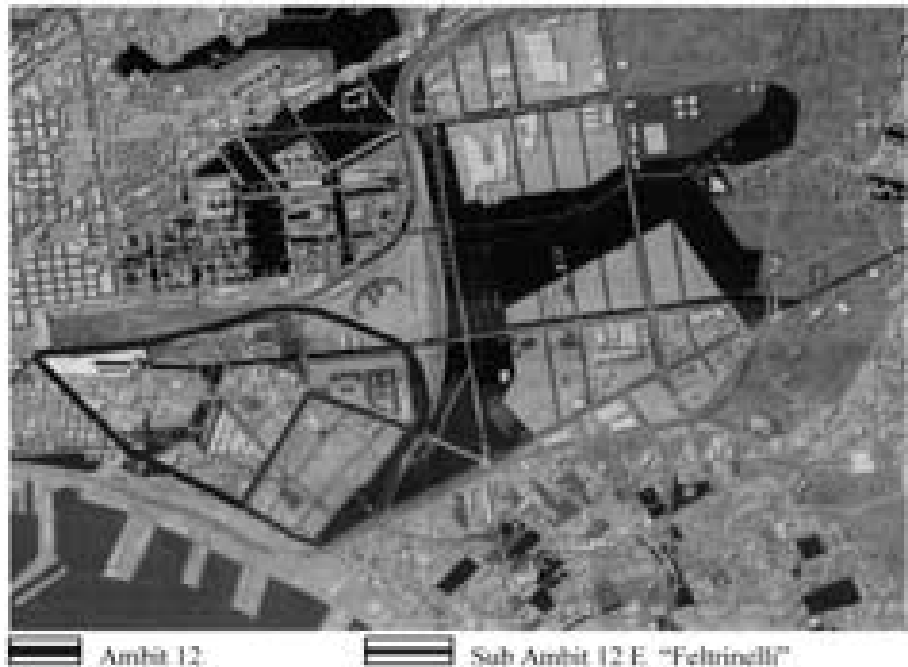


Figure 1
Sample Area, Naples eastern zone (Variation to the Master Plan)

Within sub-ambit 12E “Feltrinelli, the Variation to Master Plan specifies the following intended uses:

- Zone D - Settlements for the production of goods and services; it identifies the parts of the area where a territorial reconversion, intended for the creation of a milt-up areas, is scheduled;
 - subzones Da: settlements for the production of goods and services having a typological-historical interest;
 - subzones Db: settlements for the production of goods and services;
- Zone F - Territorial park and other equipments and facilities on an urban and territorial scale; it identifies the parts of the area intended for the creation of a territorial park consisting of all those areas having environmental and landscape-quality, including woods and cultivated areas, historic gardens, new parks, and also including urban settlements to be requalified by means of equipments intended

for the park enjoyment, both for private and public users. Moreover, the Zone F identifies equipments and facilities at urban and territorial scale;

subzones Fc: new parks;

- Zone G - Integrated urban settlements: it identifies those parts of the area to be turned into new settlements. Such parts consist of urban areas being the result of the dismantling of previous settlements

The work method of the Integrated Course of Environmental System Design is founded on:

- the Environmental Initial Analysis of the site for a Environmental Management System
- the list of impact and state indicators
- study of environmental network.

The approach is interdisciplinary with the contribution of expertise seminars finalized to a complex and diversified construction design.

The aim is to define a system for the evaluation of compatibility of uses in the case-study area.

The Initial Environmental Analysis (IEA) represents a very exacting step in order to allow the organization to acquire a complete, deep and documented knowledge of environmental aspects concerning the site as well as to identify the Environmental Performance Indicators allowing to measure the area intended uses environmental compatibilities. All the information and data gathered will be used by the Administration to pursue an Environmental Policy, that is to establish the engagement made with respect to the problems concerning the environment. Moreover, such data can be used to establish the objectives and the improving goals, as well as to set out the Environmental Planning Program concerning the steps to take in order to establish the responsibilities and to indicate the necessary time for reaching both objectives and goals.

Study started from the site setting within its area context. Nowadays this aspect is becoming more and more important in testing the sensibility of the chosen area according to the presence of particularly sensible receptors.

Main features of the place are elements of environmental and architectural quality, environmental conditions of soil, water and air receptors, urban system evolutive trends, urbanistic prescriptions, individuation of the actors (clients, financiers, contractors, designers).

The site has been split up into elementary units in order to create a thematic mapping about the existing activities within this area.

Through *in-situ* and photographic survey, students produced architectural drawings of buildings and road-curtain.

Main industrial buildings existing in the sub-ambit 12 E are:

- SO. LO. NA.: the main body of the group of buildings is formed by a loadbearing brickwork building made of yellow tufa; it is split into two areas, one of which consists of two floors and the other one of three.
- EX PATTISON: the Beaur or Beaux silk-factory sprang up around 1840 and then, in 1865, it was annexed to the new mill made by Pattison, who built other two industrial sheds. In 1904 the facilities passed under the Ansaldo management.

- FELTRINELLI: it sprang up around 1940, near the AGIP oil warehouses on a surface of about 25.000 square metres. Although it was considered one of the most important import companies of the '70s, it has been forced to dismantle due to the Agip explosion. The important architectural features of this building are reinforced concrete sheds, with infill walls consisting of visible bricks and vault covers, placed in pairs according to a geometric grid. Some of them have been recently restored.

Then the students defined different kinds of intended uses, ownership and made an historical reading about intended uses (Tables 1 and 2).

A compared analysis of environmental conditions and intended uses studies:

- site involvement quality evaluation
- evaluation of restoration capability
- analysis of the yesterday-today-tomorrow condition with respect to the intended use
- intended use characteristics:
 - standing, already existing
 - standing, new
 - temporary
- diversified time scale intended uses scheduling
- connected or systemic strategic scheduling of intended uses on different areas

Table 1

PLAN PRESCRIPTIONS		
N	New intended use	
T	Fixed-term intended use (until the end of the activity in progress)	
C	Intended use admitted only if compatible with the other intended uses within the area	
R	Reconfirmed intended use	
D	Intended use to delocalize	
OWNERSHIP		
Pb-Pb	Public property	Public use
Pb-Pr	Public property	Private use
Pr-Pr	Private property	Private use
Pr-Pb	Private property	Public use
HISTORICAL READING		
E	Already existing intended use	
N	New intended use	
P	Not existing yet intended use, but provided for the project	
A	Not foreseen intended use	

Table 2
Summary chart. Student: Ulderico Tornincasa

Destinazioni d'uso rilevate	LETTURA STORICA	PROPRIETA	ATTORI		PRESCRIZIONI DI PIANO
			Produttori/Operatori	Fruitori/Consumatori	
RESIDENZA					
RESIDENZA PRIVATA	A	Pr-Pr	Cittadini privati	Abitanti dell'area urbana/metropolitana localizzati nelle aree periferiche	D
ATTIVITA' PRODUTTIVE					
ATTIVITA' ARTIGIANALI non inquinanti (De Rosa alimentari)	E	Pr-Pb	Imprenditori	Utenti delle attrezzature commerciali	R-C
ATTIVITA' ARTIGIANALE inquinante (Fabbro)	A	Pr-Pb	Commercianti	Abitanti dell'area urbana/metropolitana localizzati nelle aree periferiche	D
ATTIVITA' TERZIARIE					
ATTIVITA' COMMERCIALI AL DETTAGLIO (Bar Tabacchi)	E	Pr-Pb	Commercianti	Abitanti dell'area urbana/metropolitana localizzati nelle aree periferiche	R
ATTIVITA' COMMERCIALI ALL'INGROSSO (S.O.N., Goth logistica, Materiali termotecnici, La Nuova Lince, Siemens "deposito", Figliolini "import-export")	E	Pr-Pb	Imprenditori	Abitanti dell'area urbana/metropolitana localizzati nella città consolidata, Utenti delle attrezzature sanitarie, Utenti delle attrezzature commerciali, Utenti del trasporto privato	
INFRASTRUTTURE					
INFRASTRUTTURA VIARIA PER IL TRASPORTO (Sistema di trasporto pubblico)	E	Pb-Pb	Governo locale	Abitanti dell'area urbana localizzati nelle aree periferiche Pedoni	R

The fourth phase of the study is the identification of the environmental aspects in relation with the single intended uses.

Data gathering will particularly concern: polluting emissions, waste production, employed raw materials consumption, energy production and consumption, water consumption, noise emissions, water draining, natural resources consumption, electromagnetic emissions, etc., such information are useful to quantify the environmental aspect.

Once the aspect connected to the carried out activity have been identified, the environmental impacts can be determined (Table 3).

Table 3

Environmental receptors and intended uses analysis. Student: Ulderico Tornincasa

<i>Destinazioni d'uso previste</i>	SUOLO		ARIA		ACQUA	
	livello di qualità di cui necessita	Impatto	livello di qualità di cui necessita	Impatto	livello di qualità di cui necessita	Impatto
RESIDENZA						
<i>RESIDENZA PRIVATA</i>	■	○	■	○	■	○
ATTIVITA' PRODUTTIVA						
<i>ATTIVITA' ARTIGIANALE non inquinante (De Rosa Alimentari)</i>	■	○	■	○	■	○
<i>ATTIVITA' ARTIGIANALE inquinante (Fabbro)</i>	■	○	■	●	■	●
ATTIVITA' TERZIARIA						
<i>ATTIVITA' COMMERCIALE AL DETTAGLIO (Bar-Tabacchi)</i>	■	○	■	○	■	○
<i>ATTIVITA' COMMERCIALE ALL'INGROSSO (S.O.N.)</i>	■	●	■	●	■	●
<i>ATTIVITA' COMMERCIALE ALL'INGROSSO (Figliolini s.r.l. import-export)</i>	□	●	■	●	■	○
<i>ATTIVITA' COMMERCIALE ALL'INGROSSO (Goth logistica)</i>	□	●	■	●	■	○
<i>ATTIVITA' COMMERCIALE ALL'INGROSSO (Materiali termotecnici)</i>	■	○	■	○	■	○
<i>ATTIVITA' COMMERCIALE ALL'INGROSSO (Siemens Deposito)</i>	□	○	□	○	□	○
<i>ATTIVITA' DIRETTA ALL'EROGAZIONE DI SERVIZI (La nuova Lince -Sorveglianza privata-)</i>	■	○	■	○	■	○
INFRASTRUTTURE						
<i>INFRASTRUTTURA VIARIA PER IL TRASPORTI (Sistema di trasporto pubblico)</i>	■	●	■	●	■	○

■ = high quality

■ = medium quality

□ = low quality

● = very negative impact

○ = medium negative impact

○ = low negative impact

Then we characterize some compatibility factors, to define the compatibility among intended uses (Tables 4 and 5):

- we refer to *Physical Compatibility* when, comparing two intended uses, one does not impact on the environmental receptors of the other;
- we refer to *Functional Compatibility* when an intended use can act as supporting structure of another one;
- we refer to *Fruition Compatibility* when a multiplying effect of environmental, social and economic benefits due to the integration between the two intended uses is foreseen;
- we refer to *Managing Compatibility* when the involved subjects are the same for both intended uses;
- we refer to *Strategic Compatibility* when we can suppose a mutual enjoyment / promotion / fruition strategy.

Table 4
Defining the compatibility

DEFINITION	INTERPRETATION
Absolute incompatibility	The two compared intended uses cannot coexist in neighbouring areas.
Scarce/lowest compatibility	The two compared intended uses are compatible only after the carrying out of mitigation measures concerning mutual impacts (i.e. realization of anti-noise, windbreak and anti-crossing barriers, ...)
Moderate compatibility	The two compared intended uses are compatible
High compatibility	The two compared intended uses are very compatible

Table 5
Compatibility evaluation

VALUE	DEFINITION	FACTORS				
		<i>Physical</i>	<i>Functional</i>	<i>Fruition</i>	<i>Managing</i>	<i>Strategic</i>
0	Absolute incompatibility	NO	NO	NO	NO	NO
1	Scarce/lowest compatibility	SI	NO	NO	NO	NO
3	Moderate compatibility	SI	SI	NO	NO	NO
5	High compatibility	SI	SI	SI	NO	NO

The different intended uses are compared two by two in order to evaluate compatibility (Table 6):

Table 6
Student: Ulderico Tornincasa

	1.1	2.1	2.2	3.1	3.2	3.3	3.4	3.5	3.6	3.7	4.1
1.1 PRIVATE RESIDENCE	5										
2.1 ARTISAN ACTIVITY: not polluting (Grocer's shop)	2	5									
2.2 ARTISAN ACTIVITY: polluting (Blacksmith)	1	2	5								
3.1 COMMERCIAL ACTIVITY - RETAIL (Bar – Tobacconist's)	5	4	2	5							
3.2 COMMERCIAL ACTIVITY - WHOLESALE (S.O.N.)	1	2	5	2	5						
3.3 COMMERCIAL ACTIVITY - WHOLESALE (Figliolini s.r.l. import-export)	1	2	5	2	5	5					
3.4 COMMERCIAL ACTIVITY - WHOLESALE (Goth logistica)	1	2	5	2	5	5	5				
3.5 COMMERCIAL ACTIVITY - WHOLESALE (Thermotechnical materials)	1	2	5	2	5	5	5	5			
3.6 COMMERCIAL ACTIVITY - WHOLESALE (Siemens warehouse)	1	2	5	2	5	5	5	5	5		
3.7 SERVICE COMPANY (Private surveillance)	3	3	3	4	4	4	4	4	4	5	
4.1 PUBLIC TRANSPORT ROAD- INFRASTRUCTURES	5	4	4	4	3	3	3	3	3	4	5



Figure 2
Compatibility evaluation.
Student: Tommaso Fumante

The same case study was the topic of the International Workshop in Environmental Design NA_est, 2-7 october 2006, Cappella della Croce di Lucca, Napoli.

The initiative has been open to graduand, graduated and PhD students, for a number of 35 people. It concerned environmental recovery of sub-ambit 12 E of the PRG, with the aim to attribute to this dismissed area a new urban meaning, with capacity to attract social interest and prompt dynamic economical processes.

Specific topics have been three:

- the Park and big connecting infrastructures;
- Public open spaces;
- Hypothesis of sustainable architecture on private allotments.

Groups have been lead by tutors and teachers from other Universities (Politecnico di Torino, Politecnico di Milano, Università di Firenze, Università Roma Tre) participating in the national research programme: *The environmental compatibility in the rehabilitation and reconversion project of disused area*.

We invited as visiting teachers Francesco Veenstra (Mecanoo, Delft, Netherlands), Christine Dalnoky (Atelier de Paysage, Gordes, France), Rafael Serra (Escola Tecnica Superior d'Arquitectura, Barcelona, Espana), Rodica Crisan (University Ion Mincu, Bucarest, Romania).

In the following pages is described the final presentation of one of participant design groups, that worked on topic 1: Park and big connecting infrastructure.

Design group: Mariachiara Catani, Giovanna Di Stefano, Mauro Giuseppe Maresca, Manuela Musto, Elvira Pensa. Tutor senior: Luca M. F. Fabris. Tutor junior: Caterina Frettoloso.

Visiting teacher: Cristine Dalnoky

The idea that guides the project is to use the time as a material of design.

The hierarchies among the elements of the project are defined:

1. water
2. vegetation
3. buildings,

and, within each one of them, phases of intervention are specified, that will bring to the final configuration (Figures 3 and 4).

Moreover, time introduces a factor of variability among those elements of the project that are heavy / structural / permanent / and those light / subordinate / transitory.



Figure 3

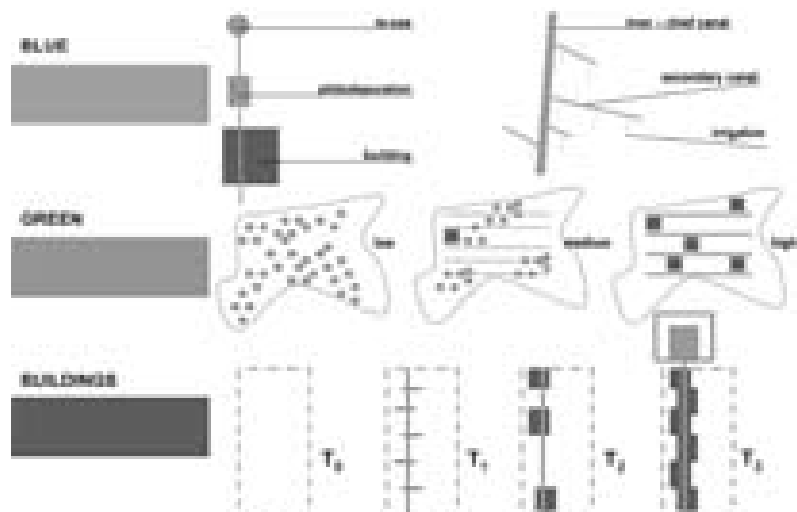


Figure 4

The attraction poles of the area are the infrastructural nodes of the TAV station and of Metropolitana – Circumvesuviana line 4, being the area access points from the rest of the town and the privileged area access points at the same time. The park is defined in its formalization by the trickle of water inside the canal reminding the Corsea (Figure 5).



Figure 5

Moreover, as regards the park, we suggest the experience of the “Parco delle Cave” in Milan, where the realization of the constructions of the vegetable gardens common parts has been entrusted to the contractors themselves.

Moreover, we have the intention of entrusting, as foreign experience, the care and the light (ordinary) maintenance of common spaces and park to the inhabitants of the neighbouring areas (Figure 6).



Time defined also the improvement of the area, through differentiated systems and technologies, in relation to local characteristics, soil and water pollution and design needs (Figures 7 and 8).



Nikos Panagiotopoulos

Introducing Sustainability into Building Construction

*Aristotle University of Thessaloniki,
School of Architecture,
Greece*

Sustainable building design and construction is the interdisciplinary field par excellence. Its spectrum encompasses several environmental compartments and its philosophy is dialectic and global. Any successful example of sustainable planning postulates the cooperation of a multitude of experts. Sustainable building projects can only be implemented by a team coming from many disciplines. This brings up the crucial question, how to shape the teaching of architectural construction, in order to allow the notion of sustainability to permeate several courses of architectural curricula at an early pre-graduate stage. The proposals expounded are 1) the introduction of the notion of integral design and management into building construction, 2) the reshaping of the traditional content of building physics and construction, so as to integrate the principles of sustainability and 3) the introduction of an initiating course, open to visiting lecturers from various disciplines, with the purpose to initiate students into global thinking and sustainable building.

Sustainable Architecture and Building Construction

Environmental Architecture has evolved from the solar architecture of the '80s to *Resource Architecture* in the beginning of the 21st century. Right so, as everyone has come to realise, that the building design has to encompass several environmental compartments, namely energy, air, water, ground and materials. The building process constitutes an intervention, an action which always receives a manifold feedback. This fact calls for a new construction philosophy, which has to accommodate the aspects of sustainability, global thinking and integration.

Sustainability

Sustainable building construction entails a complete survey on a series of fields, such as land use, soil conservation, pollution, water availability, communal information and the ensuing definition of targets and actions.

The Global Approach to Construction

The engineers of today are standing before new problems, the solution of which requires a different mindset. The unsolved problems of today are remnants of yesterday's problems and cannot be solved through yesterday's thinking. Today's way of dealing with problems should be based on such considerations as *the Whole and its parts, the reticulation of parameters, systems in their environment, complexity, order, controls and development*.

