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EUROPEAN ASSOCIATION FOR ARCHITECTURAL EDUCATION

EAAE Transactions on architectural education no 29

(re)searching and redefining the content and methods of construction teaching in the new digital era

editor Maria Voyatzaki

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Initiations

Aspirations

First Theme - Part II

The New Content of Contemporary Construction Teaching: how is the 'new' related to the other(s) (specialisations and subject areas)

Second Theme - Part I

The New Teaching Method(s) of Contemporary Construction Teaching: Pedagogic Stances

Second Theme - Part II

The New Teaching Method(s) of Contemporary Construction Teaching: Teaching Examples/Practices

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Fourth Theme

Dynamics and Tendencies

Initiations

Preface

Overview

The works included in the present volume are based on two different pillars: the first one is interpersonal relationships, and the other one is the content of the workshop. The human factor should be put first as it is the most important of the two: without exchange of views and collaboration among peers, the content and the amelioration of architectural education – and in particular, in our case, of construction education – simply would not happen. My acquaintance with Ramon Sastre for 15 years now, put me in a delightful position to be co-organising with him in his School ETS Arquitectura del Vallès, Universitat Politècnica de Catalunya, Spain, and in the framework of the EAAE and the ENHSA events such workshop that gave rise to this volume.

The Construction Teachers' Network started back in 2001, with a workshop held at the Aristotle University of Thessaloniki, with 45 participants attending. At that time, the process of setting up a network was tentative and intuitive, especially when it was not obvious that having a network of construction teachers is necessary; a draft document was put together with some very basic but quite important questions which could allow the mapping, recording and understanding of where construction education stands. The entire process was speculative, and maybe, with hindsight, slightly superficial. The questions asked focused on what is taught (that is, the content of architectural education); how it is taught (that is, the methods and the pedagogy of construction teaching); who teaches it (that is, the specialisation of construction teachers, whether architects, engineers or experts from other disciplines); how much of it is taught (the extent to which construction is taught in schools of architecture); and, finally, at what stage, in what year, it is taught. Schools were asked these questions by means of an open-ended questionnaire that was circulated. The participants came up with answers to these questions, and illustrated their points with highlights of exercises that they asked their students to do in the format of an intriguing poster exhibition.

This experiment, if it can be called that, was quite successful, judging by the attendance to the workshop, but most importantly the character of the workshops to be debate-oriented was established. It was found that there was certainly a need for people to meet and exchange ideas on construction education in order to advance it. It was decided that it would be interesting for the forthcoming encounter for emphasis to be put on the methodology of construction teaching, or in other words on the 'how construction is taught' question. The question used as a vehicle the exercise, brief, course or module that if presented could best illustrate how each school operates in relation to teach construction.

The number of participants increased to fifty the second year, in the second workshop held at the very stimulating environment of the Grands Ateliers de l'Isle d'Abeau, outside Lyon, France. GA is an innovative experimental centre with a purpose-built building funded by the Ministry of Culture, which is run by people who are dedicated to the pedagogy of construction and which, of course, has partners that have put all these things together – schools of architecture, engineering and fine arts. There were student exercises running during the workshop and participants witnessed this interesting experience in just the right setting.

Last year, which was the third, having tackled questions on the state of the art of content and methodology, it was felt that emphasis should be put on the future of content and methodology of construction pedagogy; this was a theme touched upon last year and is more focused upon this year. Last year the third workshop was hosted by the National Technical University of Athens. This was a brilliant coincidence in terms of works under construction, since it was the year of the Olympic Games 2004; participants had the opportunity to see all that, and to be in a city that was effervescent with the experience of construction, from a very emotionally charged building, which is one of the neoclassical prototypes of Athenian architecture of the time. Last year, debates focused on perceptions on the future. This year the number of participants has again increased in a sort of geometric progression with 63 participants, plus the host school's teachers of construction.

This year's theme is quite controversial: "Researching and Re-defining the Content and Method of Teaching Construction in the New Digital Era". Thankfully criticised by very few participants from past workshops the delicate point of it is whether construction education will have to change in the digital era. To claim that such an issue is not worth considering could be close to an ostrich attitude. The digital era is a reality, whether we like it or not. Whether that has changed the ways in which the world of education operates is an issue, but it is certainly a reality. That was the premise of this year's invitation. It is easy enough to talk about what has been done and what is being done, but what will be done is a crucial question. To be able to foresee the future might be a pointless exercise as it deprives life from the surprise of the unknown. The ability to foresee with teaching is quite different and absolutely necessary due to the responsibility educators bear to ensure competent and updated graduates.

The workshop, therefore, focused once again on the content of construction teaching but this time with reference to the future. It was an exercise of self-criticism as to whether what we have been doing is compatible with the needs of contemporary times and therefore we can continue to teach the same content with the same teaching methods or whether we have to think again, rethink, reassess, reconsider what will be happening in the future in the world, in architecture, in pedagogy, and in the pedagogy of architectural construction in particular.

(Re)searching and Redefining the Content and Methods of Teaching Construction in the New Digital Era

From the debates and discussions of the first three construction sub-network workshops it has become apparent that teachers of construction today are preoccupied with adapting the content of construction teaching so that it responds to the new conditions rapidly imposed by the socioeconomic, political and cultural environment we live.

The demand for a knowledge-based economy corresponding to a knowledge- based society, as this is promoted by the European policies, the reinforcement of the prac-

tices of globalization, the internationalization of our cultural behaviours and the parallel accentuation of personalized choices, creates a particularly new context for rethinking and reactivating architectural education.
It is true that the content of construction modules appears inefficient while it remains distant from the current tendencies that characterize the production of the built environment, as well as from the new attestations to the architecture(s) that this condition creates.

New architectural ideas and concepts that correspond to new ways and methods of construction, as well as new conceptions of humans and social life, marginalize the so-called traditional and conventional issues of building construction, turning them into material that possesses historical value, but has a limited operational capacity. This fact reduces student interest in construction modules, as students rely on the design studio to take a closer look at technical issues, as these are initiated by the avant guard.

New content, new subject areas and new techniques seem to be necessary knowledge for the profile of contemporary architects and which students, at the time of their graduation, ought to possess in order to survive in a particularly tough professional realm.

Nanotechnology, new building materials, new ways of manufacturing building materials, elements and products, demand new knowledge in construction, as well as new perceptions of architectural design. Moreover, the increasing use of computers drastically redefines the content and pedagogy of the so-called traditional construction modules. Within this context, (re)searching and redefining the content and pedagogy of construction teaching is a priority in the conscience of the majority of construction teachers.

New research areas emerge in the domain of building materials, the domain of new living conditions and new construction methods that redefine ways of experimentation and research with the architectural form as a way of 'shaping' social life.

A great deal of research in the domain of construction has already shifted from universities – the traditionally established context for the generation of research and innovation – to non-university research centers. Therefore, the importance of universities in the socioeconomic context diminishes and researchers' interests shift into other subject areas for the acquisition of postgraduate research degrees and acknowledgement.

The Workshop lays its emphasis on the question of (re)searching and redefining the content of construction teaching and the aims and objectives as well as of the means, methods and pedagogic practices required to ensure expected learning outcomes and competences. This question has been debated upon a three-subject axis:

The content axis
What must be the corpus of construction knowledge nowadays? What are the new subject areas which will have to be included in the new construction teaching? How will these new areas coexist within and be organized around the given educational curricula? What will the prioritization mechanisms and criteria be for classifying mod-

ules as compulsory or optional? What forms of collaboration with other subject areas will have to be invented in this new context? Will new specialisations emerge from these collaborations? How could the new content in construction teaching reinforce the relationship between design and construction? Would the design studio serve as the appropriate milieu or should other niches be defined? How can the teaching of construction incorporate the continuous developments in innovation? How does this (new) content affect student competences and skills necessary to practise architecture?

The teaching method(s) axis
How do changes in the content of construction teaching affect the teaching process? Do they affect the aims and objectives of the already established modules and courses? Should new teaching methods and pedagogic strategies be invented for this new content to be transferred more effectively to students? How will new technologies – nowadays indispensable means of transferring knowledge– become even more creative tools for the teaching of construction? What tools and vehicles will be employed in the new construction teaching? How will new information on innovation, new materials and construction methods, become known to construction teachers? How could this information be taught and disseminated to students? What tools would facilitate this dissemination? What tools would respond to this need (software, databases, websites etc.)? What are the necessary initiatives our Network should take towards strengthening this new form of information exchange and towards enriching and improving the process of teaching them?

The research axis
What types of research will emerge from the (re)search and redefinition of the content of contemporary construction teaching? What can be researched, experimented and tested in the context of construction today? Where can research on construction be published and disseminated? What research results will be useful to advance construction and construction teaching? What types of interdisciplinary collaborations and effective research outputs might emerge? Are our institutions prepared, equipped and supported adequately enough to allow research to be included in the new content of construction teaching? Who would be interested in funding research in construction nowadays? What are the necessary initiatives our Network should take towards strengthening the research activities and collaborations among its members?

It is expected that many of these questions will have more than one answers in the contributions to follow. However, it is only natural for new questions to be raised, a restrlessness that makes the work of an inquisitive educator worthwhile.

Maria Voyatzaki

SAINT CUGAT

A personal reflection on the EAAE-ENHSA Conference: The Teaching of Construction in Architectural Education, Spain 22-24th September 2005

Jeremy Gould
Head of School of Architecture, University of Plymouth, UK

There was a very telling pair of images in Christian Schittich's presentation on *Detail* showing a parapet by Tadao Ando compared to a similar German building of the 1990s. The former was almost uninsulated with the single glass butting the raw concrete whereas, in the latter, the structure was entirely covered by insulation which in turn was covered with an intricate skin of folded metal with a complicated double glazed window. How, I wondered, could one explain to a young architectural student the difference between the two and why they were both exemplary technical solutions? To do so would involve history, culture, technology and philosophy and a lot of time. What did they have to do with the 'New Digital Era' which was the quandary posed by the Conference?

Of course, the answer is partly in the history. To the modern student there is no history – information is delivered digitally instantly and its reality or fiction, past or future, is only in the mind. We, an older generation charged with teaching construction, have consciously and unconsciously inherited all that baggage from the pre-digital era and regard the new era with innocence, suspicion and trepidation. Is this world really the world we want for our children and will its architecture really be better for them? Like the heroes of the Heroic Period of modernism, I guess that we still believe that architecture is for the social good and its technology a moral quandary but I wonder if this generation would analyse their chosen profession or its technology in any such way?

It is not surprising that our adoption of the new digital technology is so diverse. Was there ever an industry that wasted resources so much and calculated their profit base so immorally? The equipment and programmes with their short shelf lives are not available democratically and it is easy to be excluded from and easy to be jealous of those who appear to have cracked the digital code. So, for me, it was Mark Burry and Oliver Fritz who impressed - partly because I did not understand how they did their parametric gymnastics and partly because I realised that I was never going to imagine such forms, let alone put them into technical practice. At the other end of the rainbow were the full-size models as realised at Vallès, Dundee and Lyon but few of us have access to the resources that these require to be as successful. There is clearly a danger that the process is dominated by pragmatism and merely adopts standard technologies rather than demonstrate actual innovations.

Caught somewhere between the two is a spectrum of databases which the digital era so easily allows to grow and grow. Clearly big is beautiful and the systems can be adapted to almost any branch of the technological teaching industry – pipes and plans to typologies and tubes. It's like collecting postage stamps, one never quite achieves the whole set. What, I wondered, does the student do with all that information? Who collects and censors it all? Is the future of architecture and technology merely a metamorphosised clone, however skilled, of something done before and how do we know that the precedent was ever successful or not? We all know that we are dealing with an industry that deliberately conceals its mistakes. And then we all worried about the clone-image, what I rudely call the pornography of architecture. I suggest that it might be wise to stop worrying about such things because the students regard it all as 'normal' and they will very quickly show us the way out of the digital stamp album and get on with far more interesting things.

Then there was the thorny problem of research. Curiously, we seemed to be suspicious of the building industry and especially of the building products industry although the Conference was sponsored by one such and the synergy between construction research and product seems so obvious. That manufacturer was actually sponsoring a student construction project but this seemed exceptional as were the rumours of connections between the Schools of Architecture and industry that might be happening in Scandinavia. Was this yet another Shangri-La? Those parametric boys seemed to have cracked the problem (although the reality always seemed to result in yet another market hall roof) but this left the rest of us wondering how we could prove we were researchers and which refereed journal would accept our texts. There seemed to be a note of desperation creeping in here which might be another indication that the construction teacher has a permanent inferiority complex and it is only theorists, historians, urbanists and true scientists that achieve the research points by publication. And, of course, that it is only the studio designers that have any fun.

What struck me most were the similarities between our approaches and what we taught. From Athens to Århus, Naples to Napier, Wroclaw to Vallès we were more-or-less doing the same thing and we more-or-less understood each other. Was this another sign of new European unity or a result of the universality of the digital era? When *Detail* is published in English, Japanese and Chinese, European construction culture will be available worldwide as will that cloning culture. Whilst this may be interpreted as a triumph of Europeanism, one wonders if the Chinese really deserve it and if it would be better if they sorted out construction for themselves. Sitting here in Plymouth with an autumn Atlantic storm beating at the (single glazed) windows one is reminded that climate and natural environmental conditions are not the same universally and what may be appropriate for a building in Stuttgart may not be appropriate in Xinjiang. So first on my list for the construction course subjects would be climate and environmental conditions and then the materials and then the details. Two obvious things follow from this: that new buildings might be very different in Germany and China and that the divisions between environmental teaching, construction teaching and design are very artificial indeed. I think that we would do well to remember these when bogged down in the machinery of construction teaching, architectural courses and the realities of modern university education. The current student generation cares not one bit about all this stuff but believes that the world is accessed with the prehensile thumb via its mobile 'phone. We too have to decide where we stand.

Aspirations

Antonino Saggio

Antonino Saggio has been the founder and editor of the book series "IT Revolution in Architecture" published in English by Birkhäuser, in Italian by Testo & Immagine and in Chinese by Prominence. The book series has to date reached twenty five titles and represents an asset in the process of foundation of a new digital culture in architecture.

Saggio wrote essays and introductions within this book series (the last one is "Architecture Informs" in a book co-authored with Derrick De Kerckhove and Peter Eisenman), in Exhibition catalogues (Digital | Real Dam 2001, Architecture in the Digital Age, UPennsylvania 2003), and in Conference proceedings (Acadia, Caad Futures, Docomomo). He is also author of several books, among which: Giuseppe Terragni Life and Works (Laterza, 1995 2004), Peter Eisenman. Trivellazioni Nel Futuro and Frank O. Gehry. Architetture Residuali (Testo&Immagine 1996 e 1997). His editorial activity comprehends the co-foundation of the magazine "Il Progetto" the direction of the section "The Architects" after the death of the Founder of Universale di Architettura Bruno Zevi. He has collaborated with many magazines of architecture and culture in Italy and abroad. Prof. Saggio holds a professional degree in Architecture (1979) and a diploma of Planning from the University of Rome La Sapienza, a Master of Science from Carnegie-Mellon, and a PhD from the Italian Ministry of Research. He is currently Tenured Associate Professor of architectural design at La Sapienza Rome, and has been teaching in several universities in Europe, Africa and the United States, particularly at Carnegie-Mellon University- Pittsburgh, GhK-Kassel and Eth-Zurich. He has lectured in many major cities in Europe and North America. He has won awards in design competitions in the first phase of his career, and academic research grants from institutions such as the Fulbright Commission, the Graham Foundation and the Council of Italian Research. He founded in 2003 the research group Nitrosaggio.net which operates interdisciplinary in the relationships between Design and Information Technology. Saggio keeps a web site that was a hub of architectural debate in Italy and one of the most visited of the University La Sapienza http://www.arc1.uniroma1.it/saggio/

Christian Schittich

Christian Schittich was born in Halle/Saale, Germany in 1956 and holds a diploma in Architecture and Engineering (Dipl.-Ing. Architekt). He undertook his studies at the TU (University of Technology) Munich followed by seven years`office and design experience as an architect.

From 1991 till 1998 he was responsible editor of DETAIL, Review of Architecture in Munich and from 1998 he is editor-in-chief. Under his direction DETAIL developped to become internationally one of the most widespread and distinguished magazines among architects.

Christian Schittich is the author and editor of numerous books, all of which have been translated into different languages:

Glass Construction Manual, with D. Balkow, M. Schuler, W. Sobek, G. Staib, 1998
Single Family Houses, 2000
Building Skins, 2001
Interior Spaces, 2002
Japan – Architecture, Construction, Ambiances, 2003
Building in Existing Fabric, 2003
Solar Architecture, 2004
High-Density Housing, 2004
Building Simply, 2005

He also published numerous articles in DETAIL and other international magazines such as Architecture and Urbanism/a+u (Tokyo), L àrchitecture d`aujourd`hui (Paris), Shinkenshiku (Tokyo).

Mark Burry

Mark Burry (born Christchurch, New Zealand in 1957) took up a position at RMIT University as Professor of Innovation (Spatial Information Architecture) in July 2001. Previously he held the Chair in Architecture and Building at Deakin University for five years. He has published internationally on two main themes: the life and work of the architect Antoni Gaudí in Barcelona, and putting theory into practice with regard to 'challenging' architecture. He has also published widely on broader issues of design, construction and the use of computers in design theory and practice. As Consultant Architect to the Temple Sagrada Família, Mark Burry has been a key member within the small team untangling the mysteries of Gaudí 's compositional strategies for the Sagrada Família, especially those coming from his later years, the implications of which are only now becoming fully apparent as they are resolved for building purposes. He has been active with the project, and the museum associated with it since 1979. In a major exhibition on Gaudí 's exploration of form staged in Barcelona in 2003 * a principal component of the commemoration of the 150th anniversary of Gaudí 's birth, he was the only international member of the exhibitions' Scientific Committee. On February 18 2004, in recognition of his contribution to this project, Professor Burry was given the prestigious award 'Diploma I la insignia a l'acadèmic corresponent' and the title Senyor Il. Lustre by la Reial Acadèmia Catalana de Belles Arts de Sant Jordi.

Currently Professor Burry's time is divided between university and practice-based research. He is director of RMIT's state-of-the-art Spatial Information Architecture Laboratory, which has been established as a holistic interdisciplinary research environment dedicated to almost all aspects of contemporary design activity. The laboratory focuses on collocated design research and undergraduate and postgraduate teaching with associated advanced computer applications and the rapid prototyping of ideas. Projects currently include three ARC funded activities, a combined design studio with Queensland University of Technology, the Melbourne Docklands 'Shoal Fly By' Art project (Kate McLeod and Michael Belemo), the 'Village Gateway Art Integration Project' (Brisbane City Council), The City of Melbourne Sound Project, a multimedia-based design decision support environment for students, researchers and practitioners, investigations into the ontology and representation of design, and interpreting Gaudí's drawing for the Passion Façade design for construction during the coming years. The laboratory has a design-practice emphasis and acts as a creative think-tank accessible to both local and international practices, including ARUP in Melbourne and London, dECOi in Paris, Gehry Partners in Los Angeles.

Mark Burry is visiting Professor at Liverpool University (UK) and Honorary Professor at Deakin University (Australia). In 2003 he was Visiting Professor in Architecture at MIT (USA). In 2004 he was appointed to the Advisory Board for Gehry Technologies and to the Australian Research Council College of Experts.

http://www.sial.rmit.edu.au/

The keynote speakers appear with the order they intervened.

Keynote Address

Antonino Saggio
La Sapienza School
of Architecture, Rome, Italy

Give Me a Cord and I Will Build... Construction, Ethics, Geometry and Information Technology

I must tell you that I always give my lectures through internet. This is a crucial thing for me, because I consider my contribution to be a public one. Therefore it is important to me that anyone who is interested can go and see the material, follow the links and look up all the material. Incidentally, everything I am about to show you is already on the Net, and any of you who are interested can go and look at it. This is my home page (pic. 1). In order to find it, just go to Google. Also, in order to be correct with the institution that invited me, I put a secret link, which I will show you in a moment, so if for any reason you want to analyse the material afterwards, just go to the secret link that in this particular case is at the end of the home page.

pic. 1

What I am proposing for tonight's lecture is a review of different aspects of construction. I am going to start a little farther back in time and in the thinking, approaching the theme from quite a distance and not arriving at Information Technology until the second part of the talk. Then, in some way, we'll start this kind of spiral way of thinking which is what I am going to present. So I will touch on different aspects – some quite superficially, others in more depth – but the links are there and can be followed. Of course the very title of this lecture – *Give me a cord and I will build...Construction, Ethics, Geometry and Information Technology* – should put you in a certain frame of mind. This is the best title that Maria and I were able to agree on.

I will start with a few observations relating to anthropology, and particularly some connections between art, anthropology and certain basic acts relating to space and to construction. This year the topic of my course is "Tools"; the relationship between the tools that we use and the way that we build ideas and artefacts and in a manner of speaking the way in which we occupy the world. And as we go into it we understand that this idea of the tool is, at least, a double arrow that is always being influenced in process that goes back and forth between our ideas and the tools we are

pic. 2

using. Back and forth and back forth continuously. Keep this idea in mind, because although it may seem a pretty obvious conclusion we are going to build on it. Within my course activity I invite people whom I consider interesting. One such person is Costantin Morosin, an Italian artist and sculptor who has been working in this field since the early 70's. He interests me very much, because he makes observations relating to the way that man used the world in the very beginning. He studies movement and simple human tools and ways of building things, and upon his observations he decides actions, artistic actions and things like that. Here (pic. 2), we see some of the tools I mentioned, a necklace and a bow with a cord, and here we see some of the objects Morosin creates like this carved stone. The path of his thinking goes from the study to primitive objects, such as these, to a process of creation trying to show how many things you can do with a stick and how many forms you can make. The concept of tool is the key; because the tool is interwoven at the same time with the mental process of creation and with the fabrication.

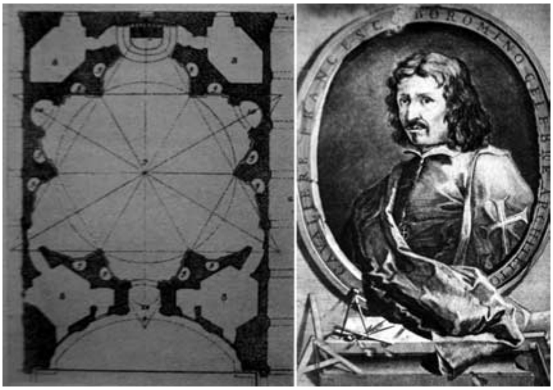
Morosin is interested in a new type of art, which is called GPRS art, a kind of a Net-art. Through the use of a satellite and different type of telecommunication we relate to each other and to the planet. He draws things on very large, almost regional, scales that can be activated with the use of new technological devices.

So from the very tiny primitive objects in a strong relationship with tools, he goes to this opposite, completely contemporary type of art, strictly related to technolo-

pic. 3

gy. Why these two kinds of art together? Why are we interested in this complexity? This is something that I will try to show gradually in my lecture.

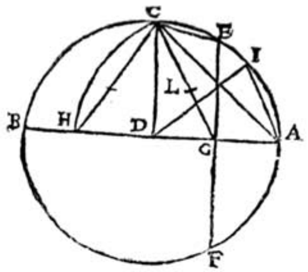
One thing that I think is quite interesting, and here we are approaching the theme of the cord, is this right here. What you see here is a tool that he found published in a book by an anthropologist. The book said that this was an amulet used for some symbolic reasons by an ancient population. What Costantin Morosin did instead was to explain and to prove that this is not an amulet but a compass: n ancient compass. And here (pic. 3) you see how to use it. Basically you use it this way: these are the places to make circular forms, and then here you see how it is done and naturally these two close ones are very important and anyone who deals with construction knows how important making a thick ring is. This idea of circular movement is one of the first acts of occupying the land, using the land, even relating to the circular movements ancient men had to do to capture animals; and it is related to the compass and such important tools as the arc and the cord. All these ideas are very closely related to one part of my recent research, which strangely enough was related to Borromini.



pic. 4

This winter I suffered from the typical Borromini syndrome (pic. 4). I only caught it now, but I think that at some time in an architect's life the Borromini syndrome is something that is very important. It is a kind of a sickness that can last from six months to a whole lifetime. I have had it for only three months, but believe me when I say that I was virtually living and breathing Borromini this winter. I was extremely interested in understanding the relationship between geometry and the way to actually construct that geometry, which I studied, evidently, as an integral thing. And all this has a great deal to do with tools, and particularly with the compass. It In a number of citations is explained how important the relationship between this tool, the compass, and the way to create geometry and construction was for Borromini. It is an integral thing, an integral process. Of course there are many other things to be said but I can only touch on that.

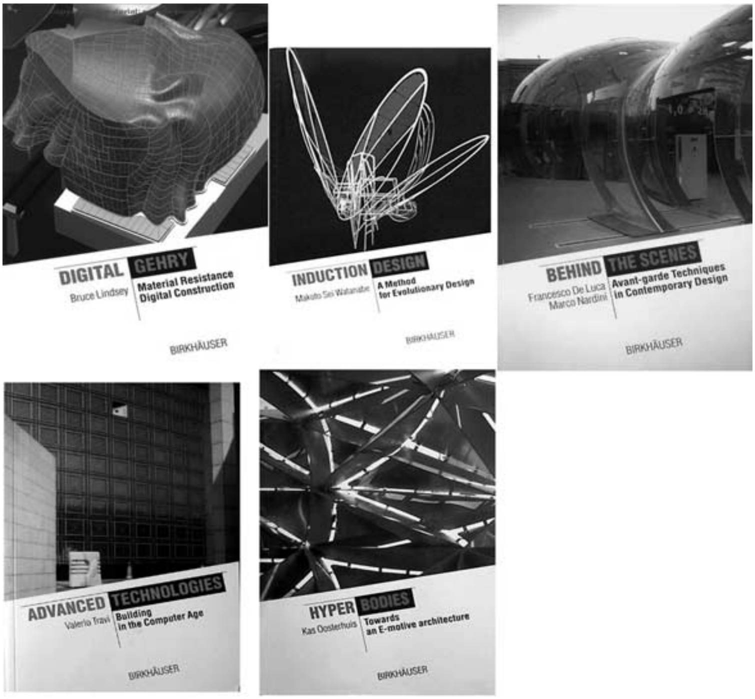
Doing this research, reading here and there, I found in a book by Federico Bellini (*Le cupole di Borromini*, Electa Milano 2004), a relatively young scholar of Borromini of the new generation, this drawing or explanation or manual. It is by Pico Fontolocano and it is dated 1605. This interests me extremely. One thesis of my research, which was also proved by Bellini, was that at that time they used very strongly "operative" geometry, which means a kind of geometry that was very closely related to how to hand on information to the workers; so the way of thinking in terms of spatial ideas, the way of handling geometry and the way of passing the information to the workers was really a world, a common world. The reason that this is so important to me is that it proves one aspect of this lecture: *give me a cord and I will build.* Basically with the rule shown in the Fonolocano drawing, a rule which was



75 VOlendo formare dentro vn circolo il triangono quadrangono pentagono esagono settangono nouangono deciangono vndiciangono, & dodiciangono. Prima diuidete il tondo con il diametro A B. & nel centro D. tirate la perpendicolare C D poi diuidi A D in metà, tirando la linea paralella E F. con C D. il che fatto la linea E F. sarà il lato del triangono AC. il lato del quadrangono, poi metti il pie del compasso in G. & con l'altro arriua in C. e gira il circolo C H. & da C. in H. tira la linea retta, dico che la linea C H. sarà il lato del pentagono; la linea A D. metà del diametro il lato del esagono, la linea E G. il lato del settagono, la linea A I. l'ottagono, e se dal lato del pentagono C H. trai la metà del lato dell'esagono l'auanzo sarà il lato del nouangono, la linea D H. sarà il lato del decagono, ouero dalla meta del semidiametro A D. tira la linea GC. dalla quale leua la linea G D. quelche rimane che è L C. sarà il lato del decagono, la metà della linea G H. il lato del vndiciangono, & la linea E C. il lato del dodiciangono. Ben vero che il lato del nouangono e vndiciangono non sono secondo la theorica precisamente giusti, ma à Manuali per compartir tal figurami, non e di molta variatione.

really established in the Renaissance, using the circle and particularly a magic point on the circle, pont "g", one can build a great number of regular figures, which are all movements of the cord. These movements can be very easily passed through.

How to divide a circle into three parts? How to create a regular triangle? How to build a square? All these are movements of the cord in space. So the geometry and



pic. 5

the actual construction were really part of a common territory – a territory fascinating to discover. And here you can see it illustrated (pic. 5).

When you get caught up in the Borromini syndrome, you tend to go farther and farther until you rediscover things; so the time came when I had to invite a pair of engineers, important engineers on the Roman scene, both of whom had been assistants of Pier Luigi Nervi. In the middle 70's, they were both professors of mine, and they were very happy to be invited to share their experience with us, and they were very generous with me and with the class. And I asked them very specific things, not only about their careers, but specific questions relating to the relationship between geometry and construction. One of the two engineers I invited was Antonio Michetti – and let me say that he also has a syndrome. About fifteen years ago he started to really try to understand the measuring system of the ancient Romans, the way they built and used geometry and the tools that they had at the time. As you know the ancient Romans had very sophisticated ways of making calculations, but very different from what we use now. They had completely different ways, basically based on geometry. There is an applicative geometry within which they did a lot of things, and one of the key aspects of their research is the Diophantine triangle – I cannot go into great detail, but it is clearly a triangle based on the rules of the golden mean; and this publication proves how much this set of proportions was based on the Diophantine triangle and how it influenced a lot of constructions of that time.

The key aspect here is that this is not anything esoteric: it does not come from magic; it is just that geometry itself has its own constructive rules, and these constructive rules can be transferred into actual construction. At a certain moment I started to look at these things in a little more depth, and then looking back to this I saw that basically all the figures can be done in a kind of straightforward way using this kind of ‘magic’ number at this ‘magic’ point on the circle. But somebody at some time – we don’t know how – came up with an incredible invention within this. In order to create a pentagon, instead of making direct translation of this point, someone made, as I am sure you know, this overturning movement that creates point H (see Fig. 4) and HC is the dimension of the side of the pentagon. So this process is actually the constructive way to create the pentagon. But the most interesting thing is that this segment and that segment are exactly within the golden section ratio, so the ratio between HA and DA is the golden section ratio. If DA is equal to 1 then HA is equal to Φ or 1.618... This is a crucial point for people who believe, as we do, that there is a very strong relationship between geometry, construction methods and the actual rules of construction. The moment that one starts building a pentagon with the system of rules of "operative" geometry one ends up with the famous golden section ratio. But that is for very simple constructive reasons; the number 1.618 per se does not have meaning: one makes meaning out of it when you apply it in a geometrical sense!

This is extremely exciting, for me and for the students. I teach an Information Technology course, but these things are crucial: they are the engines of our research that lead up to what is happening today and our normal way of handling things. To make this study extremely brief –I cannot go into proving these things now but I can show you at some other time – the other thing, the other relationship that is absolutely fantastic is that there is a bridge between this rule of construction based on the circular movement of the cord and some manner of natural growth. As you know this bridge is represented by the logarithm. The logarithm is able to bring these two worlds together: the world of geometry – of some kind of natural way of approaching the process of construction and geometry – and the world of natural growth.