Integration

Systems and processes of construction have to be integrated into a global system or process of optimal effectiveness. Integration includes all action taken to materialise a project as well as all required information and its processing. Integral design and integral management are inextricably connected to the integration of *information technology*, which enables engineers to efficiently manage complex systems. The pillars of integrated design and management are:

- *Global thinking*: the processing of information aiming at an optimal deployment of resources, machinery and facilities
- *Life cycles*: a comprehensive documentation of an object and its components, at every stage, from the preliminary design stage to the demolition.
- *Transparency*: All information should be accessible any time.

The Holistic Building Concept

A holistic building concept encompasses several activities performed throughout the entire life cycle of facilities, the facilities themselves and the activities of the participating partners. It takes into consideration not only technological and financial but also environmental and social aspects. Facilities include buildings, land, installations and free spaces.

According to the holistic building concept, the building process is an interdisciplinary one, integrating not only engineers of various faculties, but also contractors and users in an open process, which begins with the initial considerations about the building site and ends with the buildings' closure.

From the architect's point of view, this concept involves:

- the coordination of the activities of several participating partners, including facility users
- the planning and monitoring of the entire life cycle of a building, in its entirety as well as at every single stage, including initiation, use and demolition.
- the notion of the 'living' building, which experiences changes of condition and operation throughout its life and exists not against or isolated from but with the environment.
- the introduction of adequate computer-aided planning and management systems

The holistic building concept induces radical changes regarding:

- The activities of the participating partners during the entire life of buildings
- The buildings themselves in their gradual transition from the 'common' to a 'living, intelligent', purpose oriented building of extreme flexibility and optimal expenditure on energy, water and operational cost
- The professional image of the partners, especially that of architects
- The fields of knowledge and education
- The focus in building research

B. Introducing sustainability into the architectural education

Assuming that everyone acknowledges the necessity of introducing sustainability into the curricula of architectural departments, one should determine what, where and how. Firstly, there are certain facts to be established:

The notion of sustainability postulates global thinking and a holistic approach. Knowledge and information should follow this principle. The goal should be the *integration* of existing and new contents into widened, coherent modules, as will be outlaid next.

Sustainable architecture and integral design contain subjects that are new to architectural curricula, for example, life cycles and water management. It is not necessary to introduce new courses to curricula which often are already working to full capacity. What makes more sense is, after adequately reshaping the context of construction modules, to incorporate *guest lecturers*, either physically present or via digital technology, e.g. video conference or the network. In this manner, courses will be enriched and the complexity and the spectrum of the building process will be demonstrated. After all, building design, construction and management involve a large number of partners on an equal base, with the architect gradually assuming the managing function. The interdisciplinary nature of the building process should gradually pervade our educational content.

The integration of modules

Environmental Architecture is meanwhile a standard course at all Schools of Architecture. Its scope nowadays has widened to embrace all environmental parameters, including water management, life cycles of materials and buildings, energy effective renovation (with respect to soil preservation in urban centres), sustainable town- and regional planning, etc. It is hence consequential that this field is gradually becoming an autonomous science and should be delegated to specific, independent schools or departments, of which some already exist, mainly in central Europe. Yet, many subjects of Environmental Architecture are closely relevant to architectural design and construction, such as the strategies for solar gains and passive cooling, and should accordingly be integrated into the respective modules.

Building Physics, a standard course since the '70s, was initially meant to teach how to avoid blunders leading to building damages. It soon expanded to include lighting, sound control, fire protection, etc. It is also a course known to be highly unpopular among students. Yet, Building Physics are not only an essential ingredient of construction; they are also a prerequisite for any engagement in environmental architecture. The idea is to comprise all content relevant to the *building's skin* within a single module. This module should contain several chapters related to energy management, with the addition of sound control, not only because sound control relates to the building's skin but also because any efficient building skin is unthinkable without the consideration of noise. Waterproofing can be directly integrated in energy management and be studied in connection to heat insulation.

It goes without saying that the course has to be supported by Building Analysis software, which is widely available and eliminates the use of complex manual calculations, thus enabling the teacher to focus on the essence and use examples, thus making the course more attractive to students.

This new concept of Building Physics can not only be complementary to Building Construction, but can *merge with* it, becoming an integral part of its content.

Contents, such as fire, lightning and wind protection can be assigned partly to

building design, as regards design strategies and building construction, with regard to structural measures.

Integral Facility Management as a university course is entering the curricula of an increasing number of Architectural Departments. The main teaching contents of this course are:

- The Basics of Integral Management
- Project supervision and management
- Integral Facility Management as a Management of Holistic Building
- Computer Integrated Facility Management

Once again, the final goal should be to integrate, at least to some extent, this course into building construction. The course offers the possibility for a wide cooperation with a large number of faculties, since it encompasses the entire life of not only a building, but also its surroundings, as well as the people involved as contractors, planners, workers and users.

Finally, the introduction of a **theoretical course** appears advisable, which will examine sustainable development in its social, economical and technological context. This course could offer a podium to guests not only from the technological milieu, but also to economists, jurists and environmentalists. Such a course will be able to give guidance to those students, who should choose environmental architecture as the field of their research and diploma theses.

As a conclusion

The necessity of embracing the tenet of sustainability in building construction appears quite evident today. Educationalists have to adjust their knowledge, mentality and methods so as to let the notion of sustainability permeate the teaching content. Lifelong education is indispensable for teachers as it is for students. It is also clear that teachers cannot and have not to be omniscient. What is essential, is to restructure the contents of building construction towards a global concept and allow access to our courses for lecturers from different faculties, who can support and enrich our teaching contents and methods. This path can be quite tortuous, but have to tread it, provided we care for a better common future.

Andriano Magliocco

**Sustainability, Multi-disciplinarity, Trans-disciplinarity:
New Frontiers in the Teaching of Technology**

*Università degli Studi di Genova,
Italy*

In Italian schools of Architecture, the teaching of the principles of sustainable development, as regards the possible effects on the territorial and building plan, has long been the teaching subject of some lecturers belonging to the field of Technology of Architecture. The contents of these courses have been gradually enriched and improved starting from the principles of bioclimatic planning and environmental planning.

On the one hand there is the need to consider the whole building lifecycle and the identification of an increasing number of technical solutions made up of ecofriendly materials (which I dealt with in my report in the last conference about the subject, last year); on the other hand it is evident the need to deal with the sustainable project since the preliminary stage of the intervention scheduling. As regards the first case we started from the building project and we took into consideration its aspects of energetic efficiency, in order to progressively define better those aspects connected with the environmental quality of materials; so the areas of building production and industrial design have been re-connected (as a matter of fact many lecturers in industrial design come from the area of technology of architecture). As regards the second case, more recently, we started from the principle that technical solutions are often mere consequences of political and administrative decisions, so we started to establish connections with the world of urban planning, for example by applying some systems of assessment of building interventions as regards territory (for instance, the Strategic Environmental Assessment – SEA -, from the directive 2001-4-CE - in Italian “VAS”).

Technology of architecture, as a disciplinary field - at least in Italy an independent subject, but prone to creating occasions of connection among the subjects of planning, construction theory and building physics – has a strong tendency to multi-disciplinarity; that might seem to allow dealing with the whole process in a systemic manner, by getting the necessary elements for contacting professional people who, until few years ago, did not seem to have anything in common with: town planners, biologists, chemists, and so on. The planning process has been enriched with multidisciplinary contents and the direction is more and more trans-disciplinary.

Even though teaching Technology of architecture still preserves basic courses about specific matters relative to the material definition of the architectural plan, it gets richer through courses which might seem irrelevant to this area, or in any case, hitherto dealt with by other teaching areas with different points of view. Notably, new professional people are involved as regards territory, because territory is regarded from different points of view: town planning, landscape, ecology, geology, and so on. But every professional has a different attitude towards territory changes, approaching the subject with virtually monodisciplinary points of view.

It would be necessary to connect different opinions and ask everyone involved in order to reach good results. In research and planning activity this means to go from multi-disciplinary approach (different professionals working together) to trans-disciplinary approach (same professionals working on different disciplines).

If it is true that teachers of Technology are used to digressing while doing research activities and they usually have good results, we should wonder what role these courses have as regards teaching, both towards this subject area on the whole, and towards other subject areas involved.

My present attempt is to make students understand how many different and manifold factors are involved in the creation of a project, with special regard to the effort of the least possible interference with the delicate environmental balance. It has always been our constant effort in the group (I am also including Professors Raiteri and Novi, whom I have been working with for more than ten years now) to make students understand that project conception should not consider structural aspects as separate from creative aspects, and that technological features are directly responsible for the functional results of a building as well as for formal results. Moreover we're trying to let them know that firstly the development (the planning process) and then the achievement of a project (the construction process), are often equally important in giving architecture a shape and a content.

The issue which is being faced by we Europeans – and unluckily we Italians are not the first ones – about identifying the most sustainable model of development, must be now integrated and be a part of all the elements which are involved in the project. Much has been said in the last few years about multidisciplinary, the need for collaboration, the involvement of other specialists in the project, the end of the architect's idea as a jack-of-all-trades (with obvious doubts about the possible results). This has led to overlapping different skills rather than integrating them, in particular for those aspects which had not been taken into consideration before. So I think most appropriate to deal with multidisciplinary as well as transdisciplinary.

As it is necessary to consider a variety of experts working together, each for an in-depth analysis of their specific interest in the project, it is also necessary for architects to learn new transdisciplinary skills as they are naturally used to. It is not just a matter of dialogue with experts in structures and building materials specialists, but also with landscape architects, biologists, chemists, etc, as a result of the growing relevance in the environmental compatibility of territory modifications mainly governed by the architect. I don't mean to consider the architect endowed with incredible and genial skills, in a leonardesque style, but I have seen too many architects compelled to concentrate only on quantitative and normative aspects, that is how to act within the law and obtain the biggest quantity of cubic metres, as the only buyer's request; as far as I am concerned, by doing so they fail to meet their role expectations. On the contrary the quality of interventions should be based on a systemic view of the project and the integration among the disciplinary areas involved.

As regards teaching, in Genoa, we have had some experience about it; I will mention just those I am involved in, not to undervalue those colleagues of mine who are not here today and who may be well-experienced in it. We have two courses which are held by a contract lecturer and I have worked with him for quite a while: the first course, Environmental Sustainability deals with sustainability with regard to the territory and to the use of resources in general; this course is obligatory for students of three-year degree courses in Landscape Architecture and optional for all the other degrees present in the Faculty. This six-monthly course is the first module of an annual course which can be completed with a second module, referred to as Bioclimatic Technologies, which deals more specifically with the technologies for low

energy consumption in the building industry and the use of renewable resources.

Besides that, many of our theses (Professors Raiteri and Novi are again included) are focused on different aspects of sustainability and they are usually connected to the use of technologies for the active and passive exploitation of local climatic features.

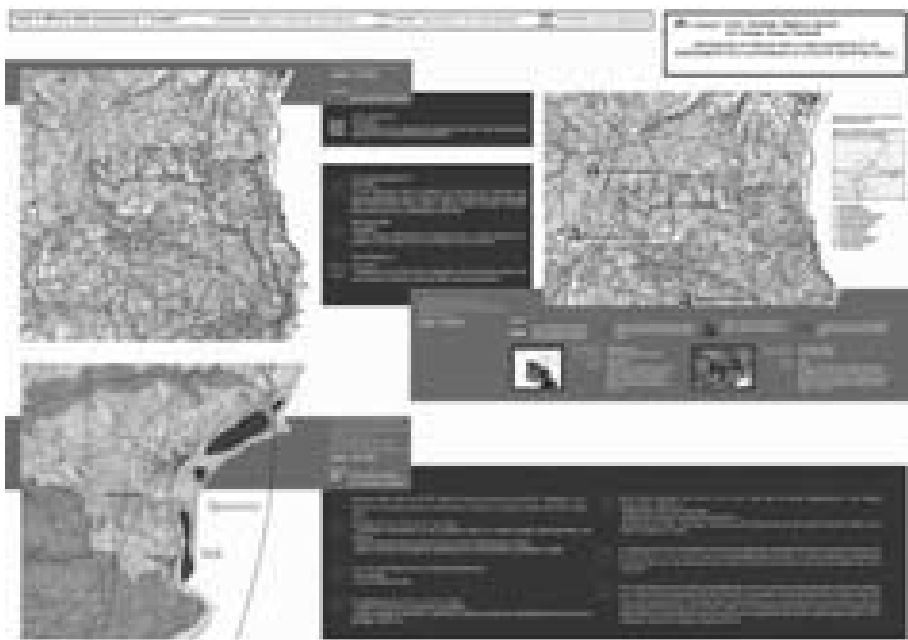
In the most recent thesis I have supervised – assisted by Architect A. Giachetta, the lecturer of the above mentioned course – we tried to study in depth those aspects connected to site analysis, delving into some of the aspects which are usually neglected. We were asked to identify a decisional structure for starting a project in Noli hinterland, a village in Liguria, our region, in the province of Savona. This was also made possible by the map-making materials that can be consulted online on the website of Regione Liguria or on paper if requested, concerning the naturalistic features of this territory and the potentialities it can offer with regard to renewable energy resources (even though little experience has been made so far in our region).

In the tables the site features have been analysed and taken into consideration for a variety of themes linked to the principles of sustainable development, notably for: the naturalistic features and the presence of animal and vegetal species worthy of attention (we are near a Nature 2000 Site of Community Importance, Habitats directive 92/43/CEE); possible impacts on the natural environment as a result of site construction and residential activities taking place after completing the intervention; conditions of solar irradiation (actually not very good) on the area and the potentialities of solar energy exploitation resulting from it; major winds and the use of ventilation strategies for summer cooling; strategies for the decrease in the use of water thanks to rainwater collection; possible use of plants for electric power production through microgeneration; the use of renewable source materials.

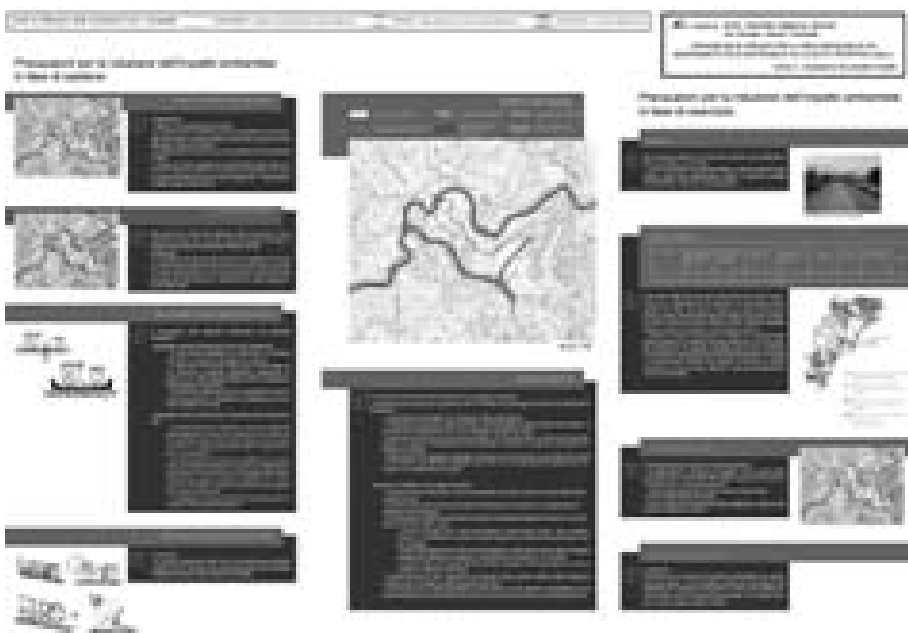
Some of these aspects were even more important provided that this is a fire-prone area (both spontaneous and fraudulent), which may risk a serious decline in local animal species (especially herpetofauna), where human presence might be useful to an action of preservation.

For every subject students had to write environmental norms to guide the planning, characterized by a different effectiveness level: prescription (relevant target to be reached with a specific solution), indication (the target can be reached with alternative solutions to those suggested), guideline (desirable but not compulsory target, should negation be accompanied by a plausible explanation).

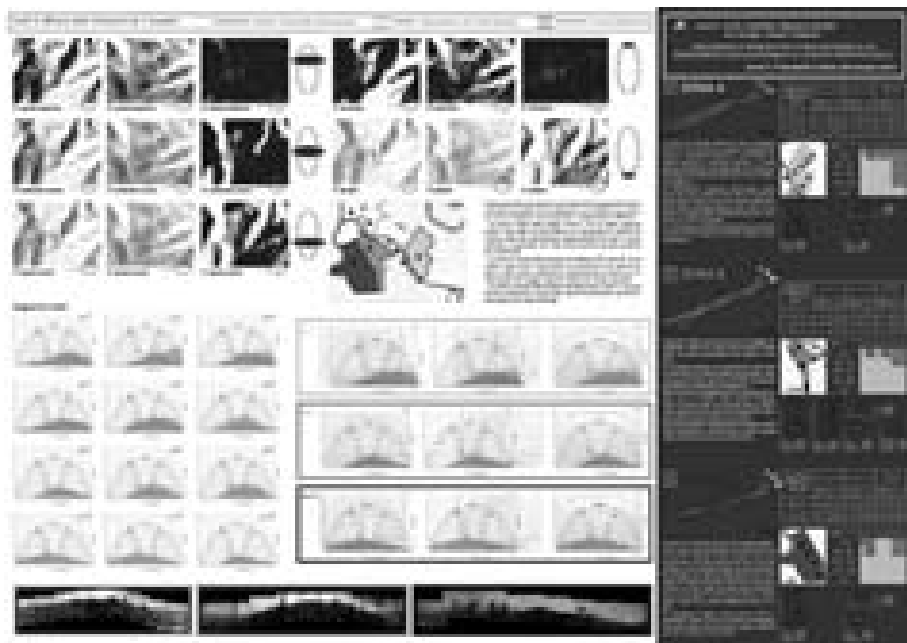
The intersection between all the aspects involved – such as the need for locating on a steep hillside in order to reduce excavation as much as possible, the need to keep the view looking north-west towards the sea – and how the students interpreted these data, have led to an interesting and balanced project. We found it particularly interesting that young architecture students could manage such a large amount of data in the project so consciously and consistently – despite many data were foreign to their background – delving into some aspects with external experts and others by themselves as architects, also when they had to deal with data on the natural environment. I think this is the right track to follow, and that in a measure such heavy disciplinary segmentation in our University should give way to synthesis: the project.



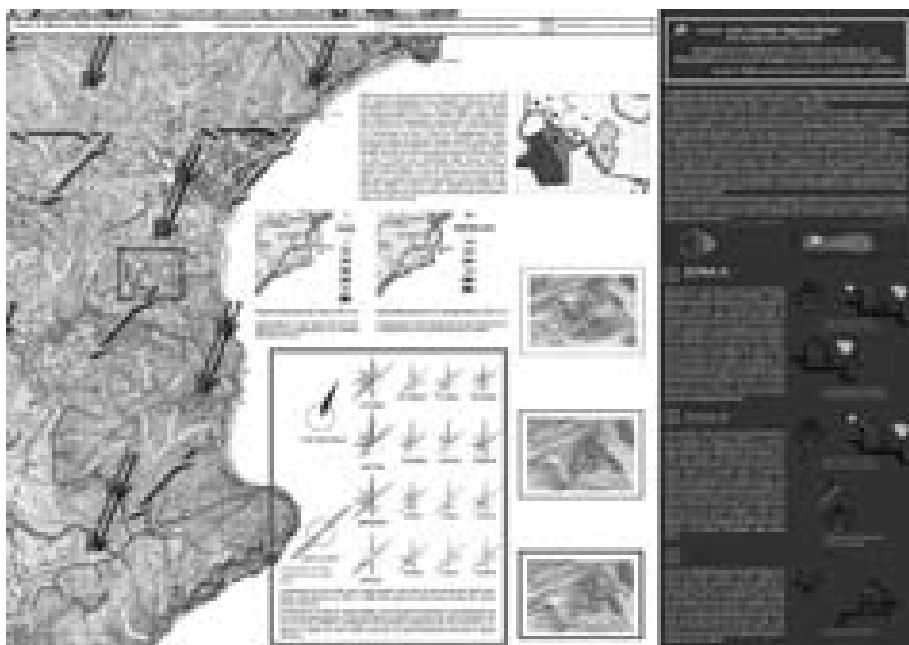
Naturalistic features and presence of animal and vegetal species worthy of attention



Possible impacts on the natural environment as a result of site construction and residential activities taking place after completing the intervention



Conditions of solar irradiation on the area and potentialities of solar energy



Major winds and ventilation strategies for summer



Strategies for the decrease in the use of water thanks to rainwater collection and strategies for fire control



Solar water heating plants and electric power production through microgeneration



Indoor pollution (radon and electromagnetism) and use of renewable source materials

**Ekaterini Eumorfopoulou
Anna Kokkinaki Daniil**

**Construction and Environment -
Scientific Object and Teaching**

*Aristotle University of Thessaloniki,
School of Civil Engineering,
Greece*

The civil engineering educational programmes are based on a wide field of subjects which examines the issues of mechanics, applied mechanics, building materials, reinforced concrete, steel structures, building construction, construction technology and organisation, engineering surveying, computer science and computational methods, transport engineering, water structures and water management, environmental engineering and so on. A basic target of the teaching is to enable students to implement successfully such knowledge in the design and the construction of civil engineering works, which they will carry out as professionals.

Laboratory of Building Construction and Physics, A.U.Th, Greece

The teaching of the Building Construction course in the Laboratory of Building Construction and Physics of the Aristotle University of Thessaloniki in Greece aims to offer to the graduates of the School of Civil Engineering, and in particular to the ones of the Division of Structural Engineering, the competence to work on the construction issues of a building project and the scientific and technical knowledge which will enable them to choose building materials and compose constructional components for a building. Such knowledge, which focuses on the Construction, is important during the phase of the initial conception of the project as well as during the phase where the detailed design and the implementation of the project take place. In addition, it influences the efficiency, the cost, the lifetime, the way and the maintenance of the building.

Building Components and Construction Details

What is more, the issues which arise because of the use and the function of the building are presented in terms of the teaching of the course. Thus, the study and the processing of the constructional details become the outcome of extensive analysis rather than the result of a mere technological procedure.

Building Construction, Building Envelope and Building Physics

As far as the environmental issues are concerned, the ever expanding energy and environmental problems of the late twenty five years have turned the design of the building envelope into one of the most important issues, since the form of the building shell influences dramatically the microclimate and the internal climatic conditions of the building. Therefore, the Building Construction touches upon the issues of the design of sustainable, energy - saving buildings. What is more, all the national and international building regulations, which are related to the issues of environmental control and saving energy, refer mainly to the form of the constructional components of the buildings. Thus, it is evident, that issues of Building Physics, and in particular the ones which are related to environmental design, such as energy saving, thermal-energy behaviour of buildings, ecological materials and ecological construction and fire

protection, have to be taught in equal terms with those of conventional construction methods in the course of Building Construction.

An Interdisciplinary Scientific Object

All things considered, it is made clear that the conventional issue of Building Construction has to widen up and relate to other scientific areas. By doing so, it will help the graduates to be able to cope with the multiple demands that the sustainable, environmentally intelligent buildings have to reach. What is more, in regard to the issue *Building+Environment*, it is essential that the graduates have sound knowledge of Building Physics, co-operate and exchange opinions with an interdisciplinary team of (special) scientists such as mechanical and electrical engineers, meteorologists, chemists, environmental engineers, computer analysts and so on.

In the present study, we try to indicate the way that such interdisciplinary concepts are embodied in the teaching areas and methods of the Building Construction courses in the Laboratory of Building Construction and Physics of the School of Civil Engineering of Aristotle University of Thessaloniki.

The Scientific Field and the Teaching Object of the Laboratory

In order to stand up to the contemporary demands, the scientific field of the Laboratory has gradually broadened up and currently covers the following courses.

Building Construction I and II: covers the basic knowledge which is essential for the construction of a building.

Special Issues in Building Construction which refer to specific topics such as:

- The construction technology of contemporary structural systems and elements or special buildings, which introduces the issues of prefabrication, standardisation, industrial buildings, light-weight facades and so on.
- The advanced knowledge of Building Physics such as: energy balance and thermal behaviour of the building, issues/problems of humidity and water condensation, natural lighting.
- The preservation and restoration of existing buildings.
- The ecological (way of) building.

Fire Protection in Structures.

Energy Saving Design and the Use of Solar Energy in Buildings

Introduction to Architectural Design.

Timber Structures (in collaboration with the Laboratories of Reinforced Concrete and Metal Structures).

The teaching of the core courses Building Construction I+ II takes place during the third and the fourth semester of studies. The rest of the courses are optional and are taught during the last semesters (the eighth and the ninth) of studies. (The overall period of studies at the School of Engineering of the Aristotle University of Thessaloniki is ten semesters -five years).

The teaching of all the courses of the Laboratory is implemented by the lectures of the teaching staff and the seminar exercises, which focus on specific issues. The teaching staff constitutes of three Architects, four Civil Engineers and one Lab Engineer. The students are asked to design in detail a dwelling or a multi-story building. The students take into consideration the structural parameters of the building; In addition they study the issues of building function which are related to those of Building Physics (thermal insulation, water condensation etc) and environmental control and so on. The students work on their own or in groups of two and have tutorials with the teaching staff.

Additionally part of the teaching procedure is the visits of buildings sites at different phases of erection; there the students become familiar with real project work.

Diploma Theses (the tenth semester of studies)

In this stage, the students, having summed up the knowledge provided by the previous nine semesters of civil engineering studies, are able to start working on their diploma thesis. If they wish to focus on the Building Construction they can select one of the following topics:

- Buildings Construction and Building Materials
- Restoration of existing buildings - Renovation - Reformation
- Building Pathology
- Prefabrication - Industrialisation of the construction
- Building Regulations - Legislation
- Building Physics: Thermal Losses and Thermal Protection - Water condensation - Natural Lighting - Ventilation
- Fire Protection in Structures
- Environmental Design
- Thermal Behaviour of Buildings - Buildings Simulations by using Thermal Analysis Programmes
- Passive Solar Systems
- Glass Facades - Special Facades Systems
- Green Issues; their contribution to the architectural, energy and environmental design.

During the diploma project, the students work under the supervision of their tutors. The students use the appropriate material that is available in the Laboratory such as instruments that measure the temperature and the wind flow, the infrared camera, climatic data software, buildings thermal analysis programmes by simulations and the like.

During the thesis, the students study and test the constructional components, the internal comfort conditions and the adjustment of the building in the local climate, the use of solar energy and the control of thermal losses from the building envelope. Besides, they work on the sustainable-energy efficient design of the built environment using methods and materials which are friendly both to the users and to the environment.

The broadening of the teaching and the practice of the students on the interdisciplinary subject of the Construction in the Laboratory is accomplished by actually providing a multidisciplinary field of theoretical and applied knowledge (research+practice), the appropriate laboratory material and the right computer programmes. Furthermore, it is achieved by the co-operation of scientists on special scientific areas, by guest speakers during the academic year, and certainly by the response of the students.

Presentation of Graduates Diploma Theses

At this point, it is important to present parts of three diploma theses, which were supervised by members of the Staff of the Laboratory, and where interdisciplinarity is in action.

The first diploma thesis, which is entitled “Energy Upgrading of a Dwelling in Panorama, Thessaloniki” is focused on the thermal test and the energy upgrading of a dwelling which did not have sufficient thermal insulation. The students had to do the tests in situ, using an infrared camera and simulate the thermal behaviour of the house with a dynamic thermal analysis programme. The test results led to suggestions of refurbishment of the structural elements of the dwelling,(1. images 1,2,3,4,5).

The second diploma thesis, which is entitled “Double Skin Facades”, is a research on the analysis and the evaluation of the double skin façade system. During the process, the student used several references and precedents of sustainable buildings which were erected in Greece and elsewhere,(2. images 6,7,8).

The third diploma thesis, which is entitled “Urban House in Sitia, Crete. Restoration and Renovation Suggestion” concerns with the preservation and restoration of an urban house which was built in 1935 in the historic centre of a Greek provincial town. In this project, the co-operation with chemists was essential, in order to get advice on chemical substances of refurbishment. In addition, the collaboration between civil engineer and architect was crucial for the study and the final restoration and preservation suggestion,(3. Images 9,10,11,12).

Conclusion

All in all, as far as the science of Building Construction is concerned, the graduates have already practiced and have been taught an interdisciplinary subject, by the time

they have completed their studies. In order to master such a subject, they should have acquired not only the knowledge of conventional Building Construction but, what is more, they should have become familiar with a wide field of knowledge, emphasising on the Building Physics and the environmental issues.

The graduates achieve such a goal because the conventional Building Construction teaching is enriched by an interdisciplinary field of scientific and technological knowledge. Not only have they gained knowledge and the capacity of applying knowledge in practice, furthermore they have become able to work in an interdisciplinary team; they have worked on their ability to analyse and they have gained basic knowledge for the profession. Besides, the knowledge and the competences that the graduates have acquired, help them become ecologically sensitive people who are capable to act efficiently in the field of their specification in any working environment. All things considered, they are fully qualified to design buildings and settlements which provide safe living conditions, a quality of life and a sustainable built environment.

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Diploma Thesis: Maria Palamitzoglou, *Double Skin Facades*. Laboratory of Building Construction and Physics, School of Engineering, Aristotle University of Thessaloniki, 2006.

Diploma Thesis: Petros Zinas, *Urban House in Sitia, Crete. Restoration and Renovation Suggestion*. Laboratory of Building Construction and Physics, School of Engineering, Aristotle University of Thessaloniki, 2002.

Supervisors: Dr. Anna Kokkinaki-Daniil, Dr. Ekaterini Eumorfopoulou.

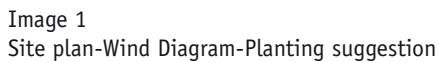
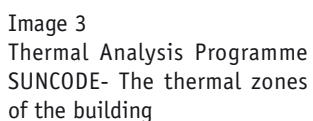


Image 2
The Dwelling-The elevations data surface/volume



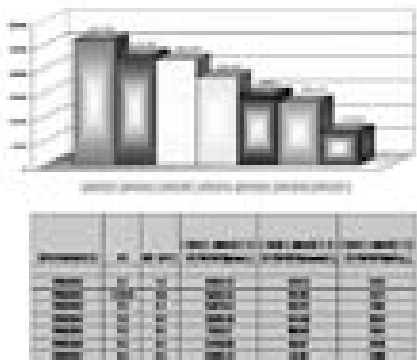


Image 4
Oil consumption results-stages of thermal protection operations

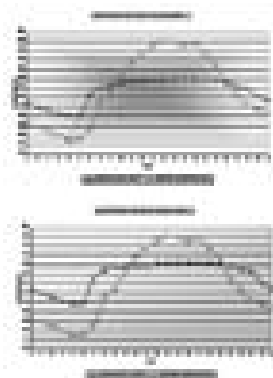


Image 5
Summer period - Diagrams of daily temperatures in the zones 1 and 2

2. Diploma Thesis: **Double Skin Facades** Graduate Student: Maria Palamitzoglou, Supervisor: Dr. Anna Kokkinaki-Daniil

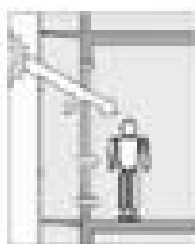


Image 6
Double skin facades-
Function during winter time

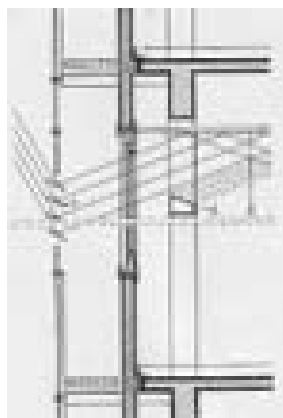


Image 7
Double skin facades-
Intelligent louvers



Image 8
Double skin facades-
Control of solar radiation

3. Diploma Thesis: **Urban House in Sitia, Crete. Restoration and Renovation Suggestion.**
 Graduate Student: Petros Zinas
 Supervisors: Dr. Anna Kokkinaki-Daniil, Dr. Ekat. Eumorfopoulou.

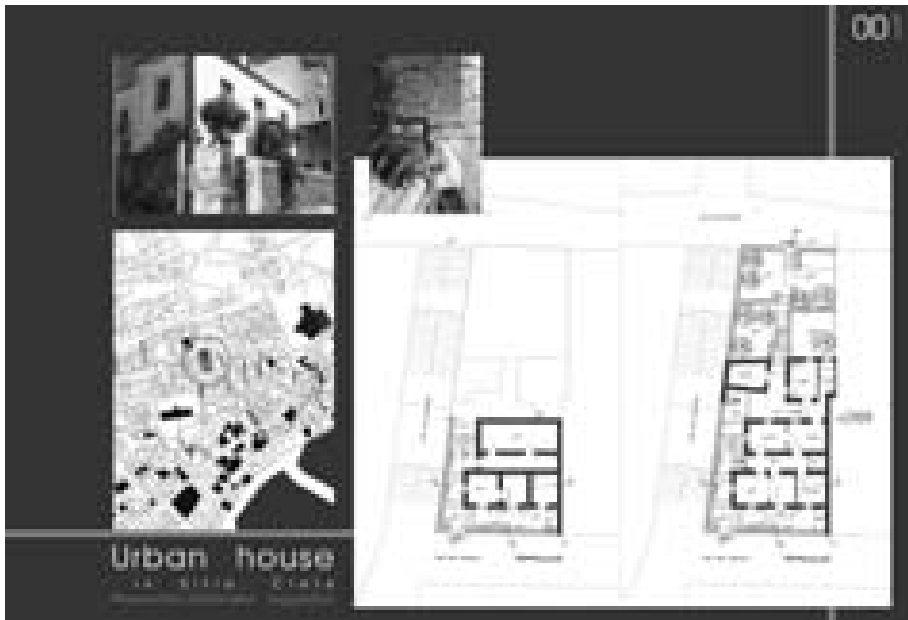


Image 9
 Site plan – The plans of the building

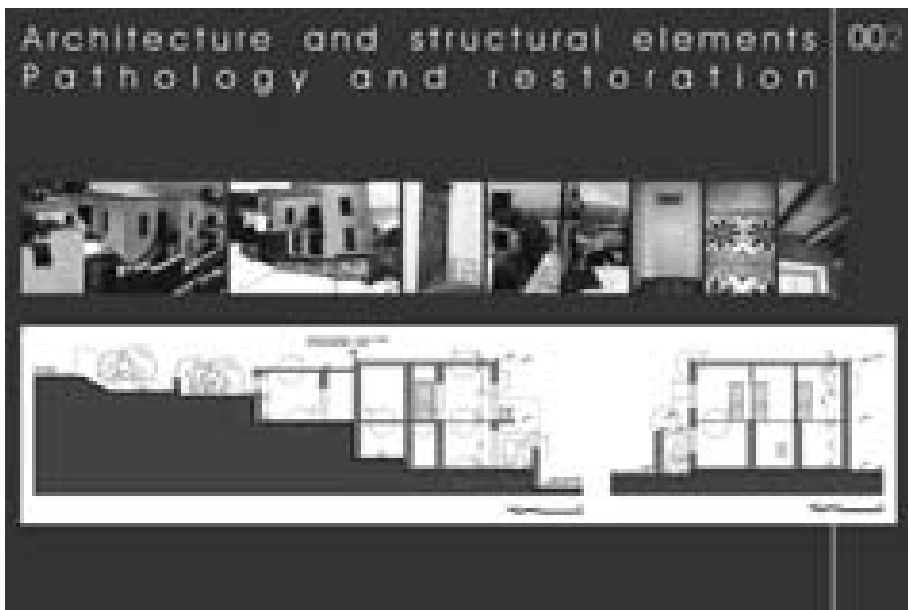
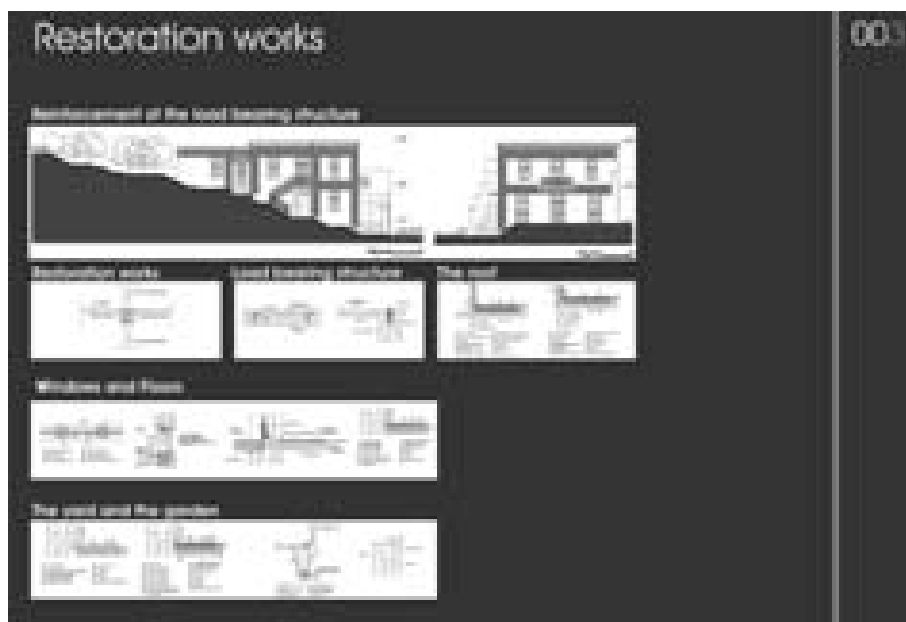


Image 10
 View and sections



Im. 11
Restoration suggestions

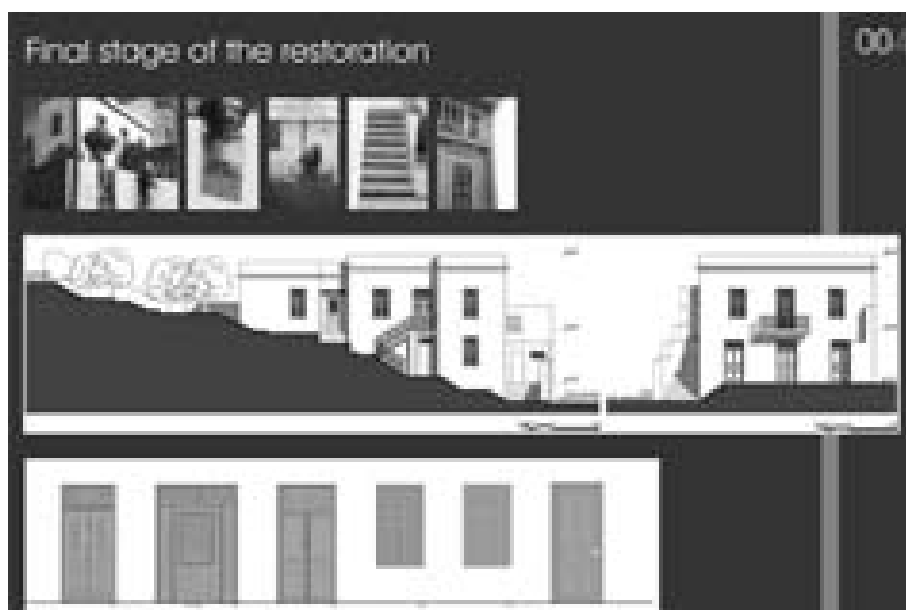


Image 12
The building after the restoration

John Brennan

**Architecture and Sustainability
as Autonomous Techniques
in Interdisciplinary Education**

*University of Edinburgh,
Scotland*

Introduction

As the skills required to execute complex projects require greater specialisation, so there is an imperative towards strategies that engender effective understanding and collaboration between built environment disciplines. There is a perception that taught courses are too specialist in nature, not reflecting the diverse skill sets to meet the challenges currently facing the building industry (Gann, Salter et al. 1999). *Rethinking Construction* identifies building processes as a 'series of sequential and largely separate operations' (Egan, Great Britain. Department of the Environment et al. 1998). The implication here is that a lack of integration at all levels of the industry embeds low levels of productivity and profitability in comparison with other economic sectors. The complex nature of contemporary building ensures that multidisciplinary, defined as co-contributions between disciplines, is pervasive and ingrained within the procurement process. The concept of interdisciplinarity, the appropriation of skills and knowledge between disciplines, is more relevant to this study. At the heart of this lies the education of architects, a process that is perceived as having an '*introverted perspective where architects are often driven by their own achievements and peer group recognition rather than responding to client and market needs*' (RIBA 2005). There is a danger however that such prevailing commentaries on the state of the architectural profession mask the potential for the useful employment of transdisciplinary techniques from architecture to allied engineering, surveying and project management disciplines.