Now we come to the second engineer, the number two at the Nervi Corporation, the follower of Nervi, after Nervi made thirty or forty buildings, ing. Mario Desideri. Since my lecture cycle was based on the tool, I wanted Mario Desideri to talk to the students about the slide rule, a tool that his generation was completely familiar with, that my generation knew of but didn’t use, and that the students of this generation know absolutely nothing about. I thought that it would be extremely interesting for my students to have a person, who apart from speaking about careers and prospects, etc, would also speak to them about the slide rule. Of course you all know that the slide rule is based on a very strange logarithmic rule that somehow enables us to make calculations (although I would love to discuss this in more depth, I am afraid we cannot, for we have many other things to cover and a limited amount of time).

I will present to you now some points that are quite crucial to this part of my research and thinking and to what I want to communicate. The first is that there is a very strong relationship, as many of you may know, between the construction of the pentagon and the golden section number (Φ).

The second derives from the first, and is that Φ is not some sort of esoteric number, but a "constructive" factor. The third is that this "constructive" proportion is not only evident in geometry, but is also found in nature, and the logarithm acts as a bridge between natural growth and golden, or better "constructive", section.

The reason that I am discussing these aspects here is that I cannot pretend to have the experience of someone who teaches construction. Formally, I am a professor of architectural design, and in reality I teach architectural design in a kind of traditional sense in the large projects I follow as Advisor in the Graduation thesis in my University. My normal teaching area covers Information technology, Architectural theory and some aspects of design.

Although my specific subject is not construction, this is a key element, a key ingredient to understanding what architecture is about. What are we looking for, what are the implications and, basically, the richness and the importance of this world. Several of you mentioned the importance of teaching the students about how to navigate and the curiosity to navigate into knowledge and the capability to create questions and to find answers. Anyone who is really interested can access the conference series from here www.arc1.uniroma1.it/saggio/Colti/vatori.html. Beside the sculpture, the first engineer, and the second I also had an astrophysicist and an architect and musicians. Follow thd link you can see the entire conference, which of course is in Italian. Today, communication is really about moving in small networks. The important thing is that the knowledge is there. And then even if there is only a small number of people who are interested, the knowledge is there. So if you are interested you can look at these things or just e-mail me and we can discuss it.

Now I would like to discuss an idea that is crucial to me, relating to how I would like to introduce you to the issue of approaching the field of Information Technology. There are two very interesting concepts that I want to put to you. Two key concepts. The first is the importance of the tool in relationship with space and construction and the second is the idea of a mental landscape. This is something I need to discuss for some minutes. These two things are interrelated and these two ways of thinking are to me quite crucial. What do I mean by mental landscape? I'll put it this way: how can you build a pyramid if you don't have the idea of a triangle? (pic. 6) This is a very simple question. Evidently you cannot build a pyramid if you don't have the idea of a triangle. This means that this relationship is a crucial one. We tend to think of artefacts that exist in the world with the tools we have today, whereas we should instead start looking at these artefacts with the ideas, scientific knowledge and operational capabilities of their time. If we start to look in this way we look at architecture as a reificatio, as something that becomes real out of the ideas that existed at that time. In a way the pyramid is the concrete product of a certain amount of

pic. 6

knowledge possessed by specific people at a specific moment in time. Of course we know that it is not only that. It is not only abstract knowledge: there is the symbolic aspect, there is the way of handling many other aspects – we know that it is an incredible work. But for now let us just concentrate on a very simple point: if the pyramid is the realization of some idea of geometry, the idea of geometry must in some way have pre-existed it, just as there must have existed the tools with which to build it. They must have reached a certain level of knowledge of geometry, trigonometry, etc. The pyramid is the reification of those ideas and therefore architecture is the presence, the physical presence of those ideas.

If we start looking at things in that way we can start to understand, for example, how the Pantheon could have been built, how such a complex structure could have been realized. With Roman numerals it would seem impossible to do any kind of calculation, but we know that in fact they are extremely sophisticated, with precisely the set of rules that Michetti shows us in a relationship between geometry and construction. Thus, we could look at the Pantheon as a way of incorporating these rules, as a reification of these rules. Then of course we go on to the tools – no true idea of the Roman city is conceivable without these simple tools. Then at some point in history you realize that certain rules and certain knowledge are not there any more – they have been reduced again, so to speak. Aesthetically they could be supremely imaginative, but the ability to depict those "rules" (by which I mean a mental set of knowledge) is no longer there.

It is very important to understand this concept, to feel the Renaissance from that point of view. From that point of view the Renaissance is the invention of an incredible new tool that was able to shape people's vision, to shape the very conception of how people are related to the world; and people, space and world became a whole measured system. It was the first time in history that something like that had happened. The new invention of perspective needed a new architecture. The new architecture that comes with Humanism and the Renaissance was precisely that: a need of perspective. Architecture had to change completely, in order to be an architecture that makes sense of perspective. The old Gothic architecture was not done for perspective, was not useful for perspective and neither interpreted nor showed the perspective that existed. A new architecture had to be founded in order to express that new mental landscape. Here the mental landscape becomes a crucial point. At a certain moment in the history of humanity our vision of space, our capability to create relationships between knowledge and space, became almost completely humanistic, and as you know it was conceived and calculated on sure roots. This was an incredible revolution, which brought about the end of the old architecture and the birth of a new architecture, a completely new architecture, and the propellant of the new architecture was perspective. The relationship between perspective and the Renaissance of the new architecture is absolutely fundamental. We could also connect this with the discussion of Borromini, the compass and many other things.

Why is this point so crucial? Because – and I am approaching Information Technology diagonally here – one of the basic parameters of fthe work of this generation of architects, writers, musicians etc, who in one way or the other are related to different activities, including the book series, is the fact that we are in front of a new paradigm. This new paradigm is based on Information Technology. It is not new materials, that we add to a pile of existing materials, it is not a new palette, it is not a

pic. 7

new technology that we add in a continuous line. We need a crisis, this is my point of view, we need a reformulation of our vision of the world. We, and particularly the new generation, are moving in a completely different landscape, a completely different mental landscape. It is something totally remote from what we have experienced, and this new paradigm that is our incredible strength needs to be represented in architecture. But not just represented; it needs to have a complex relationship with it, because the new idea shapes a new type of architecture and vice-versa. This idea of the mental landscape becomes absolutely crucial, and this is why I included these two images that are somewhat symbolic to me. This one is extremely well known, and is something that I am particularly fond of. This is Steve Jobs, (pic. 7) probably at the age of 21 or so, at a computer fair showing some of the first interpretations of the personal computer. What Jobs is doing is very interesting. He is looking at a chip. He is looking with a lot of attention at a chip – this is his partner, Wozniak. This act of looking inside – inside the technology, inside the paradigm of Information Technology, inside the mechanism of software – is for me absolutely crucial, because one of the key aspects of this world of Information Technology is that it is not static; there is a continuous mutation of information, of interrelationships of information; everything in the world of Information Technology is based on the idea of a continuous reconfiguration of models, of realities. And this idea that we are really moving and being in a kind of continuously remoulding and reshaping world of mathematical equations is something that comes from this world of Information Technology, which is not just there as an incremental improvement, but is a total revolution in the way that we approach everything, including architecture, including construction.

This idea might be a little foreign to us, but it is completely familiar to the new generation. They are used to this idea of remodelling things. It is one part of our task to understand how these things enter various activities at different levels. We are all teachers, and we know that there are different generations, different attitudes, different power structures around the disciplines and these are complex; it is a complex world, and not everyone will be involved with avant-garde thinking. What I tend to support with different activities is that this is really a challenge, an important challenge, and I think that we are facing the beginning of a revolution in certain basic paradigms of architecture. And this brings us back to tools. Tools, not only as the means to achieve one thing within this context that I describe, but as something that involves a very profound relationship with the way we conceive things and with the way that tools talk to us, talk back to us and tell us things as well. It is a much more complex relationship. It is not a one-way relationship, it has many dimensions; and I think that the example of our relationship with perspective is quite a good illustration of that. I believe that basically something similar has to happen here. On the other hand, there was a colleague before who said, "well, if we do architecture we have to face the change.

I agree and I will paraphrase slightly: I think that architecture is also, as an intellectual discipline, something that has to face the crisis, the change. The change may not be something we necessarily like, but something that belongs to the evolution of knowledge, of the times, of possibility, etc. And then the crisis happens, when our whole construct no longer fits this new knowledge. At that point we have to understand that we need to reformulate certain important things. And I believe that this moment has come, and that people are already are working with it, trying to understand how to reformulate certain ideas concerning architecture.

I will move on to the second part of my lecture. I believe that you may have expected a more systematic way of proceeding than the way in which I started my lecture, with anthropology, ancient art, etc. I would like to mention that with this link (http://www.arc1.uniroma1.it/saggio/RivoluzioneInformatica/Indexall.Html) you can go to the book series that, as was very kindly mentioned, has many books which can be found in various languages; there are some in Italian, 25 in English and also a few in Chinese. These are the five books that are related to construction, in various ways. *Digital Gehry* is a report from inside an office. The book was the outcome of almost eight months of discussion with the Gehry office, because of course as a professional place they don't want to waste time with products that are not good and serious. So the book was very closely monitored at the end by the Gehry firm (the author, Bruce Lindsey, is the head of the Auburn School of Architecture in the US), and it follows how Gehry Associates approaches this theme – and of course, as we know, Gehry is a firm that builds things, so it deals with actual construction. Interestingly enough the software "Catia" and Information Technology were officially introduced to Gehry Associates in Barcelona - it started with the project of fish in Barcelona, a story that still goes on, and is covered by the book.

In actual design there is a book by Watanabe, who as you know is one of the younger generation of architects involved with Information Technology, one of those people who build many and most interesting things; and he is particularly interested in developing a formalism that puts parametric design, partly automatic and partly guided by the architect, into the actual construction of evolutionary design. And he actually did this in a series of metro stations and other things.

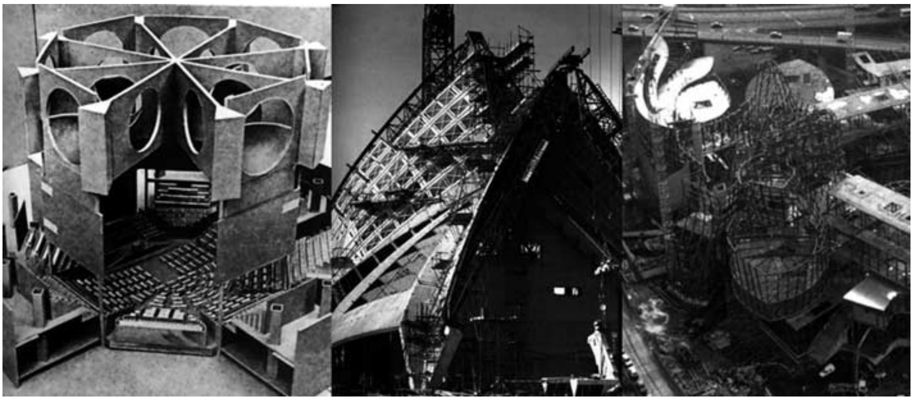
Then there is the book called *Advanced Technology: Building in the Computer Age* by Valerio Travi; it doesn't actually deal with construction – it deals more with technology – it covers (sensors, environmental controls intelligent buildings.

Kas Oosterhuis's book deals with the relationship outside the traditional construction industry – it also deals with the automobile industry, the aircraft industry, etc, within a theory and a practice of design that is quite developed. It is a sort of manual that shows certain techniques of contemporary design that are quite familiar to the new generation of students and architects, new ways of conceiving geometries some of which have important consequences in design as well.

There is this article of course by Dimitris Papalexopoulos, which is a kind of brief concentrated version of what is being presented today, which I think is something that we can discuss further later. It is one of the most complete overviews of how the theme of construction can be reshaped today for the schools that are interested to put this new paradigm of information technology at the centre, and I agree with many points he makes. Both of these have links from which everything can be seen, read or downloaded.

Now, as we approach the last part of the lecture, I just want to present some ideas on how certain things have changed within these forces of Information Technology. I trust that you will take into account the fact that I am talking about very important issues in a very condensed fashion, for of course each of these topics can be discussed in much greater depth and breadth. But there are certain things that it is very important to be aware of. One example is this process that I call engagement/disengagement. I am not sure that these are the right words, but I will explain what I mean. Kahn is to me a key figure, not only because I really love Kahn, although I do completely different things, but because he brings together again certain things that were completely dissociated in the typical modernist tradition. Kahn made an ultimate effort to re-connect space, function, geometry and construction. That was an incredible effort of a great poesy and poetry, and this effort to put everything back together. Geometry, then, defined space. Geometry is the highest representation of Institution (the human collective function); and since geometry is strongly related to construction, everything thus comes together. We, by contrast, are in precisely the opposite process. Not because we like it or do not like it, but - to cite you, Maria - because it is reality. The process today is exactly the opposite. It is a process of disengagement of the parts. The things that Kahn brings together are now completely dissociated, which has been responsible for many, many things, including incredible gains (pic. 8).

Look at Gehry in Bilbao. The Gehry Bilbao is just a proof of this disengagement. Geometry, construction, function, urban form – each of these things finds its own optimisation, only minimally linked with the rest. So whereas before everything had to be absolutely consistent and rigid, from a certain point of view, of course, today



pic. 8

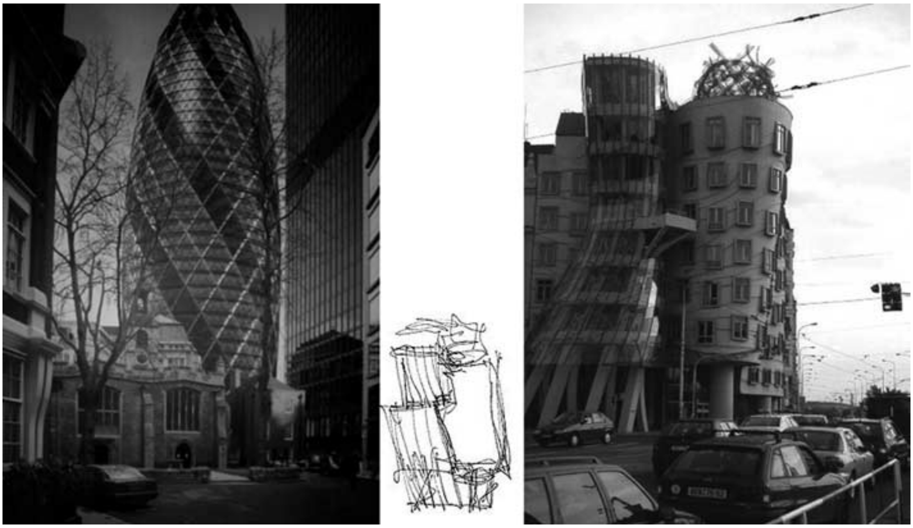
we are in a flexible system of loosely linked systems and sub-systems, each one finding its own optimisation in a much more complex process of design, knowledge, construction, etc. Naturally, if we look at a Gehry structure from the standpoint of the ethic of Kahn, it seems a real nightmare, because all the rules, all the fundamentals of what we thought good construction are not there any more. But if we really look at the different sub-aspects of that problem, we understand that a level of optimisation has been reached that was never touched before. Anyone who experiences the building knows that it is one of the most efficient museums ever built; anyone who knows about these things realizes that its relationship with the urban context is truly amazing and that the level of freedom of forms creates a contextual architecture that is expressive in a way never before conceived. This process of disengagement, this process of optimisation, of sub-systems, is something that we must understand and accept, however difficult we find it to deal with. And it becomes like that also because Information Technology is a key element within that.

Jørn Utzon is in the middle. It is important to understand that the drama of his situation stemmed from the fact that, he went to only "a partial" disengagement. He created the disengagement between form and function that we know of after the Functionalism, but not a disengagement between geometry and construction. In Utzon, form and function no longer match. Symbolic form required disengagement with actual function – there is no real relationship between the different domes and what is actually inside: it is a symbolic act. On the other side, Utzon wanted to build his Opera house using very strict geometry (the domes are all slices of a sphere). He needed strict geometry because he wanted a prefabrication system. But in order to follow and organize all this he also "needed" a close relationship with the construction industry breaking anti-trust Australian regulations.

Gehry's system instead is a much higher disengagement of the different aspects of design. Behind this there is the new presents revolutionary presence of Information Technology. The word disengagement should be called "dynamic interconnection of design subsystem" in order to understand what we talk about.

Gehry associates designed and created an optimisation of certain aspects of the project and then they passed the information to the builder that makes its studies based on its own optimisation (cost, stability etc,). It is a completely different process from the process used by Kahn and also different from the one by Utzon. The process described on optimisation of different sub goals in Gehry can only be reached at this level because of the presence of Information Technology.

Then of course we have different approaches of how to deal with Information Technology and also how to deal with form. We are in a completely opposite world here (pic. 9). On one side we have a classical consistency. Foster always follows that kind of idea, in variations of that idea, and Gehry of course follows a completely different idea. They are two opposite worlds. What is interesting to know is that these important firms have special research groups within their offices exclusively for people who deal with Information Technology. And these are not people that make drawings in CAD, of course – that is something that belongs to the 70's; they are people basically educated at PhD levels at different universities around the world who then constitute a special group of researchers within these offices that deal with the rela-

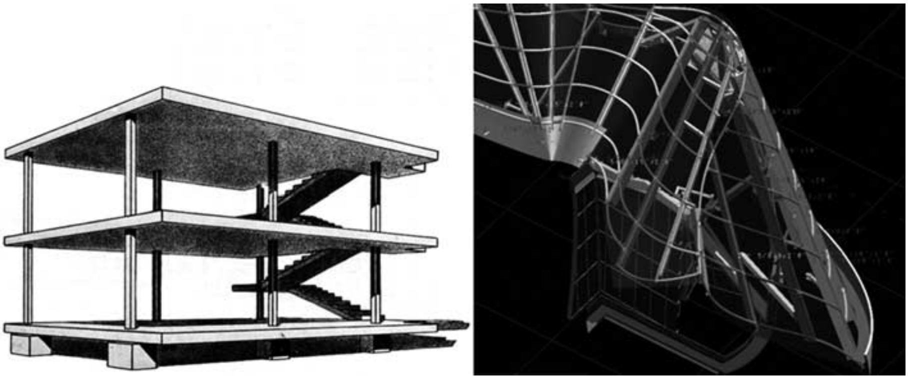


pic. 9

tionship between the form-making within each architect's idea or philosophy and what it is actually possible to develop. I say this because I know two such cases personally – both are Italians and one was a student of mine. She wanted to have me as her advisor even though she was at another university; she developed a whole thesis on the mathematical implication of form-making, and of course she ended up working with Foster. So, as I said, there are within this new generation of architects some research specialists who are involved with Information Technology. To my way of thinking, however, there has to be some degree of need when it comes to architecture and construction. Today there is a sense that if we can do something then it needs to be done, so that what we are starting to see is this idea of Calatrava's that construction is the art of the possible, and that since anything can be done today, then it should be done. This idea can be exciting in sculpture, in which we feel the effort involved in a very precarious equilibrium – and this is very appreciable in Calatrava's moving structures, which is where his genius really emerges. Sometimes, however, I am a little afraid that this may generate monsters; and I think that on this particular point we must be very careful, particularly in the teaching of design. I think that in teaching architecture and construction there has to be that sense of "need", and on this idea I will bring the lecture to a close.

This is a key concept to understanding what is actually happening today to much of the construction that is involved with Information Technology. I will read just this part of my preface to Lindsey's book. I prefer to read, because the concept is very delicate.

«...Lindsey also touches on conceptually important points. The first is one he defines as Skin in. If the modernist process begins from the structural grid towards the outside, Gehry's process is the opposite: from the shape of the skin and therefore the exterior surface he passes to the secondary plans and structure and then to the shaping of the spaces. Let's consider the consequences of this approach. (pic. 10) Does this "skin in" process bring with it a radically different method with respect



pic. 10

to the "industrial" and "modernist" approach? Naturally the reader should think about this a bit before proceeding with the following lines.

The answer is: yes, and how! The skin in approach is linked to a paradigmatic change in all of architecture. The modernist method was similar to an assembly line; pieces were developed that made up the machine/ architecture, components were standardized and the various systems (of the structure, plans, exterior panels) were made as autonomous and independent as possible. Remember the five points of Le Corbusier? The system was summarizing, mechanical and absolute. Gehry's method is instead "relational". The secret is the relation between the parts, instead of their independence. Underneath the curves of this architecture the components of the construction are connected to each other through an electronic model also realizing in coordinated layers; one that regards the exterior surfaces, one of wire that describes the geometry and structural grid and a third that outlines the interior cables. All together they form a sort of carpet: waving, electronic, and, if we recall the Futurist, Bocconian trajectories we have used to describe his work, in flight».

Now this is an important point because we brought a very different approach to the subject, and for our students who start in a different way of thinking this construction goes in different ways. It is really something that is actually happening. And the centre of this – and of course I agree with Dimitris who pointed this out – is really the concept of model. The model is not, as we used to think in the past, just an example to copy. The model today is a set of relationships between the components of a project.

Anyone who approaches information technology is generally interested in obtaining a series of practical advantages (duplication and facility of manipulation of graphs, access to data banks, three-dimensional visualization, electronic transmission of information and innumerable others). The information contained in an electronic representation of a project are not rigid anymore (as they are in the traditional supports) but easily modifiable. While this aspect is of easy comprehension, much slower is the consciousness that the novelty doesn't consist so much in the facility of the "change", as in the fact that the information assumes a "dynamic" connotation: the electronic data can therefore be manipulated not only in their singleness, but above all in their relationships as a whole.

The elaborations, which describe a project, tend therefore to be organized in a "model": in a structure that, in other words, (as in the mathematical equations) formalizes some *relationships* among unknown terms. The verification of the results can be accomplished many times, assigning specific values (which therefore is the project hypothesis) to the unknowns. This potentiality enables the architect to start to master, even in the field of planning, a "Philosophy of the simulation": that is, to make use of the project not only to represent, decide and describe, but as a structure that, from time to time, "simulates" the behaviour of the building system and allows because of its interconnected data structure the different sub-optimization we mentioned before.

Now, all these ideas of the model are coming also from the thinking of some professors already in 70's. For example Chuck Eastman who was in my early years still at Carnegie-Mellon called this concept with word database, the 3-D database. It was a kind of dream in the 70's that this 3d full dynamic description of a project could be used as a base of normal activities going from expert to expert system of interrogation to the actual construction and so on, and that this idea of model could be the centre of a new generation of architecture. One of the key aspect of this is what we may call parametric, or in another way, and this is slightly different, instantiation.

What is instantiation? It was a concept that already partly existed in the 70's. Instantiation means that the 3-D model built in such a way that touching certain elements many other things change following it, because the relationship is like a mathematical equation. If we change some parameters, they all change. Naturally this is just one of those components of the 3-D world, the world of Information Technology and the world of architecture of to day.

And here comes again that idea of the mental landscape and the relationship between electronic model and real architecture. The question that the new generation of architects and researchers are posing themselves is exactly the following: if the IT model has that capability to change, to instantiate and to make continuous different hypotheses, is not this one a characteristic only of the element model, but it should not be characteristic *of the real new generation of architecture too!*. It is the new generation of architecture that must have that capability to be interconnected mutable and changeable as an electronic model. So that is something that is being transferred from the mathematical idea of the model incorporated in Information Technology to actual architecture, becoming a feature of actual architecture; that is why we are talking about actual architecture, that is why we are talking about interactive architecture, that is why we are talking about environments that can be changeable following the evaluation of the situation, desire, problem and crisis.

And now approaching the end, I will just pinpoint some cases of friends or of very well known architects of younger generation that deal with this in different ways. These are all people that lecture around the world in different situations.

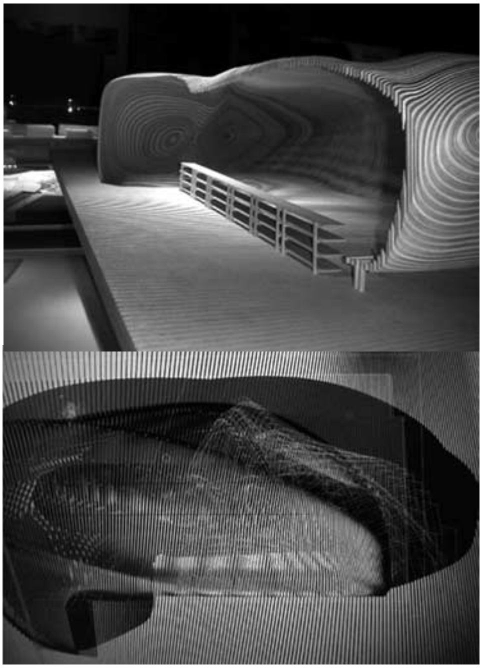
This is Mark Goulthorpe founder of Decoi. One of his last works (pic. 11) is the study of how we can make a series of spaces for a fashion exhibition in a way that is completely parametric, that means every time it is changed but following a whole process; it goes from design to actual manufacturing. Mark has been working many years in this field and has not only a very strong technical capability but also a particularly elegant touch I would say.

This is Jakob-MacFarlane, that did the Pompidou restaurant, and also this library (pic. 12), which again shows a lot of implication in construction and in Information Technology.

This is Makoto Sei Watanabe, whom I mentioned before, this is one of his stations for the fast train (he made several of them), although those that I was talking about before are other stations which are subway stations.

This is one of the genius that we are lucky to have around the world, and that is Toyo Ito. Toyo Ito had a great understanding of the relationship between Information Technology and architecture, and he was able to create architecture of enormous poetic intensity, not only from the technical point of view (you will remember *the Tower of Wind* that was one of the first examples of interactive architecture in the 80's) but also with a poetic and constructive intensity that is really rare. I think Toyo Ito is one of the greatest architects that humanity has now. This is a quite recent Competition for an auditorium he signed, and lost!, with Andrea Branzi (pic. 14).

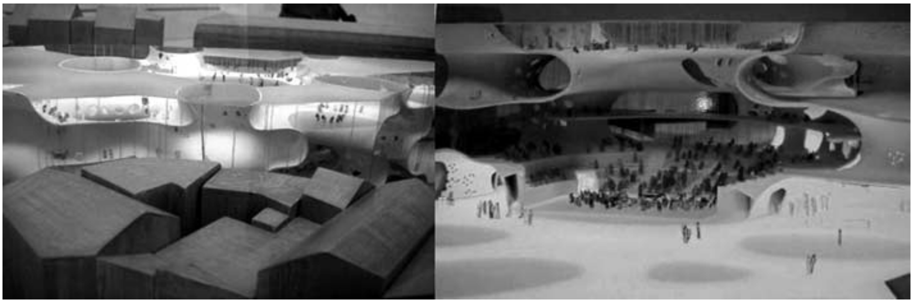
Talking about completely new ideas and real research, someone I



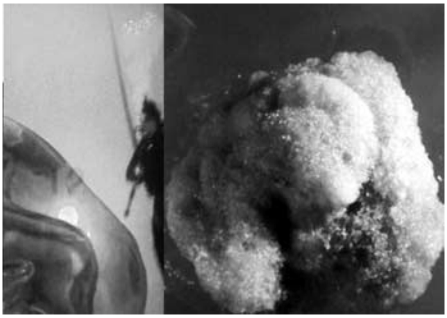
pic. 11

pic. 12

pic. 13



pic. 14



pic. 15

pic. 16

am very fond of is Zbigniew Oksiuta who is a mixture of a scientist, an architect, a researcher, who works in Germany with the support of important German companies on understanding how to create a new generation of forms that are inhabitable and also eatable. This research is very interesting, and he is beginning to understand how to work these things out (pic. 15).

I will now move on to crisis, and then I will bring the lecture to an end. For me, the concept of crisis is the fact that we as architects have responsibility and have to face issues. One of the issues of these last few years is to understand the impact of Information Technology on our own field and to search for answers. When I was invited to give this lecture, I realised that there were two things that I particularly wanted to show you. These two things are not necessarily completely related to what I have said. Each of you can put these things into whatever framework you wish. For my own part, I am totally fascinated by these two experiences that I am going to show you in a second, because they deal with constructions, they deal with education, and they have the touch of need that I think is absolutely crucial in making important architecture. This is the first one. Some of you probably know what I am talking about. We are in the American deep south, in Alabama. This is the famous bridge on which Martin Luther King started his march in the 70's (pic. 16). So, we are in the poorest region of the USA; and one thing that we understand just looking at the rural south is that there are parts of the USA that are exactly like Africa. I taught in Africa for many months, sixteen months, so I know Africa quite well. And then I can tell you there are levels of poverty in the US similar to what I found in Africa. This man is a teacher, his name is Samuel Mockbee. Some of you know him, probably some of you don't know. Samuel Mockbee also had a dream: his was to do something in that poorest region of the USA, of Alabama. He was from Mississippi, and he chose the poorest part of Alabama to set up the Rural Studio. The Rural Studio is the realisation of his dream, and it is based on a very simple concept. Why should the student of a school of architecture not have to actually build and experience construction, to experience design and the actually realisation of it? A very simple and straightforward question. The second question is why, instead of doing these things on a grassy university campus, do we not do them where there is a real need, where there is real poverty, where we can be doing something useful? These are valid concerns, but what I want to point out here is that the result is beauty at its purest level. We are interested in Mockbee's project not only for the excellent humanitarian reasons, but also because what is going on here is beautiful. What they are doing is re-using, in a very imaginative way, discarded materials obtained from donations. Carpets, for example, which in American office buildings are replaced every six years, can be used by Mockbee's students as materials. Experimenting, studying, building, making it. What we are looking at here (pic. 17) are what they call pods (before the Ipod). These pods are places where single students lived, and they were near a large mansion. What we see here, for example, are licence plates that the State of Alabama didn't use, which are being put to use as a kind of panel material. The bricks we see here that were all discards, which again are being put to constructive use.

All these things are designed and built by students. And there is a quite interesting process behind them: the community draws up a list of things that the community really needs, which can either be private – for families that for one reason or

pic. 17

pic. 18

pic. 19

another have no house or have a house in a terrible situation – or communal. And the Rural Studio first studies the priorities (and that is an important job in itself) and then starts the design process. (We could talk about what the principles are here, but I don't want us going too deeply into that.) Then they use the material in these innovative ways and actually construct them. The majority of these buildings are completed in one cycle, starting in September and finishing the construction in May. Many of them are thesis projects, but there are also second year projects that work on a slightly different level.

These are things that I really wanted to show you. You can make whatever sense you want of this experience. But just look at this house. You can see the house as it was, and then there is this intervention, this rehabilitation, this addition. This is one thing that I am really moved by, because you really feel the presence of architecture there. And you feel the need to give the space a new identity (pic. 18). This is a little chapel made of used tires. This is a little basketball camp. This is a child care facility – this was one of the first projects. And these are the type of people that live there (pic. 16). You have to feel that – this is poverty such as we can with difficulty imagine. Construction is clearly about "need" here. This is what I mean.

And then I want to show you one last project, again very simple. This was built by an architect who is a very good friend of mine, Giovanni D'Ambrosio, who for many years found little work in Italy and worked almost exclusively in Asia. Specifically I wanted to show you this little school, because it is a kind of a prototype that illustrates this sense of mood, the profound mood of a construction; and I think this is a quality that must be kept in whatever you do. This school only cost around 10,000 euros, and it is based on an idea that you can understand immediately in the section. The key idea is this beam (pic. 19). This beam, of reinforced concrete, resting on a brick wall, is the only high technology in the building. Now this beam is many things in one, as good architecture generally is. Not only is it the support of this light-weight structure of two roofs done in different ways, but it is also the green heart of the whole thing, because on this beam, which is shaped like a planter, different kinds of vegetables grow, so the whole concept is also a poetic idea in that the little children can follow the two natural processes of growth and learning. And what is also fascinating to me here is how he, from Rome, was able to build this in Bali. At that time he was not an IT person, and he still he is not very IT-oriented. Everything was based on the fax, on fax technology. It is a very simple system of modules, with very straightforward information that was passed from the thinker through the geometry to the builder. So that process would probably be completely different today; but if by fundamentals we mean something close to this, then I am with you. Thank you.