Sustainability as an Educational Vehicle

It is proposed that sustainability should lie at the core of such an integrative strategy. Although rooted in environmental advocacy, contemporary perceptions of sustainability tend to the universal, taking their cue from the Brundtland definition (Brundtland, World Commission on et al. 1987) that fashions the link between our present behaviour and the well-being of future generations. To the environmental is added the social and the economic as legitimate territories for transformation. Such a holistic approach is vulnerable to observations that sustainability is a '*concept whose strength lies in its vagueness*' and its '*unifying consensual and essentially conservative connotations*' (Blowers 1993 p.787). This perhaps is only relevant when interrogating the efficacy of sustainable development to satisfy quantitative targets in respect to environmental, social and economic indicators. If however viewed as a political ideology it can challenge the primacy of the free market as the dominant instrument for investment in the construction sector. It is recognised that in the developed world, there exists a consensus that favours ethical consumption and that such an alternative model can provoke free market advocates into viewing sustainability as a 'Trojan horse' undermining entrenched investment structures (Roth, Sustainability Limited et al. 1999). Such a stance identifies how sustainability as a construct can be perceived as a vehicle in itself to facilitate change without an obligation to any empirically measurable outcome.

The Position of the Architect

The relevance to this study is illustrated in key findings containing in *Constructive Change* a critical report as to how the architectural profession in the UK should transform itself. It observed an almost universal consensus that sustainability would be in future a key driver for change in the next decade.

'The perspective of creating social value and design quality is already inherent in the architectural profession: it looks to serve not just one client but all clients and the wider society who all benefit from the design of our built environment' (RIBA 2005).

The pluralist qualities inherent in architectural education with a wide range of skills across the social, scientific and aesthetic thus offers an opportunity the ability for it to reach beyond the confines of a narrow professional focus. This study seeks to examine the relationship between architecture and engineering that often inhabit very different pedagogic traditions. Architectural education has tended to dislocate from practice in a polarising movement towards either the arts or the sciences. Pressures brought to bear on the subject by higher education institutions have accelerated a movement towards a more hermetic construct, as Giles Oliver notes:

"This yearning has centered on creating a distinct disciplinary validity and obscured the multi-disciplinary character of architecture's production and thought" (Oliver 2005).

In a similar vein, architectural education despite criticism from within the profession displays similar characteristics in a studio culture that although attacked for its hermetic and elitist qualities, has long employed what is recently termed 'enquiry based learning' (Palmer 2002) at the core of the pedagogic process.

Hard and Soft Knowledge

In *Academic Tribes and Territories*, Tony Becher posits a framework encompassing disciplinary clusters, and differentiates between bodies of 'hard' and 'soft' knowledge. He identifies Engineering as an academic discipline and its technological character that is 'hard applied' being perceived as pragmatic with purposeful criteria for judgment. Architecture very much lies in 'soft' territories having holistic qualities, and being value laden but also displaying a lack of consensus as to singular discipline characteristics. Qualitative observation of programme structures, pedagogic methodologies and outputs strengthen such assertions (Becher 1989).

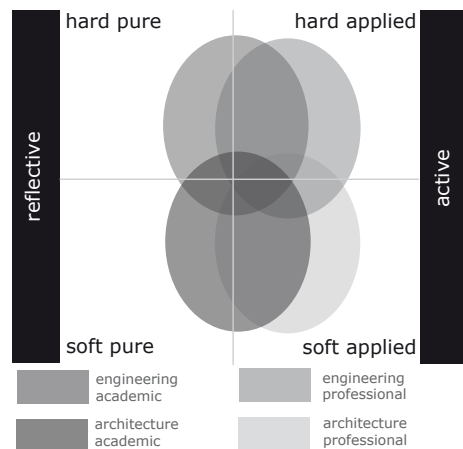


Figure 1
Hard and Soft Knowledge Structures.

At this point, this study has endeavoured to demonstrate that both architecture and sustainability are inherently challenging as intellectual constructs whereby their expansive and holistic qualities make rigorous and empirical enquiry problematic. However if viewed not simply as vehicles to achieve material outcomes but as pure methodologies, then their multivalent qualities can in themselves become valuable pedagogic tools. Although it may be curious to some that sustainability as an ideology can be employed primarily as an educative instrument rather than a means to environmental protection, it has a definite role in the promotion of effective transdisciplinary education.

The Role of the Model

A core aim of the study is to promote effective professional relationships between disciplines, realising that there are fundamental differences in the way in which architects and engineers are taught to practice. It is not proposed that a suitable approach is the promotion of the architecture design studio in engineering, rather to suggest strategies that contain elements of enquiry based learning and the desirable qualities of creativity and divergent thinking perceived to be at the heart of architectural education. The position of the studio in architectural education cannot be underestimated, being perceived not only as the physical environment for learning but as a didactic construct in itself whereby an almost hermetic atmosphere of communal endeavour dictates an unrelenting focus on the process of design. There exists within architecture the potential for the principles that underpin studio cultures to be employed as effective instruments for transdisciplinary learning.

Within this structure, the notion of a model as a simplified version of something complex has a particular attraction. The concept of the model in architectural education has been used effectively not just as a means of presentation of a finished proposal but also to interrogate the process of design both literally and metaphorically. It is proposed that the advantages to be gained in using such a learning vehicle could be used effectively in other built environment disciplines. In the anthropological field, Claude Lévi-Strauss asserts that to be successfully interrogated, a model should allow a series of transformations from a base configuration, have an ability to anticipate its behaviour and be so constituted as to such transformations be intelligible in its entirety. Lévi-Strauss then adds that a key function of the model is the ability to apply its properties across strategic boundaries.

'Thus it may be said that their ultimate end is to override traditional boundaries between different disciplines and to promote a true interdisciplinary approach' (Lévi-Strauss 1963).

The Study: Methodologies

The chosen vehicle for this research were the dissertation programmes undertaken by students enrolled for their M.Eng degree at the School of Engineering and Electronics at the University of Edinburgh. The task involves a research project that in the past has been dominated by focused and discrete experimental laboratory work dealing with

very specific technical issues. The transdisciplinary programme differed in that the field of enquiry was much wider than that previously experienced and compounded by the ambiguous nature of so many theories around what constitutes sustainability.

A vital characteristic of enquiry based learning techniques is to allow the student freedom to enquire on their own terms. Problem based learning techniques as outlined by Dahgren, involve the setting of a scenario.(Dahgren and Dahlgren 2002) This study seeks to take the characteristics of such scenarios and apply them through the metaphor of a model. The table below outlines the methodology in terms of forming a matrix that has at its heart, the three key components of sustainable development, the environmental, economic and social. To this, three transformations are applied, defining sustainable, model and discipline specific parameters that also identify the primary workstages of enabling methodologies, setting a scenario and the formulation of a project proposal.

Table 1
Study Structure

	sustainable parameters	model parameters	discipline parameters
environmental	key stage 1	key stage 2	key stage 3
social	key stage 1	key stage 2	key stage 3
economic	key stage 1	key stage 2	key stage 3
	methodologies	scenario	proposal

Key Stage 1: Define Sustainable Parameters

The identification of relevant bodies of knowledge in sustainable development is a critical challenge given its inherent ambiguities and the sheer volume of both theoretical and practical guidance. At this point, the basic characteristics of the model can be defined as a way of filtering and prioritising literature review of sustainable topics. Strategies are constantly guided towards tangible outcomes rather than further elaborations of sustainable theory. This stage also represents a joint framing of the enquiry model by both tutor and student.

Key Stage 2: Define Model Parameters

This sets out the use of the model metaphor for the students' study and as such is established at the outset. The use of a model in cross-disciplinary dialogue does not entail representation through the physical making of a piece as normally experienced in an architectural education. Instead, it suggests a scenario with spatial, social and material characteristics that is then subject to interrogation.

Key Stage 3: Define and reflect on Specific Discipline Parameters

As a learning vehicle, results and conclusions from the process of enquiry on the constructed model can respond both to measured outcomes of building performance

but additionally as a reflective process by the learner in regard to their own discipline. Critically it also constitutes the framework from which the study proposals are formulated.

The Studies

Two projects have been undertaken by small groups of 5th Year Engineering students at the School of Engineering and Electronics at the university of Edinburgh over two years. Students have embarked on this work over a semester the final output being in the form of a dissertation report.

Study 1. An Analysis of Live-Work Housing

This typology is becoming a critical area of study in the UK because of its potential to reduce transportation impacts and to promote a richer variety of usage patterns in urban areas. It is also a difficult hybrid building type to develop effectively and thus makes it a contemporary and relevant field of study.

Table 2
Study 1: Key Elements

	sustainable parameters	model parameters	discipline parameters
environmental	embodied energy downstream impact operational energy	location orientation localisation	component & material impacts
social	occupancy scenarios live-work scoping	employment futures household diversity flexibility	space maximisation
economic	adaptability permutations benchmarking KPI	replicability unit size unit density	structural redundancy
	methodologies	scenarios	proposals

Sustainable Parameters: Methodologies

These were built around the principal advantages of live-work buildings and included the inherent adaptability of relevant planning layouts. The students employed their already acquired skill sets in empirical analysis and scientific method to interrogate such propositions. These analytic abilities are entirely complementary to the cultural and contextual characteristics of the model and ensure an inherent reciprocity of enquiry across disciplines. The students chose to analyse the various permutations of the model with a number of quantitative tools, including UK based systems such as ENVEST and SAP2005.

Model Parameters: Scenario

The parameters of the model were based on programme and context; key elements that define cultural and economic aspects of sustainable development. Through this the concept of live-work building was investigated. Such typologies are becoming increasingly common, reflecting more the more ambiguous nature of the workplace

in increasingly service driven economies where monolithic office developments are becoming less responsive. This basis for the model allows a full examination of the economic, social and environmental aspects of sustainable development.

Discipline Parameters: The Proposal

These included specific study areas that maximise the students' prior knowledge and experience in their specialist fields. The relationship between resource impacts, structural design and environmental sustainability is predictably encountered. However research also ranged across more complex relationships such as potential conflicts between reducing material consumption and designing for a degree of structural redundancy, thus ensures a building's adaptability over time. In this way the students experienced some of the paradoxes that regularly occur in differing interpretations of what constitutes a sustainable strategy.

Study 2. Sustainable Disaster Shelter Design

This project involved students enquiring as to how such vital provision could be made more sustainable in both short and medium term timescales. Given the greater degree of climatic unpredictability through global warming, such a study is very relevant. However, rather than focus on a narrow environmental and material impact analysis, the students were able to reflect on the wider social and economic implications of their chosen study model. Specifically, notions of localisation in respect of how such temporary settlements adapt over time has resonances to the theories of shearing levels of change as proposed by Stuart Brand. (Brand 1994) The same methodologies were employed and are summarised below:

Table 3
Study 2: Key Elements

	sustainable parameters	model parameters	discipline parameters
environmental	downstream impacts embodied energy transportation impacts	location orientation localisation	component & material impacts
social	scoping study localisation strategy	shelter adaptability acceptability	frame connection speed of erection
economic	agency benchmarking outline costing	prefabrication localisation	structural economy
	methodologies	scenarios	proposals

Sustainable Parameters: Methodologies

The key sustainable parameters as defined by the students in this respect gave equal emphasis to a wide ranging set of criteria including the obvious downstream environmental impacts of the manufacture and construction of shelters both in their manufacture and siting. As important however was an emphasis on localisation studies to ensure that any proposal would be assessed within a framework that ensured it was suitable for use in specific geographic and cultural contexts. Rather than rely on predefined assessment techniques, they formulated their own scoring system tailored

to the specific nature of the study. Although because of time and resource constraints, it displayed some anomalies in its findings, the process of putting together such a system and testing their proposals were valuable in gaining understanding of the complexities of the process.

Model Parameters: Scenarios

Again the mapping across all sustainable criteria engenders a holistic response by students. The model parameters adopted were as diverse as prefabrication, shelter design and again responding proactively to geographic location.

Discipline Parameters: Proposals

This stage where students took control through the harnessing of sustainable agendas to their own discipline specialisations such as frame connections, material properties and speed of erection were subject to analysis not only in terms of their scientific behaviour but also the implications in terms of cost, durability, ease of construction and adaptation.

Conclusion

The purpose of this research was to reflect on how both sustainable theory and architectural education can act as effective vehicles to encourage cross disciplinary understandings between built environment professionals. The benefits of such an approach include:

- The ability to focus literature review and case study material quickly to specific cultural and contextual sustainable parameters.
- Freedom for the students to construct their own programme and variants to test their conclusions within a resilient framework.
- Clearly understood sets of relationships between engineering design decisions and social, environmental and economic impact.
- An ability to identify leverage points in the design process where sustainability criteria can be effectively introduced by the design team.
- A wider understanding of convergent and divergent forces within architectural and engineering disciplines.

On a more general note, such a method gives built environment professionals an insight and an opportunity to design using sustainability as a vehicle without requiring the specialist spatial skills that both define and isolate the architectural profession.

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Kleoniki Axarli

**Interdisciplinarity:
Building Construction and Environmental Design**

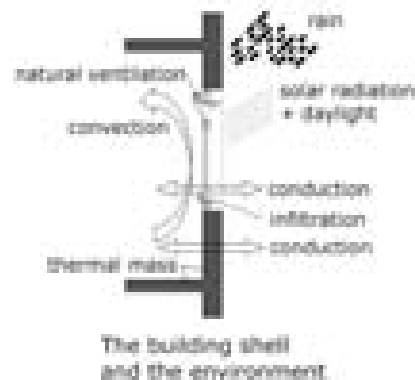
*Aristotle University of Thessaloniki,
School of Civil Engineering,
Greece*

Introduction

Teaching building construction is a very broad area of research, which covers several issues, such as statics, aesthetics, functionality, endurance, use of materials, specification, economics and building physics. In recent years, building physics, has proved to be an area of very fast development and extended study since it is directly related to building energy consumption, internal environmental quality, human comfort and sustainability (both of the building and the overall environment).

The study of building physics is essentially the study of the building shell, *the part of the construction that actually interacts with the environment*. The building shell should:

- Keep the *moisture* out
- Let the *solar radiation* in or exclude it, according to building use and energy demands
- Let sufficient *daylight* in the space while avoiding overheating
- Be “heavyweight” or “lightweight” (right amount of *thermal mass*) according to building use and climatic conditions
- Allow for sufficient *natural ventilation* without maximising the thermal losses.
- Offer *sound insulation*



From the above, it is clear that the “perfect building shell” is not something easy to create. The difficulty is mainly in that *the environmental performance of a building is a complex, dynamic situation, directly related to time and the continuously changing environmental conditions*.

Interdisciplinarity

Another issue that relates to the complexity of environmental design of buildings is the fact that many *different disciplines are involved in the design process*. Architects can not face environmental design alone. They are the ones to handle primary issues of the design, like planning layout, orientation of building facades and openings, sizing mass and voids, integration with the environment, use of passive systems etc. In other words, architects should have been taught how to work with sun, wind, light and sound, taking advantage of the benefits these elements have to offer, and how to handle the climatic data. But at the same time, they must also have basic knowledge about efficient building services, statics, renewable resources, and sustainability in general so that they can successfully communicate with and manage the design team, which, apart from architects, may be composed of structural engineers, mechanical engineers, landscape architects, environmentalists etc. Today it is evident that *successful environmental design of buildings presupposes the effective collaboration of all disciplines involved*.

Simulation Software

As far as the *design tools* for environmental design are concerned, many hand calculation techniques have been written in the past in order to describe the physical phenomena involved. But, due to the complexity of the whole situation, it is almost impossible for a practitioner or researcher to actually work with them and come up with a design that meets all the requirements. This is where simulation software comes to fill the gap.

The development of simulation software concerning building physics has started early, following the advancements in computer technology. Today it can be said that simulation software can face the above mentioned complex physical phenomena at a satisfactory level. In particular, current simulation software allows researchers and practitioners:

- to investigate and visualise the behaviour of the building shell by means of three dimensional images, graphs, diagrams etc that enable them to experience the relationship between different designs and results
- to evaluate the interaction between the different components which make up the environmental performance of a building shell (e.g. a good design for daylighting is also good for avoiding overheating?)
- to easily manipulate the model by speeding up time (e.g. when studying solar shading), by making quick changes at the design of the shell or by concentrating on a specific aspect alone (e.g. air flow) if desired.

Having stated that sound environmental design is based on the effective collaboration of different disciplines, it can be said that simulation software should also try to bring closer the different research areas, so that in future the whole design team could work with one design tool alone.

It is a fact that much more has to be done in order to reach the point where computer software will be capable of perfectly simulating the complex physical phenomena involved in environmental design of buildings. It should be emphasised that *valid simulation outcomes presuppose good theoretical knowledge of the processes involved*, a fact that makes the teaching of building physics to young scientists so critical.

Which is the role of simulation software in the teaching and learning of environmental design?

Today there is a large variety of software concerning building environmental modelling. At the moment it is not widely used in architectural education but as time goes by it is more and more appreciated as a successful teaching approach. Environmental simulations enhance motivation, have better transfer of learning and are more efficient. The pedagogic advantages offered are of great importance and promise an advanced level of the teaching and learning in environmental design.

Apart from the above mentioned advantages of simulation software, *the greatest contribution concerning Education is the development of thermal intuition to students*. Just as producing physical models is important to checking spatial intuition, creating

thermal models is crucial to checking that the complex interactions of the building's thermal physics have been correctly understood. In this way students can start, little by little, to understand what, for example, the increase in glass area means for thermal losses and what for daylighting is, without having to use dull hand calculation techniques. The development of thermal intuition in combination with the three-dimensional images, the colourful graphs, the ability to study the interaction between many different components, to make quick changes to the model etc. promise the development of new types of teaching material, which will enhance the process of teaching and learning in environmental design.

Giovanna Franco

“Eco”-construction Pedagogy Facing the Built Environment

*Università degli Studi di Genova,
Italy*

Introduction

The paper assumes as starting point the very well prepared document to organise the workshop that focuses on some crucial points of our contemporary culture, that influence the way of teaching too.

The importance of “disciplines” in the history of science has already been established since XIX century: the discipline delimitates a domain of competences, without which the knowledge would become “intangible” and, on the other side, it constructs the objects of the scientific study.

Anyway the institution of disciplines involves the risk of hyper-specialisation of the researchers and, consequently, the domain of the disciplines could be perceived as a self-sufficient object.

The “openness” is therefore necessary. It happened, in fact, that an outside look, extraneous to the discipline, could solve a problem where solution was invisible inside the discipline itself.

The recent history of sciences is also the history of the break of the disciplinal borders, of the circulation of concepts, of the forming of hybrid disciplines destined to become autonomous, or complex in which different disciplines are aggregated.

Focusing the attention on the theme of the workshop, architecture represents one of the domains in which interdisciplinarity represents a fundamental requirement, where (following the thought of Blaise Pascal) it is not possible to know (or to understand) single parts without knowing the whole.

Nevertheless, our contemporary condition is characterised by: multiple information, velocity and acceleration (of ideas, cultural processes...), uncertainty/precariousness (it is more safe to be protected inside the field of disciplines) and, as a consequence, weakening of the sense or responsibility (that means also the following of specialized duties).

Main questions that directly rise from this scenario are:

- Which competences have to be acquired?
- How to acquire them in the academic curriculum?
- What use of these competences in the architectural and environmental project (to better dialogue with experts)?

These questions are, more or less, also strong inside the “Tuning project”, one of the main topics of the activity of the Association. In fact, the best answer that we could imagine, has to be expressed in terms of a set of competences, as:

- a) The ability to develop a pertinent knowledge: it is in fact necessary to substitute a way of thinking that separates and divides (reductionism) with a way of thinking that distinguishes and connects (holism) and, in other words, it is necessary to recognize and understand the risk of mistakes and illusions (a very common risk that could be hidden inside the concept of “discipline”).
- b) The capacity to develop a project finalised to the optimization of a result (and not to a maximization of an aspect (that often means the prevarication of a system over the others, as happened in our contemporary culture with the hyper technicality and the myth of progress). On the other hand, the design process, because of its innovative character, implies the risk of the choice and it is therefore necessary

to recognise and to face, in every innovative design process, the possibility of risks and the risk of possibilities.

- c) The ability to elaborate a strategy that takes in account the complexity of specific purposes and their implications on systems and sub-systems (following the theory of systems that characterises the contemporary science).
- d) The capacity to “contextualize” the choices (in terms of “ecology”, that means to have in mind that each design process involves specific cases, decisions, relations, risks and unexpected events).

Didactic Examples

The teaching examples presented during the workshop regard the recent experience carried out with the students of the annual “Laboratory of construction of architecture” (a sort of workshop) within the undergraduate course of Architectural Restoration, in the School of Architecture of Genoa. The Laboratory is settled at the second year (10 credits). The same approach, with different contexts, also characterises the teaching method inside the PhD in “Building and environmental renewal” (in which are involved, all together, architects from the Universities of Genoa, Naples and Palermo) and the School of Specialisation in Monumental Architectural Restoration (for degree architects all over Italy, held at the School of Architecture of Genoa).

Main educational objectives of the teaching activity in the Laboratory are: to understand the relations between materials, morphologies, structural principles and ways of connections that characterise different parts of an architectural building; to know built architecture and environment within its physical consistency and related to the whole constructive process; to face an architectural project (from the morphogenesis to the development of building details) merging architectural needs with other requirements linked to the building facility, the duration in time and future deterioration, the possible maintenance and energy saving.

More precisely, general competences to be acquired by the students of the Laboratory are:

- Trans-disciplinary and complex understanding and knowledge, especially regarding the built environment, that is in fact the main field of application of the undergraduate course of Architectural Restoration. In other terms, the teaching attempt is to help the student to understand the main origin and meaning of the word “complexus” that in fact means “what is tissue together”.
- Ability to understand the objects in their complex and as a sum of parts with mutual influences – trying to stimulate the curiosity of students for all is settled in the built environment and especially for reasons, ideas and concepts that are behind forms, signs and in general architecture.
- Capacity to apply a spirit of “synthesis” in the design of new buildings or part of them (that is in fact the most important feature of the design process but, at the same time, the most difficult aspect to be taught because it involves invention, innovation and creativity).

- Ability to develop a design process as General Problems Setting and Solving together with experts, following a circular method named by contemporary scientists as *"attempt and error"* increasing therefore the sense of responsibility of the future architect for each personal choice that raises up from his mental design process. This means, in other words to verify each design choice in terms of future possible consequences on each system and sub-system (as the environment, the duration in time, the expectations of final users, the comfort, the energy consumption...).

The students, within a common theme, are invited to work on a specific and existent object to be recovered and refurbished (a single building, a complex of buildings...) and to develop their personal choices of intervention, also with the help of specialists, trying to face and to solve with a strong architectural "idea" main problems as: morphogenesis of the parts and the whole architecture and "insertion" in a real landscape and territory, possibility to read and to interpret and develop the existing "signs" and marks also developing architectural details, use of new materials and compatibility with the existing ones, structural behaviour and shape of the new parts and compatibility with the whole structural behaviour, knowledge of existing technologies and of phenomena of decay of materials and techniques of intervention, consciousness of the "environmental behaviour" of the new building or of the complex... Following the thinking and the teaching by Edgard Morin, it is not only important the idea of inter- and trans- disciplinarity; furthermore he adds the "eco-disciplinarity" that means the necessity to contextualise the disciplines (in this case construction pedagogy).

As an example, two main objects of the course have been: the design for the "missing tower" of the castle in Saliceto, near Cuneo (low Piedmont) and "the reconstruction of parts" in the medieval complex of the Abbazia of Valle Christi, near Genova. The sites are chosen because contextualisation becomes a preferential field of experimentation.

The Set of Competences

To develop a trans-disciplinary and complex understanding and knowledge of the built environment, traditional architecture is a preferential field, also because it is far from normalization. The effort that is asked to the students is to refine their way of investigation and understanding built architecture as a first step to develop a complex knowledge and to face innovation vs. tradition. As an example, the comprehension of a sub-system (part of the whole building) as the "false vault", typical technique from the Genoese tradition. The false vault, made of a wooden structure, is a genial invention to solve in a very easy, economic and quick way, formal, architectural and constructive problems using a "light technique" that, at the same time, obtains different performances: lightness – rigidity – indeformability – structural resistance – thermal insulation – acoustic insulation – fire resistance – architectural appearance...

As in many parts of traditional architecture, the student is helped to understand the very close relations between materials (wood and reeds) and man work; relations between products (wooden skeleton) and building construction (a sort of prefabrica-

Figure 1
Castle of Saliceto in the actual state. Plan of the second floor. Theme of the didactic experience is the construction of the “missing tower”

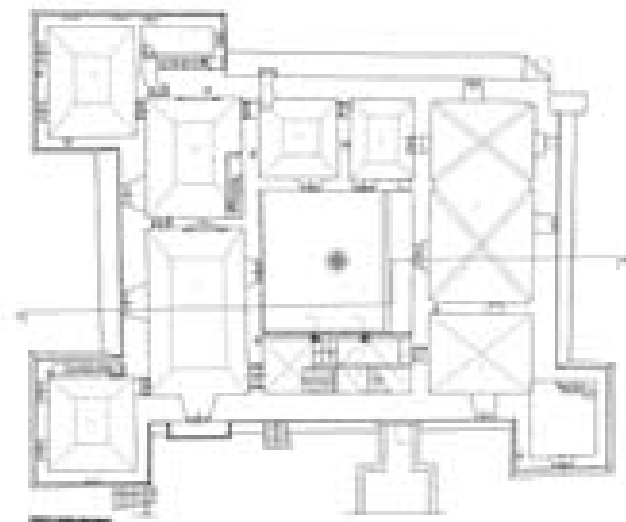


Figure 2
Castle of Saliceto in the actual state. Elevation

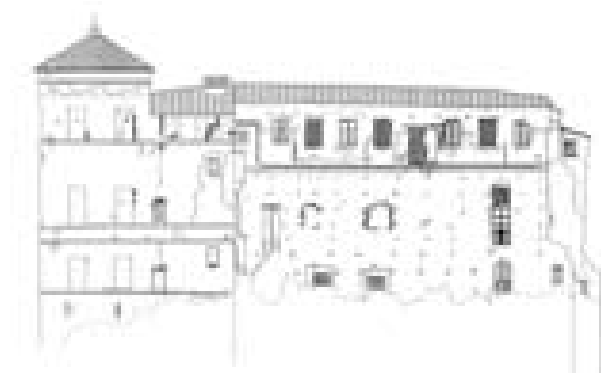
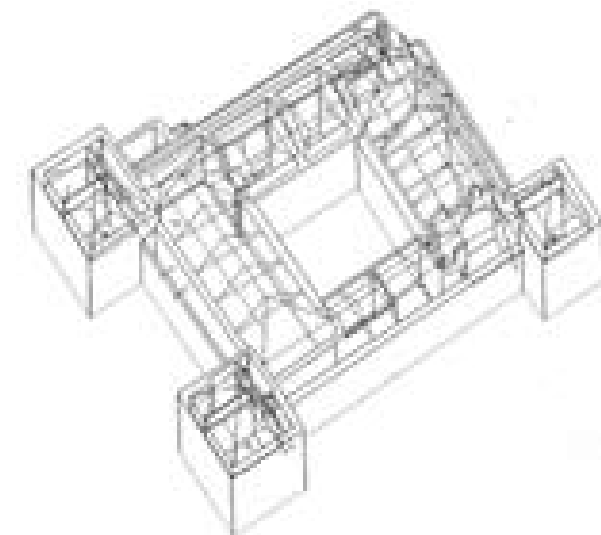


Figure 3
Castle of Saliceto in the actual state. Axonometry



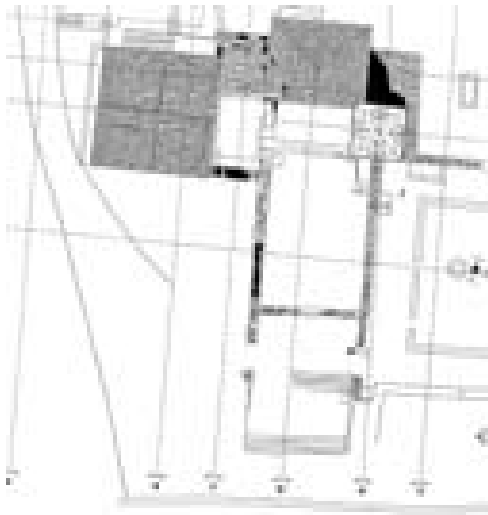


Figure 4
Abbazia of Valle Christi in the actual state. Plan. Theme of the didactic experience is the reconstruction of parts of the existing buildings (roofs and floors)



Figure 5
Abbazia of Valle Christi in the actual state. Elevation



Figure 6
The appearance of the "false vault" of Santa Maria delle Grazie (Genoa)



Figure 7
The consistency of the "false vault" of Santa Maria delle Grazie (Genoa)

Figure 8
 Abbazia of Valle Christi, proposal of
 the students for new inner floors

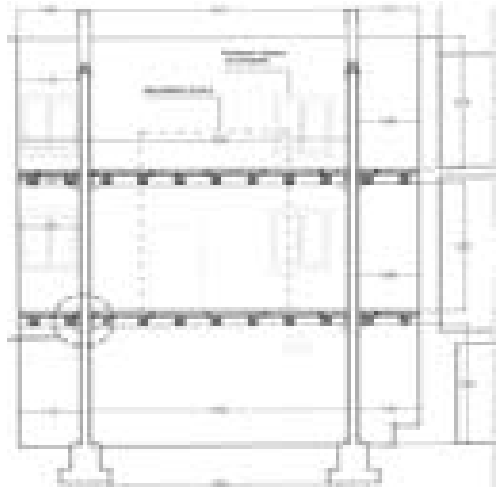


Figure 9
 Abbazia of Valle Christi, proposal of
 the students for new inner floors.
 Details

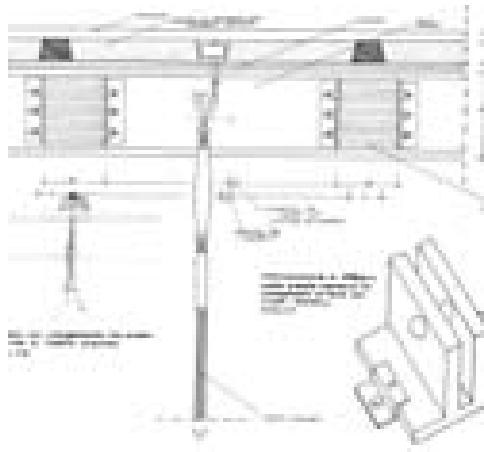
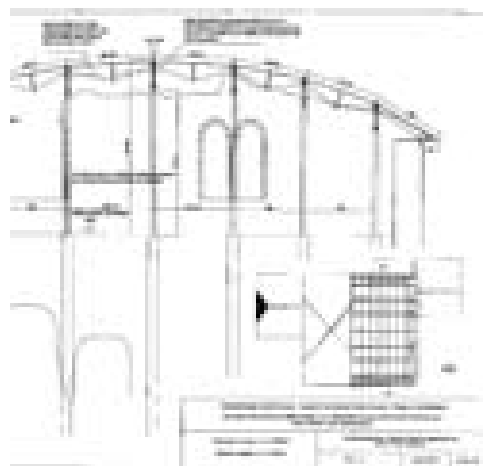


Figure 10
 Medieval building near Genoa. Pro-
 posal of the students for a new glaz-
 ing covering



tion “ante litteram”); relations between building techniques and the environment (indoor comfort, acoustic insulation, easy maintenance...). As a first step, the students are asked to analyse the site and the object of the new design in a such way like the described one, to capture also the ideas and the concepts hidden behind simple signs.

To acquire specific competences, more related to the ability to face the built environment, the design process is carried on continuously verifying ideas and their consequences (mutual actions) on sub-systems, that means, in other words, to essay an “eco- construction” pedagogy.

Specifically, in relation to the assigned item (that could be the reconstruction of a missing part, as a roof, or a staircase, or a tower and so on), the students are asked to develop preliminary ideas (first of all morphogenesis) and to immediately verify their consistency in relation to:

- Materials (traditional and innovative) they want to use and structural conceptions (*new facing existing architecture*)
- Industrial products and building market (*research on new materials, their possibility, their performances and, again, the relation between tradition and innovation*)
- Building techniques and connections between parts and elements (*that means to deepen the language of detail, the significance of signs*)
- Connection between new buildings and existing one/s (*language, morphology, structural behaviour especially in the joints between old and new*)
- Relation between building/s and environment (*indoor comfort – use of renewable sources – energy saving, especially related to the new parts*)
- Tools to evaluate environmental quality of the building
- Inclination to a future decay and maintenance strategy of parts and the whole building.

As the students are in the second year of their curriculum, it is almost impossible to cover all the requested items without the help of experts: the dialogue with them (most of whom belong to the School of Architecture) is at the same time useful for the specific contents and - moreover – for the curiosity they are able to stimulate in the students and for the possibility to solve specific problems all together around a table.

Depending on the item and the object of work, it has been already tested the interdisciplinary dialogue with:

- Structural engineer (to face the need of safety of the new and the existing building)
- Specialist in restoration of monuments (to increase the need of conservation of existing architecture instead of an unnecessary demolition or heavy transformation)
- Expert in archaeology and stratigraphy (*to better understand the scientific method to investigate the chronology of an ancient building and, at the same time, to understand the significance of signs – for example left by hand tools on ancient stones*)

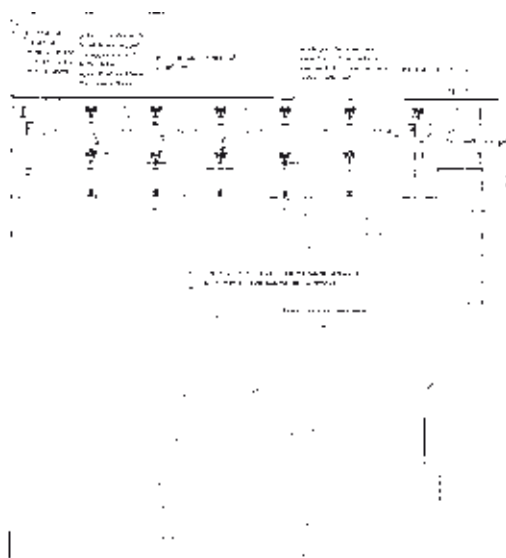


Figure 11
Medieval building near Genoa. Elevation showing the structural conception chosen for the new roof.

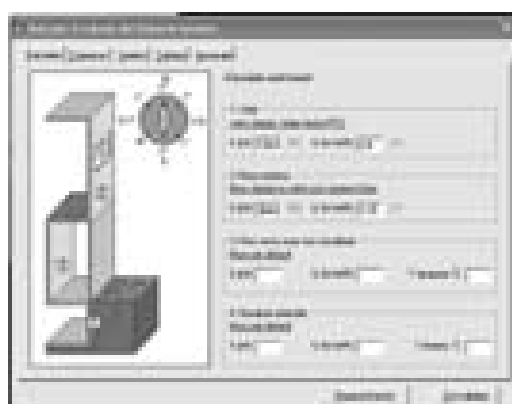


Figure 12
EPIQR software, developed within an European project, offers a user-friendly tool to simulate thermal behaviour of existing buildings and potential refurbishment, especially in terms of energy saving. The figure shows input data for energy balance heating calculation.

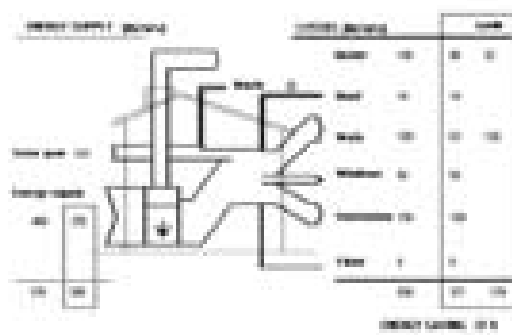


Figure 13
EPIQR software, energy balance heating calculation shows the potential of some refurbishment actions (in the frame the effect of new insulation on the façade).