All the lecture with many more other images, the quicktime movies and links can be followed at www.arc1.uniroma1.it/saggio/Conferenze/Barc/Eaae05.htm
Extra information about work if needed

Jakob & Macfarlane, Librarie Florence Loewy, Parigi
Mark Goulthorpe Decoi, Line of fashion Atelier
Makoto SeiWatanabe, Shinkansen / ShinMinamata Station (2004)
Toyo Ito - Andrea Branzi, Opera House, Gent, Belgium, 2004

Keynote Address

Christian Schittich

Architect, Detail Editor

Munich, Germany

Designing with Details – Actual Trends

The main topic is "Actual trends in Designing with Details". By way of introduction I will give you some general thoughts about construction, and specifically about construction detail. Then in closing I will say a few words about the magazine DETAIL.

In this present company I do not have to explain the meaning of construction or of construction detail at great length, but I would like to express a few thoughts.

Each detail has two key aspects, or functions: the technical aspect and the aesthetic aspect.

The primary function of structural details is to resolve technical problems; but their aesthetic and artistic significance is equally important, since the latter has a major influence on the character and appearance of a building. How details are formed has a decisive impact on the building's aesthetics – which in turn governs whether the building imparts a smooth, textured, filigreed or sterile effect.

Teaching construction is mainly a matter of the following two issues: Conveying comprehension of the technically correct detail to the students, and showing how one can design with construction details. And this, in my opinion, applies regardless of whether one designs by hand or with the help of a computer.

Even if in some areas details are getting more and more complicated and increasingly more detail work is being done by specialists (such as contractors and specialist engineers), architectural education must provide comprehension of what is good and what is wrong. It is the architect who has the final responsibility, which is to say that he/she must remain in control.

Sadly, I have the impression that the subject of building construction is being increasingly neglected at the universities, although of course I can only speak for Germany. Traditionally, great importance is attached to technical solutions in Germany. Our standards are very high – sometimes too high. Traditionally, the teaching of construction was also very important, and students were very well trained and very highly skilled. In architecture firms quite a lot of young associates work on detail planning in order to realise these high standards.

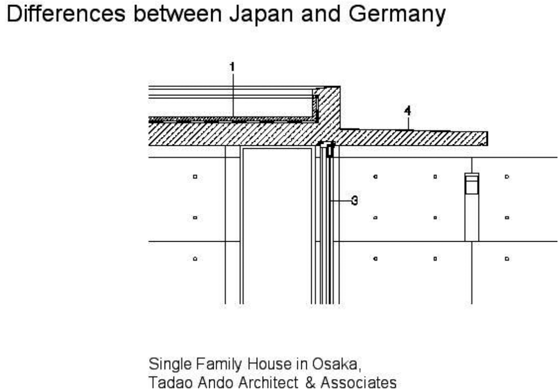
Recently, however, I have got the impression that for many of those teaching, even some holding a chair in building construction, the design of the building is far more important. This, however, is very dangerous.

If the architect is no longer qualified in this area, he will not only lose some of his influence in terms of aesthetics and design, but will also lose his influence within the building process generally, and sooner or later will end up as nothing more than a packaging artist.

The client will judge the architect first and foremost by the fact of whether the basic functions are accomplished. These basic functions also include - besides keeping to deadlines and costs – the professional solution of all technical problems.

Regional differences

Attending this conference today are people from different countries across Europe, each of which has different building standards. It is interesting, therefore, to see the positions at the extremes.



Pic. 1 Detail of Ando House

This slide is one I prepared for a speech that I gave in Tokyo some weeks ago where I intended to show the differences between Japan and Germany – which are probably the most extreme cases.

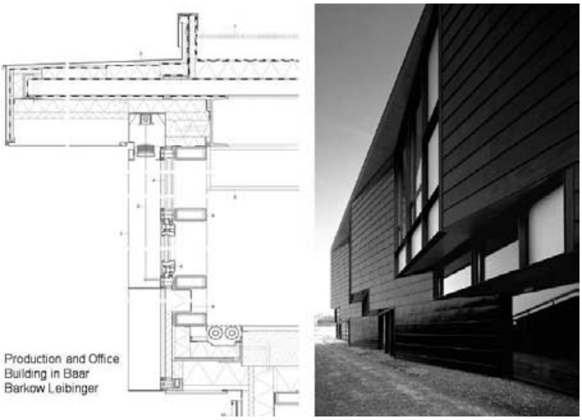
Germany, together with its German-speaking neighbours, Austria and Switzerland, has the highest and most restrictive technical standards in the world. For reasons of safety and guaranteed durability, nearly everything is regulated and controlled right down to the smallest detail. There are regulations dealing with every aspect of a building: its expanse, its appearance, the minimum height of a flashing at the edge of a roof, how a moisture-resistant layer negotiates a curve, and so on. Architects may not disregard these standards, unless they wish to be liable for any ensuing damage.

Japanese architects, on the other hand, enjoy greater freedom in how they may design, face a more temperate climate, and can take a somewhat casual attitude towards energy consumption. This allows Japanese architects to produce lighter, more filigreed forms of construction. There is much less insulation, and windows are usually fitted with single glazing only. Related matters like the avoidance of thermal bridges do not arise.

These, however, are the very aspects that generate problems in designing details in Central Europe. There the approach is to have an evenly insulated outer enclosure, impermeable from the outside or the inside by any elements with high thermal conductivity, like concrete or steel – regardless of whether one utilises brackets, columns, or casements with non-thermally separated frame sections.

The slide shows the perimeter of the roof of a single-family home in Osaka, designed by Tadao Ando. Any German architect would be envious of Ando, for simply having the opportunity to incorporate such details:

In Japan, there is no need to consider thermal bridging, insulation is almost non-existent, no sealant strip and perimeter flashing need cover the protruding part of the concrete roof, and filigreed single glazing only is used.



Pic. 2 Production and office building in Baar / Barkow + Leibinger

Things are not the same in Germany or Switzerland (where this building, designed by German architects, is located), as depicted by this section through a production and office building in Baar:

Thermal insulation is packed around everything, thermal bridges have to be avoided and metal sections are thermally separated, while insulated glazing results in thicker sections, which in turn lead to a more massive overall structure.

Nevertheless, this slide shows that even under such restrictions one can build light, filigreed structures, provided the details are designed with care.

You all come from different European countries, whose standards lie somewhere between these extremes...

These examples show how different standards – different building standards and different general standards – can involve the aesthetics as well as the technical solutions of a detail.

I would like now to move on to the theme of designing with details.

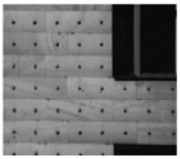
Pic. 3

The attitude of the designer/architect has much more influence on the aesthetics of detail than do any standards. And, as I have already said, it is the construction details that critically leave their mark on the character of a building.

This applies to traditional houses... (Pic. 3)

... to the Postsparkassse of Otto Wagner with its expressive stone trim...
(Pic. 4)

Postsparkasse Vienna, 1903
Architect: Otto Wagner, Vienna



Pic. 4

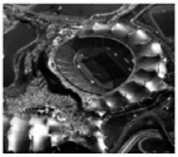
... to the details of Walter Gropius at the Bauhaus...
(Pic. 5)

Bauhaus Dessau, Germany, 1926
Walter Gropius

Pic. 5

... to the very technical details of lightweight structures like the Munich Olympic Stadium by Behnisch and Frei Otto.
(Pic. 6)

Olympic Stadium in Munich 1972
Frei Otto
Behnisch & Partner



Pic. 6

... and to so called high-tech architecture, like Norman Foster's Renault building in Swindon.
(Pic. 7)

Pic. 7

In the high-tech architecture of the early seventies, enthusiasm for the technology of the times began to materialise in the form of a playful handling of structural elements. The buildings drew their expressiveness from the overemphasised, virtually mannerist, design, where structures and related design details were elevated to the level of decoration. Besides being functional, each screw, each bolt, each tension cable took on an aesthetic symbolism – to the extent that connecting nodes were consciously broken up into multiple single elements to underscore this effect. This is quite apparent in this view:

I am showing these examples of high-tech architecture to highlight the fact that, compared with this period, details had been far less exaggerated, from an artistic sense, over the previous century.

High-tech is not a style, but rather a trend among several others. It lasted through the mid-nineties and in its time influenced detailing even on non high-tech and residential buildings.

Pic. 8

For an example of this trend and the initiation point of today's trends, I would like to draw your attention to this single-family home in Münster (Arch.: Gabriele Andreae). (Pic. 8)

This house represents very high-quality architecture that is barely a decade old, but it is clearly not from today. Details like these breaks created with ceiling mouldings, the accented screws and the use of profiled metal sections rather than smooth ones were typical of that period.

Having covered the initiation point, I shall now spotlight today's trends:

I will not attempt to give you a comprehensive overview, which would be impossible due to the wide variety, the many possibilities and the countless different approaches, but will instead make an effort to highlight a few of the latest trends in designing with structural details.

In order to simplify things and to make myself clearer I have assigned the examples that I am presenting to various keywords. This does not mean that I want to classify or pigeonhole architecture (like the art historians); it is simply that using keywords makes it easier to point out vital aspects and explain the varied approaches.

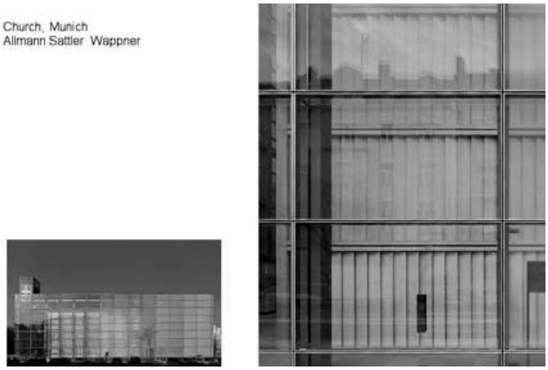
1. Reduced detail

Minimalism is one of today's key trends that has cropped up worldwide, and whose origins in Europe lie in German-speaking Switzerland. In pluralistic times, like today, minimalism appears in parallel with other, sometimes opposing, trends. One of minimalism's main attributes is its recalling of the simplistic form in response to an increasingly complex world and an ever more heterogeneous, but also louder and noisier, environment.

This simplicity of form expresses itself as a box, like this glass box – the Herz-Jesu-Kirche (Church of the Heart of Jesus Christ) in Munich. (Pic. 9)

The details on the surface have been cut down as far as feasible, to allow as clear as possible a transformation of the basic concept of a simple form.

This also helps explain the next example, which was designed to integrate a modern building made of three separate structures into the existing small-town environment with steep roofs.



Pic. 9

The idea of a continuous skin of bead-blasted stainless steel stretched over façades and a roof without visible seams has been carried out beautifully, down to the most minute detail. Reflecting the colour of the sky, the buildings seem to defy any corporeal existence. Built for a metal industry association, this concept is persuasive in terms of the task, materials and construction.

This illustration (Pic. 10 / Südwestmetall, Arch. Allmann Sattler Wappner) PP. 15 underlines the fact that minimising surface details is technically very complex.

With an increasing focus on the surface, the nature of the materials becomes the focal point of an architectural debate: the material itself emerges as the means of highlighting an aesthetic exterior with tactile qualities.

Pic. 10

The concept of minimalism also emerges in many of the buildings of Tadao Ando, where the details are very reduced and the material – concrete – expresses itself.

The same attitude, but using another kind of concrete, a kind of artificial stone,

Pic. 11

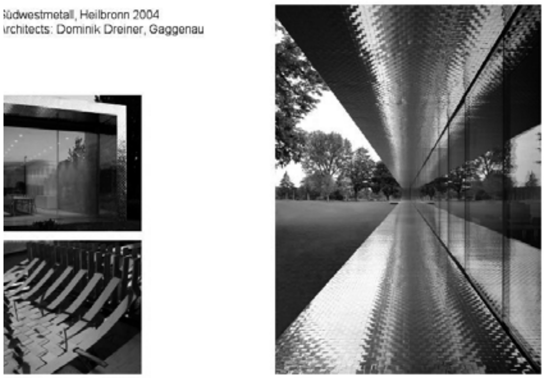
Pic. 12

is seen in the façade of the new Museum of Art in Liechtenstein (2000) (Pic. 11), designed by Morger, Degelo, and Kerez: by reducing visible details in the building, the material unfolds to convey a more intensive sensory impact.

At the Museum of Modern Art (2001) (Pic. 12) in Vienna's museum quarter, architects Ortner and Ortner strived to achieve the illusion of a massive masonry wall made of shimmering, green and black basalt. The overall impression of an archaic structure is achieved, in that the façade extends above the roof and all interfering elements like flashing, gutters and building equipment are hidden within the building's shell.

Textile details

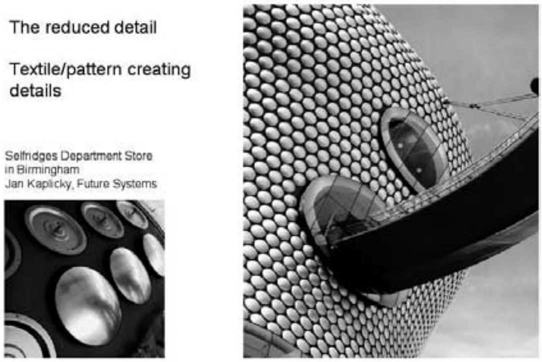
Dominik Dreiner's Administration Building for a Metal Industry Association in Heilbronn (Pic. 13) has re-ignited the debate on Gottfried Semper's theory of textiles as the origin of architecture.



Pic. 13

The two sides and the roof of the clear, unadorned shell of the building are clad entirely in a stainless steel lattice mesh that reflects the surroundings, and which either dematerialises the structure or articulates its contours, depending on the lighting. This new means for cladding the façade uses stainless steel strips, 0.4 mm thick and 50 mm wide, woven in a warp and weft system to form lengths of lattice sheeting.

Jan Kaplicky of Future Systems in London used an evening dress from fashion designer Paco Rabanne as a model for cladding the uneven, curved façade of the Selfridges department store in Birmingham with 17,000 individually attached aluminium discs. It comes across like a coat of chain mail clinging to a body. This is again a case of details with textiles, even if in the true sense of the word it is not a textile structure, but rather a uniform pattern. (Pic. 14)



Pic. 14

The main aspect of the glass hangar for the fire and police station in Berlin, designed by Sauerbruch Hutton, is not its 3-D texture, but rather its colour and the coloured pattern. (Pic. 15)

Pic. 15

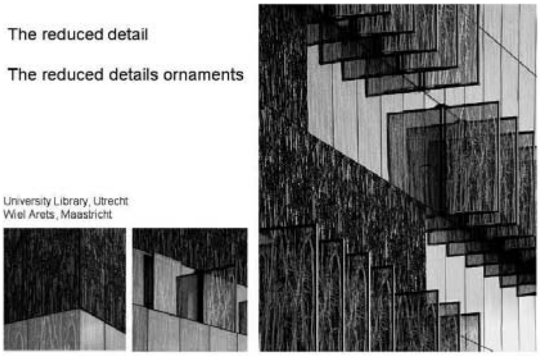
Ornamental details

Ornamental details do not refer to structural details involving the addition of structural components, but primarily to the treatment of the surface.

As mentioned earlier, the current trend in architecture is to push the structure and space into the background while stressing the surface. This can manifest itself in the presentation of the materials, as shown earlier, and as a strong preference for ornamentation. The architects involved here consciously oppose the modernist dogma that disapproves of ornamentation. Ornamentation, however, is not always decorative, since one purposely employs the façade as a symbolic means for displaying messages and for communicating.

Modern computer technologies and reproduction processes support this trend, by enabling pictures to be reproduced at will on construction surfaces such as glass, metal and concrete.

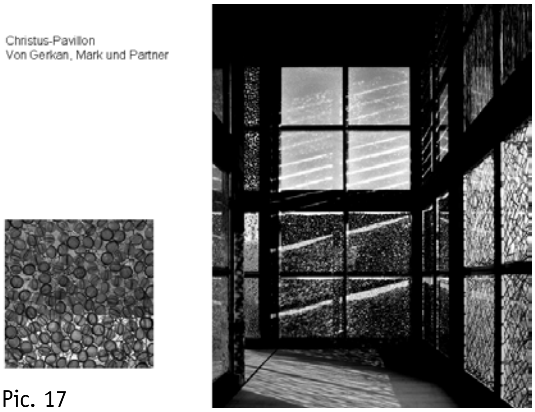
Generally simple structures with reduced details are ornamented.
This is confirmed by the library of the University of Utrecht by Wiel Arets (Pic. 16), where the same pattern of willow branches is embedded as a relief into the concrete,



Pic. 16

and displayed as a silk-screen print on the glass.

The library of the Forest Academy in Eberswalde, designed by Herzog & de Meuron, is probably the most radical example of a decorated box, where photographic motives designed by an artist cover both the concrete and glass. From a distance, the two materials are hard to distinguish from one another, resulting in a clever game of perception.



Pic. 17

Another completely different experiment with surfaces is seen in the Pavilion of Christ, designed by Gerkan, Marg & Partner, for the Expo 2000 in Hanover (Pic. 17). All kinds of common objects reflecting the Expo theme fill the sidewalls of the enclosed space, as displays between two panes of glass. The objects in this diverse collection, including feathers, wood chips, light bulbs, tea strainers and cassettes, combine to form a variety of patterns, casting fascinating images of lights and shadows onto the floor. The materials appear in a new and unusual context. Here, too, emphasis is on the pure nature of the material, whose structure is transposed into a form of ornamentation.

Pic. 18

2. Expressive detail

Expressive detail does still exist, although today it is not so common. (Pic. 18, Museum Dr. Makino, Arch. Hiroshi Naito)

3. Simple detail

With simple detail, as opposed to reduced details, the aim is not to give the impression of simple, archaic structures, since these are often heterogeneous. The details here appear outwards in a basic form; they are smooth, sometimes even sterile, and do not possess the finesse of reduced details. Under the visible surface, however, these details may be as complex as the reduced details.

Simple details are often a common feature associated with office construction, but they occur both here, and frequently, as the standard solution for large offices. (Pic. 19, GIRA building, Arch. Ingenhoven)

Pic. 19

4. Handcrafted details

Handcrafted details are also quite simple, but very different, as shown on this modern interpretation of a traditional wood log bridge designed by students in the Italian Alps. They used only locally sourced timber to enmesh ecological aspects with a spirit of experimentation, by radically minimising all the details down to the structurally essential elements. (Pic. 20)

Pic. 20

5. Engineering details

Ackermann: Classic engineering details in the footsteps of Frei Otto and high-tech designs (Pic. 21)

Pic. 20

Pic. 22

Calatrava: Reduced engineering details, so that the entire shape conveys a 3-D, sculptured effect. (Pic. 22)

Pic. 23

Herzog & de Meuron, Allianz Arena: Even here, reduced details of the façade lie in the synthetic foil air bags, reflecting Herzog & de Meuron's strategy of distancing themselves from structures while accentuating surfaces. The details of the building skin have mainly been developed by the contractors (like Covertex) (Pic. 23)

Pic. 24

A much clearer structure shows the roof of the Berlin Olympic Stadium, designed by von Gerkan, Marg and Partner (Pic. 24, PP.55, 56)

Keynote Address

Mark Burry

Spatial Information Architecture Laboratory

RMIT University,

Melbourne, Australia

What can the Architect Antoni Gaudí -who died in 1926- Tell us about the World of Digital Design

The three main topics I am going to deal with – quite quickly because there is a lot of material to get through – are germane to this conference. One of the topics I want to look at is the research loop, which has been referred to before. Typically, we can see the research loop as the nexus between the academy, practice and research. We are familiar with the academy and research nexus: typically we see building science featuring there; sometimes we will get history and theory with some prominence; but generally it is the sciences that seem to be favoured. And equally, if we look at the academy and practice, there is significant connection there too; most of the schools that I have been involved with rely on eminent practitioners contributing to the projects. But one of the strangest anomalies is the relationship between practice and research. There are very few practices that actually support research in any meaningful way. When I interview practices they will tell me that they are undertaking research; but, when I dig deeply, I find that what they define as research is not really what we, at a university level, would define as research. And so we look for the relationship between the practice and the university to happen at a meaningful level around research. This should be a golden triangle, but is actually more like a black hole. My entire research effort is dedicated towards the idea of some tremendously fertile relationship between practice and industry, research as an activity, and part of the academy's role as a teaching establishment. A recipe for fixing the black hole would be: indulgent clients in no real hurry; governments who believe in tax-funded research for public good; practices willing to share their knowledge; universities able to work with real-world constraints and share their databases; and postgraduate students willing to extend their architectural education by quite a few years. The failure to provide all the ingredients for this recipe is probably the reason why we have such a difficult situation regarding the nexus of architectural research, teaching and learning, and practice.

Most of my talk tonight is going to be around Gaudí's design for the Sagrada Família Church and the efforts to continue its construction, a project with which I have been involved since 1979. I am going to tell you the story of what has happened there over the past twenty-six years, and I am going to use this as a benchmark for how practice, the academy and research can actually come together quite well.

Gaudí the design and construction innovator

My involvement with this university, The Universitat Politècnica de Catalunya, started in 1991, when the University was invited by the Sagrada Família to participate on a number of levels. The Sagrada Família Church technical team required support for geometrical resolution, including support for some structural and engineering principles, and they also needed support at a theoretical and historical level. So without further ado, I will describe my insights on the Sagrada Família, and why I think that it is so important for our time in demonstrating some powerful reconnection between the academy and practice. However, before looking at the Sagrada Família, it may be better to look at the image of this building first [Figure 1] in order to assert my personal position first.

I have to make a small diversion here: for those people who are very disturbed

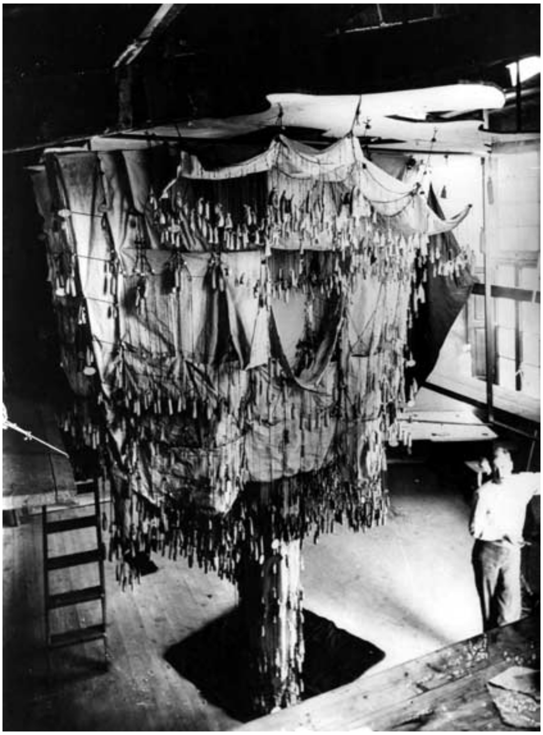


Figure 1.
Colònia Güell Church hanging model.

about the digital invasion into the practice of architecture generally, and I have the impression that there is an obvious undertow here at this conference of folks who feel that the admittance of the digital into architecture is an abuse, I am going to state my position very clearly here: I am a post-digital operative. I have no particular interest in the digital *per se*, just as I have no interest in the traditional *per se*, but I have a lot of interest in their fusion. And I think that the people who I admire most and work best with are the people who rather than polarising one way or the other are able to form some kind of fusion between the digital and the analogue, without getting too strung out about the difference between the two modes of practice. And I feel that the more we try and polarise between the two extremes, the more we shoot ourselves in the feet, so to speak, particularly when we are trying to be a meaningful profession operating in increasingly difficult circumstances (competition from other sectors, the rise of the project manager etc.). Gaudí, however, keeps offering us *post mortum* opportunities to rethink just what our priorities might be.

The image referred to [Colònia Güell Church], which is pre-digital Maya™, contains the whole idea of trapping forces for modelling, which you can see Gaudí has done using this hanging model. This project will no doubt be familiar to all of you, but I just going to labour the point that it is actually a post-digital project even though it was done in pre-digital times. It is a project that seeks to understand how gravity asserts itself in terms of forces applied to materials, by representing the church subjected to forces of tension by hanging it upside down. This is a small church that was planned for the Colònia Güell, just outside Barcelona. Gaudí's idea was that if you could understand the forces modelled in this case in tension, all you needed to do in order to 'see' the proposal subjected to the 'opposite' effects in compression was to invert the model. So Gaudí arranged for photographs of this particular model to be taken, inverted them, and painted over them, and thus you would have a reasonable representation of what the church might look like as a completed building.

It is an extremely interactive model, and the more you load it up with little bags of bird shot the more you pull the model out of, or into, shape. And as we know with Greg Lynn's work and from looking at animation products such as Maya™, this is pretty much closely aligned theory for experiments in form trapping physics, in my view; it is just the technique used that is slightly different.

I have to confess that being a forty-eight-year-old proto-fuddy-duddy I find Gaudí's haptic physical experiments more attractive than using the computer, but I imagine that a lot of the students that I work with would find this process both slow and awkward (and I would probably have to agree with them if that is their point of view). So if the hanging model photograph represents pre-digital Maya™, the painted-over photographs of the inverted model might be pre-digital Photoshop™. The idea that you can actually use an imaging tool, which in Gaudí's case was a paintbrush and a photograph – and photographs were new technology at the time, but the paint would not have been – in order to represent this building, was a technical innovation for design exploration of its time. And for the interior, equally relying on the camera, which was stuck inside the model, a photograph was taken and painted over. This alone would be a fascinating story if it were the sole extent to which the experimentation was taking place; but, furthermore, the model itself, which was on a scale of 1:10, was hanging in a shed adjacent to the site of the proposed church construction. So instead of having to dive into any dominant paradigm in order to build it, that is the plan, section, and elevation, Gaudí relied entirely on the hanging model for deriving the requisite spatial information. For all these little props that can be seen in the photographs of the construction process holding the columns in their preferred alignment, the information came straight from the analogue hanging model. The church itself therefore has a remarkable interior where all these forces have been captured with the axes of the columns aligned with them, with the information for this alignment coming directly from the adjacent hanging model.

The building was over-structured from Gaudí's point of view, so he requested a stonemason to take scarfs out of these basalt blocks, which are naturally occurring hexagonal prisms of basalt, just to increase the sense of finely equilibrated structure. Apparently when the stonemason concerned was a little alarmed about the prospect, Gaudí was obliged to stand underneath the column while he completed the task. From a constructional point of view, the junctions between columns and bases are demarcated by a layer of lead, a couple of centimeters of lead, that has been put into the joint, so that as this building would go up in height and concomitant mass, the equilibrated structure would relax into its ultimate form, as Gaudí had anticipated. What we have, therefore, as a model for our potential to invent today is an architect who could not only experiment in a most philosophical, theoretical and very extreme way with a hanging model, but one who could also actually anticipate and interpret the constraints of constructing such a building to the extent that he adapted the church accordingly at a most detailed level.

The Temple Sagrada Família, from Gaudí's point of view, was a church for a site

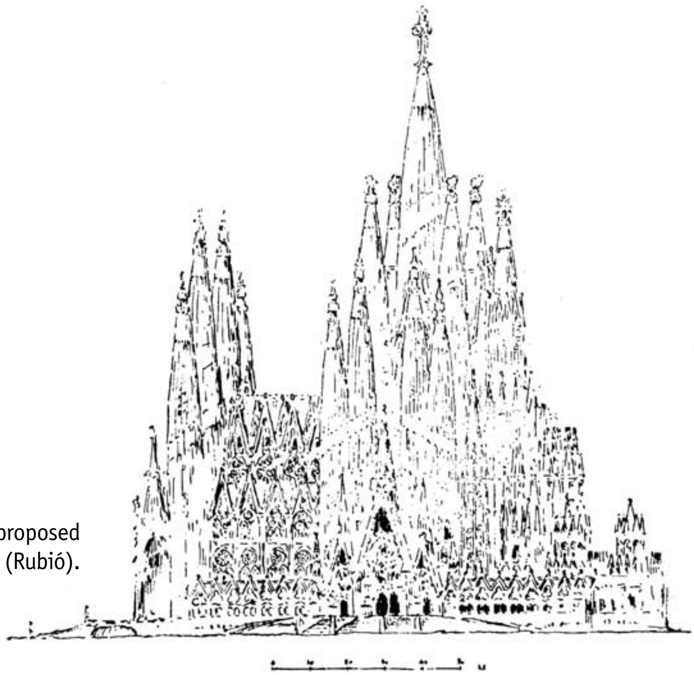


Figure 2.
1906 drawing of the proposed church – oblique view (Rubió).

on the periphery of the growing city of Barcelona that was founded to celebrate the Holy Family (hence the name Sagrada Família), and particularly with Joseph, the Patriarch and father of Jesus in mind. The young Gaudí started the building just a few years into his career. As my students always love to hear, he had a difficult time at university and he had to repeat several of his courses. He arrived in Barcelona from Reus in neighbouring Tarragona province – the son of a coppersmith and thus from a fairly humble artesanal background – but on qualifying he became very much a man-about-town, (a 'dandy' architect is another way he has been described), who apparently used to bark out orders from his carriage window without getting out. This is the same man who later became a very devout Christian, abstemious in all his habits, including being an extreme vegetarian. The Sagrada Família Church project that he took on had been designed by another architect del Villar, and the construction of del Villar's design were underway on site for at least a year with the foundation stone laid in 1882. Gaudí himself worked on the project for forty-three years, having started in 1883, and in this time he was able to complete only the apse, and most of the group of four towers that comprise the east transept (the 'Nativity Façade') [Figure 2]. This first drawing of Gaudí's project was produced by a colleague, Rubió, but not until 1906, twenty-three years after Gaudí had started and twenty years before he died. So, the first drawing we actually have by Gaudí of the church as a whole was a generation in time from the point he had started, yet if you look at the original proposal for the church, it was supposed to become just a small parish church. Apparently, however, the foundation promoting its construction received a large bequest of money at a critical moment; and so, rather than simply bring the church to a fast conclusion, Gaudí decided that it was time to change the scale of the building to cathedral proportions.

The 1906 drawing referred to is the *schema* of the building, as it were, and it is the most important drawing that survives as an image. We do not have the original, just photographs of the drawing; but was published at least three more times, with slight variations, before he died, all of which suggests that he was wedded to this as being the overall form of the building.

In 1914, twelve years before he died, Gaudí had a number of personal catastrophes: the first was the abandonment of the little Colònia Güell church project, (derived from the hanging model discussed earlier), which had eventuated from a fourteen-year gestation as just the basement crypt and no church on top (which remains its completed state today). I should imagine that that was a major disappointment. Then, he had to sue his client for his fee for Casa Milà, also known as La Pedrera, because by the time he finished the building the whole taste in architecture had shifted from the *Modernista* period to the relatively reactionary neoclassical revival of the *Renaixença*. The third disaster for Gaudí was the Güell estate (Parc Güell), the suburban village development that was meant to have sixty houses established within it, but in fact was abandoned with the surviving and much-loved extraordinary infrastructure in place, but with only three of the intended sixty houses built. So, in all probability, around 1914, Gaudí had some sort of breakdown, because he ended up going to the Pyrenees for a few months to recover. He had something called Maltese fever, but I have never really found out the details of Gaudí's ailment. In any case he certainly had some kind of physical if not mental breakdown, and I think that at that time he must have been wondering what he was going to do with this church, of which only a tiny fraction had actually been completed. Once he returned to Barcelona following his alpine convalescence, he was re-focussed with an essentially new *modus operandi* developed over his remaining twelve years ultimately bequeathed to his successors as the completion strategy for the Sagrada Família Church.