- Urban planner (*to emphasise, also in a small design, the need of urban/landscape identity and the contextualisation of new concepts*)
- Expert in technology of materials (*to better control the compatibility between old and new materials and the infinite possibility offered by chemical research*)
- Expert in technical equipment (*especially regarding thermal and acoustic comfort*)
- Expert in sustainable architecture (*energy saving – environmental quality – renewable sources*)

When possible, as a final approach and not a first one, students are encouraged to use specific thermal software as a user-friendly tool to be able to visualise energy performance simulation of their works and to improve energy saving changing technical features (especially on the architectural envelope, on materials and sustainable equipments).

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Frazer Hay

**Systems to Recycle Buildings
and the Interdisciplinary Nature
of Interior Architecture**

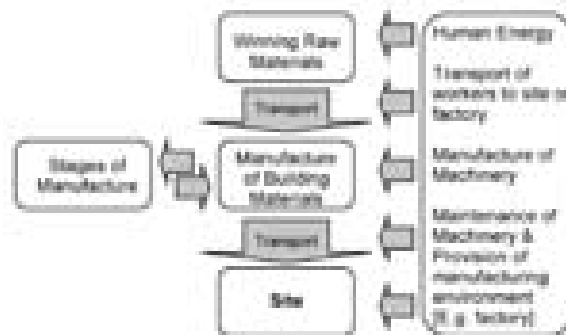
*Napier School of Interior Architecture,
Edinburgh,
Scotland*

The intention of this paper is to highlight the environmental merits of recycling buildings, to present methods [or systems] developed to tackle this form of environmentally sensitive construction and to discuss the potential advantages of an interdisciplinary design and construction Pedagogy.

With attentions focusing on the environmental aspects of Architecture and design, aspects such as sustainability, smart buildings and buildings built as energy generators, it is easy to overlook the environmental merits in re-using the structures that already exist. By re-using existing structures the architect saves energy and resources by re-engaging with a buildings embodied energy.

As you can see from the diagram below, the embodied or invested energy relates chiefly to the process and materials used in a buildings original construction. Therefore re-using an existing structure would also logically mean reprocessing the initial energy invested. This environmental attitude of re-using buildings is beneficial in many ways, from capitalising on the energy and materials initially invested, to reducing waist due to construction and demolition. The building industry in the UK alone is currently responsible for 70 million tonnes of construction and demolition waste every year and most of it is sent to landfill.

When added to an architectural list of alternative solutions in regards to environmentally sensitive design. Recycling buildings could assist in alleviating the growing pressure on the environment due to construction and help to inspire an increasingly frustrated profession to new levels of innovation and ingenuity.



"An air of doom hangs around the subject of the global environment. Fossil fuels and raw materials are running out, the greenhouse effect is causing climatic change – even if nobody is quite sure how or to what extent – and numerous creatures face extinction. It is universally clear that we cannot go on consuming our world the way we are doing. So how can we frame measures to ensure that on one hand the environment is spared- or at least less severely restrained – and on the other hand we can rely on continued economic growth?"

The environment is a significant political issue in the Netherlands, as it is in neighbouring countries such as Germany. A number of the measures that have taken to lighten

the environmental burden related to the built environment. This is hardly surprising, since as much as fifty percent of energy consumption is due to buildings. In the Netherlands, these measures are covered by the term 'duurzaam bouwen' – literally durable buildings – which places a greater emphasis on buildings that are long-lasting as well as environmentally-friendly"

[Ed Melet Sustainable Architecture ISBN: 90-5662-118-1]

An environmentally friendly alternative therefore to building new sustainable /durable buildings is to recycle the buildings we already have. Recycling buildings can be an exciting dynamic way to breathe new life into our tired and strained cities. New-build construction consumes enormous amounts of energy and resources in comparison to recycling original structures, which although labour intensive is not capital expensive and in fact attracts financial incentives and tax breaks.

In order to recycle our existing structures successfully, a set of methods or systems need to be adopted to make the most of this architectural approach to sustainable building.

These systems depend on the architect's analytical ability with which to make sense of the host building's structural, historical and contextual information. This information is a lot like human DNA in that it dictates character, build and physical ability. It is this ability to decode a building's makeup which underpins the architect's choice of system from which to recycle an existing structure successfully. It is therefore essential that architects and designers learn the skills require to analyse and explore structural DNA as soon as possible. Uncovering the DNA can prove complicated, so it is split into 4 key analytical strands; the composition and form of the host building, the historical and functional factors, the buildings context and environment and finally the building's future function.

In order to understand the DNA clearer, students are encouraged initially, to analyse the building's structure [analytical strand 1] by modelling them three dimensionally [Using the latest MicroStation CAD Package] and physically [Using the traditional methods [such as card and timber] in conjunction with the latest "Rapid prototyping" machinery], exploring:

- Exterior and interior dimensions
- Column grid spacing, floor and ceiling heights
- Location and dimensions of exterior and interior openings
- Location of interior bearing and non-bearing partitions
- Composition of structural frame, floor, ceiling and roof systems
- Composition of exterior walls and interior partitions
- Survey of vertical transportation systems
- Survey of capacity of floors & roof
- Orientation



Image 1

Student's presentation 'Board One' highlighting the structural, contextual and environmental aspects of the project's host building.

2nd Year Student Project by Graeme Dunn Napier University, Edinburgh Scotland

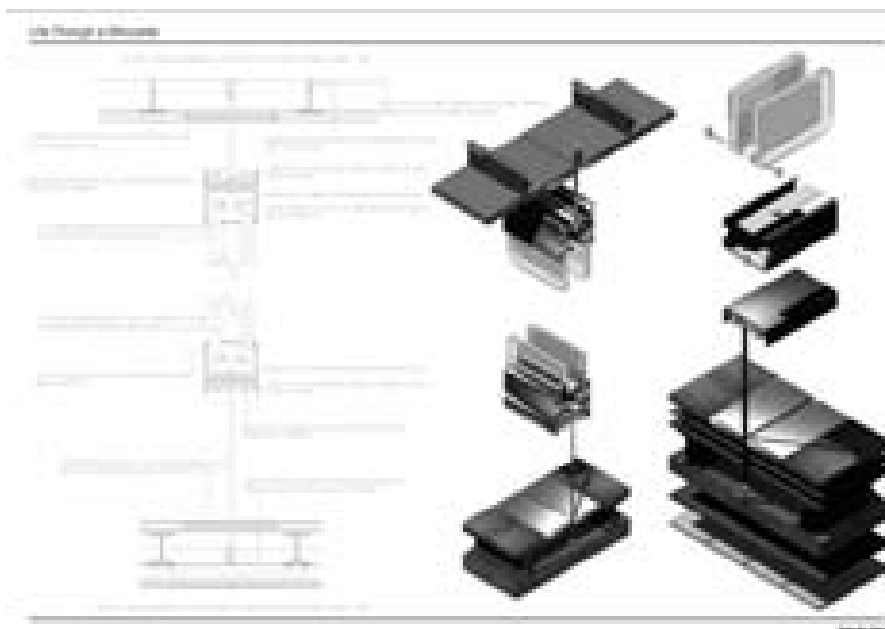


Image 2

Student's presentation Board highlighting the detailed aspects of the project's host building

3rd Year Student Project by Deborah Allan Napier University, Edinburgh Scotland

The historical and functional factors [analytical strand 2] are often overlooked, however it is these factors that directly contribute to the building's initial design and use. Exploration of the materials, and construction techniques used can determine the approach regarding the redesign, whilst remaining sympathetic to the existing architecture. Material and construction methods are only part of this analytical strand. Equally important to considering the host building's past is to understand how the building functioned with regard to the circulation, services and spatial hierarchy which are also woven within the fabric of the analytical strand 2.

The structure's context and environment [analytical strand 3] play a key role in the building's makeup and continues to play a major part when creating a new design solution for a building's re-use. Considering and questioning the relationship established with neighbouring structures, public spaces, the natural elements and landscape help establish a clearer representation of the structure to be recycled. How does the structure engage with the street, the city and the areas demographic? How has the site and its orientation influenced the original design?

The future function intended for the host building [analytical strand 4] has an enormous impact on the redesign. Programmatic requirements of a new function require exploration to ensure compatibility.

Once the DNA is understood the correct architectural system can be applied. There are three architectural systems; Installation, Intervention and Insertion.

The Installation System:



Image 3



Image 4



Image 5

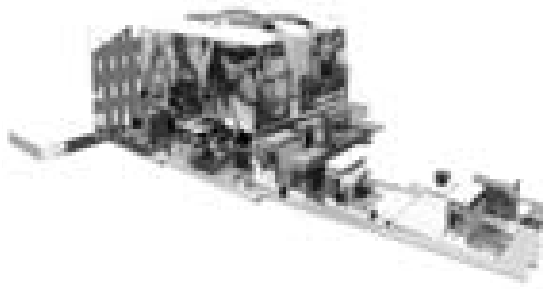
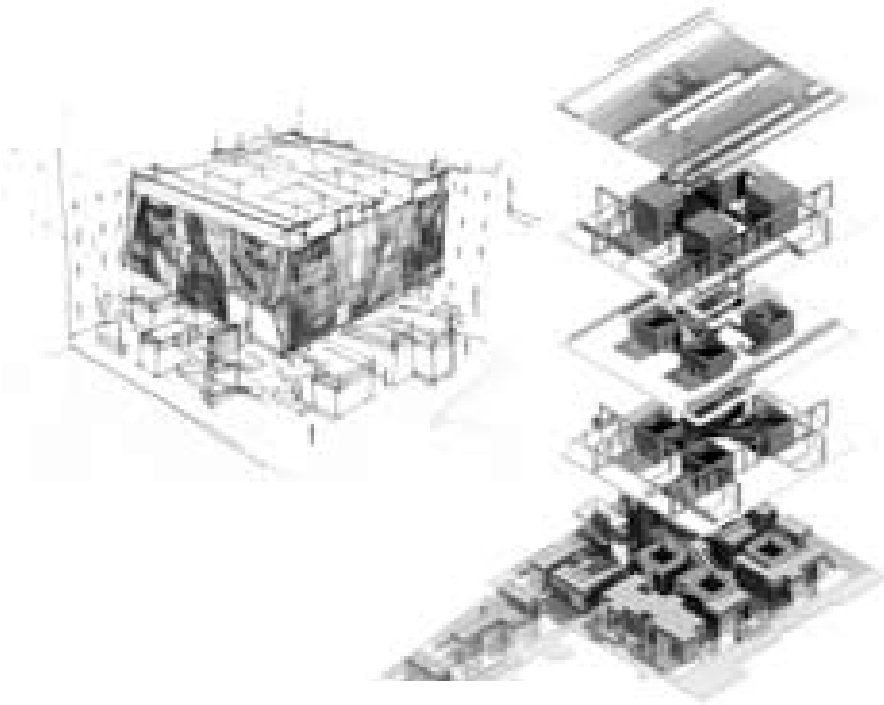
The above project, "The Archbishopric Museum of Hamar" by "Svere Fehn" shows an example of "installation", in which the old and the new exist independently. The new elements are placed within the boundaries of the building. The design or the grouping of these elements may be influenced by the existing, but the fit is not exact and should the elements be removed then the building would revert to its original state. Below is an example of a final year student's work. The Old Post Office on Edinburgh's Princess Street has been redesigned to house a market space that nestles beneath a key high street store. These new elements sit within the host building however the new and the old exist independently.



Image 6



Image 7



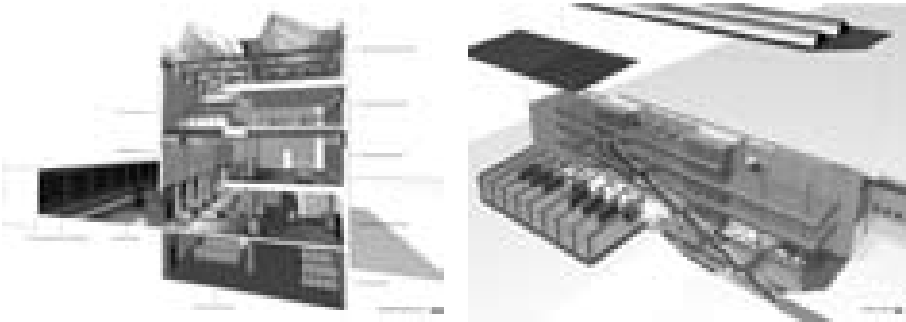
Images 8, 9 & 10
Final Year Student Project "The Old Post Office on Edinburgh's Princess Street" Francesca Appolinari Napier University, Edinburgh Scotland.

The Intervention System:



Images 11-15

The above project is “Richard Murphy’s Fruit market Gallery”. If the existing building is so transformed that it can no longer viably exist independently and the nature of the remodelling is such that the old and new are completely intertwined, then the style is “Intervention”. Below is an example of a final year student’s work. A warehouse on Brick Lane London has been redesign to accommodate a white goods recycling industry. The student has intertwined the new architectural elements within the fabric of the existing structure manipulating light and circulation.



Images 16 & 17

Final Year Student Project “White goods warehouse, Brick Lane London” Jacob Fintch, Napier University, Edinburgh Scotland.

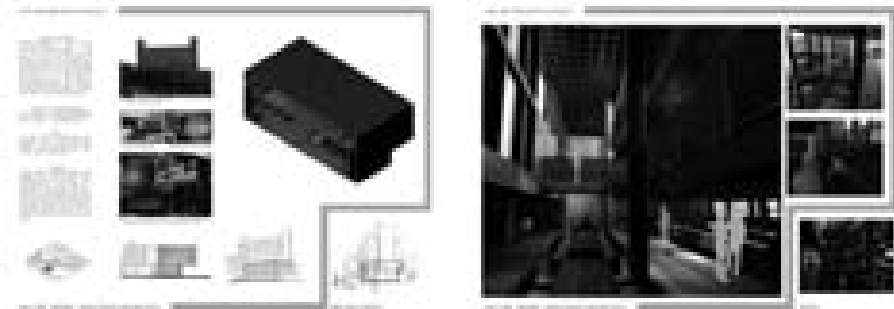
The Insertion System:



Images 18-22

The above project is “Aparicio & Fernandez’s Architectural Documentation Centre” in Madrid. The final classification is that of a new autonomous element, the dimensions of which are completely dictated by those of the existing, that is, it is built to fit, is placed within the confines of the existing, then the system is “Insertion”. Below is

an example of a second year student’s work. No 6 Bristo Square has been redesigned to provide the area with a restaurant and bar that reflects the demographic within the local area.



Images 23 & 24
2nd Year Student Project “No 6 Bristo Square, Edinburgh”, Napier University, Edinburgh Scotland.

The student has inserted a sleeve of timber within the existing structure which holds the new design, whilst creating an interesting tension between new and old materials and structure. The timber sleeve also serves to discretely facilitate all services required.

To implement these systems in new and contemporary ways the architect / designer must collaborate with a growing number of professionals out with the regular realms of architecture.

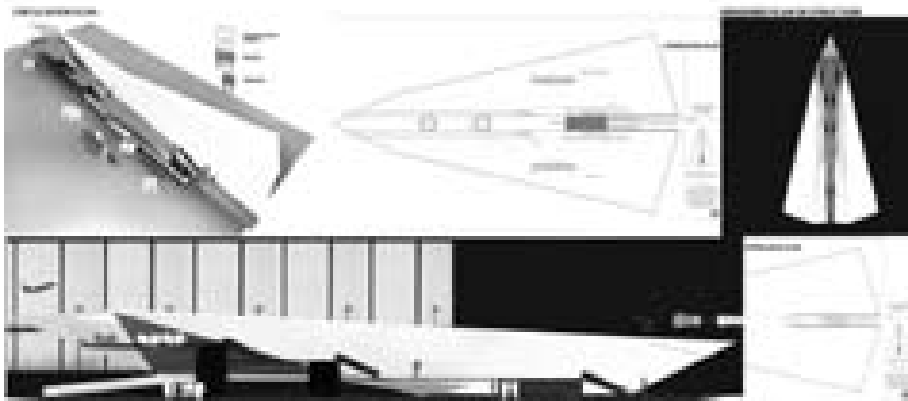
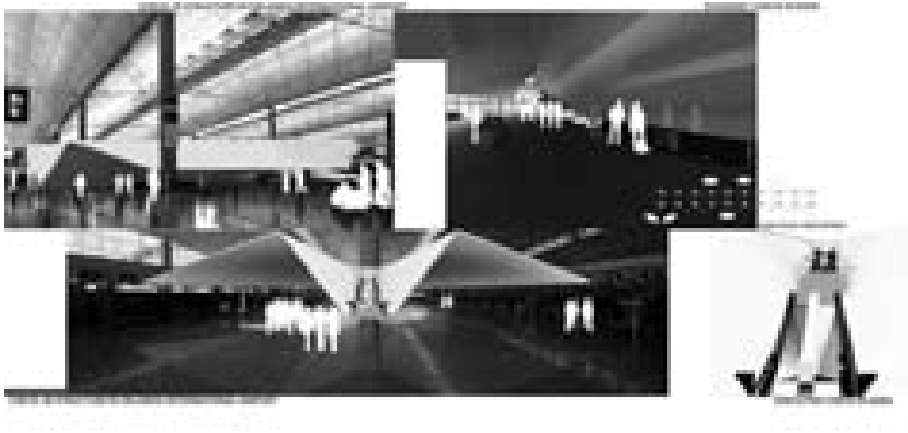
“The Interior Architecture Programme at Napier University promotes this new interdisciplinary reality and prepares its students to be active, good partners, efficient and productive members of a design team that strives for innovation in architectural form and construction”

1st Year	2nd Year	3rd Year	Final Year
All students complete Year 1 with "Int. Architectural Students" "Consumer Product Designers" and "Design Futures" students Collaborating to create design briefs in a new and contemporary manner	Programme Specific (Int. Architecture)		

The Interior Architecture Programme at Napier University is Unique in the UK in that its first year students are completely integrated with the Consumer Product Design and Design Futures Students. This multidisciplinary group of student work together sharing and learning, design skills, presentation techniques, research techniques, tectonics and technology. This integration of design and architectural students also

promotes an interdisciplinary communication and understanding valuable in later professional practice.

Once in their second, third and final year, the Interior Architectural students are comprehensively educated in the skills and techniques needed to create contemporary Architectural solutions that respect the integrity of the host building whilst optimising its potential. Skills and techniques that include: lighting, tectonics, material exploration, 3d dimensional modelling, animation and interdisciplinary communications.



Images 25 & 26

3rd Year Student Project "Virgin Atlantic D&AD Competition Winner" Rory Apap Brown, Napier University, Edinburgh Scotland.

This combination of Interdisciplinary communication and interaction exposes the architectural students to new materials, philosophies and practices. The students are encouraged to utilize production techniques and construction methods to further their exploration of their architectural systems to recycle buildings.

The above examples hopefully show how our construction pedagogy is starting to equip students not only with the skills to manipulate existing structures but also to create eager professionals that are easily integrated into the Interdisciplinary culture of contemporary Architecture today and in the future.

Luca Maria Francesco Fabris

**Design as an Interdisciplinary Field:
Teaching Environmental Design
to Future Landscapers**

*Politecnico di Milano,
Italy*

Preamble

Environmental Design (in Italian 'Progettazione Ambientale') is an academic multidisciplinary subject explaining how to relate projects with the reality of the interior habitat, the settlements, the open spaces, and the wide territory. This means that Environmental Design is taught in different approaches and several points of view at students attending at Industrial Design, Planning and Architecture studies. So, it happens very often between Environmental Design teachers to ask each other: 'What do you mean for it?' as even if we talk the same language we speak different dialects. The proxemics interest of Industrial Design for furniture and industrial components and mechanics is very far from the territorial question of ecological and sustainability researched by planners.

However the peculiarity of the subject consists in its actually real connection to the 'world-we-live-in'. And it counts on a wide source of literature in theory and analysis. In Italy several scientists and researchers, between them I want to remind Tomás Maldonado (who first invented the course of 'Progettazione Ambientale') and Maria Bottero pioneers of this discipline at Milan Polytechnic, in the last 30 years have created an interesting literature on this subject that, as Maldonado writes in his 'The planning hope' ('La speranza progettuale', 1970), talks about 'environment and society'. This makes Environmental Design a subject very flexible and contemporary.

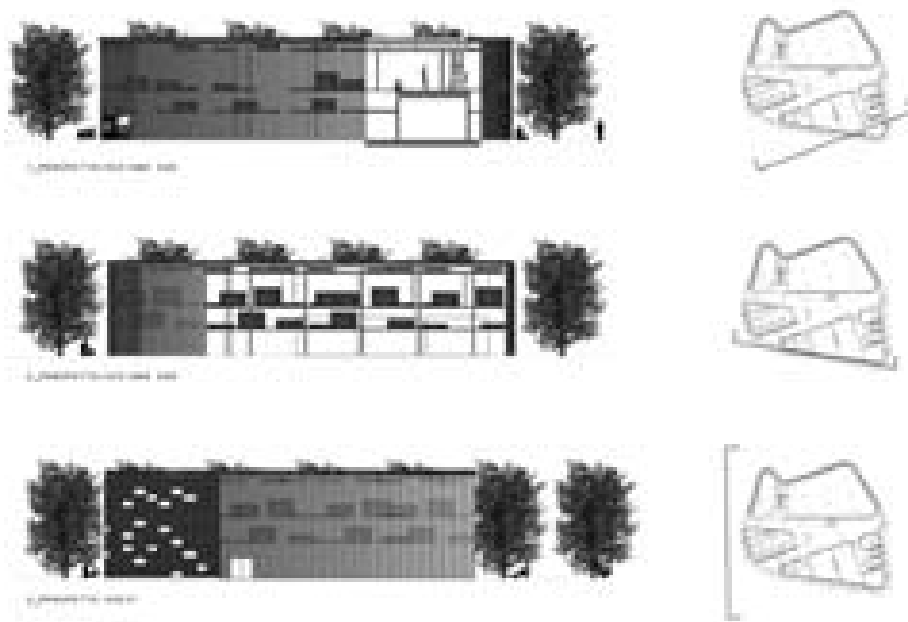
Environmental Design, in our Schools of Architecture, is linked to the subject area of Technology of Architecture and stimulates students to find friendly solutions with sustainable matters, materials and low-impact use of resources and territory.



Towards Landscape Architecture

Landscape Architecture as a School in Italy is making its first steps. It's only a few years that we have some PhD and Specialisation Courses on it and, after the opening of the 3+2 carriers, only very few Schools of Architecture have organised post-graduate courses (Laurea Magistrale, in Italian) for people that want to become landscaper. It's really a picture in motion. The 1st Faculty of Architecture of the Milan Polytechnic started a Bachelor course in Environmental Architecture in 2000, and since two years now it's opened an oriented course for students interested in Landscape Architecture inside the post-graduate Laurea Magistrale in Architecture, where I teach Environmental Design.

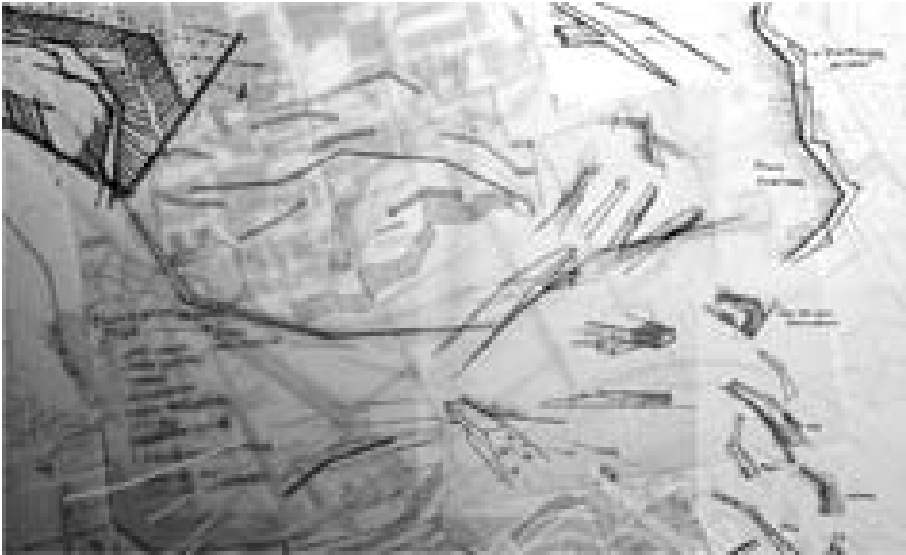
The idea is to upgrade this oriented carrier in a real post-graduate Landscape Architecture course in the next years as we see an increasing number of students, not only from our Athenaeum, but also from the rest of Italy and other countries. In fact, starting from this year our Landscape Architecture oriented courses are offered also in English, to comply with the internationalisation success obtained by the Faculty of Architecture and Society (that's the 1st Faculty of Architecture of the Milan Polytechnic).



Technology - Construction

As shown during the various presentation at the workshop, in several Schools of Architecture the Construction subject is shared by architects and engineers, sometimes this creates for students the difficulty to put together technologies and materials with the

structural elements and their relation with natural forces. These fractures get wider when teachers, even referring to the same student project, don't explain the inner necessary relation between structures, materials and shape of architecture. To avoid this after the last Italian university reform where the 'Laboratorio' as studio-design courses was introduced, where design, technical and structural teachers operate together applying their competences directly to students' practical design work. The introduction of the semester-long courses accelerated the integration between the subjects, but something new was to be searched for the landscape-oriented students. Their necessities are different from architectural students as they'll play a different role inside society's expectations.



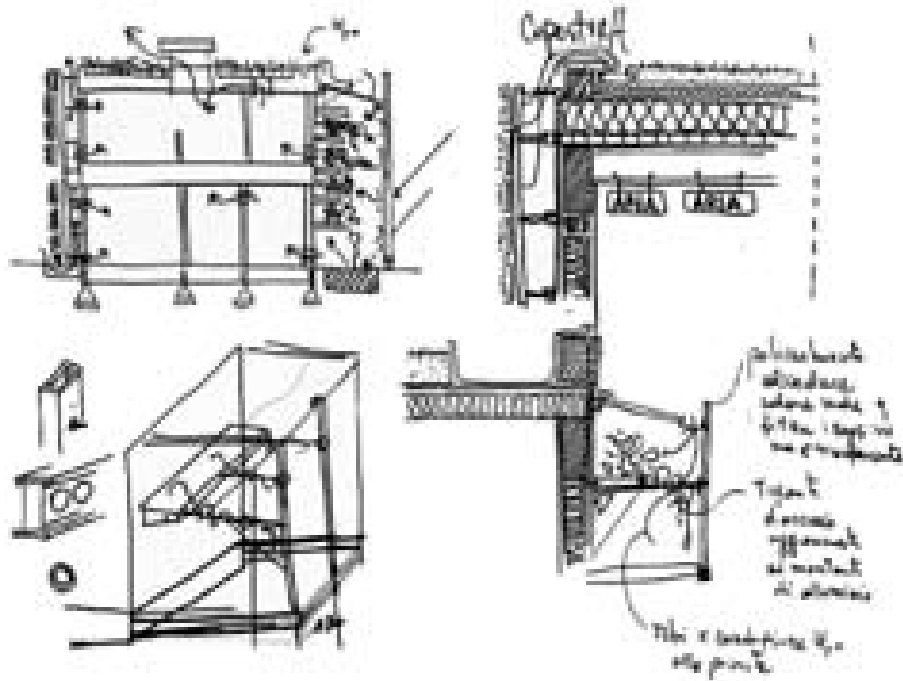
Re-invent

I introduce my course starting from the reading of the Landscape European Convention. This helps students to move from the (specially in Italy) romantic and conservative way to intend landscape to a real and contemporary vision of the subject. As the Convention very clearly explains, landscape is the place where we're living, the habitat we have constructed or changed. And it appears, beautiful or ugly, just as we have transformed it. We have the landscape we deserve: neither more nor less than this.

So, we have to remember that landscape (all the kinds of landscapes) and construction (all the kind of construction) get together in a continuum that we call environment. It's a really strong relation that imposes to plan, design and share knowledge and ideas about all those components both natural and artificial we connect.

Despite I notice that at the workshop I was the only one (surely in my section) to talk about 'landscape', I felt that most of the lecturers and contributions discussed the environment. In fact I could say that the subliminal fil-rouge connecting all the presentations of this workshop is the search for a new way to teach how to play the

role of natural environment and natural factors into our life and our habitat. From this point of view, it seems we all have talked about finding new relations with landscape via structural or technological factors.



Actually

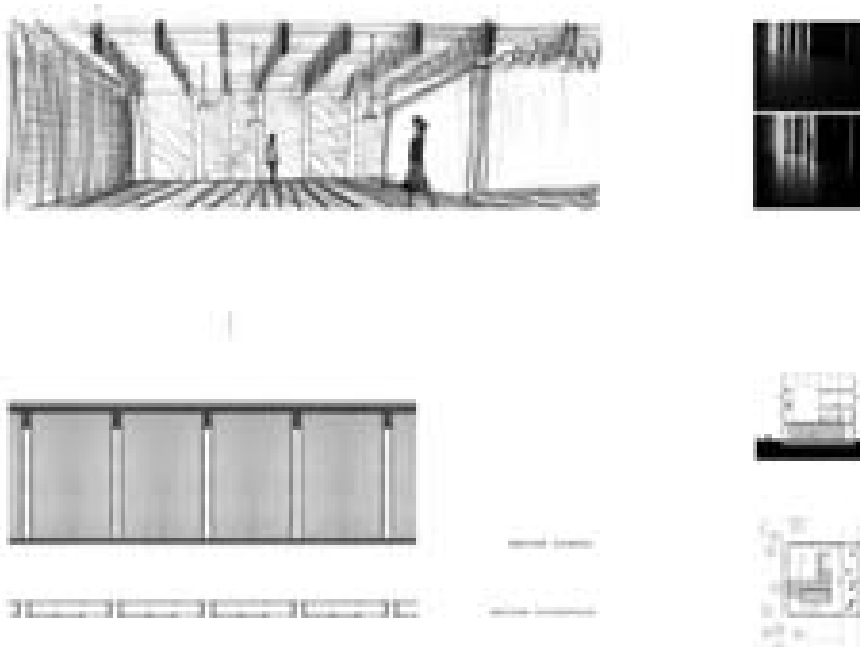
Maybe as I come from a 'students-big-number' University (2 Faculties of Architecture, 1 Faculty of Industrial Design, 6 Faculties of Engineering), very far from the auspicated 'atelier' numbers (my Laboratorio course counts more than 60 students) I feel the necessity to react to this moment of maximum specialisation, technological expansion, and trust in the digital potentialities in the architectural world. Reacting, not rejecting.

Working with students used only to draw with CAD programs it is very hard to try to recuperate the hand drawing for sketches and design. It's a little thing to start again to draw on paper, but it notices students of the great mistake of use the computer as a limited tool, accepting programs routines and interpretation rules as normal condition of working without any invention. Inventions that could come more simple to impose or introduce starting with a sketch and its free variations.

Reacting to the incredible quantity of electronic tools to analyse or find environmental solutions: it seems incredible, but our students very often use them without knowing (or having forgot) the theories or the meaning of these applications. They are poor users, not curious students, and it's a real pity. In my opinion we need to increase their curiosity also on fields of non-architectural culture and knowledge.

For landscapers interdisciplinarity means to design the built environment together with engineers, physic technicians, agronomists, naturalists, etc., but also from humanistic subjects related professionals and researchers to understand them and to be used to talk and interact with them too. It's something we teachers should have clear.

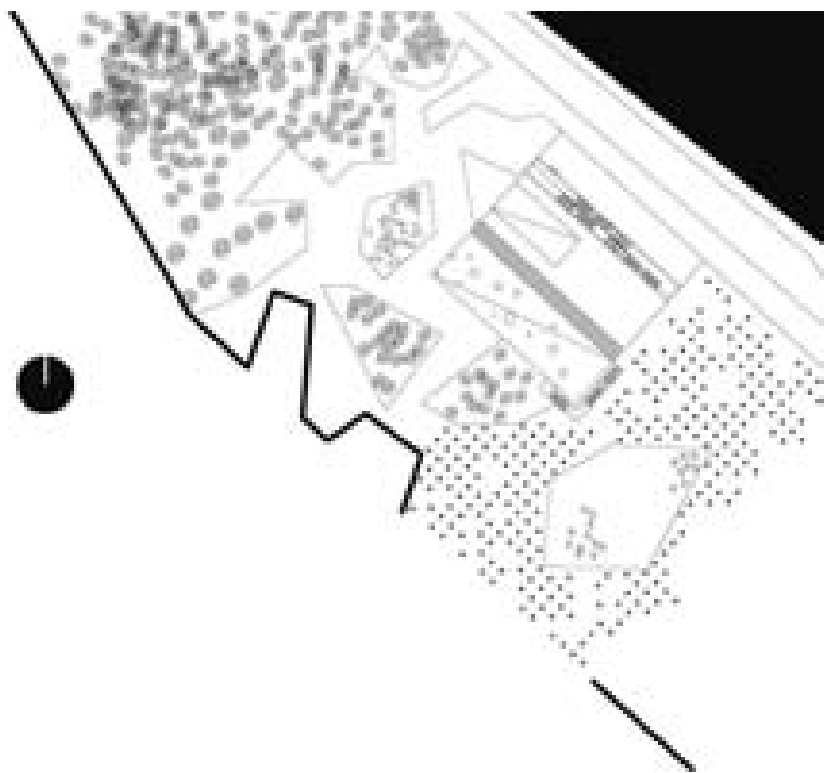
This could be a way to let ideas from pure concepts evolve in real transdisciplinarity having as final target the 'fine' relation with the environment.



Next thing

Last, a consideration about the workshop and its intriguing feed-back. Despite the workshop title and the differences in the thematic of contributions, one of the most interesting things I noticed was the necessity of new words to express notions and concepts. Something occurred to me (and most part of Italian teachers) talking about landscape. Very often the Italian noun 'paesaggio' is really un-appropriated to describe the contemporary meaning of landscape. I like to think in the near future there will be someone who acts as 'enviromscaper'. For sure we have to work a lot searching to create a new vocabulary, just to understand one each other without misunderstandings.

To me people, architecture, country and landscape are just separated elements of a whole. We can't separate them. The actual word global situation asks for this, we can't be blind and deaf to this. All aspects of design change if we take count of this, the next thing. We have to find a name for it.



Discussion on the Presentations of Theme 2

Chairs:

Ulf Janson

Michael Fedeski

Michael Fedeski, Cardiff, UNITED KINGDOM

As planned, we will begin with a brief summing up of what has been said in our respective sessions. I chaired the presentations in Room 2, so I will start with those. One of the things I thought was interesting was that all the speakers were teaching across disciplines: engineering to architects, architecture to engineers, environmental design to architects and environmental design to engineers. This indicates in itself the need for one group of professionals to have access to the knowledge of another group of professionals. There was a theme that kept reoccurring in the speeches, the idea of the polymath, really, or, as one speaker put it, the holistic view of the designer, who has personal knowledge of a number of different disciplines. Another theme that emerged was the tendency towards wanting to celebrate differences. To put these two together, one could say that there was a theme of integration and there was a theme of dispersion, and with the theme of dispersion came the theme of working together in an interdisciplinary fashion.

Another thing I thought interesting was a project one of the speakers mentioned in which the students were working together in an interdisciplinary way. This was part of a phase in the teaching programme in which a number of different disciplines, although not entirely divergent disciplines, within the school came together to work on a joint project.

Of course there were many more things, but I think that those were the main relevant themes that I would like to bring up at this point.

Ulf Janson, Goteborg, SWEDEN

I will start by pointing out that the primary duty of architecture is and has always been to provide shelter – shelter from the climate, but also shelter for our belongings and our privacy. The duty of architecture is also to provide the possibility for a good life, good quality of life. Nowadays we are increasingly aware that we have to look at this with an eye to sustainability; but I want to ask, is sustainability enough?

Tom Jefferies presented a student project aimed at testing a building system that was provided by a UK supplier, aimed at constructing 100% perfect building. He indicated that the building fulfilled all the regulations while remaining within the financial restrictions, but he ended his presentation by raising the question of its architectural quality. Because he raised this question but did not answer it, I would like to hear his reflections on it.

Thomas Jefferies, Manchester, UNITED KINGDOM

The project was called “The 100% Perfect House” and the objective was to test current advisory guidelines in the UK set up by government approved panels to assist in the design of housing for the mass market. I think the interesting issue is where you take your position on quality from. Assuming that the main duty of architecture is to meet the basic requirements of producing shelter, which a house does, then certainly the 100% House meets and vastly exceeds current standards in terms of renewability, etc., but this raises the issue of what role will design have in the practice. One thing architects are trained to do, as I said before, is to make stuff look good, but also to produce unique, tailored iterations of a programme. The question raised by this project is that if you act along the lines of putting your individual mark on a project,

it actually makes it worse from the point of view of the assessment criteria, which in turn raises an interesting problem in terms of how things are judged, especially in a very rigorously controlled, policy-driven system, as we found to be the case in the UK. My intention really was to raise the question of design standards as specific elements within a programme and to question how far those could be applied. I am not saying that the 100% House is nice. I am not saying that the 100% House is attractive. But I am saying that the 100% House is perfect, and that is a different thing.

Ulf Janson, Goteborg, SWEDEN

Thank you. The presentations in this room, as in the other, were focused on the teaching of sustainability, and everyone agreed that this is an interdisciplinary task; but the question is whether one group can manage all these variations of interdisciplinarity or whether you need to incorporate several groups, and if so by what means? What are the tools for transferring knowledge from one group to another? These are questions I want to put to the floor.

Michael Dickson, Bath, UNITED KINGDOM

My name is Michael Dickson, I am from the University of Bath and I am a practising engineer. I was fascinated by Michael Fedeski's penultimate diagram, because in a way it addresses the very question that Professor Janson just raised. His final diagram showed the engineer, the architect and the constructor all focusing at the job table, and one of the dilemmas we find in practice is that nobody really takes responsibility for the total editing of the final quality and balance of a project. Traditionally that used to be assured through the confidence given to architectural students, and to use the words of Mr. Smithson, the confidence to edit everyone's contributions to make a holistic composition. It really seems to me, not being an architect myself but having worked with a lot of architects, that all your educational processes in many famous schools of architecture have to be directed at giving your students this confidence. Although I would not go so far as to overrule the other contributions shown on Mr. Fedeski's diagram, but to select and have a conversation about how to go about it. In a way, it seems to me that this is really the critical issue of this whole symposium. As far as I can see the first diagram depicted exactly what we need from our sustainable, delightful built environment for the 21st century. Thank you.