Towards a new paradigm of construction representation

This background to Gaudí, the design and construction innovator, leads me to the main part of my account, which is what Gaudí did in those last twelve years of his life. This is a pretty obscure period, and would have been totally obscure were it not for his efforts in trying to complete the design for the building. He made large-scale models (1:10 and 1:25) of most of the remaining unbuilt parts of the church; that included the second transept, the nave and the sacristy towers, which are the prototypes for the main towers over the apse and crossing. A quick run through what those models were, what they represent and how they have been translated will emerge in this address. But first, some basic information on the building.

Gaudí inherited the building project as a proposal for a relatively small parish church, for which the basement crypt had been half-built. The original architect had resigned on a matter of disagreement with his client on matters of construction: del Villar had insisted that solid masonry was to be used for the entire building, but the commissioners who were financing the building insisted that they use random rubble as a way of saving money. It was only in the last few years of the work to strengthen the apse crypt columns, to accommodate the scaled-up parts above them, that we have been able to establish that Gaudí at least acceded to his clients' wishes and allowed himself to be directed in this way on how to build his building – something that the original architect was apparently not prepared to accept. It was ever thus!

So, looking down at Sagrada Família from above: for most of the twentieth century the apse was just as Gaudí left it, with the first group of the Nativity Façade towers forming the first transept front to the east, with the second group of towers forming the front to the west facing second transept completed between the conclusion of the Spanish Civil War, which ended in 1939 and 1978. Their actual construction started in the late 1940s, when the building's commissioners had successfully raised more funding, and they were finished in 1978.

I arrived in 1979 to research aspects of Gaudí's career for my university thesis – I was studying at Cambridge University in the UK at the time, and I was fascinated with Gaudí before I had even seen the work personally, because he had been rejected in a single sentence at my school as an architect of no consequence "because there was no school". In other words they just considered him to have been some kind of crazy individual with a sense of design priorities bordering on genius but with no followers. Of course nothing could be further from the truth as I hope to establish in this talk.

The intention is to have the whole of the church interior finished by December 2008, for a number of reasons. My involvement with the project began from the time that I visited the building in 1979 when I posed two questions to the two architect directors leading the project at the time: where was the authority to continue the building when the architect had died with so little constructed and, how do you explain to each builder what they have to do for their day's work? And they told me that the answer would be best investigated through a longer visit from me than just an afternoon, pointing to some dusty boxes of shattered plaster of Paris models for the church nave, which apparently held some potential answers to my questions, inviting me to come and spend some time with them on site over an extended period . It was a question of timing, really. I arrived at exactly the moment when the two directors were investigating these models that Gaudí had finished after twelve years, just before he died with a view to commencing the construction.

Image 3.
1:25 model of a section of the Sagrada Família Church project.

This is what the model looks like today [Image 3]. This is the 1:25 version of the design model, and this type of exploration for most of the unbuilt portions of the project existed before Gaudí died. The models took him twelve years to make, and occasionally despite their manifest existence, you still hear things about what a 'terrible Gaudí pastiche' is being built at Sagrada Família, although this kind of ill-informed observation is made less often than ten years ago. It is as if the current project for the Sagrada Família Church is some kind of weird abstraction of what was there already, and that of course if Gaudí had not been run over by a tram at the age of 74, he would naturally have come up with some completely new ideas in his dotage supplanting all the years that had gone before. What that would have involved would have been for him to go back to his client and say: "I know I have just spent the last twelve years devoted entirely to building these large scale models principally of the nave and sacristies, but in fact I have changed my mind and it is going to be something else".

In fact we can see in this part of the building – the nave - and for those of you who will visit it as part of this conference, if you start looking from the bottom of the nave and work your way up – that the surfaces being used become ever more complicated.

Down at the lower regions the nave is relatively Gothic Revival, with one important difference, but as we move our eyes upwards in the building the interplay between surfaces become much more sophisticated. The reason for this was that he was experimenting with second order geometry or hyperbolic ruled-surfaces. This is essentially what Gaudí was devoting himself to during the last twelve years of his life. Very little is known about it because, in the whole of his professional career, Gaudí did not write a single word about his theory or his position, which is pretty remarkable when you think about it for an architect of this stature. On the other hand, we look at his buildings and realise that of course he did not need to write anything at all, since the work is so rich in detail at every level, and has so much to say.

The building was and is funded entirely by public donations – not by the church, nor by the Government, nor by large corporations – and is consistent with the building's full name being the Expiatory Temple of the Holy Family, that is, a church that is intended to allow for the atonement of sins through sacrifice. The reason why there was not much progress during the 1980s was that an enormous proportion of the available finances at that time were being invested in the foundations; if you are giving money to a building that you hope will go somewhere at that time, preferably in your lifetime, it would have been no doubt disappointing to see only these walls emerge. However, in the following ten years during the 1990s and to date the situation has changed completely, with the superstructure proceeding apace.

Image 4 shows Gaudí's design process which neither then nor today represent the conventional building processes. These model makers are intersecting half hyperboloids of revolution (of one sheet), in order to make moulds to produce shapes like this. Figure 4. shows part of the central nave vaults using Catalan vault techniques, and we can see the surfaces themselves suggest the formwork being played out throughout the entire construction.

If we are getting all excited about the fact that it is going to have the interior finished late 2008, we then have to take a step back –because from the perspective of the exterior there is a significant amount to be done beyond 2008 to complete the entire project. The principal tower will be at least 170 metres in height.

One of the reasons that the building's commissioners are so keen to complete the interior by 2008 is that there is now more than two million visitors to the site every year, and, due to the improved financial situation, the building is now being built on in every sector of the site. Two million people are sharing this building site with the building operation, so for obvious reasons they are keen to complete the task, on the inside at least, so they can get some separation between the builders and the 'spectators'.

Moving to the surfaces themselves, now: the process from Gaudí's point of view was that these surfaces are ruled surfaces, that is, they are non-planar but can be described by straight lines (generatrices) that span between two curves (directrices). Apart from an intrinsic beauty derived from the play of light that Gaudí described as "gliding" across the surfaces, he identified the surfaces as occurring in nature and with properties that gave a practical advantage over freeform surfaces, which I will outline briefly further into this address.

Mathematical models for these surfaces existed in his time and would have been known by Gaudí himself. [Figure 5. mathematical model of

Figure 5.
Mathematical model of a hyperboloid of revolution of one sheet.

Image 4.
Gaudí's design process using plaster of Paris to intersect adjacent ruled surfaces (hyperboloids of revolution).

a hyperboloid of revolution of one sheet]. This is a pre-digital parametric model; it is not digital, as you can see: it is a parametric model because it represents one set of values for the three constants that govern the actual form. Any mathematical model that represents a 'frozen' state from an otherwise flexible construct can be regarded as a parametric variant. I regard it as a parametric model, because what it is doing is show an instance between the two extreme states of a cylinder and two opposed cones – these being the maxima and minima for this particular geometry. This is one of an infinite range of in-between states. During this conference I heard one of our colleagues say that parametric modelling had all sorts of problems, and that it was meant for the car and vehicle industries. Possibly it is in terms of software engineering and ultimate markets, but it certainly has some potential for the Sagrada Família, as I will show you in this address, as it has for leading edge practices such as Gehry Partners.

In his final twelve years of practice Gaudí conceived the interrelationship of these forms in his mind. He knew these surfaces had these lines on them, because he studied them when he was at school. We have seen his textbooks, and we know that he was aware of this second order, ruled surface geometry, and you can see fragments of model like this in the Sagrada Família Church museum, which includes samples of the sort of material that I was working on by hand in 1979 and onwards. In figure 4 we can see a whole series of these surfaces intersecting. I think that this needs to be emphasised, because in my experience most people, when they look at these models, do not recognise this is as being advanced geometry. I do not know what they would think it might otherwise be – architecture as cut-gem jewellery, perhaps – but in fact each of the edge curves being revealed are intersections between adjacent surfaces, and these curves are 3-D curves. Where three curves themselves intersect they give points. Such points are the intersections between three lines in space, themselves complex curves, and are referred to as 'triple points'.

Now, if you accept that all this geometry has parameters to it, has constants, then obviously – even if this model was smashed – as long we knew where these shapes are roughly located, we could re-make the model guided in projected view by the proportional system that can be extracted from surviving photographs of the models taken before destruction, taken some years before Gaudí died. As long as we have fragments of a model that includes triple points we could start reverse-engineering the component surfaces and restore the models; and that was exactly what our task was, in terms of my first twenty years on the project. Figure 6. identifies my research areas over these years, and when I was most focussed on these sections.

I am going to show in detail how we found the geometries for the clerestory window along the central nave, and the power of scripting and advanced computation in homing-in on optimum solutions. I am going to show briefly how the parametric design software that we have been using since 1992 was used to uncover the geometries for the central nave roof.

When I first went to the project, and you can imagine going there from a Cambridge late modernist education, where plan section and elevation were not just the predominant paradigm, they were **the** paradigm. I remember lines like "the only time you need to use a curve is when there is a curve in the road"; otherwise everything had to be rectilinear, and certainly something like a circular window was completely taboo. Finding myself in Barcelona after that intense study, being handed pieces

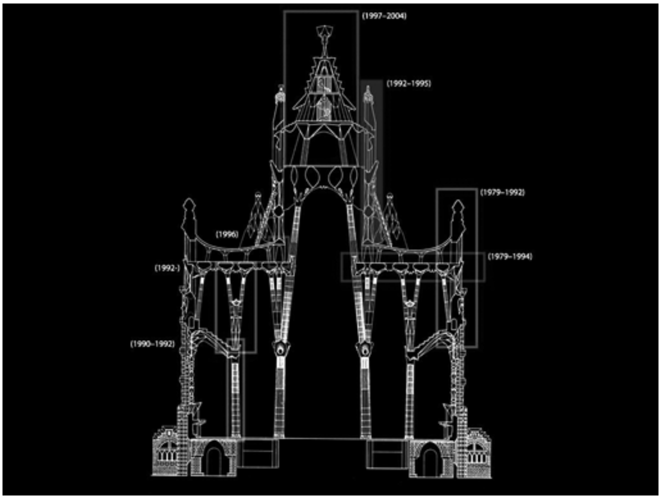


Figure 6.
Sections of the nave and the years during which the component geometries were identified.

of models like this and being asked to use archaic instruments such as dividers and obscure measuring tools, that I had last used at school for geography, was a kind of bizarre turn of events. And the idea was to use a graphic technique to reconstruct Gaudí's geometries – which at that point they were techniques that did not exist: I was asked to come up with some kind of new process – with which we would try to beat the plaster model makers' target. It takes many months to make these elaborate models by hand, which was Gaudí's technique, as shown in figure 4.

The two directors asked me to see whether there was some way of drawing using a drafting technique. My immediate superior was Lluís Bonet Garí, aged almost ninety, who was ably assisted by his slightly junior colleague, Isidre Puig Boada, who was, I think, younger by a few months. Both of these architects had worked with Gaudí before he died; they had worked at Gaudí's studio as young and very enthusiastic apprentices, and so they were a vital link. The only problem was that all that work that Gaudí had done in these last twelve years of his life had never been put into practice, and with the Passion Façade (essentially a version of the Nativity Façade) that precisely was my task. So for me, a very romantic intellectual journey started when I was working on drawings the size of tablecloths, a task in which I was asked to interpret these bits of shattered model with this living link back to Gaudí through my two senior colleagues.

The sorts of drawings I came up with were very different from the ones I had been taught to draw at Cambridge [Figure 7]. One of the reasons that they seem to excite interest is that they are not architectural drawings. They are geographical; and I hit upon a system, after some desperation, of treating these surfaces as landscapes, and these triple points, which I have noted above, were in fact mountain tops, and these 3D curves of intersection were actually crests, the sort that you walk along when you get to the top of a mountain. I was pursuing these points and the technique does not look a lot different from later computer drawings, which of course I had never even heard of at that point.

These 'wire-frame' hand-produced drawings, which were produced very laboriously by me, were to try and find the intersections [Figure 8]. My drawings from this

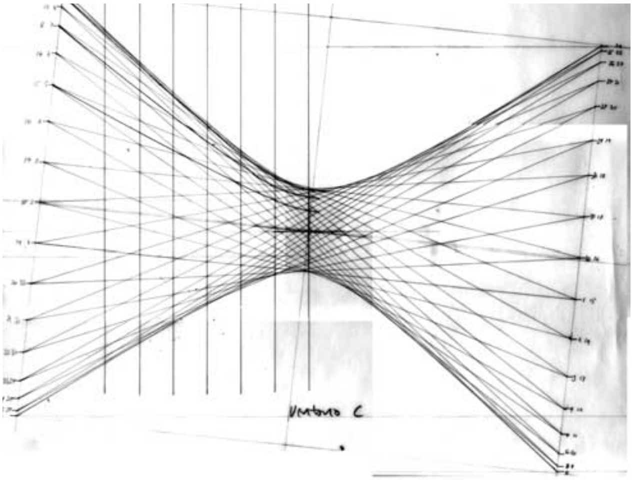


Figure 7.
Side-view of tilted hyperboloid of revolution drawn as a 'wireframe' a decade prior to the introduction of the computer to the project.

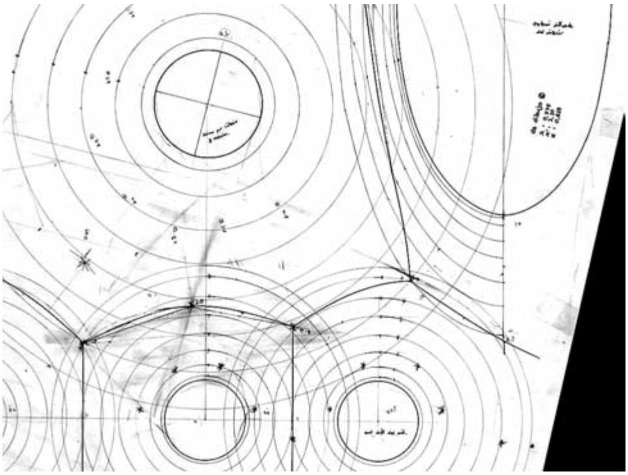


Figure 8.
Graphical system to plot intersection between adjacent hyperboloid surfaces.

period were only scanned last year because they had been buried in the archives, but now that they have been found I find them quite amusing: when I am taking this post-digital line, I think it is quite appropriate to show such 'wire-frame' drawings that predate the use of the computer; and I can use them for compelling effect. I had to do things like intersect the hyperboloid column capitals with the nave ceilings, and the drawings are actually covered with myriad little calculations; again, as far as my education was concerned, there was no need for us to do any calculations whatsoever. I remember spending almost a week on rendering light on the nave ceiling by hand in 1979, trying to calculate through all sorts of inverse proportional laws what the lighting effect might be on these hyperbolic surfaces looking up at the ceiling from below, and I have not dared yet do the equivalent exercise with the computer in case these drawings are found wanting.

When I went back to my native New Zealand in 1989 to take up a university position as a lecturer in construction at exactly the time they needed to put my earlier drawings into effect, my former colleagues asked me how I did the drawings, so I explained and their eyes glazed over and our current director, Jordi Bonet, the son of the former director, asked if I was interested in just trying to provide some kind of interface from the antipodes – and the interface that resulted then is still going, thank goodness, because I greatly enjoy the opportunity.

When I spoke to my colleagues in my new university environment (I had been in full-time practice prior to then), who were all computer experts (and I am sure that a lot of people here who use the computer and had to speak to a senior colleague first would have received the same response), they said "but you make it sound so complicated, while for the computer of course it is nothing". And so after the first week I could see what they meant, because it took very little time to get a three-dimensional representation of a hyperboloid of revolution of one sheet up and running. And that, I thought, was really terrific, because it saved me from spending the time and making my eyesight even worse after the several kilometers of 0.1 Rotring™ line-work per week of drawing that I was doing previously. I then moved on to the next task – intersection of adjacent surfaces, and three months later I could confirm that there was no way that we could actually use the most widely used architectural software to intersect two interpenetrating surfaces; so the conclusion that we drew in 1989 was that there was no architectural software that was satisfactory for this task. And the conclusion in 2005 is exactly the same. The only way that we can use architectural software for this task – and we do use it – is to draw the templates for the stonemasons; the rest is all done with aeronautical software now, and has been since 1989 when we first started. And when you see Gehry Technology as the spin-off from Gehry Partners, advancing the use of aeronautical software for architecture, I suggest that rather than seeing it as being rather peculiar, an aberration even, it is probably just simply that this particular aspect of architectural representation was, like Gaudí, a bit ahead of its time.

The only 'drawings' that we do whether by hand or their latter-day equivalent using AutoCAD™ is the same: templates that guide the builders to which particular surfaces go in which particular spot. The process from Gaudí's point of view was to get a curve, which is a section through one of these surfaces, made into a zinc template, which would just swivel around a set of plaster – and this is plaster of Paris, which only takes twenty minutes to set. [Figure 9] This process is making not what we want, but what we do not want. What we really want is the positive form which is secondary to the production of the primary form, which is actually the negative. It is an extraordinary process – you actually model what is not there, in order to get what is wanted.

Figure 9.
Formation of a 1:1 scale plaster of Paris hyperboloid.

Curiously the computer process is the equivalent; it is exactly the same: we model what we do not want in order to get what we do want. Having made a variety of these forms, they are then intercepted by hand so there is the line of intersection between one, and another, and another, and of course in so doing the triple point emerges. With that process at that time it would have taken several months to make one window model at a scale of 1:10; and we are virtually certain that that was Gaudí's experimental design process. We are virtually certain because Josep (the model maker in figure 4), who with his colleague Jordi Cussó the head model maker, is one of a long line of plaster model-makers who has always been on site. So while Gaudí himself never saw these surfaces being made at full scale, which meant that the architects had a relatively easy time between 1926 and the 1970s in this regard – engagement with the complex geometries, the inheritors of the plaster modelling technique knew most about his techniques – the trouble is that like many skilled handcraft processes, it is just incredibly slow. The equivalent drawing technique itself takes several months, it seems to be the equivalent of 50% of the time to model in plaster, but obviously still painfully slow if all you are trying to do is reverse-engineer an existing design. The equivalent computer technique using aeronautical software (in this case CADDS5™) takes ten minutes – at least it took ten minutes for this particular project at that time; it would be much faster now. The trouble is that you have to do multiple iterations in order to home in on the optimum result – we had to do 96 –in order to get one that fits perfectly. The practice in terms of reverse-engineering the surviving model fragments in the post-digital era was to inherit the original model, which is the grey form shown in the accompanying images, and construct a mathematical version, which is the golden or orange version behind it. [Figure 10].

So that is the theory. Each iteration is just another iteration from a complex process, that proceeds until eventually we obtain a combination of surfaces that will match the original. In making a sequence of iterations where the parameters of adjacent and intersecting surfaces vary slightly we find that every now and again the computer gets unhappy, and fails to complete operations based on particular combinations of values, and does not actually give us a result at all; but that is good, is it not, really – the computer is not necessarily master of this domain?

In taking the work to a stage of being able to be executed we are focusing on the outcome, but from Gaudí's point of view he is looking at those other issues too such as composition, because that is what this is all about ultimately. The hyperboloid of revolution, which predominates in both the windows and the ceiling vaults is accompanied by the hyperbolic paraboloid, which is a reasonably familiar form – it is sometimes described as a saddle; straight lines again on the surface, and there is the concave and the convex curve you can see on the surface. [Figure 11] There is a significant constructional advantage of this geometry through the rulings of the surfaces, making them relatively easy to build compared with freeform. On the other hand, take the La Pedrera, the Casa Milà; I am sure one of the reasons why it was so late in finishing and cost so much was that it was a free-form building, and every piece of stone had to be modelled on a scale of 1:1 down at ground level, then cut and lifted up and matched to its neighbours, and obviously if the curves did not match exactly the stone would have to go back down to the ground again and be reworked.

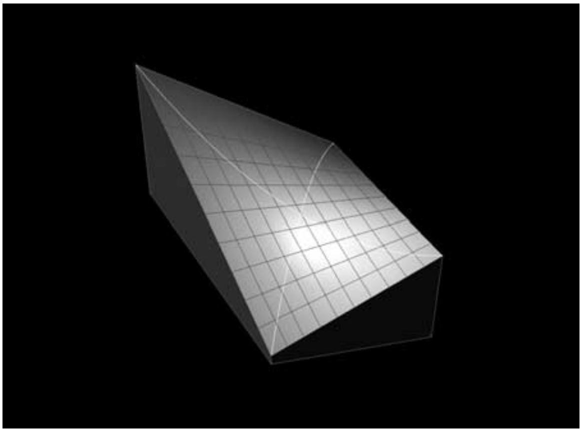


Figure 11.
Hyperbolic paraboloid.

Figure 12.
Casa Milà – La Pedrera.

The beauty of this system [Figure 12] is that as long as you provide the stonemason with a template of each cut, then all you need to do is show lines of intersection between adjacent points and you can just cut the stone and the surface will appear as if by magic with no reference to its adjacent pieces. A stonemason could be making one piece and another stonemason could be making the piece adjacent to it with no reference to each other beyond their shared tem-

Figure 10.
Shows several iterations in this process – we are seeking derived mathematical solutions (orange colour) to match the measured version of Gaudí's original 1:10 model shown in grey.

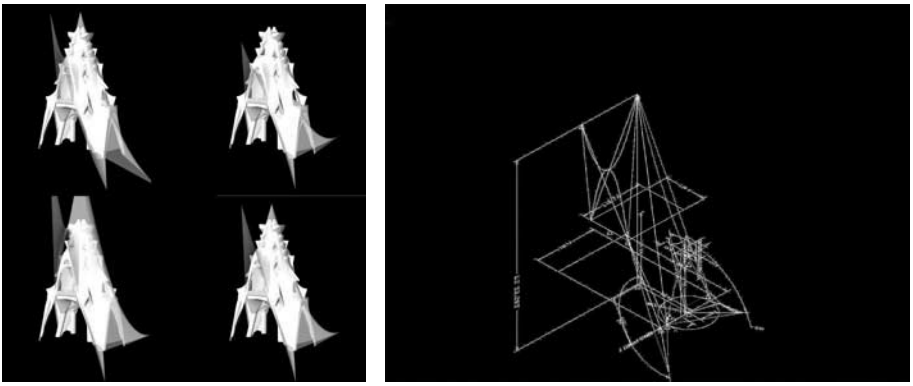


Figure 13.
Parametric design software used to find the set of hyperbolic paraboloids that comprise the nave roof (‘cobertes’).

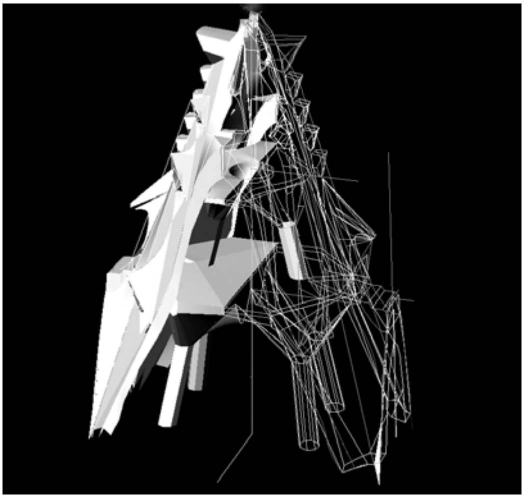


Figure 14.
The original model by Gaudí scaled 1:25 is shown digitised and rendered in 3D.]

plates, and they would produce a perfect result. It does not have to be a rectilinear piece, you can take any shape; the outcome is the same. This is the theory of the straight lines on the ruled surfaces, their constructional advantage, and there are actually a lot of philosophical and theoretical reasons of why he would have used these surfaces which I have already referred to. Let us just say, at an architectural construction conference, that facilitating construction of significantly complex buildings is one of the major reasons for his choice of this geometry.

Parametric design approaches were also instrumental in solving the geometrical construction for the nave roof. [Figure 13]

In figure 14, the original model by Gaudí scaled 1:25 is shown digitised and rendered in 3D. At that time (1996) the digitising was undertaken by hand – we measured all the points and built a digital model of it. We know from an account that the entire composition uses only hyperbolic paraboloids: there is a whole series of surfaces that meet at a virtual point above; the problem is that we do not know where that point is. We do know that the bisected curves on the surviving fragments of nave roof model are sections for the hyperbolic paraboloids. That, in fact, is all we really need to know; and we just have to find a parametrically variable selection of surfaces, so that as long as the sections through those surfaces coincide in space exactly where these planar curves of bisection occur then we will have have found the definitive solution.

Discussing 'parametric design' is just another way of talking about databases; the geometry of the model is within the software's database and we can refer to it visually, directly through the screen of our computer. The figures referred to are the pictorialisation of the data in question, that is the position of the virtual point in space where the various hyperbolic paraboloids share their vertices above the roof, is the point where this collection of hyperbolic paraboloids meet. To find this point all we have to do is tweak the various values (parameters). In this the image of four such tweakings the effect of trying to make the assembly narrower in one case. too narrow in another, too low in another, and in the fourth we have it just about right. By moving various points upwards and downwards and from side to side we can just coax out the shape as Gaudí envisaged the roof, and eventually we will have the desired result. This is why parametric design software at its most basic used in this way for interpreting Gaudí's geometries is a very powerful tool, because it is an easy task to work out just how many months this would have taken working without a factory of computation.

The process by which the bottom half of the roof is made is relatively straight forward – the top half is yet to be detailed and built. The whole lower portion was made from one A3 drawing, that is the entire documentation required for this task. The reason why so little documentation is required for such a complex looking assembly as the roof is the reliance on ruled surface geometries. All the drawing needs to communicate is basically a whole set of coordinates of points with sufficient straight lines identified with the links they make to the points at their extreme ends. From the drawing the points that have been identified can be located to within a half millimetre of accuracy, and straight lines connecting the points to their opposite numbers are made with string. So from that, we can see a virtual post-digital surface: it is post-digital because it is analog in terms of its production – Gaudí's model was digitally analysed by us, but originally analogically synthesized by Gaudí. We can see the final surface emerge first as a virtual surface in the construction of the moulds for the in situ and precast concrete elements through strings stretched between corresponding points roughly at 20 cm centres; using this technique it takes about twenty minutes for the plaster to dry, so the 1:1 mould makers can make these surfaces very quickly. About two centimetres beneath the stretched-out strings, a false surface is built using hollow brick-tiles fixed together by the rapidly setting palster. Onto this false surface where that string had been a line of wet plaster of Paris is placed in which a straightedge is made to lie so that its edge is where the string was while the plaster sets. Once set, the plaster channel which coincides with the string is chiselled away to where the string had been to make a knife-edge. And because these surfaces have two-way rulings, all you need to do once you have got this surface prepared is run a straightedge across the original line of strings to find the hyperbolic paraboloids' complementary set of rulings, gently moving the straightedge backwards and forwards until it stops rocking, then just float it up the line of plaster 'knife edges' (the virtual surface where the strings had been) and the basis of the

Figure 15.
Sequence of video stills showing the process described for making the mould masters for the lower half of the nave roof.

mould emerges. This is the mould master, made of plaster of Paris, from which a series of glass fibre moulds are made, into which the in situ concrete is poured. [Figure 15]

The 'Rosassa' (elliptical rose window for the Passion Façade)

Bringing this process from Gaudí's original 3D material through to the period now where we do not have original material from Gaudí other than photographs of drawings, we can look at the rose window for the west transept (Passion Façade), which is an element that sits between the two groups of two campanile towers. [Figure 16]

It was intended to be completed in time for the change-over of the Christian Millennium, at the end of 2000. The challenge was that we had just thirteen months in which to go from creating a design – because there is no surviving design for this element from Gaudí, so it is essentially an interpretation based on the nave windows – to making and glazing the window, made from granite and measuring 8 metres wide and 35 metres tall.

We used Gaudí's syntax or codex of these hyperbolic forms for the composition, a series of extractions, and the parametric model. [Figure 17] Our parametric model comes into its own at this point. The software is no longer just for making cars or airplanes: it is making windows. It means that points in space that have to coincide with the existing fabric of the building can be dealt with as late as mid construction.

We do not need to know where those points in space are exactly at commence-

Figure 16.
Completed 'rosassa' seen in its location.

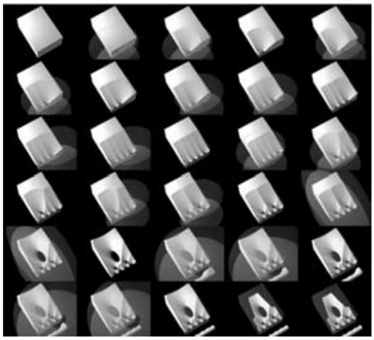


Figure 17.
Boolean subtractions in sequence top left to bottom right, in this case the clerestory window but similar for the rose window for the Passion Facade.

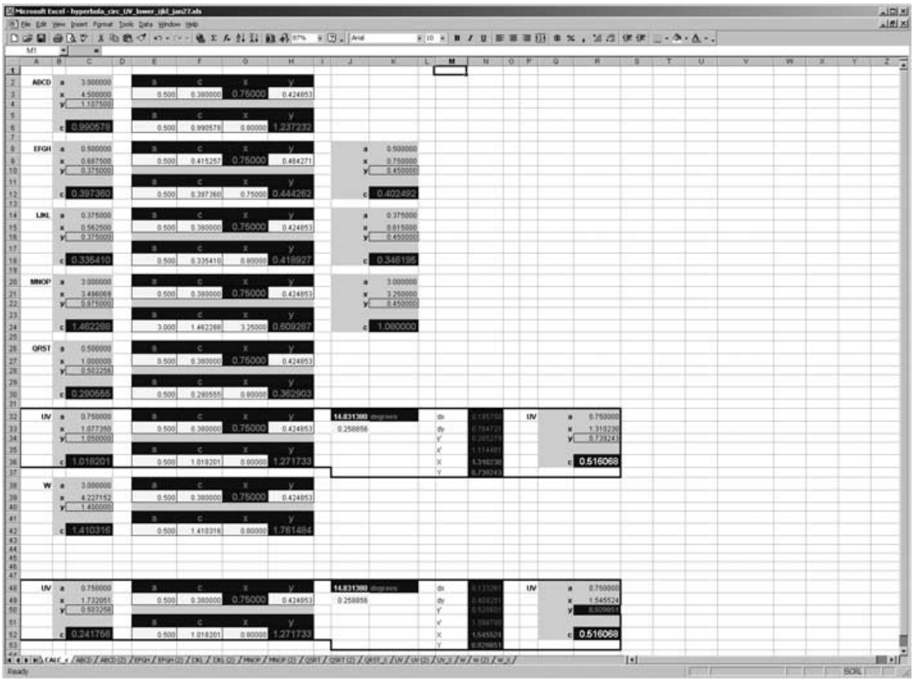


Figure 18.
Excel ì spreadsheet used to drive the CADDS5 ì parametric model

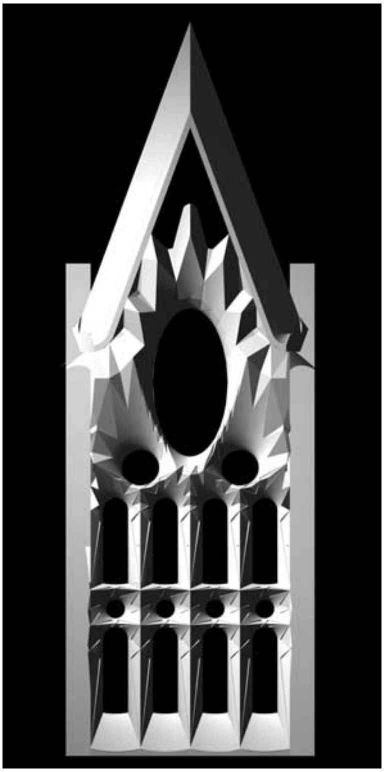


Figure 19.
Fully rendered computer model of the rose window.