Kleio Axarli, Thessaloniki, GREECE

If we think of sustainability only in terms of energy use and energy conservation and not in terms of cultural heritage, because in my view cultural heritage is also a matter for sustainability, then I could suggest, as I suggested already in my short presentation, that the architect must be the leader of an interdisciplinary group, and in this position he should be able to use these various software simulation techniques, which could then be the single common tool that everybody can work with. If they have a common tool then they can solve a wide range of problems, such as energy conservation, adaptation to the environment, all the sustainability problems with regard to the climate and the materials that they can use, the embodied energy of the materials, and with the help of mechanical engineers and service engineers, all of them can work together to solve problems as long as they have a common software simulation tool.

Michael Fedeski, Cardiff, UNITED KINGDOM

I think what you are saying is very interesting, and I agree that environmental software could help bring these areas together in research and practice.

Maria Voyatzaki, Thessaloniki, GREECE

May I ask a question? Out of courtesy I was wandering between the two rooms, so I could not really get a clear idea of all the presentations. I was trying to pick up things, and I am an amateur as far these environmental issues are concerned, so I have a question of clarification regarding the discourse on the environment, and I also have a provocative question. I will try to strike a balance between being naïve and provocative. The clarification has to do with the following: for a number of years now, flicking through things on the environment, I think that a dominant term has been 'envelope', and I noticed when I was going back and forth between the two rooms that mostly people used the word 'skin', as opposed to 'envelope'. Although, as I said, I do not have any special knowledge in this area, nevertheless, I feel that these terms are not innocent – they have a lot of connotations attached to them. An envelope to me is much more technical and technocratic, as opposed to the biological references of the skin. I would like to ask the specialists to clarify this for me. Are we talking about a skin or an envelope? And when you specialists use the word envelope, do you mean something else?

To move to question number two. You may initially think that it is unrelated to the first, but I will try to show that there is a link between them. For many years in our discussions in this meeting, one thing that we keep saying is that we are the unattractive species of teachers who speak to our students about construction per se, whereas we start becoming popular when we talk about construction as a continuation of design. What happens with regard to the question of the environment is, and I will put on the table my view, other views that I have heard and also what I have read from the bibliography, that buildings that have been designed with a priority and an emphasis on their environmental control are, to put it bluntly, ugly. This is not a mean thing to say. In the introduction to his book *Buildings and Projects*, German architect Thomas Herzog (nothing to do with Herzog et De Meuron), who mainly designs buildings that have an emphasis on environmental control, says that even though he has won the Pritzker Prize, he has been criticised for producing forms that repeat themselves – those triangular in section forms – and that the buildings he designs effectively have no identity. He mentions this himself as a criticism that he hears from other people. And even environmental scientists and people who care for the environment, as well discussions I have overheard among you, all seem to support this idea that these buildings are ugly, or at least that they are not handsome. So the connection between my two questions and between terms like skin and envelope, is how within the education process can the question of the environment become attractive to students so that environmental teachers or teachers of construction with an emphasis on the environment do not become yet another unpopular species?

Henry De Weijer, Amsterdam, the NETHERLANDS

I am afraid I will not be able to answer Maria's question at all. When I hear people

talking about the quality of life it looks as if, as Thomas Jefferies said, we are looking for perfection. And then I think, what are we talking about? The quality of life is not something objective at all. On the contrary, it is a very subjective issue, and when dealing with sustainability, with the envelope and the skin, as Maria said, I think that it is completely impossible for anyone to design anything in an objective way. When students put forward an idea I ask them what their arguments are for it and they answer one thing or another, but usually their answers have to do with whether they like it. And I always tell them that liking it is the last thing they need to do; what they must learn is to give arguments. But even if all your arguments have been answered, of course the question remains of what your approach is to the envelope, because the envelope must become your skin, your solution. So the question between the subjective and the objective is a matter of subjective opinion, information, but it is also a matter of balance. No skin should ever be totally subjective. It should also never be a solution that is totally objective. In my opinion it is impossible to design a totally objective, sustainable and environmentally friendly building, but at least there must be a balance in what you strive to look for. Following from that, I think that if you enjoy what you are doing sustainability becomes interesting and can become an interesting design, but if you are designing sustainable structures out of necessity, as one of the things that need to be done, you will never reach anything very interesting.

Michael Fedeski, Cardiff, UNITED KINGDOM

I think in a way that does answer Maria's second question. However, I think that there is a degree of objectivity that one can bring to bear environmentally. A building environmentally designed will respond to its context, and that is a beginning I guess, in the sense that a building designed in its context will be an individual building, and one can be reasonably or to some extent objective about that. So there will be differences between buildings in different places, and especially in different countries, following from environmental design. It definitely does not make for uniformity. But that is not enough, and I think that you are absolutely right in this. It is not just that we do not want it to be enough: it cannot be enough. You cannot solve the problem completely by such an objective route. It needs something more, and we have to ask students to take that dual approach, objective and subjective, on board.

Mario Sassone, Turin, ITALY

As a structural engineer I am interested in the problem that distinguishes the envelope from the skin, because the counterpart is the distinction between structure and skeleton. When we use terms such as 'skin' or 'skeleton' or when you talk about the 'life' of a building or about 'sick' buildings, we are using an organic metaphor. We consider the building as a living organism, and we imagine that this organism lives in the environment. But from the teaching point of view I think that we should use these metaphors in a conscious way, and we should teach our students that when we use these metaphors this is just one way to approach the problem and that there are many other different ways. For example, in buildings made of brick masonry, there is no distinction between the envelope, the skin and the structure. The masonry walls are contemporary skin and structure. So I think that this distinction plays a role in some situations and is not applicable to other situations; it is just one of the

different approaches that we can use to relate to buildings and to teach building construction.

Michael Fedeski, Cardiff, UNITED KINGDOM

I would just like to say something else about skin and envelope. For me the terms are pretty much synonymous, and I use them not to distinguish the skin from the bones, but to distinguish the skin from all other aspects of what I call the building fabric, which is the part that insulates the building and that environmentally at least is very important, because it is the part through which the light and the heat move from the outside to the inside. So you need some kind of term to distinguish them. Skin, I think, is a more recent term and I have feeling that it is favoured by environmentalists exactly because of its biological implication and maybe also because it implies that the modern building skin is reactive in a way that biological skins are.

Lucien Denissen, Antwerp, BELGIUM

I think that there is only one problem with sustainability, and that is that architects have a love-hate relationship with it. Some like to think about sustainability while for others it does not matter at all. If we begin at the teaching stage to try to raise insulation thickness in order to get a better envelope, that is alright, and it is something that everyone can follow and most students would follow; but at the same time we must not forget that a great amount of glass is often used solely because it gives a modern look to some buildings. And at the end everyone needs cooling for buildings, and on a European scale that is a big problem, because cooling takes a lot of energy. And although architects are mostly thinking about shape and design and so on, I think that they focus more on pushing for some kind of legislation, at either state or European Union level, that will put a stop to that kind of waste. I think that is the only solution. I put this forward as something to think about.

Nikolaos Panagiotopoulos, Thessaloniki, GREECE

With regard to the question of why sustainable buildings look so ugly, a question I have often asked myself, all we have to do is consider that there is no passive or sustainable building strategy that was not tried and tested 2000 years ago. Everything we use today derives from some older strategy from the ancients, so all we have to do is just look at traditional architecture and ask ourselves if it is ugly or not and I think that most of us would agree that it is not. Therefore, I think that the problem lies in our attitude and in how we encounter sustainable buildings in modern times. We build machines from which we expect an immediate response to the environment, whereas in traditional architecture we had adapting organisms. That is where we should think the matter over a little more as architects, because certainly, modern sustainable passive energy houses or whatever, if not ugly are at least dull.

Thomas Jefferies, Manchester, UNITED KINGDOM

I think 'ugly' is a pejorative term that actually has no real validity. I mean, if people will buy the Porsche Cayenne because they think they are nice, when they are the ugliest car on the road and use loads of fuel, that raises the question of how 'ugly' is

defined. We recently undertook a survey on sustainable building practice where we asked members of the public to say what they thought visually defined a sustainable building – incidentally, we are planning to extend the survey, so if you are interested you could pass it on. According to the 150 or so people who responded to the survey, the ideal sustainable building has vents on the roof. It has a grass roof and it is made of brick. It does not have glass walls. It does not have any louvres and it can have wood on the façade. And objectively, in answer to the previous question, I think that you can design objective façades, when you step back from behaving like a designer and you start to use design as a methodology to get you somewhere.

Environmentalism, as a field, is quite interesting. It is at a very early stage at the moment. My analogy would be with the steam locomotive. When it was invented in the early 19th century people looked at it as a boiler with some wheels attached, but by the time you get to the 1930s you have the Mallard that can do 126 mph and looks gorgeous. I think that it is the same case with sustainable architecture at the moment. It is at a very early phase and it looks ‘ugly’ because the cultural aspects have not actually been figured into the design. We could be behaving like engineers and not like culturally responsive designers. That would be my point really.

Markus Aerni, Stockholm, SWEDEN

I would like to comment on the issue of skin and envelope and the environment at the same time. We invited an environment specialist to our school for lectures and an intermediate review. The nice thing about the environment is that it is everywhere. For us it starts inside the building and the students loved the lectures and loved working with these ideas of environmentalist qualities in a spatial way. My point is that it is possible to approach skin, for example, in a different way, not as a technical boundary, but as somewhere between the inside and the outside, and you do not have to solve the problems in the skin itself, it is in the space, so it is a kind of buffer of space.

Ferenz Makovenyi, Budapest, HUNGARY

I think that Maria is very sensitive and that she understood something about these envelopes and every reflection says that they are very, very important. The last thirty years have been about energy, and energy and the envelope are similar. Where we are now, skin, is about health, and I think that health will be the future and health is about environment and environmental connections.

Then, I want to say something about why sustainable buildings are considered to be ugly. I do not think that a clay building is ugly, just as I do not think that the earth-covered building in Stockholm, is ugly, and they are very environmentally friendly buildings. So what is the problem? In my opinion the problem is that the market did not understand that there is no cultural imprint in these products. I have not seen any solar cells in the form of a balustrade, for instance. If there were, then I am sure all the houses would be full of balustrade-form solar cells. This is of course nonsense, but people like very simple things and they like things they are familiar with; for instance, the first railway had a very different form from today, that of a coach, because that was what people were used to. I think the problem is that these products have a different attitude, they are not culturally driven, but technically

driven, so what we have to do is try to change it from a technically driven thing to a culturally driven thing. This conflict is shown in the building, and the reason that they look ugly is that they do not fit in. It is as simple as that in my view.

Dimitris Papalexopoulos, Athens, GREECE

I am thinking that the skin metaphor is a tricky one, or maybe I should say a skinny one. In some architecture the skin has depth, so much so that you cannot really define where it is at all. In some architecture the skin has depth, so much so that you cannot really define where it is at all – I am thinking of architecture that is not really traditional, but more Mediterranean. What I mean by saying that the skin metaphor is a tricky one, is that skin architecture, even when concentrating on sustainability, leave the interior to be designed by someone else. I was talking once with Hani Rashid, who after losing the BMW competition asked Otto Prix why he won, and he answered, “My friend, you designed the whole building, whereas I designed only the skin and let BMW design the interior”. So in the end skin architecture would be only those few centimetres left to the architect to exercise his design.

Donal Hickey, Dublin, IRELAND

I live in a society that is gorging on consumption, so in terms of ecology the first step should be to encourage a tradition that is about ecology and sustainability, which does not exist at the moment. And I am reminded of an Irish poet, who died recently, who commented that tradition when all is said and done becomes culture. The attitude I try first of all to teach to architecture students is a cultural shift that starts with questioning; so when it comes to a design for a supermarket, the question is fundamentally what a supermarket is about, and the answer is that it is about supplying goods and services. Then, if there is a cultural shift in the way students think about the implications of the work they do, it will begin to change their attitude towards all the things that happen thereafter. I do think that a traditional and cultural shift is required as a starting point, in terms of how students learn, and after that all of the other things, about skin and expert systems, will come into play.

Angeliki Antoniou, Thessaloniki, GREECE

My name is Angeliki Antoniou. I am student at the moment and I think it might be interesting for you to hear something from the point of view of a student. I would like to make a comment on the question you raised about ugly sustainable buildings. I believe that ugliness and beauty are things that are defined by people that live in a specific era. In the period in which we are living we described as beautiful or handsome architecture the buildings that are very stark and that do not have a very classical form. Students, who are new to architecture, are immediately drawn to the image of very modern buildings, partly because this style is greatly promoted, it is ‘the thing’ at the moment, and they believe that this is a career they want to follow. On the other hand, sustainable buildings are not promoted as much as modern buildings and therefore students do not choose to follow in that direction. Students that choose to study sustainable subjects are either very ecologically conscious or have an interest in physics and these kinds of subjects. So there is a general notion that

interesting subjects are fashionable and those are the ones based on the analyses and the form of buildings. Thank you.

Michael Fedeski, Cardiff, UNITED KINGDOM

Thank you very much.

Henk de Weijer, Amsterdam, the NETHERLANDS

I would like to say something in response to a remark made by a Belgian colleague, that architects are not interested in sustainability. I think this is partly true, but on the other hand it is not true at all. What are architects interested in? Architects are interested in integration and, coming back to the point of perfection or non-perfection and subjective or non-subjective, I think that deconstruction is teaching us that nothing is objective, that everything is subjective and that the information that specialists give us is not contributing to the design of a building.

There is an architect in Holland who has been using a special advisor on sustainability, based on the idea that sustainability, ecology and energy are all part of a necessary concept – a concept that combines all these fears that were mentioned before plus their influence on architectural form. Before making a design with regard to these influences, the first thing he does is look at how these things can be defined in such a way that architects can benefit the most from them, and this is a completely new and very interesting approach. It is a new development, an approach that is much closer to architecture and that gives an architect a much more direct kind of influence because it is related to creativity also.

Luca Fabris, Milan, ITALY

I want to say something that is a bit simplistic: an envelope is something that is sealed whereas skin is something that breathes. We just have to remember that when we teach and when we are talking about ugly environmental architecture, that we are making buildings that have a façade. A façade is the face of a building, so we have to make sure that we make buildings that introduce themselves well. I think that the only problem with regard to ugly but sustainable architecture is that perhaps, concentrating on making buildings that are very environmentally friendly, we have forgotten about the façade, the face of the building. Maybe if we think about the face, the skin or the envelope would also change.

Per Olaf Fjeld, Oslo, NORWAY

In a way I think that all the opinions we have heard in this room are correct. The very nature of architecture has always been rather complex. It is true that sustainability is an important issue, but it is one of many other things for which architecture is responsible. I think that it is also true from what we hear, that the will to bring forth further information and knowledge is certainly here. In other words, there is no longer a lack of information in any subject, and I think that we attempt to disregard it in a way, particularly in teaching, which is our main responsibility. If we do not have the ability or the possibility to somehow even intuitively comprehend and pass on this vast amount of knowledge, I think that we are not doing our jobs properly. And

although everything that we have been talking about is important, we must also find a way to instil in our students the inspiration to create. I was fortunate enough to see Leonardo da Vinci's inventions yesterday, and they made me think that it is not knowledge alone that enables us to create things: we also need inspiration, especially when there are so many issues clamouring for our attention. We cannot focus on everything at the same time, and I think students that find themselves within this process must be quite confused. We have to show students from the very start that architecture is by its nature complex because, since they have the capacity to bring forward the information itself more than we could ever have done, the question is how to find for them a creative approach in which they will be able to use everything they have? As a teacher I think that is a creative act in itself.

Gligor Liviu, Bucharest, ROMANIA

I think that 150 years ago the world was probably facing a similar cultural shift, because, faced with the use of iron and glass in architecture, many people discussed the aesthetic aspects but few architects accepted it as a new architecture. I feel that we find ourselves nowadays in a similar position. We have to agree that society or the level of life today needs other requirements, or that contemporary requirements put us in the position of having to think or to shift or change our thinking. And I think that architects today, like those of 150 years ago, have to make a step forward, because then as now there were other professions that were able to adapt more quickly.

Kleio Axarli, Thessaloniki, GREECE

Before we think about whether sustainable architecture is ugly, we first have to try to define what a sustainable building actually is. Is a sustainable building one that fits into the external environment or one that consumes less energy? For me, a sustainable building is one that does both these things. Take a totally glazed building, for example. Even if it has the right orientation or position to collect solar energy, does it fit into the surrounding environment and does it really consume less energy? And how much energy has been consumed in order for it to be erected? If we find that it is not really a sustainable building after all, then we have to return to the local architecture, to the indigenous buildings and the indigenous materials, and say that these are truly sustainable. And in that way all the sustainable buildings are nice buildings, not ugly buildings. But if we consider a glazed building as a sustainable building, then we have to accept a new attitude and a new era, where we believe that totally glazed buildings are really solar buildings and therefore they must be nice buildings.

Maria Voyatzaki, Thessaloniki, GREECE

I feel responsible and somewhat guilty for having raised the question of ugly sustainable architecture. On the other hand, I am happy that it provoked a discussion. With regard to my first question, I think I am bit clearer now, but for the second question I do have an agenda, obviously, and I put it forward to show that this discussion about ugliness does not get us anywhere. But in the same way it does not get us anywhere to discuss the objectivity of a building fitting into its context. I think that it is as arbitrary to judge the appropriateness of a building fitting into a context as

it is to judge its ugliness or beauty.

I do agree with Angeliki Antoniou on the point she made about the impact of architecture as a star system. It is true that this is characterised by many, not me in particular, as the architecture that is striking, that becomes imprinted in people's memories, and so on and so forth. For me, the answer to the question of how we become popular, although environment is one of the issues, is to underplay environment, and this I think is what good architecture does nowadays. I would mention the case of Glen Murcutt as opposed to Thomas Herzog. Thomas Herzog has a plaque on his forehead that says environment and for some, his critics, his architecture is bluntly ugly or uninteresting. On the other hand, when Glen Murcutt lectures about his architecture we hear a discussion that involves climate, environment, comfort, all the time, in all his lectures on his buildings, but he never labels himself as someone who has the environment as a priority when he does architecture. If you see the concept diagrams of his buildings, in most cases he starts with a section with the travelling pattern of the sun as it falls on the site before he even begins to design the building. His buildings are aware of what is going on and respond to the climactic conditions of the site, but he never really puts this forward as the top priority in his agenda. And I think that this is the way we should proceed. If you look up the book, *Building Skins* by Christian Schittich, who was one of the keynote speakers last year, you will see one of the buildings he demonstrated as an example in his presentation. It is a tube dressed with photovoltaic panels. It is an experiment. It is interesting to look at, for it is a building that saves energy as no other building on earth, because all its envelope, or skin, or whatever you would like to call it, saves and converts solar energy. It is an experiment and it is interesting, but it is debatable whether it will remain in peoples' memories as an architectural masterpiece, unlike, for example, the Villa Savoye. Most of my colleagues here know that when I talk about the Villa Savoye in the building physics course we have, I mention this just to demoralise my students a bit. As you know the Villa Savoye is one of the most visited buildings on earth, and in a room on the ground floor there is an exhibition of all the correspondence between Le Corbusier and the patron of the building, where you can see that he sued the architect because the building was damp. The building was damp and the owners were unhappy, but nevertheless it is a building that is engraved in people's memories as a masterpiece. I will say no more.

Michael Fedeski, Cardiff, UNITED KINGDOM

I think that is a good note to finish on. Thank you very much everybody.