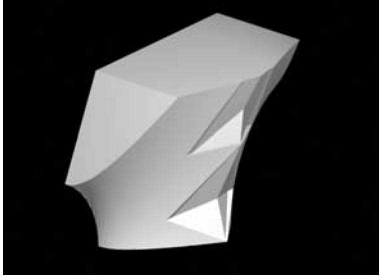


Figure 20.
The completed 3D computer model was sectioned in consultation with the stonemason into the final masonry elements.

ment as we would need to for an 'explicit' (inflexible non parametric model). We could not work to such defined data in any event, in fact, because some of the crucial points of coincidence are located on the upper parts of the towers with which the window connects, and the towers themselves are tapered and are immeasurable until the scaffolding gets there. So all the points on the parametric model are flexible, because the model can be adjusted to suit long after the design is 'finished'. The only information that is of any real consequence to us is not this model, but the accompanying spreadsheet that 'drives' the parametric model to conform with any given set of variables. This spreadsheet has all the characteristics, all the parameters for the surfaces, and simply by changing the value in the spreadsheets we can change the model backwards and forwards. [Figure 18]

Senyor Mallo, our seventy-eight year old master stonemason who was working from his quarry on the other side of Spain, some 1200 kilometres away in Galicia, came down every week for the six weeks that I was based on the site, while I was completing the design work for the window; and I heard him on the phone saying to a colleague that he did not know where he was going to go with the project because he could not understand a thing that we showed him on our computer screens in Barcelona, and surely the problem would be compounded by our return to Australia. The drawings that he was referring to as being confusing were our wireframe 3D models. Interestingly enough it took us ten years of using the computer at the Sagrada Família before we actually started producing material that had any degree of photo-realism to it. Simply, from our point of view, it was unnecessary to do so: as design authors we know what is going on there. The wireframes are not images to us, they are simply maps, as I have described earlier in referring to my hand drawing approach to solving the interrelationships between Gaudí's geometries. They became images, though, for the important communication route that we had to agree with our distant stonemason. [Figure 19]

From his point of view, the virtual rendered model meant collectively being able to chop the model up, since we were able to export the parametric model to the more user-friendly Rhinoceros ì software, and fracture the whole into the small sections he would actually be producing, a context that he could understand very comfortably. [Figure 20]

We then found this new 'innovation' called 3D printing, which is computer-driven wax model making. I think everyone at this conference is familiar with it now, but in 2000 it was relatively new. It is still cripplingly expensive, but it is extraordinarily accurate and quite quick: it only took four hours to make this model, to a fraction of a millimetre. The only trouble, from the stonemason's point of view, was that that was two hours too long, because in two hours he could make prototypes himself, using polystyrene, with sufficient precision for the job; and moreover he had to read the drawings to make the model, which meant he understood what he was asked to do much more than with the automatically produced prototypes. So in the post-digital world we sometimes need to be very sceptical of the rhetoric; we know that there are times when the high technology is useful and there are times when using our hands is even more useful. This is a lesson that we have learned very well at the Sagrada Família, and that is why there are now more people making models at the Sagrada Família by hand than there were before we started using the computer. The two go hand in hand.

The process was to produce 780 A0 templates; these were done using AutoCAD™ because of the opportunities of scripting within that product. The process was large-

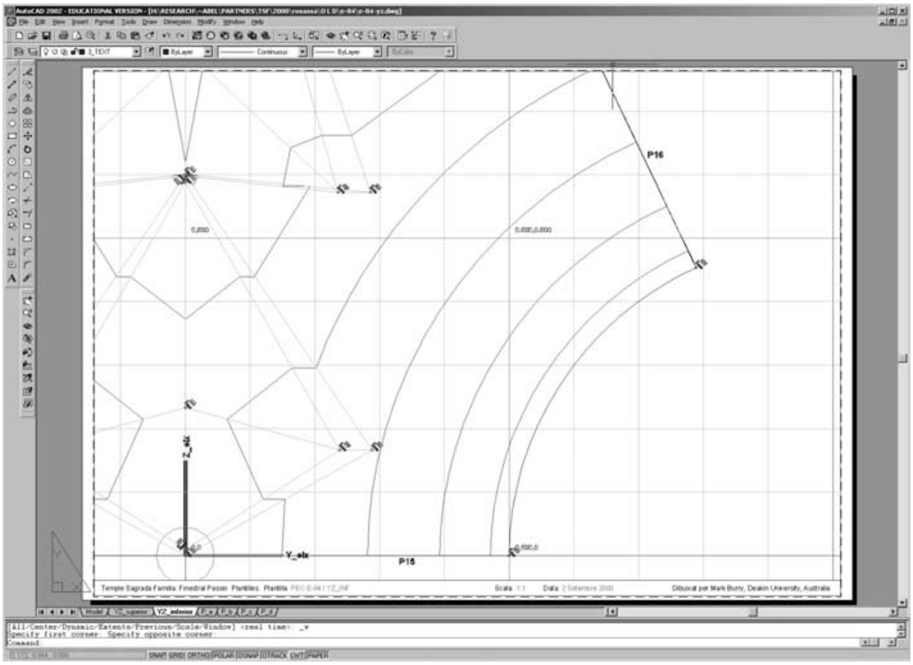


Figure 21.
Example of A0 template sent to the stonemason in Galicia from Australia via the site in Barcelona.

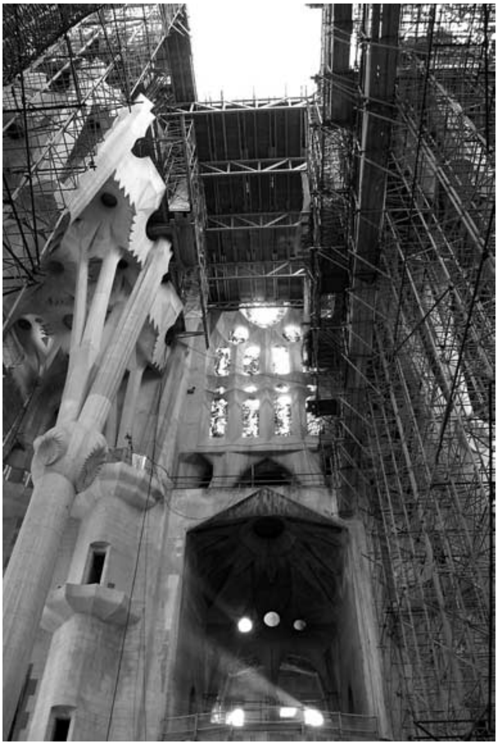


Figure 22.
Completed window (interior).

ly automated. Sr. Mallo would get an image of the stone piece in question, and he would get a map that shows contours at 10 centimetre intervals, which allows him to cut polystyrene to make the facsimile at 1:1. [Figure 21]

The green lines shown in the template are the hyperbolic geometry's selected straight lines that lie on the surface, an element that is part of the decoration regime; and the little marks that are dotted around the template are coordinates in 3D. Sr. Mallo, whose only technical equipment on site at the time – apart from the stone cutting machines themselves – was a telephone, seemed to be perfectly comfortable with taking 3-D coordinates and making them into a plan of action. The reason he was comfortable with this is because he himself was an extraordinary innovator and an inventor. He managed to speed the production process up significantly by adapting a diamond-encrusted wire cutter that is used to cut stone. Descending in a straight line, it ordinarily makes a planar cut through the stone, and obviously we can cut stone into flat planes reasonably accurately in this way. What he discovered was that if he twisted the stone in space as the wire came down, in other words, if there was a person at each end of the stone steering it with the levers that he had adapted the machine with, they could actually push the stone as the wire came down, such that the hyperbolic ruled surfaces were cut very close to the finished surface of the stone – within about a centimetre of the final surface generally. All that the stonemason was required to do was to finish the stone off by hand; and that was an amazing confluence of studio and workplace innovation, I thought.

The first quarter of the window was being built on site while the second quarter was being cut in Galicia, with the third quarter still being templated in Australia. The top quarter was still being intersected with the roof, with the university team based in Barcelona and myself and colleagues in Australia. This was an example of a fast-track or just-in-time project. [Figure 22]

Moving briefly to 1:1 prototyping, figure 23. shows painted polystyrene facsimilies of proposed columns for the colonnade that sits forward of the rose window I have briefly described above. On the one hand, these perfectly produced prototypes are evidence of the viable extension to the rapid prototyping of models discussed earlier. On the other hand they expose some of the current myths about this emerging technology – the cost and time required principally. In my opinion the prototypes were very expensive. They took a month longer than they were supposed to take, to the extent that we the architects were asked to reduce the time that we required to produce the digital models, as usual, so we were squeezed while the rapid prototyping company based in southern France had their time extended. And it still took a month longer even than with the extension they had already asked for, and apparently it was not profitable for the company producing them either, in the final analysis. So my view is that, yes, the boat-builders do have the technology to make these 1:1 columns – and my students get very excited because they think this is the future and the future is now – but I would say that we are still a very long way off producing 1:1 prototypes of this order at a reasonable cost. And the cost of this was a significant proportion of that of building a house, as far as I can tell.

Figure 23.
Painted polystyrene facsimilies of proposed columns for the colonnade that sits forward of the Passion Façade rose window.

To conclude I shall refer briefly to how this translates through to the real world in terms of our students.

In 2001 we ran a studio with RMIT students in Australia, MIT in Boston moderated by Jim Glymph and Dennis Shelden at Gehry Partners in Los Angeles. The studio / workshop was looking at the accommodation between design synthesis and design realisation using digital techniques experimenting in both synchronous and asynchronous modes of cooperation. For the first time in studio we were using parametric design tools, and Gehry Partners were also interested in using this as an opportunity to assess the appropriateness of this new parametric approach to design resolution. The students first had to make their blobs, and then take them through to some kind of constructional regime, and hopefully to a scale of 1:1 for a representative part of their proposals.

The projects were all relatively complex and would have a significant factor of difficulty in terms of procurement. One project, for example, took a cube and morphed it fluidly into the proposed 'reading room' and then covered it with copper louvers. Each one of the 170+ louvers could be parametrically twisted and made into little fins. The group then had to investigate the current practice for bending timber. The project was made into a very large model and the parametric design software was extended from simply pursuing geometry as we have used it at the Sagrada Família

Church to considering the structural performance of the various surfaces and elements in tandem with the formal geometry.

At the post-graduate level a project from my university studio has recently been exhibited in Melbourne; the exhibition that opened in September 2005 was called *Pavilions for New Architecture*, and specifically called for ten young and vigorous practices to come up with proposals whose construction represents the future and not the past. The company BKK with whom, Rory Hyde, one of our PhD students is embedded – came up with the concept of taking a cube and having a central point (it is actually off-centre) from which a series of hexagonal geodesic cones 'explode' through the cube to make the surface. The idea is that you can stand within this cube and look through an exploding kind of stellar thing. I have not experienced it, so I do not know how effective it is; but of the ten contributors it was the one that featured in the local newspaper 'The Age' – that is to say of the 10 projects it is the one that has appeared as a photograph. The practice BKK thought the project offered significant opportunities for digital experimentation, and they made a 1:10 model of the final project using a laser cutter a process from which the scorch marks on the cardboard were hard to avoid. As a consequence, when the time came to make the several hundred cardboard components for the full-scale exhibition piece they decided when it was time to make the real one to conduct an audit between hand and laser cutting. It was not a matter of cost nor were they driven by the undesirable scorch marks from the laser cutting, but a matter of time, because they only had a few days to build the pavilion in time for the exhibition opening. The audit revealed that it was significantly quicker to cut the cardboard out from printed templates using a hobby knife, than having them cut by laser, because taking the cardboard over to the laser and getting the laser centred up took relatively long compared with the actual burn time. This is just another example of how we have to be quite circumspect about the adoption of technology without a proper assessment of cost-value over time.

The last projects I wish to discuss are from a studio that I ran in Wellington in from 1990 to 1995.

First of all, to sell architecture study to school leavers we ran a live project for Open Day, and one particular year I managed to persuade a brick supplier to drop off two pallets of bricks. The students had a little competition among themselves to see what they could do with dry bricks during one day of construction. The idea was that they had to build something and take it down again in the alloted day, and that anyone visiting the school could see this in action. And they were looking at all the Gaudí techniques, particularly elements such as the 'false arch', where you just use corbelling from two sides to produce an arch, the two corbells lean against each other. The students could not do the amazing honeycomb brickwork that Gaudí used for the attic in the villa *Bellesguard*, but they could at least find a way of lightening the load by reducing mass by adopting a simpler version of the technique from the master, long distant in both time and place.

The next projects that I am going to show come from a series we ran every year until I left in 1996, which gave the students an option of moving from the conceptual design scale to 1:1. The reason that I am ending with this is that I do not think that the crucial architectural design issues have anything to do with our current digital tools, and I think that in this work that I am discussing here, in asking students to work from a conceptual to a 1:1 level actually stretches them in ways that I think we desire for all our students. In this case they were given the Wellington railway station where they were asked not to touch the interior space of the building, but only the specific exterior space of the station. They worked with an artist called Rhondda Greig, who was to be provided with a studio and a selling point for her work somewhere at the busy terminus and in a way that would not interrupt the function of the station or its use after they had built it. The students had to come up with something that would be built while the station was still functioning and would then operate. They then proceeded to do all the usual student stuff. I did not care how conceptual their projects were, because they had to build part of the project at full scale in the end. That was the context – ideas (no matter how extreme) realised at 1:1.

I am not going to go into their designs here, but I will show you aspects of the outcomes.

One such project was proposed by a student Douglas Nysse where the structure was to be built almost entirely from glass. I presume he had seen the Renzo Piano table and had wished to examine its potential. The accompanying image shows one of the major joints all made from laminated glass. [Figure 24]

The students had only three weeks to work conceptually and three weeks to make the model, so it was a six-week project in all. And, crucially in terms of this conference, this was not a design studio, so it was not part of their official design load; it was a *construction* component to their final year's study.

One of the most remarkable pieces of construction that I have ever seen from a student was Colette Mullin's proposal to restrict herself to two sizes of square section timber and one size of timber shelving section associated in a highly inventive way with steel plate. The image here shows this essay of both dynamic tension and cooperation between the metal and the timber, so the elements are both cooperating *inter alia* and also antagonizing each other at the same time. [Figure 25] Various

Figure 24.
Glass structure by Douglas Nysse.

Figure 25.
Project for artist's studio by Colette Mullin: wall-roof structural interface.

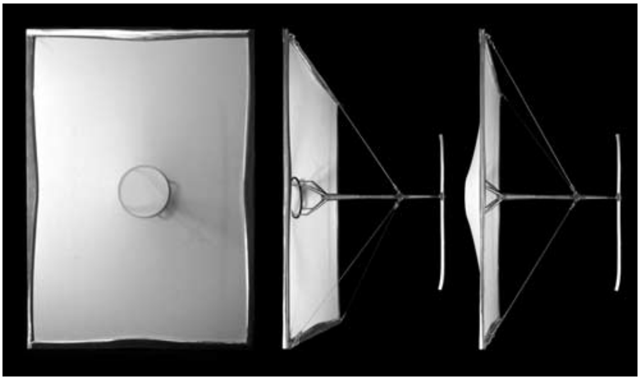


Figure 26.
Canvas frame by Chris Norman using minimum material through calculation by spreadsheet.

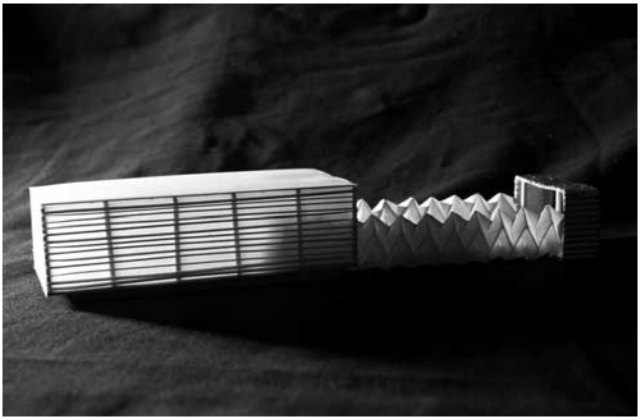


Figure 27.
Retractable exhibition space by Peter Mitchell.

Figure 28.
Kit of parts for retractable exhibition space by Peter Mitchell.

timber elements are being antagonized by the steel, by being pushed apart, but at the same time the timber is gripping the steel through the tension that the bolts are providing. It is just a very remarkable piece of work for a student to propose and develop in just a couple of weeks.

In the early 1990s the 'digital' was hardly a design issue. An exception (from 1994) was from Chris Norman who actually conceived a repetitive canvas frame using the least aluminium possible; so he calculated all the bending moments such that the proposed frame bordering stretched canvas, the canvas kept permanently in tension, is pulling on the aluminium, and the aluminium is being shaped through calculation exactly as it needs to be to consume the minimum of material. [Figure 26] The connection to Gaudí here is that he himself used the minimum of materials including recycled material wherever he could.

The final student project in the vein of Gaudí-hands-on is a splendid retractable studio proposed by Peter Mitchell that could just be closed up for the times when Rhondda had no art on show. [Figure 27]

You can imagine our sadistic pleasure of asking him how he was going to make it, but, bless him, he did make it. He developed and prototyped a universal three-dimensional joint, complete with aluminium castings, that was sort of proof of concept, proof that you can actually make this structure youth and relative inexperience being no barrier. [Figure 28]

Concluding comments

So where does that leave us in terms of today?

I think that most of us have divisions between the constituent disciplines in our schools. We all seem to have these silos that tend to preclude rather than sponsor cooperation. In all the schools that I have worked in the relationship between design and construction teaching has always been a problem. There are schools where the design module does not even attempt to engage with the 'specialist' disciplines such as construction technology because the design community regard themselves as being everything, with the rest possibly in a support role or possibly even redundant. Other schools make design actually stretch out to include everything; that can be successful and it can be unsuccessful too, especially in enforced marriages, because the students then complain that they are not being stretched enough in terms of design exploration, this being reigned-back to meet pragmatic realities. Each school can find its own successful reference points, of course, but is this the norm?

In any case it is pretty irrelevant, because I think that there is a new context, the 'post digital' context, which is the situation where analogue and digital thinking and practice for design and construction co-exist in an exciting kind of fusion. This is certainly the case for the laboratory that I direct, which is the *Spatial Information Architecture Laboratory* at RMIT University in Melbourne, Australia. When people ask me for a simple explanation for what 'spatial information architecture' is I have great difficulty in explaining, other than to say that it is guided by the principles that Gaudí himself espoused before he died in 1926, which, I think, is one of a 'total architecture': one where design is considered at the deepest, most intense level, to include constructional and structural and environmental considerations - as well as cost.

In all respects for me Gaudí was the total architect; and if the digital gives us anything at all, it gives us this fluidity, it gives us a chance to be actually much less *disciplinaire* with the way we look at things. It is the status and culture of architecture that dominates our thinking at SIAL, in effect, as opposed to 'theory'; acoustic design and soundscape is actively included – sonification as opposed to simply whether or not you have enough decibels; visualisation of complex systems rather than just visualising the building proposal; the whole role of architecture to help explain things that we cannot ordinarily explain, like BKK's exploding cube project described above; parametric design, the whole idea that the model is only a representation, that it is not concrete or fixed or explicit, but a representation and can be flexible; the whole ontology of design communication; the fact that we still have an enormous amount of work to do to really understand how we communicate with each other. And the fact that we have all these new digital tools and these fantastic Internet connections and all that stuff today yet I still end up coming to Barcelona every six weeks for site visits, for our reality is that by simply being around the table we find that extraordinary sixth sense that no computer system that I have ever come across can even get near matching, and which is still very important; and, ultimately, design and computation, which I think is also a crucial design ingredient. That people would use the computer without even bothering to understand what the computer is or what computation is about seems very odd to me. So many schools, including my own, do not want to include mathematics as a key part of the curriculum because "that is not what architects do", yet at the same time they want to take advantage of these extraordinary machines that are predicated on computation.

Again Gaudí's approach is my guiding principle, because, as I have showed – I hope – in this lightning address looking at the way he ultimately used this very advanced geometry, we too can work with greater sophistication. I do not believe that Gaudí would have adopted an either / or approach to the uptake of digital design opportunities. We can overlay traditional practice with the new opportunities for enrichment that digital design offers: I just believe that it is all about folding what we have now over and in and around what we had at our disposal before. And we do not have to make distinct boundaries between the various things that we do. I believe that we can look at Gaudí as one of those architects who have been a tremendous guiding force for that which lies ahead.

First Theme

Part I

The Content of Contemporary Construction Teaching: what's new?

What must be the corpus of construction knowledge nowadays?

What are the new subject areas which will have to be included in the new construction teaching?

How will these new areas coexist within and be organized around the given educational curricula?

What will be the prioritization mechanisms and criteria for classifying modules as compulsory or optional?

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Dimitris Papalexopoulos

The Design – Construction Continuum for a non-linear, not-fragmented and not limited in time Design and Construction Continuum

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The intervention is within the "content axis". Reference will be made to the new subject areas which will have to be included in the new construction teaching. How can the teaching of construction incorporates the continuous developments in innovation? Three directions are proposed, following:

- An effort to map the new subject areas.
- A proposition to relate them to the history of technology.
- An invitation to locate some concepts of philosophy of technology in action.

The above directions designate three major educational axis we are dealing with in a 9th semester course of the School of Architecture of the National Technical University of Athens, called "Information Technology management and architecture". This course is not about economic management but is related to the fact that architectural/construction design is evolving through the integration of IT. We are embracing the position that IT, after dealing firstly with virtual space and then with digitally connected space, is increasingly implicated to physical space and its materiality.

As it is pointed out[1], a "structural turn" is witnessed, that prompts for a new relation of design and construction. "Smooth architectures" that existed only in paper are now constructed and offered to critical analysis. For a third time, after the modern movement and the open industrialization experiment of the seventies, Architecture meets Industry in a new registry managed this time by IT. Many researchers even think that this *structural turn* opens the possibility for architecture to completely redefine its theoretical and professional position and this precisely because of the changing design / construction relation paradigm[2].

In order to deal with those changes a conceptual diagram is elaborated called the Design – Construction Continuum (DCC)[3]. It is not about building a theory, but a field of thinking, permitting to cease the evolving integration of design and construction, as it is catalyzed by the IT applications. The DCC positions flows of information on the design construction process. It is a flexible educational tool in order to incorporate the continuous developments and innovations referring to IT in building design and construction.

In the design field, new concepts and tools are established giving emphasis to change, variability, generative logic, parametric design. They all try to deal with the *design of the transformable* and *interaction design*:

1. They propose to integrate the future building transformations into the initial design phase.
2. They also propose to extend design during the building's lifetime.

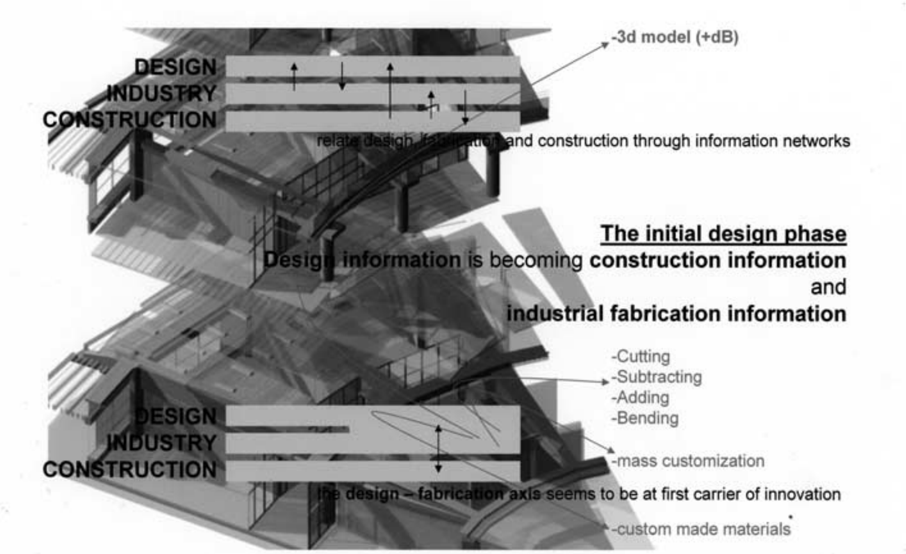
The questioning about the transformable is not new. In practice we rarely deal with a one shot elaboration and then construction of a Form that remains stable without any changes. Programmatic changes occur even during the initial design phase, changes may take place during the construction phase and also important modifications may occur during the building's lifetime. An individual or collective user does not want to take a definitive decision for all of its future activities and their spatial support. As George Kondylis had pointed out, we move from mass democracy to a *society of evolving expectations*. And as Antonino Saggio noted[4], defined spaces related to needs are replaced by *evolving supports of desire*. The definition of an ultimate Form is no longer the architect's goal and the IT is helping thinking towards that direction.

Mapping the new subject areas - Current trends that must be integrated in the construction educational curriculum

An effort to map the new subject areas shows that one of the dominant consequences of the IT implications in design and construction concerns the importance given to the *relations* between participants in the design / construction process rather than the production of the "final object" per se. As Branko Kolarevic had shown[5], the main trend is to relate design, fabrication and construction through information networks. Through that, *design information is becoming construction information and industrial fabrication information*.

Design information is becoming industrial fabrication information when *C.N.C.* is applied. Cutting, bending, subtracting, adding are industrial technologies operating through an immediate link to the design process. Fabrication information is produced and evaluated during the design phase.

Design information is also becoming industrial fabrication information when *mass customization* technologies are in action. Mass customization is proposed to an architecture that deals with *locality* restrictions and the *unique*. User defined variations are permitted. The digitally variable takes the place of the standard. The debate for



the definition of the identity (of a product) shifts to a debate that is related to the definition of what is stable through time and what must be parametrically defined.

At a different level from that of custom made products, *custom made materials* obey to the designer's prescriptions embracing the particularity of each project. The *virtualization of materials* integrates digitally intelligent parameters.

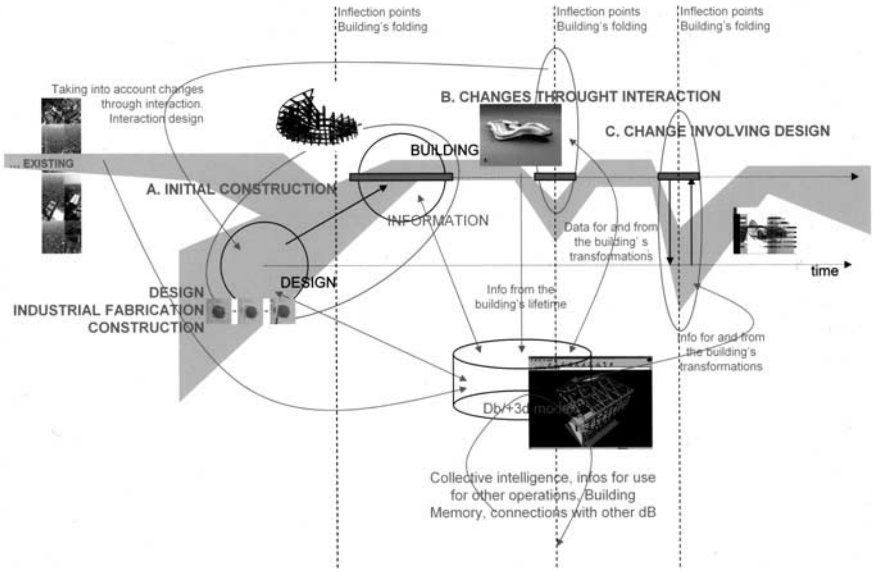
Conventional materials are redesigned in order to meet specific requirements. (carbon fibers in concrete). *Composite materials* are engineered in order meet specifications that alter from building to building. *Smart materials* integrate sensoring functions to transform environmental stimuli into information, alter their properties and become actuators or have both functions (smart concrete detects stresses and prevents damages). *Interactive materials* prompt for user's actions not included in a priori schemes. Swarm intelligence technologies are applied. High end technology embraces the very small scale. Well known classifications of materials cannot be operative and the whole scientific classification schema must be redesigned[6].

In the design construction continuum the *3d-model* is less considered as a representation tool and more as a vehicle of information trying to hold together a centrifugal gathering of actors. It is considered as s field where the management of the relations of all participants in the design – construction process takes place. The 3d model of Boeing 737 is proposed to take the place of Ford's T model. *Shop drawings* are seen as an obstacle not permitting to the architect to take the position of a digital "master builder". Construction "drawings" have to change their status. The 3d model can play its role of coordinator only if it is equipped with the capability of absorbing the pressures and demands of changes, due to the local strategies of the participants to design – construction process. That is if it is equipped with a parametric – generative logic. It is where this DCC coordination model meets the idea of architecture as field of forces, architecture not without identity, but with one continuously redefined, negotiating its *omoiopoiopoetic* and *eteropoietic* status.

The extended Design Construction Continuum

Extending the Design Construction Continuum towards the building's lifetime, propose us a larger conceptual field, adding to the DCC, issues of space transformation in time and interaction design. This research field is relatively new. Interaction is linked to the design of *dispositifs* prompting the user, but not defining in detail the space that will receive its action. We note more questions than answers:

- In what particular way future transformation and interaction with space are taken into consideration in the initial design phase?
- How do we deal with instable space identities?
- How do we represent and construct the "not yet defined in its details"?
- How do we define the constructability of intelligent evolving environments?
- What is the materiality of evolving supports of desire instead of predefined frames of needs (Antonino Saggio).



Technologies of interaction started to make their way into the field of architectural theory and practice[7]:

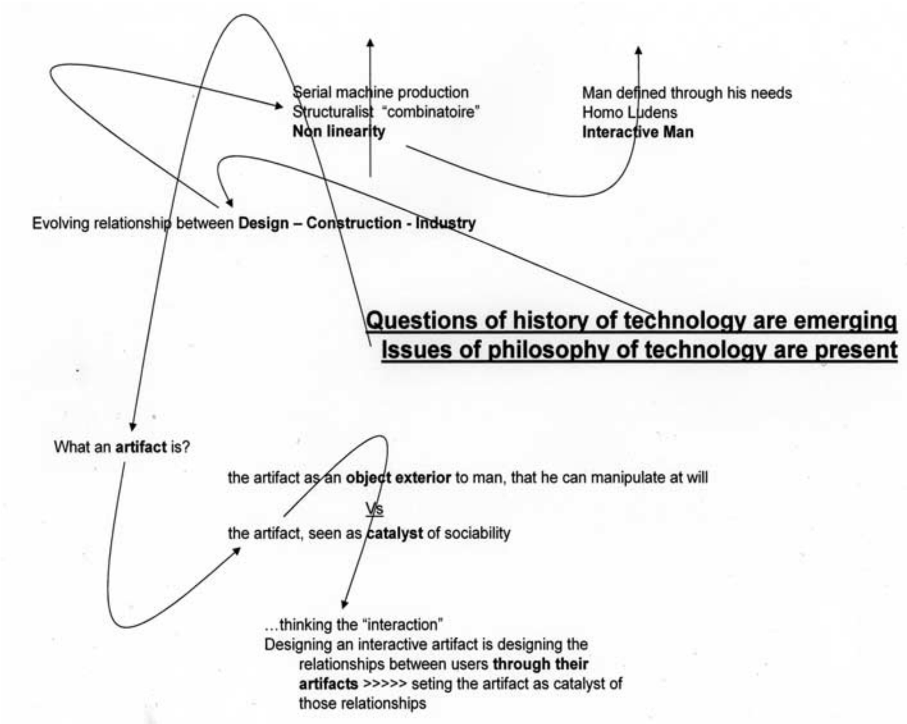
- Sensors detect action
- Tags identify actors
- Actuators close the loop
- Controls, displays, User Interfaces make it participatory
- Software models situations.
- Adaptive reassignment, growth and change are possible.

A need to elaborate location models or diagrams for their space distribution and integration is outlined. Interaction *dispositifs* are integrated into the physical – build space, forming *bridges between the physical and the digital*, giving birth to *Digital Territories*[8].

Questions on the history of technology are emerging

Thinking the DCC cannot escape a twofold reference to issues of history and philosophy of technology. First of all the DCC must think itself in terms of its past.

We need to count steps back from the present non-linearity of the digital DCC to the open industrialization's linguistic / structuralist *combinatoire* of the seventies and from that to the serial machine production dogma of the beginning of the last century. In parallel, we have to think, respectively, the correspondence of those steps with mental constructions as the *Interactive Man*, the *Homo Ludens* and the *Man defined through its Needs*.



Another step back is to the 19th century. In the Introduction of *Digital Tectonics*, Neil Leich, David Turnbull and Chris Williams are proposing the conceptual operationality of an old distinction between the Gothic and the Classical: "The Gothic is based primarily on understanding architecture in terms of materiality and structure, while the Classical is based primarily on understanding architecture in terms of visual composition. The Gothic is concerned more with process, the Classical more with representation"[9].

Furthermore, questions about a new relation to the "master builders" arouse: "The tradition of master builders did not survive the ...shifts of Renaissance... the theory was to provide the essence of architecture and not the practical knowledge of construction"[10]. "As architects shift their attention from drawing production to digital information authoring"[11] and as digital info authoring is directly related to the construction site, architects could regain a central position in this new close relation between architecture and construction, as "digital master builders". We must pay attention to the fact that the history of construction technology is closely related to the history of the profession of architects and in extension to the history of architectural theories. A French theoretical tradition dating from the '70s had already given strong conceptual basis to this matter. Reference must be made to the works of Jean Pierre Epron, especially because his thinking embraced open *industrialization*, a technological breakthrough of the '70 promising a *marriage* de raison between architecture and industry in a very closely way IT is promising now.

Issues of philosophy of technology are present

DCC cannot escape the questioning on its concepts, the evolving answers to the question "what an *artifact* is". The thinking of the artifact as an object exterior to man, that he can manipulate at will, as on object exterior to him, is a strong current in the philosophy of technology. But this conception of technology is a clear obstacle in the thinking of the transformable. On the contrary, the artifact, seen as catalyst of sociability, (in the direction of Latour, Serres, Levy) permits us to think the technology (and the materiality) of interactivity. as they prompt for interactions and frame virtualities for their evolution / transformation.

We need to let the artifacts "speak"[12], to be *quasi-objects* or *almost -subjects*[13], and possibly refer to the objectile - subjectile dichotomy in the works Bernard Cache. We must also let the artifacts tell us complex stories about the *real* (i.e. digital / smooth architecture based on concrete IT procedures, methods of fabrication, material production), the *discursive* (when artifacts take place in a discourse on fluidity and interaction) and the *social* (because changing relations between all participants in design – construction are at stake).

An artifact is then seen as a catalyst of relations that at the same time and with the same movement give it birth and transform it through time, a *catalyst of continuous interactions forming collectivities*. Those interactions could not be understood outside the materiality of the artifacts involved. That is, interaction design (in architecture) can not be seized outside the materiality of constructions involved.

As a conclusion, there is a triple path to follow for the incorporation of the new subject areas in the educational corpus of architecture:

a Mapping them with the help of a conceptual tool (may be DCC), including the initial design phase and extending it to the transformable and interaction design
b Make parallel and constant reference to the history of technology in general and the history construction in particular.
c Continuously elaborate an open constellation of concepts in action, related to philosophy of technology .

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Embedment of Study Programs in Research

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The advantages are many when study programs are embedded in research. Some problems may, however, occur due to the differences in the nature of research and teaching. The following text addresses these problems through the descriptions of study programs at the Aarhus School of Architecture, Denmark.

Research has by nature a well defined point of departure – the hypothesis. In opposition to this, it does not have the same predefined results – the conclusion. If the conclusion was known on beforehand, there would be no research. In other words, research follows the rule: if we know where we are going, there is no need to go.

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

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

The title of the research program in which we have embedded a study program is 'industrialized individuality'.

This research program takes it point of departure in the reality of the new production methods of today.

Briefly described, previous production methods were based on craftsmanship. From an architectural perspective this resulted in designs of great variation and individuality. The 'Arts and crafts movement' resounded the essence of this production method (ill.1).

Ill.1.
Craftsmanship + individuality
(Machintosh house)

With the industrial revolution, the production method changed from craftsmanship and individuality to mass production and standardization. For the architectural design

Ill 2
Industrialization + standardization
(Mies van der Rohe, Montreal)

this change in technology led to repetition and rationality. The design components were not individually designed, but came out of standardized fabrication. Architecture lost its previous individuality and became standardized (ill.2).

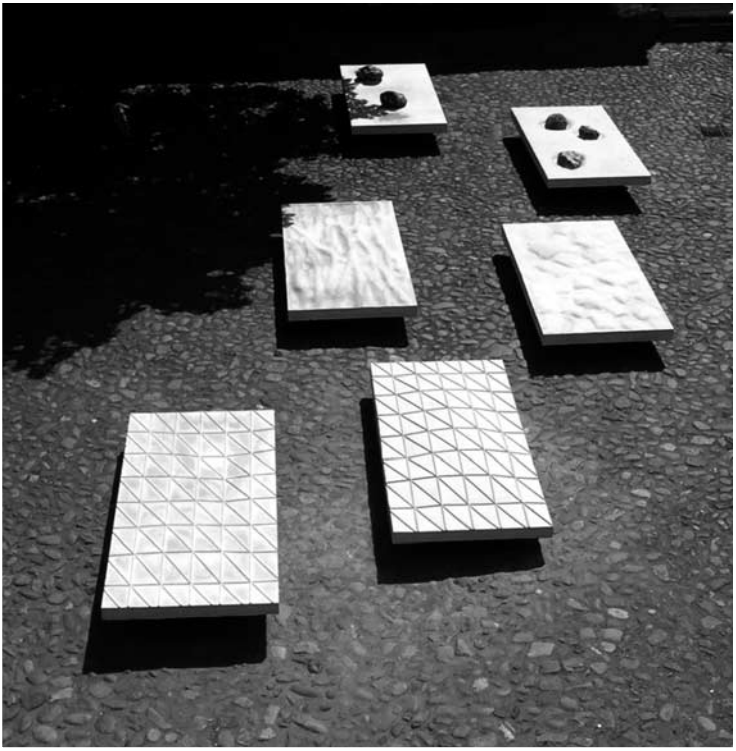
In contemporary production methods, a shift of paradigm has arisen. Due to the computer and robot technology CAD CAM, it has suddenly become possible to produce objects and building components with individual forms. This technology rapidly developed in the car industry and is today a reality in many areas of the building industry.

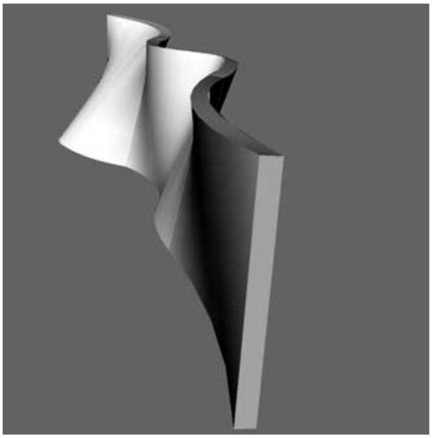
In the research program that we are involved with, we specifically focus on the technology embedded in pre-cast concrete industry.

Through a preliminary research program, it has become evident that the pre-cast concrete technology lacks the embedment of the new technology. A survey reveals that the industry is still in the era of standardized mass production, and even this does not seem to be the entire truth. What was to be expected today would be a production characterized by a large number of identical elements cast from the 'mother' mould.

The reality in numerous concrete industries is, however, that only a few elements are cast from the same mould. This requires a large number of moulds and therefore an extensive degree of craftsmanship in the production. In other words; there is to a large extent an individual production method in the pre-cast concrete industry, it is just not based on industrial techniques but mainly on craftsmanship.

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





Ill 3-12
Industrialisation + individuality. Experiments with industrialized mass production in precast concrete

The aim of our research program is to develop a series of techniques for the embedment of customized mass production in the concrete industry - or to be more specific: to develop moulds that are capable of producing a large number of different elements. This requires a crossover between different technologies, and that is why our aim is primarily to demonstrate that such a technology is plausible (ill.3-12).

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

To initiate the study program, a workshop has been arranged. The aim of the workshop has been to cast a wall consisting of a number of concrete elements. On these elements a series of bronze objects has to be mounted.

As a result of the workshop the students have learned different techniques of casting. This has involved casting of bronze and plaster as well as casting of concrete. The casting of plaster has been necessary in order to make the mould that casts the final concrete elements (ill.13-17).

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

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

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

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

Ill 13-17
Study program, workshop,
casting a concrete wall

Henk de Weijer

Discovering Essence in Presence

Academemie van Bouwkunst
in Amsterdam
The Netherlands

Meaning and relation

Change and stability

Since the very start of creation, which most likely has begun with the Big Bang, change is a fact of life. Movement and dynamism are essential features of our Universe. Change has always been, occurs here and now and will never cease to exist. So, it is nothing to worry about. On the contrary, lack of change would be a ground for such worry.

It is undeniable; change is present in everything, in every situation. But, is it really true that everything changes completely? Indian philosophy says: "No, not everything changes. The existential core of the universe – and everything in it – is 'Sat', 'that which undergoes no change'." Buddhism pictures the scales of change with the metaphor of a turning wheel. The outside moves fast and continually, while the hub is stable and unmoving. Does it follow then that in the space between the superficial dynamism of the sensory perceivable universe and the unmoving existential core everything is in chaotic change, in disorder? Fortunately, by accurate observation it has been discovered that already immediately under the skin of the observed world grids of order, containing a certain kind of stability, exist. This grid of stability, these laws of nature, may be stable, but what is being described is the dynamism that is inherent in all things. The deeper the world of forms will be penetrated, the longer lasting stability will be discovered. Certainly, looking for new meaning in architecture and its construction will demand more energy than flowing with the wind of the past or the breeze of the day. But we are fortunate: the need for meaning is an essential characteristic of the human mind. The resulting new practical discoveries, also while researching our common subject "teaching construction in the new digital era", will be of tremendous help to teachers, researchers, designers, students and institutes alike. At the same time, without consciously observing and distinguishing between what is changing and what is more stable no progress can be made in whatever field of action.

Wide-angle view

The Laws of Nature may not be Nature itself, but at the same time Nature and its laws are certainly not separate from each other. The same applies to change and stability. These may seem to be contradictory or opposites; yet, they are not separate, but connected. One of the most important recent discoveries of science is the interconnectedness of all and everything in the grid of Nature. Opposing elements are united on a common scale and appear to be components in a common composition. Everybody is able to discover opposing elements like: inside and outside, the virtual and the physical, intellectual and emotional, systematic approach and the need to rise above it, digital tools and the vision of a creative heart. This broadminded approach, trying to continuously find relations and a wider perspective is in harmony with the way our brains work. Every activity in the left part of the brain is accompanied by a suchlike activity in the right side and every thought is accompanied by an emotion, whether we are aware of it or not. In order to be able to unite extremes we need to add wide-angle view to precise, but narrow-minded, telescopic view. This will contribute to whole, healthy beings; whole, healthy buildings and a whole, healthy society.

Two illustrations
A number of years ago a student was working for Herman Hertzberger on a music hall in Utrecht, Holland. The design of the project was following what many called a "structuralistic" approach. The main structure of the floor plan of the music hall is a square in which another square, but turned under an angle of 45°, was inserted. At a certain stage the student was struggling to shape a certain lobby at a certain floor. The situation was complicated and Hertzberger took the challenge home in the weekend, as he always used to do. When he returned to the office next Monday-morning and showed his approach, the student was elated to see the solution. While he had been looking down to conceive of a solution, Hertzberger did exactly the opposite: he raised the one specific situation to a higher order.

Students of the "Academy of Building Art-Amsterdam", where I teach, work during daytime in an architectural office and study in the evening. So need to work as efficiently as possible. The Academy asked the help from a time manager. Like in all institutions of architecture our students also need to learn how to present a design verbally. Some have a natural inclination for this, but in a number of even capable students emotional hindrances for such activity exist. Very soon it appeared that the first and the second hindrance were related and united on a bigger scale: the psychological stratum. Everyone has imperfections and quite often these specific imperfections function as a positive drive to achieve something constructive. But other imperfections may impair a student's activities in a certain direction. This was quickly discovered and the initial time manager soon developed into a personal manager of students. By discovering their own unconscious, emotional limitations students often arrive at a higher level, reach a new perspective, attain a new state of freedom and learn how to play, be creative and function more at ease with themselves and consequently how to work more effectively.

Blurred and detailed vision

The Indian mathematical genius S. Ramanujan, who lived between 1887 and 1920, never answered questions regarding the methodology of his approach. However, one day he was commenting on the qualities of a certain English mathematician and said: "He is a very accurate and reliable calculator, yet he will never discover anything new. He has only detailed vision, while in order to discover what is unknown one needs blurred vision."

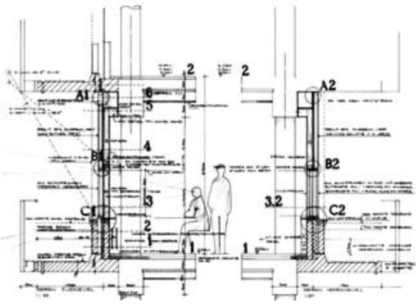
Cybernetic relationship between dream and reality
Every design process starts as a most personal approach form deep down; as a vision, an initially vague commitment. At first a cloud hangs over the conceptual idea and slowly, in the course of time, focussing on smaller and smaller details will be included, furthering increasing clarity. Designing is a path from the immaterial towards the material. The process of materialisation also starts with an initially vague and general concept, after which an analysis of different occurring situations and their demands follows. After a first decision regarding materials a more precise analysis of the different occurring local positions and their relationships will be started. Whether the direction is for expressed or abstract details ("no detail"), the goal will be: a certain

connection between all details in their different occurring locations. The ultimate goal of this approach is unity and a cybernetic relation between different levels and scales. In buildings with expressed details the way of looking is from small to big (and all in-between dimensions) and each detail will have identity, while in projects with abstract details the way of looking is opposite: from big to small and detail have given up identity (but not their specific quality).

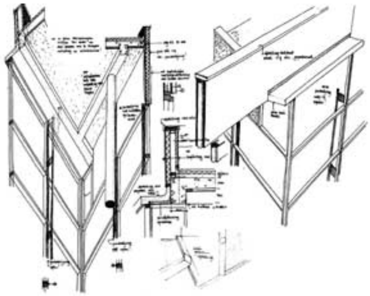
Both concept and materialisation give mutually shelter to each other and their common built-in dream, which Louis Kahn so beautifully described: "I felt that a reading-room would be a place where a person is alone near a window, ... a kind of discovered place in the folds of construction." Designing means never to stop being creative while playing with materialisation, continuously going up and down between concept and detail until the two really meet. When such moment of convergence has arrived one can truly say that the concept is ready, and not a second earlier.

Students

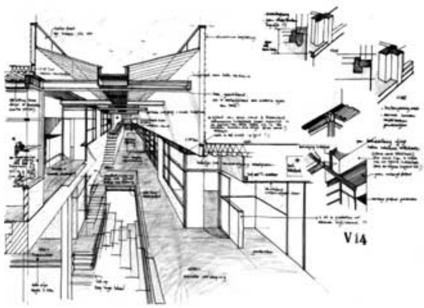
Gradual acceleration



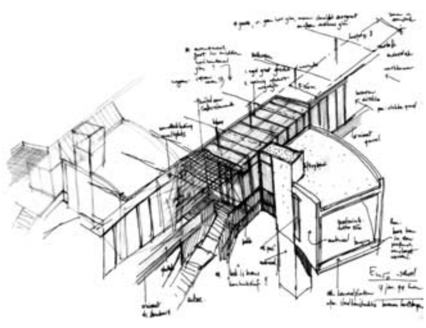
Do students immediately need all available information about the latest knowledge, insights and materials? Let me answer this with a counter-question: is it safe to jump on a moving train, provided the doors are open? Maybe it is better to go to a train-station and accept some time delay. In my opinion the same approach can be applied during the course of education in construction. Yes, researchers, teachers and designers need to possess a wide field of know-how, approaches, materials and constructions, but they need not pour all that over the heads of the students. It is far more important to overlook what is available, distinguish and conclude what is helpful at a specific stage. If students will be allowed to develop insight and tools in order to make their choices, they will be able to use any present or future method and material or develop new hybrid constructions themselves.



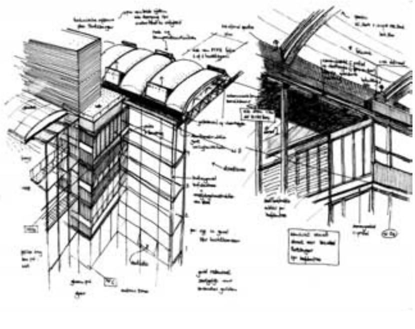
Autistic versus realistic approach
What students first of all need is the mental space, the necessary freedom to ask individual questions, make individual choices and find individual answers. If they don’t learn to come into contact with themselves and develop their own vision, all they will learn is the vision of others. A balance between their internal, autistic approach and the realistic demands of a project will then soon result in the discovery that for no meaningful question readymade or multiple choice answers exist.



Looking behind any screen
Mart Stam, a Dutch architect, once said: "A door is two meters high and we all know why." He assumed his own understanding and his second assumption was the agreement of the world around him. Le Corbusier was not so sure. His answer was: "The question is not whether a door is 2 meters high. The question is, do we need a door?"



Le Corbusier’s approach was more essential. What we know today will be outdated tomorrow. What is available now and applicable at local level will be spread mouth to mouth, through internet, experience of participants of the projects concerned, contacts with the industry, contractors and subcontractors, advisers, researchers and universities. Of course students and designers can learn from the past, but it is still more important to see that the solutions of the past were specific answers to specific questions that were asked then.



Teachers

Mental constructions and "education permanente"

No doubt, specific knowledge is essential for a competent teacher. So, teachers in architecture not only possess enough luggage, they also have learned how to handle this luggage in a creative and/or effective way. But applying this capability individually is quite different from teaching others how to develop this knowledge and collect enough information to start functioning in the field of architecture. Teachers have a much higher responsibility than ordinary or even exceptional professionals. Transmitting knowledge, as well as the ability how to use it, and teaching by example will no doubt be a great help to students, but also teachers need to learn how to rise above themselves. Then they will better be able to also see hindrances that hold their students back in their development. And such hindrances certainly exist. Who will not recognise the power of limiting mental constructions:

"How well did I do this!"
(Falling in love with one's own achievement.)

"I am not good at this."
(Rejection of one's own potential.)

"This is the only way to reach at a solution"
(A preoccupied, mental construction.)

One day a student took his most recent concept to our class bringing a sample of a newly developed building material with him. He showed the sample and said: "My concept-tutors tried to convince me that I cannot possibly use this for the construction of my concept. This material has been specifically developed for constructions that occur in my concept and I want to prove my tutors are wrong!" The answer he received was: "What do you want to do: to prove that your tutors are wrong or develop your concept into a beautiful design? You can do either of the two. The choice is yours." The student provoked additional reactions, but he was so preoccupied with his own mental constructions that it was impossible for him to receive helpful messages that were sent to him. Finally he became totally frustrated and said: "I have no idea what to do with your answers!" Then we challenged him to discover the different material situations that occurred in his concept and the different influences they were subjected to. It soon became clear to him that this analysis was an essential start in the process of making decisions. After he realised that it is not possible to decide for a solution if the problem is not clear, he was able to view the discussion as a help he could work with.

Pouring knowledge into human vessels will create knowledgeable machines, at the most. But especially in a complex human society creative, co-operative and competent designers and researchers are needed. If teachers and their teaching become freer, more creative and more open, the students will carry the results of this attitude towards any future, be it non-digital or digital.

Helpful tools in the digital era

Cooperation

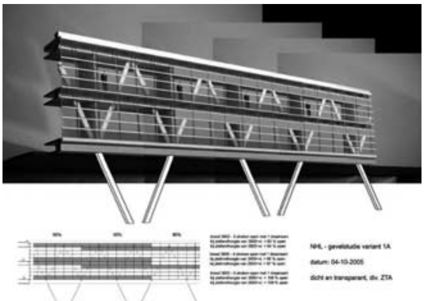
We live in an age with strongly increased levels of information and emotional communication. We reach wider and wider. At the same time we are able to look deeper and deeper. We have passed the levels of milli- and micro-technology and reached those of nano-technology. We need a new technology doing justice to the deep needs of individual, social human beings and the society they live in, while properly understanding the subtle functioning of biotic and pre-biotic structures in, on and above the surface of the earth. The required knowledge to be able to achieve this is rapidly evolving. The keyword for the next generations is 'structures' and the flow of cybernetic co-operation that is involved. Biotic structures have two distinct but related characteristics; one is the struggle for survival and the other is the need for co-operation. The microbiologist Lynn Margulis discovered that amoebae (unicellular micro-organisms) easily exchange DNA, even from antagonistic amoebae. Just like co-operation exists at the lowest levels of life, we can also do everything to further co-operation and consequently benefit from its advantages.

Co-operation in research is a need as well as a realistic possibility. In the Netherlands the TU of Eindhoven has initiated research and co-operation in a foundation "Slim bouwen" (Smart building) to develop new concepts of building products and constructions. Because digital information can be spread fast and towards a large public an internet-site has been opened; furthermore public meetings, seminars, courses and fairs are part of the activity. One first result is the integration of floors and technical installations, for office and housing projects, in a system called "smart floors".

Creative use of digital possibilities

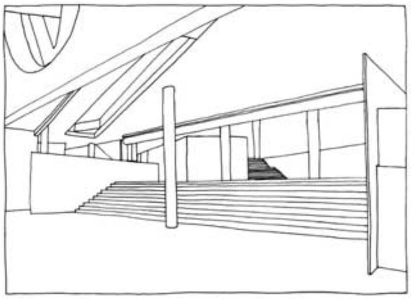
Rationality, creativity, knowledge and competence are vital tools for researchers and designers with vision. The presently available digital technology, which we are going to discuss, can be a powerful tool in their hands. Yes, digital technology is a tool in a tool. It will certainly change the form, directness, speed and external approach of teaching and designing construction, but it will only follow the meaning that has been allotted to it. No doubt: discovering the potential capacities of the digital - provided the number of system crashes will go down! - Is a joyful adventure, but the information it contains and brings forward is what really matters.

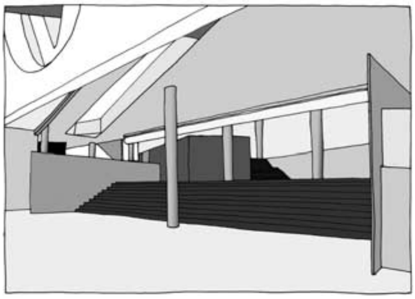
The methodology of the digital will continue to be parallel to existing old ones, physical models will not disappear, neither the use of drawings. It has become relatively easy to combine the properties of physical models with the digital approach. Two examples of this will be presented on the next page.

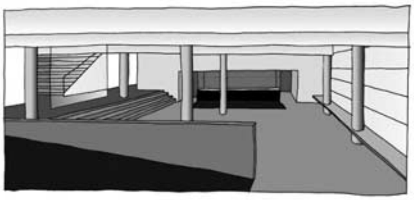


The first example is a method that has been used to assist in designing a façade of an office-like building. First a physical model on a scale 1:50 was made and photographed with a digital camera. After importing the picture into the computer Photoshop was used to quickly present different façade schemes with varying transparent and translucent surfaces. No need to say that this technique was helpful as an extra illustration in a period of intensive research into the many-folded physical aspects of differently located and oriented facades.

In the second example also a physical model was built; this time on a scale 1:100. A digital picture was made after which it was printed. From this picture a line-drawing on transparent paper was made by hand. The drawing was scanned and imported into Photoshop. Different from the first example, this method was used as and aid in the interior design of a school and a museum. In the process it became easy to quickly make digital notes and consequently judge different possible colour schemes.







Emmanuel Tzakakis

Construction in the New Era

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Introduction

The means and the methodologies of construction are changing systematically. Due in large part to the results of applied research that continuously advance the technology available, these changes are also the product of the new possibilities opened up by information technology and the tools it provides.

Together with these changes come changes in the means and methodologies of engineering studies. The computer has evolved from a means of presentation to a means of project design and of support for project production, and has at the same time become a tool for architectural research.

The teaching of construction has to adapt to this evolution, if not anticipate it. The minimum that is required of construction teaching is that it follow the changes and adapt to them. A more attentive examination of the matter, however, taking into account the fact of the inevitable time lag between graduation and professional employment, points to the necessity of anticipating developments.

In order to test this position we will be describing the following points.

- The classical structure of the construction curriculum.
- The basic factors that lead to changes in the subject matter and the components of construction teaching that change.
- Our proposals for a new structure.
- The basic effects of these changes on the teaching of construction.

Construction as it is classically taught

Given that the teaching of construction traditionally follows the order of order of building construction, its content is naturally adapted to that pattern. Thus we have the familiar series of component units within the overall subject of construction, as listed below.

- Introduction (standards, directives, regulations, standardisation)
- Foundations (soil, excavation, foundations, waterproofing)
- Skeleton (concrete, steel, masonry, wood)
- Floors, balconies
- Stairs (design, geometry, construction, ramps)
- Masonry (heavy, light, cladding, painting)
- Floors (sub-floor, surface, false floors, floating floors)
- False ceilings (suspension, finishing, systems)
- Joints (kinds, construction)
- Roofs (sloping, flat, chimneys)
- Openings (doors, windows, façades)

Although changes, both cumulative and of weight, are beginning to be apparent in the contemporary literature, most textbooks remain heavily influenced by the classical approach to the subject. What are particularly interesting are certain differences of approach that attempt to follow what is happening in contemporary architecture more closely, proving that the classical way of teaching construction is not enough.

The basic factors driving these changes

The constant increase in the requirements for building protection

The components of building physics (heat, damp, fire, sound, light, energy, climate) were assembled into an autonomous branch with a considerable entity in, primarily, the 1970s, after the first energy crisis. What had up to then been a largely empirical approach to the elements of building physics in the teaching of construction, as in matters of damp-proofing and sun protection, was replaced by a contemporary scientific approach that was initially (and to a considerable degree still is) handled as ex post facto measures of protection.

However, the growing importance of environmental planning, for society and for the economy, in conjunction with the increasing integration of elements of building physics into building design (forms of buildings, spatial layouts, construction materials), led to the incorporation of building physics into construction (and into other aspects of design). This incorporation was not cumulative but substantive, and so definitively altered the classical way of building.

The incorporation of these aspects of construction into construction teaching is obvious in the content of the most recent books on the subject. At the same time, and this is something that is becoming more obvious every day we are also seeing the shell as a more complex entity in the building. The shell is acquiring a particularly important role, since it must meet many critical but conflicting requirements of the building. The conjunction of digital technologies for handling the functions of the shell and the continually increasing importance of energy as a component element make designing the shell even more complex, from the initial conception to the final resolution.

The constantly growing number of products used in building construction

The significant reduction in the amount of work done on the construction site and the corresponding increase in the use of industrially prepared building materials are a well-established reality. The construction site on which basic materials were processed and turned into a building has become a construction site on which a building is put together from ready-made elements.

Although some on-site jobs still preserve the old image of the construction site, with the exception of the skeleton almost all the remaining elements are now ready-made building components: that is, they are factory-made rather than being produced on the site. Even the skeleton (in Greece almost exclusively of reinforced concrete) is factory-prepared (ready-mixed concrete and iron bars) and transported to the site for assembly. With the increased use of metal skeletons (almost all industrial buildings), the construction site is losing the last vestiges of its traditional appearance.

Quality control in engineering projects and the standardisation of quality

Today, every single element that goes into the making of a building is described in a standard. The description of each component element, and the concomitant description of the means of testing to determine conformity with the standard, constitute the basis for the quality control of building construction and the creation of a framework for fair competition in the field.

EC Directive 89/106, which is a synthesis of hundreds of technical texts, promotes the creation of the conditions that will permit any interested party to learn the specifications of all construction materials products. Apart from the basic principle of establishing rules for fair competition in all dealings, the Directive fixes certain basic requirements with regard to mechanical strength and stability, fire protection, sanitation, health and the environment, safety during use, noise protection, energy saving and conservation of heat.

For its implementation the Directive provides for the operation of declared inspection bodies, the procedure for the obtainment of the CE symbol, certification of conformity and assurance fees. These changes mark a new drastic shift of content that creates new issues that require an important position in the new construction curriculum.

New materials, new forms

Since the days when the subject of construction materials existed as a separate field, independent of the teaching of construction, the introduction of new building materials has always caused a change in the content of construction teaching. The huge quantity of new materials as such, especially in the cladding and insulation sector, and the enormous changes brought about by certain materials that have developed into building systems (dry construction and construction glass among others) make it impossible to incorporate them, and the concomitant increase in course material, into the programme. In addition, in current practice engineers are more and more frequently working with chemists, biologists and physicists to explore the possibility of creating new materials to satisfy the specific demands of the project or altering the characteristics of familiar materials to meet other technical specifications aimed at securing a specific aesthetic result or specific environmental behaviour needs. At the same time, as we all know, a large part of the architectural avant-garde is experimenting with and creating forms that do not follow the "rules of art and science", forms that emerge from the utilisation of the possibilities of special computer programmes. In conjunction with the issue of energy-sensitive buildings, or buildings that use contemporary materials and new construction methods, the quest for these new forms is based on experimenting with materials and how they can yield the new architectural forms.

The increase in the importance and size of building installations

Contemporary building technology has readdressed and incorporates – in new forms, given their direct operational value – knowledge that had long been dissociated from the content of construction, such as for example the networks of installations, naively accepting that these could be incorporated into the plans for the building at a later date. The increase in the number and complexity of these networks (electricity, water, drains, ventilation, air conditioning, gas, heating, Internet, communications, sound and image, sensors, remote controls, security systems, etc.) and the complexity of the specifications for each one of them makes it essential that networks be addressed today creatively and as an integral and fundamental part of the design and construction of the building.

In addition, many installations have acquired dimensions that impose special technical solutions for the passage and service of their networks, something that was virtually unknown just a few years ago. Even in a simple building, the old approach of containing networks within the plasterwork is no longer enough. Finally, both the basic building installation control systems and the additional installations demanders by the users depending on their specific needs are promoting the systematic use of computers to control the various functions, which are bound to increase systematically in number and kind in the years to come.

The increase in the requirements of basic studies
Contemporary project requirements demand more of the basic studies. They need to incorporate more elements, they require input from more different specialists, they demand greater precision of application, there are more specifications that have to be met. In order to satisfy all these requirements engineers have at their disposal new design tools and new sources of information.

Plans in digital form have made the collaboration between engineers both closer and more efficient. The existing software allows fuller control of the validity of the plans. It also allows plans to be altered faster and at less cost, which paves the way for plans and studies to cover more aspects and for projects in the planning stage to be vetted with advanced evaluation and presentation tools.

At the same time plans have become a more flexible component of the project, open to alterations by more specialised engineers, so as to incorporate more expertise and experience. This in turn requires greater superintendence of the progress of the work of other engineers, which is to be used in the project, and a minimum level of security expertise to allow them to communicate with one another.

The consequence is the creation of a new layer of content in construction, in conjunction with the shrinking of older once important aspects, the shifting of the responsibility for the construction of many elements of the project to industry, the new and constantly changing requirements demanded of projects and studies, the need to monitor changes in the work of other engineers, the exploit to the maximum the new materials available and to explore more thoroughly the new relations between drawing board and construction site.

The entities of the new science of construction

The above exposé allows us to formulate the view that a number of new entities have appeared in construction. These have nothing to do with the order of construction but with the problems the architect has to address in designing the project and the matters that arise and have to be solved along the way. Thus not only does the role of each element in the whole of which it is a part become more comprehensible, but the dynamic relation between synthesis and construction becomes clearer, as does the artificial distinction between them, product of the formal classificatory approach typical of classic construction teaching.

The shell of the building
The energy crises of the past few decades have heightened the importance not only of heat insulation but also of other aspects of building design and construction, such as lighting, sun exposure, microclimate and in general all the positive and negative

factors that contribute to their energy efficiency. At the same time, new requirements, until recently unknown, such as the demand for sound insulation, have further complicated the matter.

The complexity lies in the fact that all the above, and other related matters connected with security and specifications, have been quantified (and the results are therefore verified) and must, despite the fact that they require conflicting measures, be resolved simultaneously upon the shell of the building, which has for this reason come to constitute a new entity.

The need to recognise the shell as an entity is intensified by the fact that it constitutes an important element in the form of the building, the external expression of its architecture. Architects have thus acquired a "new" design object, in the sense that it cannot be designed simply in terms of heat or at most heat and sound insulation. New forms of shells that reflect these issues are being described internationally in numerous contemporary examples of works by cutting-edge architects.

The situation is becoming more complex, since the resolution of basically conflicting requirements upon the shell cannot be done by simply adding successive layers of material or constructions, because the requirements are not only mutually conflicting in their method of handling but also imply different time frames. A simple example is that of insolation, as gain or loss depending on the season and in some seasons depending on the time of day and the orientation. More complex examples are the multiple requirements and the many technical solutions available in contemporary glazing, with regard to heat insulation (heat loss) and insolation (heat gain).

Interior finishing

With the recognition of the shell as a new entity, with its own special requirements, that covers the whole spectrum of Building Physics, comes the counterbalancing recognition of the other important entity, that of the interior space. Given that the relations with the outside world have already been resolved by the shell, the architecture of the interior space has to do with handling the arrangement of the interior and designing rooms with other problems such as fire safety, artificial lighting, sound-proofing and acoustics, and also with other materials and products, suitable for interior use. This entity is the interior expression of the architecture of the building, and comes into contact with even more specialised aspects of interior finishing, such as decoration, furnishing, equipment and of course the health and comfort of the occupants.

Interior design determines all the elements that interface with the occupants on a daily basis. At the same time the architectural elements that shape the arrangement of the interior spaces are now all industrial products. The use of components of known and controlled properties shields both the occupants from risks they are not (and have no reason to be) aware of and the engineers from liability in the case that a product causes a functional or health problem.

This creates a new reality in the designing of interior spaces, at once more complex and more demanding. It also demands more of the architect, if within a more demanding environment he is to be able to retain his capacity to design more than standard forms and solutions without having to resort to extremely high-cost options. This was always the problem, of course, but the environment used to be less complex.

The bearing structure
If the shell and the interior space are pre-eminently the domain of the architect, who must retain control of them by increasing his involvement with increasingly complex scientific matters (as the author believes), both the bearing structure and the building installations necessarily involve other engineers.

Despite the fact that the architect is the head of the team of engineers and other experts who play a role in the design of a building, it is the civil engineer who is responsible for the static sufficiency of the bearing structure and who therefore basically builds it.

The inability of the architect to control the form and dimensions of the bearing structure (or his indifference) results in buildings where the bearing structure is incompatible with the architectural design. This incompatibility becomes more complicated when there are specific requirements to be met (e.g. the existing anti-earthquake legislation) that increase the dimensions of the various elements of the bearing structure.

By contrast, the integral incorporation of the bearing structure into the architectural design (which presupposes its initial design by the architect) is not only a basic element for the architectural plans themselves but a basic necessity for anyone who wants to follow the trends that call for a single design incorporating both bearing structure and shell or bearing structure outside the shell.

Reasons for changes in teaching

The proposal for a new approach to construction is not intended to establish this or another arrangement of subjects or entities. The object is to stress the need for a new way of looking at construction and incorporating it into plans and projects.

The effects of the new reality on the production of engineering works are immense, and they impact on many sectors of social and economic life, beyond the narrow framework of the several specific aspects.

The influence of the long-term attempt to achieve European harmonisation on these matters is quite significant, especially through the redefinition of technical content, the introduction of minimal specifications for all the elements of a building and for the structure as a whole, the division of requirements into safety, properties and performance specifications, the organisation of a control framework with European standards and control mechanisms.

There are many reasons why the teaching of construction ought to follow these changes, but primarily because it must

- Adapt immediately to the new subject matter
- Promote a shift in the centre of gravity of interest towards new questions.
- Promote a better perception of the project and its organisation.
- Support compatibility between the project and (all) the requirements.
- Exploit the new design and communication tools that exist
- Prepare the architect for changes that are on the way (10-year horizon).

That will be its contribution to the evolution of architecture.

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The content of Construction Teaching in the new Digital Era

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In the last decade and in the light of the creation of the European higher education area as prescribed by European policies, a great deal of changes are taking place regarding the curricula of schools of architecture in Europe. These changes concern not only ensuring of their graduates to be awarded diplomas with broader professional recognition in the common labor market[1], but primarily to achieve the highest quality of the education they offer. Even though these changes concern mainly the educational structures such as the length of studies, the cycles of studies, the modularisation, etc., they also concern the redefinition of a competent contemporary profile of the future architect through the redefinition of the content and, as a consequence, the educational methods associated with it[2].

Broadly speaking, an educational system as an expression of the culture of a certain era is influenced by the socio-economic context that breeds it. Education, therefore, has to follow the spirit of the age and its social and cultural issues. Similarly, architecture is an expression of the culture of a certain era, is influenced by the socio-economic context that breeds it and has to, in turn, fulfill contemporary socio-cultural needs. Architectural education, as a consequence, in order to meet the needs for the education of people with social responsibility and cultural awareness that will 'shelter' contemporary human beings, has to be continuously updated. By grasping this spirit educators will be enabled to redefine the content of their curricula and adapt them to contemporary needs and demands.

Construction educators have been concerned with the question of content research and redefinition within the works undertaken through EAAE-ENHSA construction sub network in the recent past[3]. Interesting results have yielded from this exchange, and despite the innate of the individual differences of the exchange of views and information, enrichment of personal experiences was noted. The particularities of each country relating to different perceptions of the cultural and socio-economic context suggest divergence of individual opinions in the way architectural education and more specifically construction education should be redefined in the contemporary changing environment.

The fundamental deviations of this discussion concern primarily the extent to which and the way in which new materials and new construction methods, as suggested by avant-garde architectural practices, must be integrated in the subject areas of construction education. As these practices are tightly interwoven with the use of IT, the central question of this discussion is to what extent these practices will have to influence construction teaching. The present article has two objectives: The first deals with the framework in which the above question can be answered and the second will articulate a series of axes on which the design of a contemporary construction module could be founded.

In order to tackle the second objective the article will start with the premise that a construction course is a two-fold activity seen from pedagogy to building or the teaching as a communicative process by touching the student pulse, and from building to pedagogy, understanding the production and realities in the production of the built environment [4] as these are described from the characteristics of the triangle architecture-construction- student. This two-folded activity is considered to be a necessary condition in the redesigning a contemporary construction course since it combines the moral needs of an education with the pragmatics and realities of the building industry.

Architecture and IT

There is no doubt that IT plays a dominant role in contemporary social, cultural and financial practices and has an impact on the way we live and think, facilitating speedy changes that are often hard to follow. The creation of architecture in the design process, as a social, cultural and financial practice is nowadays inseparable of IT both as a means of representation but even more as a means of form generation, especially in the so called avant-garde architecture[5]. As there is a reciprocal relationship between the perception of architecture and the means to generate it, the involvement of computers in the generation of architecture demands new perceptions of architecture. On the other hand, perceiving architecture in a new light demands new strategies for form generation and imposes new means to assure the spatial manifestation of a new value system. There is a shift of paradigm from the orthogonal projection and use of Euclidean geometry and Cartesian logic to the use of topology and non-Euclidean geometry. The former paradigm resulted in static linear constructions of intersecting orthogonal and linear axes that in turn made clear-cut distinctions of conventional construction elements such as walls, roofs, windows etc., whereas the latter generates systems of curves that create surfaces movable with time and blur the boundaries between the conventional construction elements of a building. In the new paradigm computers cease, increasingly, to play the role of representation tools in the hands of the architect and tend to become a decisive, opinionated or even sometimes stronger partners.

There are clearly changes in the perception of architecture in the past and nowadays. Franco De Luca and Marco Nardini define as new architecture the species of architecture the forms of which are born with the intervention of IT. According to Saggio[6] a building was successful when '...well constructed, economic, logical and with the rationality of a machine...'. Nowadays, according to the same source, a building is 'A form that precisely informs'. Similarly Kas Oosterhuis suggests that nowadays '...a building is a set of fixed and moving components, a totality giving form and substance to the flow of information passing through it', and goes on to say that 'a building, like an organism, should have metabolism to abort and make good use of information'[7].

Construction and IT

The fundamental question is whether the construction of an architecture generated in this context with the support of IT can be realised with construction methods, perceptions and means that do not belong to this new ways of contemplating space? Are conventional construction methods sufficient and appropriate to realise these new approaches to architecture? Does this new architecture suggest new ways of perceiving and adapting pedagogy of such construction?

Construction is no longer an assembly of standardized parts as was the case in the Modern Movement but personalized techniques of creating desire for formal variation and uniqueness[8,9]. Nowadays form and its 'construction' are generated from computers. From vehicles[10] to clothes[11] this is possible and much more efficient than conventional methods, control is much easier when every point of a surface lies within a certain algorithm and has its identity through its precise coordinates, a characteristic that makes it easier to change and to manufacture. As De Luca and Nardini suggest 'the mathematical control of surfaces gives a higher command of forms both in creating as well as modifying them'[12]. Along the same lines both Kas Oosterhuis and Greg Lynn propose the 'tailoring' of building elements on computers which is then 'sent' in the form of file to the factory[13,14].

The Student and IT

No educator would deny that in order to design a course appealing and attractive to students one has to 'feel' the student pulse. The emerging question is, then, what the student pulse is in our days. It is true to say that Information Technology is increasingly dominating and becoming the context of students' lives. The worldwideweb is to them the prime source of information, communication and cultural awareness. Architecture students, in turn, use the Internet to access in the speediest of ways contemporary architectural examples. Individualization and personalization is one of the top priorities in their life and as a consequence their architectures acquire similar pursuits. Architecture students not only get informed and communicate through IT but they also create and represent architecture through IT. At the same time, individualization in their personal life is confirmed and reinforced by creating their architectures through the same central pursuit of their role-model contemporary architects.

From pedagogy to building

If we attempted to 'transcribe' the characteristics of architectural creation and the contemporary aspects of its materiality into pedagogic practices, we could put forward seven fundamental principles for the organisation of a construction course. These principles constitute the core around which the content of construction education must be redefined today.

1. In the last decade, there has been discussion on the need for a tight relationship between design and construction. This is more so nowadays. New perceptions of architecture and the use of digital means both as a representation as well as a form generation tool encourage the smooth transition from design to manufacturing[15,16]. Digital means, understandably, have dominated students' ways of thinking and doing or rather making architecture. The integration of design and construction, or form generation and materiality facilitates the smooth transition from the one to the other and digital means are catalysts of this transition.

2. Students should be connected to the building industry via their university through the Internet, site visits, lectures delivered by the industry to schools, etc.
   The same way building elements go 'from file to factory' students should go 'from file to factory'. In other words students should have constant contact between their laptop and the advances, technological developments and manufacturing

techniques of the building industry and the emergence of new materials. Contact with the industry and research centers puts experimentation in students' practices and therefore in their design and anticipation of manufacturing and construction of their designs.

3. Experimentation in both the explorations of design and construction should be encouraged.
   Experimentation plays an important role in design teaching as well as in construction teaching. The content of construction teaching should encourage experimentation. Undoubtedly avant-garde architects in the history of architecture have always experimented with their ideas and their constructions, and even more so in the contemporary paradigm, therefore it follows that experimentation should be encouraged in architectural education. Experimentation as students' modus operandi, in design and construction education, in manufacturing and research and in the generation of contemporary architecture leads to individualized and personalized ideas and constructions. Individualization and experimentation are the main ingredients of (re)searching the constructability of ideas.

4. Education should be an open-ended forum of information flow.
   The teaching of construction must become an open forum, a network of information and data flow courses well connected to the building industry and research, readily available to be enriched and changed. Case studies of the state of the art buildings that have been generated and manufactured through computers must fill the students' mental stock and enable them to follow the current trends.

5. Emphasis on individual case studies as a teaching tool rather than the teaching of certainties and laws. Moreover, case studies are the only useful and operational means to teach the exception, the non-standard and the constructive ways of thinking uniquely and creatively construction as part of the design concept.

6. Access to programming. Students should have a choice to learn not only the relevant software available, but be educated to computer programming through optional courses their School should be able to offer.

7. Attention has to be paid to the management and selective as well as constructive use of the infinite information available to students. This can only happen if education develops critical thinking in the student consciousness. After all teaching construction lies within the boarder umbrella of teaching architecture. Therefore teaching construction like teaching architecture should be about developing judgement and students' critical faculties against any obsession with any kind of technological determinism, the seduction of forms and the distraction of progress in the form of new materials and techniques, computing or indiscriminate information flow.

It is becoming increasingly clear that the shift of paradigm in the ways architecture is perceived, designed and hence materialised has a great impact in the ways architecture and its materiality is taught. The new paradigm is based on the teaching of experimentation, improvisation and creativity through student centred learning or in other words the infinite, non-standard, open-ended, unconventional and experimental through experimental teaching methods, while at the same time aiming at the investigation of the process. This proposition clashes with the old paradigm, which is articulated around rule- based learning in other words the finite, standard and conventional through conventional teaching methods aiming at the optimisation of the product. The above thesis does not intend to undermine the importance of the traditional ways of teaching the fundamentals and basics of construction. However, some of it has to be constrained and condensed so that 'space' is also afforded to the new and different. In achieving this goal it will not be enough to superficially manipulate a school curriculum but will require the conscious effort of shifting pedagogic philosophies.

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In Search of Restructuring Construction Teaching

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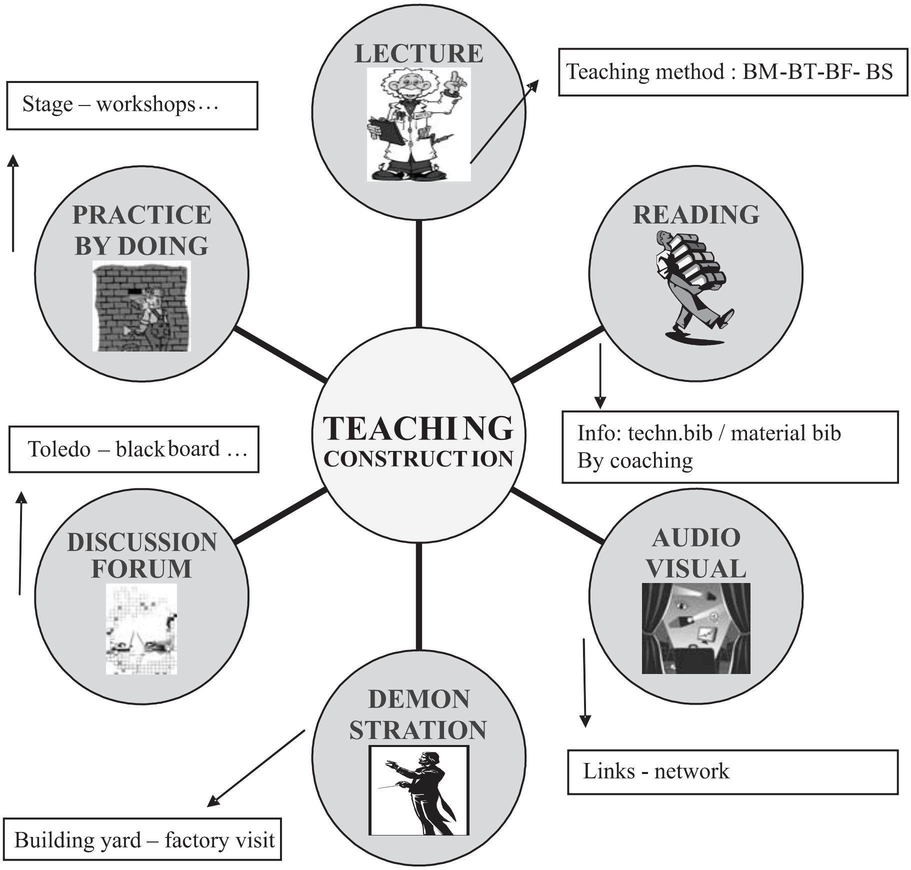
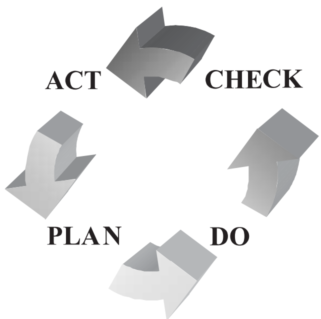
Teaching in the new digital era produces an enormous population that is able to surf worldwide to information, but who is not able to distinguish what is worth to be read! So the teacher is guidance and coach. He opens the door, but the student must enter by himself.

Pilotis of Teaching Construction





Some Objections of the Teaching Staff

The content axis

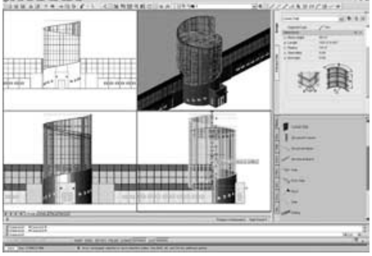
1. What must be the corpus of construction knowledge nowadays?

   - Elementary principles of BM (Building Method) – BS (Building Stability) – BT (Building Technology) – BP (Building Physics).
     - Elementary principles of stability are - and will always be - the core of a well-balanced construction course.
     - New materials and production modes will definitively alter our way of dealing with construction issues.
       Knowledge of materials is important and the properties of these materials (view, stability, dimensions...) The objective for which the materials were brought on the market must be part of the elementary principles.
     - The ability to calculate complex structures is widening our horizons already. It became possible to calculate highly complex structures, to create and evaluate simulations before building them. We are indeed entering a new era. So any technique we can come up with to make our buildings better will be interesting to know more about. Therefore, these new techniques may be compulsory to the elementary ones.

   - Base: materials – elements – configuration
     materials
       - physical & structural properties of contemporary building materials
       - strict classification (will provide framework for full content): masonry – concrete – steel & alloys – wood & derivates – glass –plastics & composites – membranes
       - relevant distinctions must be clearly defined (e.g. isotropy-anisotropy)

     elements
       - based on above, and preparing next
       - classification according to above / availability paramount

     configurations
       - resulting from fusion of structure & elements of construction
       - analysis of today's archetypical configurations (mass active / vector active / hybrids etc) fully case based & documented
       - classification based on 1/ materials classification & 2/ typological classification, thereby allowing for scale-related aspects to be introduced



AutoCAD Architectural Desktop

2. What are the new subject areas which will have to be included in the new construction teaching?

   • First we have to teach an Attitude and a Working Method to solve an architectural problem.
     - There are no new subjects areas. There are only new materials. Materials are able to be used for other aims then for which they are devised to be. E.g. : A large evacuation tube can possibly also be used like a flower barge. More and more new materials are fully used, particularly plastics. This involves in fact a basic knowledge of chemistry in function of these material leathers.

wall made of carpet tiles
(Lucy's House -S. Mockbee)

     - Even more importantly and exactly this way are new production techniques important to discuss, e.g. rotation mould ...

   • Permanent update is essential / significant shifts in evolution (e.g. glazing technology) and breakthroughs in materials technology must be integrated without delay.

3. How will these new areas coexist within and be organized around the given educational curricula?

   • Clear sequence of "must know" (# 1) can be directly transposed to bachelor structure (1-2-3) ; superseded and outdated distinction between structure and construction must be abolished.

   • We must ask external specialists who have knowledge of these areas. It must be part of the curricula.
     - Company visits are a good manner to make knowledge with the production processes. Because you pick up at such a visit more (sometimes other matter) than postulated, both it includes this formal and informal leather.
     - Workshops on school (cooperation with design studio) which examine the possibilities of materials. F.e.: How do you link two materials ? How do you make an invisible connection?

4. What will the prioritization mechanisms and criteria be for classifying modules as compulsory or optional?

   - Bachelor-master structure is instrumental in this distinction : "must know" – "want to know" typological approach of built situation allows for personal choices to be made, once "must know" part has been accomplished.

   - Nature and basic principles will never change. The law of gravitation will exist to continue. Main point and side issue always exist to continue. A nail hangs to the finger, the finger to the hand, the hand to the arm, the arm to the shoulder, the shoulder to the back bone.
     - Optional matter is possible in function of certain current tasks in the studios. (Within a 'traject'*.)
     - 'Trajects' are coherent entities of theory - and practice professions of which the topic is commonly socially relevant or dovetails the research competence present within the institute. 'Trajects' are therefore really interdisciplinary and they form a means for the integration of education, research and designs. These 'trajects' can be taken as several tracks along which the student can graduate. A 'traject' is as it were an angle from which a field of architecture approaches.
       All 'trajects' within the master in architecture have equivalent end aim (an architectural design in its complete meaning) and the same general final attainment levels.
       By 'trajects' there is a separate formulation of the specific final attainment levels where the required development level and return are specified each time.

5. What forms of collaboration with other subject areas will have to be invented in this new context?

   - see above : materials technology – structure – construction must be fully integrated; any artificial distinction must be abolished at once.

   - Design studio. Collaboration with laboratory's of the university.

6. Will new specializations emerge from these collaborations?

   - Definitely. These changes and shifts can already be observed in the field, where a new division of tasks is emerging.

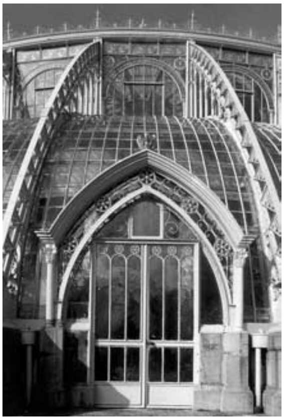
   - This seems inevitable, but also unforeseeable. There was a time that we could weld no metal, and that figures were cut by models and not with software.

7. How could the new content in construction teaching reinforce the relationship between design and construction?

   - Preseding the main point: Teaching construction: can it be disconnected of teaching design?
     Christian Schittich (DETAIL) distinguishes six different types of construction details. No doubt the architect/designer first has to decide which type he prefers before he proceeds to the construction.

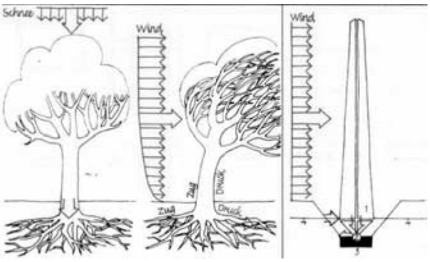
   - This is a sensitive area: cooperation is fully dependent on willingness on behalf of teachers in charge of studios.

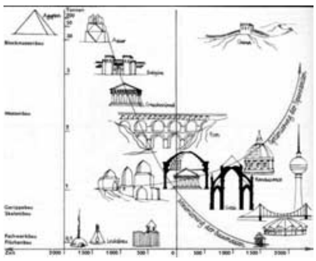
   - Construction matters are an intimate part of the overall design process. Construction matters are not "added" to the building.
     - By indicating that construction is an absolute component of design. But that is not new. In the Art Nouveau e.g.. they could take part in a conversation about that.



1. Balat (Royal serres) 2. V. Horta (House Van Eetvelde)
Photos: Christine Bastin & Jacques Evrard voor Lannoo
Author: F. Dierkens- Aubry & Jos Vandenbreeden

     - By discuss constructions from a relevant context. This offers tasks within the design studios. For example: the link between nature and structure or the link between the old construction methods versus the new.





Buttner Hampe : Bauwerk Tragwerk Tragstruktur.

- By giving exercises which are more linked to construction (including structures).
- Of course it is the intention that our students learn to apply the most essential aspects of construction in a creative manner. For up to that point, I emphasise the importance of well-accompanied (developed by the students themselves) case studies. The manner in which the books BIRKHÄUSER EDITION DETAIL are built, we find exemplarily. If we would use these books as a "handbook" (where several teachers stipulated components of the learning substance for them account) in the Bachelor years, then "valuable case studies" incorporated in parallel with design projects would lead to remarkable results.

8. Would the design studio serve as the appropriate milieu or should other niches be defined?

   - It is the preferred environment for application, not for acquiring knowledge / these are clearly different tasks.

   - It is obvious that the design study is the test area and also feedback of the construction. But the construction as separate discipline must continue to exist. But there must be more bridges laid between the disciplines.
     We would formulate it differently: the civil engineer remains in existence, the architect will continue to exist, but the architect-engineer is a duality which must become incorporated in each designer."
     - E.g.: in our school 'construction studio' is already an answer on rather pragmatically an approach to the design. The design can grow from material. There attention is given on technical details, taken into account to realise the project.

R. Rogers Airport Madrid

9. How can the teaching of construction incorporate the continuous developments in innovation?

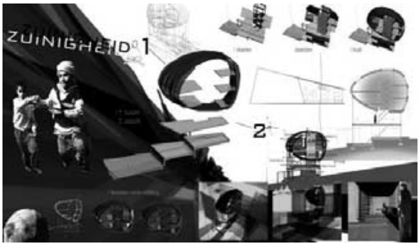
   - Achieving this aim is fully dependent on dedication and commitment of teachers in charge of construction. It's a 24/7 commitment, no way round.

- As it was described earlier: to continue as feedback of the design studio, without losing itself as a discipline. By making a network over Europe with this item.

10. How does this (new) content affect student competences and skills necessary to practise architecture?

    - Again, a very sensitive topic. Design briefs in studios are often by very far remote from the actual building practice, representative only of a very small fraction of present building environment. An error of focus. Yet a shift of emphasis could lead to depreciation.

    - By tests, by digital portfolio. Concerning construction: insight in the logical advancement, spatial insight, interest.
        - He is a designer.
          He knows the resources.
          He has insight and is obvious.
          He uses the existing resources in a creative manner, more than a practitioner. As an author with 26 characters makes words and uses this in a certain language, and writes with that a new novel.



Gilles Retsin (Second year project)
WENK St. Lucas Ghent Belgium.

The teaching method(s) axis

1. How do changes in the content of construction teaching affect the teaching process?

    - Clearly, evolution in present applied building technology. Anyone concerned should have a very clear understanding of distinction between gradual and fundamental changes in applied technology. This can only be achieved by personal activity and involvement in the field, combined with permanent and accurate analysis through publications and assessment on site. There can be no doubt about this.

2. Do they affect the aims and objectives of the already established modules and courses?

- All the time. Offering State of the Art information on construction is crucial. We've seen enough time wasted on obsolete and/or irrelevant knowledge and technology.

3. Should new teaching methods and pedagogic strategies be invented for this new content to be transferred more effectively to students?

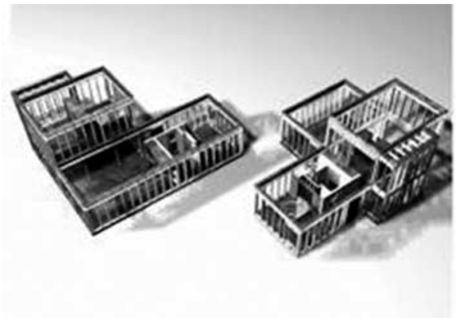
- The pedagogical methods possible must remain; the education methods may be adapted.

4. How will new technologies – nowadays indispensable means of transferring knowledge– become even more creative tools for the teaching of construction?

- Reality-related information is the key. Any means of bringing reality as close as possible to the student must be welcomed. Guided study of the building process in reality, on selected sites, is ideal, but hard to achieve in practice. Everything depends on the number of students that must be taught.

5. What tools and vehicles will be employed in the new construction teaching?

- 3-D images of material, if possible a scale-model is made, 2-D picture material and if possible yard visits or direct contact with the material. Mainly the relation between 3D and 2D of the same object show how the student learns to understand a detail.



Lamia El Bouazzaoui
(second year project)
WENK St. Lucas Ghent Belgium

- In the first year we have to try students to learn reading 'constructions' by understanding. By means of projects from 'publications e.g. "detail" ' can infer about what it goes.
  Isolate a detail from a project to discuss, to apply in a another project, to give feedback by means of exercise. Make vertical sections of some horizontal sections.
- By making an European network.

6. How will new information on innovation, new materials and construction methods, become known to construction teachers?

   - No need to! This is fully the teachers' own responsibility and task. If he/she doesn't respond to that, he/she is clearly not the right person to be in charge.

7. How could this information be taught and disseminated to students?

   - Newsletters, provided that they are read. Expo of ' innovations ' in technical library/material library.

8. What tools would facilitate this dissemination?

   - Any university is nowadays sufficiently equipped to achieve these aims. Let's devote our energies to using these means, instead of wasting our time in studying the means instead of the real aim.

   - Technical- and material library with the presence of teachers in construction techniques. Good software to search for information on the Internet. Technical work shop (research application of materials).

9. What tools would respond to this need (software, databases, websites etc.)?

   - Access to this sort of information channels is now absolutely universal. One should no longer divert his attention to them. It only detracts from the real activity.

10. What are the necessary initiatives our Network should take towards strengthening this new form of information exchange and towards enriching and improving the process of teaching them?

    - Permanent communication will only enhance confusion. Only treated and analysed information can eventually be exchanged. Only then does it really serve a purpose. Quite often today it is only a means of stirring loads of information, instead of analysing and implementing them first.

    - Interest for lifelong learning by teachers and students. It is mainly an "attitude" of the staff which must look that information is read and processed. As long as letters, e-mails, circulars, communications by means of the mail box are not consulted or unanswered, as long as you cannot count on a sufficient information and communication.

The research axis

1. What types of research will emerge from the (re)search and redefinition of the content of contemporary construction teaching?

    - Means and infrastructure available to Institutions and Universities are indicative of relevant research which might be envisaged. Duplication has to be avoided at all cost. It looks like research on configurations is presently lacking worldwide. Clearly, here is an opportunity to be pursued. A benefit is the relative modesty of means required to conduct relevant research.

    - Particularly I don't believe in the research within our institute. We have not the arrangement, people and money. Moreover we see that research mainly comes of the industry. Those have, however, the resources and ambition.

    - Energy aspects within the context of the European Energy Performance Directive (EPD). For Flanders this is of application from 01.01.2006: we have also EPB (EnergiePrestatie en Binnenklimaat regelgeving), legislation about obligation of certain comfort aspects (e.g. summer comfort and indoor air quality (IAQ).

    - Sustainable constructions: ecological building...

2. What can be researched, experimented and tested in the context of construction today?

    - In view of the emergence of new materials, coupled with the development of new elements derived from them, the path to be followed is clear.

    - Creative applications of existing material. Therefore in fact, we must force the industry to go further than the utility objectives which first they have put themselves. E.g.: It is possibly the designers who are asked (required) to run on a glass floor. The industry has found the solution.

    - Which consequences mean all these new aspects to this energy legislation and environment aspects both in building design and construction?

3. Where can research on construction be published and disseminated?

    - Here is a discrepancy between the announced intentions and the means available or the willingness to make use of them. Only a very clear and consequent policy can offer a way out here!

    - There are a lot of possibilities to this point. For that purpose we refer e.g.. to the Internet site of the WTCB (Wetenschappelijk en Technisch Centrum voor het Bouwbedrijf), where is referred to a lot of research work and the manner of distribution. (http://www.wtcb.be/)

4. What research results will be useful to advance construction and construction teaching?

   - A lead could be established through the approach described above. Obviously, results can be put to use immediately in design studio activity.

   - It depends of the results of the research and for which training year.

   - Above aspects will mean a revolution in the world of building design; the policy and the colleagues firstly want make free the necessary attention and time for this item.
     Also for our department within the framework of the association K.U.Leuven, education must be based on research.
     It is an important aspect for further accreditation, of what many teachers apparently are insufficient or in whole not aware.

5. What types of interdisciplinary collaborations and effective research outputs might emerge?

   - The abolishment of outdated distinctions between disciplines (see above) will make this question superfluous.

   - All disciplines up to and including the historians.

   - Given that schools of architecture do not have laboratories, etc... cooperation with universities, other scientific partners (e.g. WTCB) and industry are necessary.

6. Are our institutions prepared, equipped and supported adequately enough to allow research to be included in the new content of construction teaching?

   - On the face of it : yes.

   - We have to cooperate with universities, scientific partners and industry.

7. Who would be interested in funding research in construction nowadays?

   - Architects, the engineering trade, element manufacturers.

- The industry under presses of the designers.

- All designers, customers and building contractors (because there is new legislation, which will bring many consequences with itself).

- The government, because obligations Kyoto-protocol.

- Our children, grandchildren... because they want also lives in a livable place (environment).

8. What are the necessary initiatives our Network should take towards strengthening the research activities and collaborations among its members?

   - Willingness and a clear policy are the main objectives. Talk and intentions will get us nowhere. If no real opportunities are offered to able teachers (not only budgetary, but mainly in terms of time) any initiative will be stillborn.

   - We must be sensitised.

   - We cannot research everything: therefore specialisation becomes necessary. The results of its own research must carry a discussion at an international level by means of conferences and such.

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Debate on the Presentations
First Theme, Part I

Chair:
Maria Voyatzaki
School of Architecture
Aristotle University of Thessaloniki
Greece

Maria Voyatzaki

First of all, I would like to remind you of the content and the questions that were raised, going back to the content of contemporary construction teaching and the question of what is new. I am reiterating these things for fairly obvious reasons. People want to get involved in this conversation, not necessarily in relation to what has been said, but also to express their own views on the matter; so when we put together the theme, and we have had different suggestions coming from different angles, there is one practical question that has to be borne in mind: obviously, from what we have heard so far, there are new things that have to be taught; but they have to be fitted into a curriculum with a finite amount of space. The question here is what the corpus of construction knowledge nowadays must be. In other words, do we need to reconsider it at all or just stick to what we have got already? What are the new subject areas? Dimitris Papalexopoulos and our Danish colleagues tackled this radically; but then the question arises as to how, if there is a corpus of construction knowledge that has to exist, the new material is going to be fitted in. And if the new has to be part of construction pedagogy, what place should it have in a school's curriculum? Because, obviously, if we decide that the new and the old should co-exist and have the same weight in a curriculum, then the next question is, what is left, in terms of time and space, to the other subjects that have to be taught in a school of architecture? We could end up teaching nothing but construction for five years. So we have to start thinking about what the new corpus of construction teaching should be, and see what of this should be prioritised, emphasised, and so on.

So that is our theme, and you can relate your questions or positions to what has been presented here.

Joseph Thurrot

I have a question for Dimitri Papalexopoulos. You threw me there a little bit, Dimitri, on a couple of things. One of them was the word 'artefact'. You said that there was a duality, with the artefact being a catalyst as well as an object. And I just wondered if you could explain that again briefly, because I did not quite follow you on that.

Dimitris Papalexopoulos

I cannot explain briefly two major directions of the philosophy of technology. There are two ways of looking at an object. One is as something exterior to the subject, something that can be fabricated and manipulated at will. This leads to the position that computers are something outside us; they are things, so we can use them in a good or a bad way. That is one position – with which, incidentally, I totally disagree. When I said that each society can speak through its artefacts I meant that each society is linked, merged, with the things that it makes. That is a more or less French current in philosophy. The other position I did not argue, because it is a big philosophical discussion and is a question that must be addressed to the whole congress. What I said was that, of the two points, the second one – that is, the artefact as a catalyst of relations, or of sociability – helped me see the question of interactivity and interaction design. That is the whole idea. As a technologist and as a teacher of construction, not as a philosopher or a social science man, I would like to let the object speak and tell multiple stories about how humans use it. Let the object speak. It is a huge debate.

Joseph Thurrot
I gathered that, and I just want to ask how can we possibly think of an artefact as something that is malleable, a catalyst, because surely all artefacts are objects. As architects we make buildings, we make things that are always going to be part of the objective realm; so I really do not understand where the second line of thought is coming from.

Dimitris Papalexopoulos
When I build a house, a building, I build a thing. But I do not decide its materiality: I decide the multiple interrelations that are incorporated into the thing. So I accept that I have a social relation between design, construction and industry. I cannot see mass customisation or industrialisation of the building outside the complex relation of industry and construction, what is fabricated in situ and what is fabricated in the factory. There is a divide, a powerful economic and social divide. So if I let the neutral proposition of a prefabrication system speak, it can reveal the whole set of social, economic and ideological relationships behind it. This is my general position; this is my thinking. I am not a philosopher or a social analyst, but these are my beliefs, following a French tradition of the 70s. A very concrete tradition of thinking about construction.

Joseph Thurrot
Perhaps I will let someone else speak now, but I would like to speak to you later when we have more time.

Dimitris Papalexopoulos
Yes, of course. But let us just mention another paradigm, which is close to digital construction: the constructive approach of Bernard Cache and the way he fabricates different kinds of things using the objectile-subjectile dichotomy within the theory is the same kind of thing.

Henk de Weijer
If I understand correctly, it is as if what you are sitting on is not a seat but a staircase. The staircase is an object, or an artefact, in itself; but when it is used as a place to sit rather than as a staircase, it becomes a catalyst: thus, form becomes a catalyst. There is also a connection with the relationship of form and interpretation. Our colleague from Aarhus was talking about it as a machine or a tool. A tool is an object that catalyses some idea or interpretation, while, as a form, a machine is closer to the idea of an object itself.

Herman Neuckermans
I would like to address a question to Maria Voyatzaki regarding what the corpus of construction education today should be and how it can accommodate the old and the new. That is a really tricky question. I think that what we teach is a window to knowledge, and the focus changes over time; but that does not mean that we can throw out of that window the core of what we teach in construction. In my country, for example, 60% or 70% of building activity has to do with remodelling buildings, converting them to the needs of today. To do this you have to know – as we did –

about ancient and previous technologies. In my view, therefore, it is not difficult to define what is new knowledge and what is old knowledge in construction, because it is a continuum; but, on the other hand, we are limited by time. We have five years – no more – to teach the corpus, even though that corpus is growing continually.

Maria Voyatzaki
So if we accept your assumption, then we have to decide which segments of this continuum are important to teach. We cannot teach everything from, for instance, dolmens onward.

Herman Neuckermans
There is a famous series on construction in the Netherlands, which has gone through some fifteen editions; and if you go back to the last edition but one you will find the – "The Gift of Fundamentals".

Maria Voyatzaki
Yes, but the point is, what do you teach in a limited, finite period of time? That is the main question. I do not disagree that it is a continuum; no one says that this is old and this is new and this is what connects them. But the point is, what do you teach? What do you teach, when so much has to go into five years and construction is given sixteen credits and thirty hours, or whatever it is? This is finite, and this is where we need to find answers.

Herman Neuckermans
I think, from the personal experience of my own school, that it is partly up to the school and partly up to what the design studio requires us to teach; for they are on the cutting edge of architecture, they are always producing new architecture.

Maria Voyatzaki
This is one position.

Herman Neuckermans
Yes, it is; and in the same way I do not think that digital construction can be part of it. You can introduce part of it in the school, but you do not have to cover all that exists between the old and the new. But **my ultimate answer to the question is that courses should teach fundamentals.** It is the face and not the body that changes; the fundamental principles remain. That is my answer to your question. Now I have a question for our Danish colleague, related to the example you presented: what was the theoretical foundation of what you were doing? Secondly, you said that you made a digital model: how did you do that? To me there was a gap in your explanation. How did you get from the concept to the digital model?

Anders Gammelgaard
To answer your question: it could seem as if we were trying to avoid the outer form, or that the students were wishing to do that; but the point of departure was, as in a home study programme, the form potential of this material and exploiting this form potential. So instead of the commonplace of concrete slabs that are just flat, this

material has another potential; and that was what they were pursuing in their project. So theoretically it derived from a tectonic point.

Maria Voyatzaki

I want to go back a step, because Prof. Panagiotopoulos from Thessaloniki wanted to ask a question or make a point, when we were discussing the finite and the old and the new and the continuum.

Nikolaos Panagiotopoulos

I have two questions for Prof. Papalexopoulos. His presentation was a very interesting one, because these issues will come up again and again throughout this meeting. The first question is a statutory one: can we specialise engineers to predict human behaviour so that we can adjust buildings to that? And the second question is: speaking of transfer of information from the designer to industry, does that not sound as if we are using the same tenets as in the building of aeroplanes or cars? Because I strongly doubt that buildings obey the same laws as aeroplanes and cars.

Dimitris Papalexopoulos

To your question on whether one can predict human behaviour, the answer is obviously no. So there is one current interaction design, because mostly the problems are with interaction design. As to how we design an interaction, there is one trend that says that we can predict human behaviour and there is another trend that has the ability to deal with objects that are not strictly defined. It is about the logic of ambiguity. But it is an open question. I think that that is why I place it not in the courses within the architecture curriculum but as a question for research, possibly for a diploma thesis or for post-graduate studies. I think that in the question of interaction design Antonino Saggio has things to tell us; but **we are in the presence of a paradigm that is shifting from needs to desires.** That is something that has occurred in contemporary reality. Also, if we go to industry for that part of interaction design (not for the other, not for airplanes and cars), we will see that there are models that seem to predict behaviour when in fact they provoke it. That means that designing industrial objects today does not mean designing form, but designing also the connections and the possible uses of it, the transformations and the performances. Jeremy Rifkin has described the whole model very well. I do not agree with everything he says, but he has a very clear description of this type of thing.

Regarding the second model, I spoke about what we tend for brevity to call smooth architectures, like what we saw from our Danish colleagues here. I do not know why we have to think like that. Digital does not necessarily mean smooth. We all have cell phones, and right now we are in a rectangular building, not a smooth one; so digital does not necessarily mean smooth. Smooth architectures create smooth objects, and we are finally in a position to build them, and that is a very good thing. So the model is not the car, it is the airplane. It is the Boeing 737, and maybe the shipyards; and this is a new paradigm. I am being very careful here: I am not saying that we have to build architecture like that, I am saying that we have to study what they have done. Surely construction is much more complicated; and I believe that I made it pretty clear in my last slide, where I put forward a sort of dichotomy, saying that we do not have to make a choice between digital and physical. I remember many years ago that Nikolaos Negropontes, who was also an architect, said that nobody has to answer the question 'either/or': it could be 'both/and'. Thank you.

Anders Gammelgaard
There seem to be two discussions running parallel, so if I may I would like to return to the question Herman posed about the demands that define the future of teaching in construction, because you suggest that these demands come from the architecture offices, which I...

Herman Neuckermans
Not the offices, the design studios.

Anders Gammelgaard
The design studios? Then I misunderstood you, I am sorry. I think that it is true that the design offices can make an impact on the kind of teaching in construction that is carried out; but at the same time the really important thing for any school, for any university, is to have this open space where research into fields that are not immediately useful can go on, so that the question of where the demand comes from is, I think, a very important one.

Dimitris Papalexopoulos
A small comment on the demands of the design studios. I do not believe that the demand is clearly defined. A group of us once said, "let's ask them what they want us to do, and we shall see how they will not answer us". "If we are your servants", we said, "then tell us what to do"; but they do not know what to tell us. Thank you.

Maria Voyatzaki
That is understandable, though; it makes perfect sense. Why should they know the answer?

Henk de Weijer
I think that there are two things involved here. One is the need for investigation, for servile-mindedness: I want to build what you want me to build. But there is also the other side where, just as in politics, there is a need for vision. Take stairs, for instance: if a student gets an exercise in making a staircase in a certain environment, I will ask him first to analyse the situation he sees and is working with, and then to decide what to do, whether he needs a staircase at all, and if so what kind of staircase is needed. Analyse the situation, step outside yourself, and then decide; but also make a statement: you add nothing towards this new analogy if you just make an analysis without the statement. Architects and designers are increasingly asked to make a personal emotional statement.

Ole Vanggaard
I am an engineer from the School of Architecture of the Royal Danish Academy of Fine Arts. It was the words 'smooth architecture' that made me pick up the microphone, because smooth architecture is something that we had earlier, Saarinen with the TWA Airport. I think we have to introduce the teaching of digital tectonics, which

we used to call informational tectonics. I think these things are interesting today because they represent this new era, and architecture has to experience everything new that comes up, even in the simplest things. This has another reality in today's world, because materials and industry and the new design network of experts that work together make it possible to do other things in industrial ways, to create new surroundings around us. This, I think, is a very important thing; and it is also important for us, as teachers in schools of architecture, to understand that this is not just a style. It is something that is related to all the basic facts, it is related to the techniques, it is related to society, and it is linked to the way we talk to each other and communicate.

Anders Gammelgaard
I would just like to make a final remark about the fundamentals in construction teaching, which you mentioned before, Herman. This is the fourth time that I have participated in this workshop, and you are always speaking about how we have to teach the fundamentals in construction; and you said before that in the Netherlands there exists this book, "The Gift of Fundamentals", which has been slowly changing over time. I think that this is a very normative way of thinking, because **it seems to me that the fundamentals of construction are going to be narrowed in the future.** If you see the number of topics that the students have to meet, and we still want to give them a fixed package of construction teaching, then there is simply not enough time. **I think that it is important to be able to let go of this idea of fundamental construction teaching.**

Maria Voyatzaki
I would also like to add something to this. Maybe the fact that a series of books continues and is enriched is not a sign that these people are stuck in the fundamentals, or that the fundamentals are the basic construction tool, especially given the fact that there are young people that are operating and creating public buildings with cantilevers like the MVRDV. I cannot believe that the cantilevers in the MDRDV Wozoco house were designed by someone who had only been looking at the fundamentals in his or her construction education. Marcel Heistercamp has been wanting to speak for the last ten minutes, but first Herman would like to add something more.

Herman Neuckermans
You may have mixed up my comment a little bit. First I talked about the series of books, which has an important content; and then, at the end, as I wrapped up my comments, I wanted to say something about what we should be teaching, and that is when I mentioned the fundamentals. But that has nothing to do with the books; the books are another story. I would also like to say something about what I think we should teach and what we should leave out. First of all, there is no single rule that says that we all have to teach this or that. Schools differ; they differ in the content of what they teach. For example, and I will speak about my school because I know it best, we went to the Bachelor/Masters, and we have a series of courses, starting with mechanics, materials, construction, etc.; but one of our electives is always one full-year course in construction where we just look at whatever is in the air at the time. This is where the actual difference comes in; this is a means of including

things that come up. I do not know whether blocks or digital is most important to teach: I think, for example, that special construction materials like structural glass are also important. These things differ from school to school. I have thirty teachers who have practices, some traditional and others at the cutting edge. The ones at the cutting edge come and make demands of the school and say that as the head of the school I ought to be aware of things that emerge; and when I come to Barcelona, apart from being here at the meeting I can also go to Jean Nouvel; and since I am a teacher of construction I can somehow smell out what is going on these days. I like to be kept informed, and I will probably ponder on how we can incorporate it into our school. So, I repeat, it is an evolving matter; and what we do varies from school to school because it depends on the teacher. But this does not exclude the teaching of fundamentals. The fundamentals are not only how to bend a stair: the fundamentals are about how to make a hole in the wall, and what carries it if it is an outer wall; and then there is the water, and the insulation. These for me are the fundamentals. How we solve these can differ for each one of us.

Marcel Heistercamp
I think **that what we have to teach are attitudes and working methods that can be used to solve architectural problems. I think that there are no new subject areas; there are only new materials, and they that should be used in the ways for which they were designed. What we have to teach, therefore, are elementary principles in building methods, building stability, building technology and building physics.** These are and always will be the core of a well-balanced construction course. Second, new materials and pollution laws are critical when dealing with construction issues. New materials are important and provide new stability dimensions. The objective for which the material is brought onto the market must be part of an elementary principle. Third, it has become possible to calculate highly complex structures, to create and evaluate simulations before we build them; so we are indeed entering a new era.

Constantine Spiridonidis
I have one question for our Danish colleagues. This research project was financed by industry, I suppose?

Karl Christiansen
Yes, partly.

Constantin Spiridonidis
Partly. And the other part?

Karl Christiansen
The other part was financed by the school and by the foundations.

Constantin Spiridonidis
The initiative came from the school? From you as individuals, from your school, or from industry?

Karl Christiansen
Well, actually, the project could be on any sort of material. It was concrete in this case, but the research programme dealing with the industrialised individuality was our choice. It could have been any other industry, but in this particular case the concrete industry offered themselves.

Maria Voyatzaki
So the initial concept of the research project came from education, then.

Karl Christiansen
Yes, it did.

Constantin Spiridonidis
From you as individuals or from the school?

Karl Christiansen
From us personally.

Constantin Spiridonidis
The reason I am asking you this is because I strongly believe that schools of architecture are very conservative institutions when it comes to innovation. I am sure that you see this everyday, too; and it has come up in every one of our discussions these past four years. So that is why I wanted to know if it was a personal interest that someone mobilised in order to be able to develop such a project, or if it was something that is structurally organised through research, an activity of the school that is organised and coordinated within a certain framework. But you gave me the answer, so thank you.

Karl Christiansen
It came from us, and I think it is very important that it should be like that. The school is us, and we are the school; there is no board telling us what to do. The question came from the concrete industry, but we should neither run after these commercial firms nor serve the architectural offices. **What we at the school should be, both when we teach and when we do research, is lighthouses; and industry and practice should navigate around what we light the way for; otherwise we are just servants.** I think that it should be that way around.

Maria Voyatzaki
Karl, have your students ever asked you what your agenda was on this project? Not your agenda maybe, but the agenda of the module, what you were trying to teach them. Do they ever ask you this question?

Anders Gammelgaard
May I answer? Because, yes, it is something that we tell them right from the beginning. We come out very clearly with what we are doing, and with the possibilities and the demands that come from the industry, so nothing is hidden in that interplay between us, the students and the industry. The students benefit, because they are

supported financially and because they have access to industrial techniques, which is also very important. The students are also very interested, because they see themselves in a situation which is not like it used to be, when a lot of architectural research was carried out in the framework of the design offices. This no longer happens, because it is too expensive. The students are very well aware that there is a possibility for a job in the future if while they are studying they get some sort of a connection with these companies. They see this, and the industries see that in the future they will need, at least in the big corporations, architects to guide them and help them towards the kind of research they should be doing and how best to get in touch with the architectural offices. So they see a possibility in that, and they are very interested in this two-way communication.

Karl Christiansen
Actually, though, we have no agenda per se. We do not tell the students what the agenda is, because it is so very broad. The agenda is architecture; and if we want to make architecture we cannot just repeat what was done earlier: we have to do something new, because otherwise it would just be a replica, and to me that would not be architecture. So actually, when we go to the companies, we say that we would like to try to find new ways to make concrete, for instance, but that we cannot predict anything about the results. We do not know if there will be results, but we would like to work on it and we have to work on it. So that is the agenda, and they accept it. And in the same way we tell the students that we do not know where the exercise is going to go, because that depends on their work. And we do not want know, we do specify a certain agenda, because we want something new to show up, for that is the way that architecture progresses.

Maria Voyatzaki
If I ask you, for example, whether you teach conventional brick work in your school, I suspect that the answer would be no. The next question would be how these students will survive when they have to supervise a building site. And the answer would be that they survive just fine. So how does this magic thing happen? How can an architect who is taught this concrete module, but is not taught conventional brickwork, be a good architect in practice? How do you work this magic?

Anders Gammelgaard
Right. We would not teach traditional brickwork, and whereas the material – concrete – is not important, we do teach the technique of casting a steel wall. In terms of brickwork, that would be a full course on stacking, on how things can be stacked: how stones can be stacked, how constructions can be stacked, how bricks can be stacked. Stacking is the idea, but it does not lead to traditional brickwork.

Maria Voyatzaki
Yes, but do not put it so specifically, Anders. I am sure that there is something more generic than that. There is a philosophical attitude to the education of construction here; it is not about stacking, it is not about concrete, it is not about timber, it is not about brickwork. There is something behind it, which is what you have been claiming all these years in these meetings; and that is experimentation, teaching

students how to learn things by doing research by themselves, and basically teaching students how to do research, rather than giving them the answers and having the existing body of knowledge as their only tool. I think that this is what you have been saying all these years.

Anders Gammelgaard
Yes, and in the end, **we teach the students to think for themselves, because that is what they get by a more experimental attitude to the exercises. We do not teach them that there is a norm.** And that is also my reaction to you, Herman, because you said that there is a standard for what they should learn, and I strongly believe that that is a wrong way of thinking, at least in our context, because the fact is that they should always be interested and should retain that interest through their own work, so I do not see any standards, fundamentals or basics.

Karl Christiansen
You all know that the work of architects is double: we never stop studying; and in an architectural institute it is exactly the same. One thing that is happening is that students are being taught that if they learn how to think, how to ask the proper questions, then a moment comes when they can teach themselves. And when they can teach themselves, they may also begin to ask other people questions on how other things can be done in a more traditional way. This happens throughout their education process; and of course it takes time, but life-long learning is part of architectural life.

Ola Wedebrunn
We like to challenge the students. This is the way we operate. We ask them questions to which we do not know the answers ourselves. This is how we talk to the students, continuously asking them questions. We concentrate on one project during the semester, and the students have to learn in relation to this project.

Ramon Sastre
Let us go back to the issue of what is new. This gives rise to two questions: what is new for the students, and what is new for the teachers. Sometimes, when we are teaching, we want to use new exercises or new materials or new anything; but **we have to remember that even the simplest things are new for the students, because they are doing them for the first time. I think it is interesting to think about new things from the teacher's point of view, because for the students everything is new. We have to be aware that everything is interesting in itself, when it is new to us, even when it is just something useful.** They are so excited to receive a lesson on a new plastic or a new complex or a new anything, because everything is new. And it is right that we should change, because we feel different when we teach different exercises every year, instead of always repeating the same ones. But **we also have to be aware that the students, for whom everything is new, sense that the teacher is also participating in their discovery.**

Miltiadis Tzitzas
This discussion is very interesting, but I think that we are focusing on the same

things, because we all teach the same thing with different methods. There are other things that we should also be discussing, since we are from different parts of Europe and in our teaching of construction we have to take into consideration not only new materials, but also certain differences between our countries: in Greece, for instance, earthquakes are a very important factor in construction. Since we are sharing things here, I want to share with you a problem I have as a teacher of construction, and for this I want to go back to two concepts: teaching, and new technologies in teaching. Students are so familiar with digital technology, and I find it very difficult to understand how they can express what is in their minds by just clicking on a mouse instead of drawing it on paper. What I see from the students in my school is that, as they work with plans, they go to 3-dimensional plans very easily, and I doubt that the first years, at least, can understand what is happening. So what I found when I was experimenting with that is that students from the very first year have to start thinking with models and with sections of the buildings; sections in scales 1:50, 1:20, etc. What we achieve with that is that they see the complexity of a model on a 1:50 scale, not of the materials themselves, but learning how to create a model that will not fall down. And in that way, **by using their hands, they are able to express themselves more freely, and when they see their thoughts in a 3-dimensional model they really begin to understand how to build it.**

Maria Voyatzaki
About Miltiadis's point regarding the relationship of students and their hands, I would put it more generally. I would put it as the importance of the relationship that human beings have with their hands, their eyes and their brains, and there will be no one in this room or in the world who doubts the importance of this relationship; but when you say that you do not understand how it is possible to comprehend or create architecture without touching and drawing and sketching, **you have to realise that these students played football from the age of four without kicking a ball, flew a plane at the age of fourteen without ever having been in one, listened to the 110 – if they have a small MP3 player – without changing twenty CDs, talk to their friends without opening their mouths. They are the thumb-generation, well versed in using the finger that has always been considered the least useful of the five; they have terrible handwriting, but they can write, with their thumbs, ten pages that you would take ten years to write by hand. They belong to a different world; they have a different relationship with the screen and the keyboard than we do; so to ask them, to force them, to use tools and means that belong to another generation is like forcing the impossible. You underestimate these new abilities, skills and competences they have to have, this relationship with the screen and keyboard that we do not have.**

Miltiadis Tzitzas
I am not saying that they do not use these skills that they have.

Maria Voyatzaki
To create architecture…

Miltiadis Tzitzas
No, no, no. In the very beginning, when they are very young. I am talking about their attitude, about their way of thinking, about their mindset if you like. This experiment, if I can call it that, is really working, in that they have found something new, something that they have never done before..

Maria Voyatzaki
But, Miltos, going back to our generation's relationship with computers: when I was a student, there were no computers; then when computers did appear I would write something on paper and use the computer as a typewriter, because I could not think while I was keyboarding. Now we compose informal messages on the e-mail quickly, and we do not have to make notes before we do so. But more than that, when we do research we write our thoughts directly on the screen, and there is nothing in between, there is no intermediary. So to make a cake, for example, with your own hands by mixing up the batter is quite nice, and to make models is a nice experience, but the world out there is moving differently and this is exactly what we have to come to terms with.

Ramon Sastre
There is one thing I would like to add. I see the same problem that you are facing also, and as I mentioned before, students who are very capable of drawing 3-D's can easily fool themselves by just making form without going into the form, for the form is based on something more. And your approach of making models is one approach, which is I think effective, but there is another way this can be done, either in 2-D or in 3-D, and this is a structural analysis of what they are drawing and then going into 2-D drawings, maybe even 3-D drawings, but in a different way than the glossy performances that the students prefer, with added depth. So to stay only with form is very interesting, and maybe very helpful, but to go deeper than the form and look for the material cause of form in this way is, I think, helpful.

Maria Voyatzaki
Maybe I misunderstood, but in fact you can work through and fly through a computer model, rather than a physical model. Because you would have to make a physical model that is 1:1 to be able to walk through it and experience it. That is how I see it.

Donal Hickey
I have been listening to the discussion for a while now and I think that the apple still drops following the Newtonian principle, despite the big doubts that you may have; and there are still things that we understand as being truths, like that fire burns or the sun shines, and these are not going to change. I am very impressed by our friends from Denmark in terms of the projects that they spoke of, in terms of exploring concrete. I think that there are students that are immensely capable, and I think that this is a way of learning which is more interesting than just laying down the rules. I once asked my students to give a lecture, and I was quite surprised that they were willing and able to deliver lectures that were as capable as any that I could give. It may have taken them slightly longer to do it, but they covered the rules in

the same way I would have done, explored the ideas in the same way as I would have done; and I find that quite interesting. I am the one with the expertise; but if I was the one teaching new material I would have to go and research it, I would have to learn the techniques. So what are we doing as teachers but teaching ways of navigating? There are tones in navigation. We are exercising their brains in the same way as their tones are exercising that navigation. And my point is just that it is the method of navigating that is much more interesting than what the question is. And if they understand, the question does not matter. They will answer the question that is posed to them by a system of navigating. And **I think that we should teach them how to understand, because if they find a particular way to understand and learn, they can learn anything, particularly in terms of technology.**

Per Ola Wedebrunn
I totally agree with what you say. Students come to us and they are extremely motivated. We are teaching something that they really want to learn. They do not come to us because they have to, they come because they want to; and they like to be there as much as possible – sometimes they stay up all night working on something they find interesting. They are motivated and they are imaginative. And in many ways they are a challenge to us. They come with their cell-phones and the technologies that they handle with such ease, and they make us wonder how we can tackle these new things, because we are used to teaching architecture the way we learned it. So we, too, are developing new ways of learning.

Joseph Thurrot
Kids nowadays may be able to drive a car when they are seven years old and fly a plane when they are fourteen, but I have yet to see a piece of software that can keep you dry in a thunderstorm.

Maria Voyatzaki
That is another skill, Joseph. It is a both/and situation not an either/or.

Joseph Thurrot
We must not forget that architecture is physically embodied in the world...

Maria Voyatzaki
When it is a building, not while it is being composed.

Joseph Thurrot
Are we saying that architecture is something else other than just a building?

Maria Voyatzaki
Architecture is a philosophical attitude, if you want to take it that way.

Donal Hickey
I bought a book recently that was very interesting, called "Requiem for a Staircase". It was about an exhibition that was held here in Barcelona a couple of years ago, on "Staircases through History". Unfortunately the premise of the exhibition was all too

true: it really was a requiem for the staircase, because **contemporary rules in most European countries, and most of the civilised world, would not permit any of the staircases featured in the book to exist. What I would propose is that we have a 'Requiem for Rules': that we try to forget as many rules as possible, to allow the future a chance. You know, I worry. I look around me at various teachers that teach architecture, and they all talk about the rules; and I think that in our time we try to impose too many rules and by doing that we reduce the possibility for new opportunities. So my proposal is that we have a 'Requiem for Rules".**

Dimitris Papalexopoulos
Yes, but rules are very good things – they give you the impression that you have something to fight.

Ole Vanggaard
We mentioned the point of how to navigate. To my mind the future of architecture or of the engineer is not so much to be able to know a great deal about what they are doing but, as was said, to know how to navigate. This, though, raises the problem of how we can navigate within this system, because it is a network of specialists. Architects and engineers have to go to specialists, whether the building is a new one or an old one. So the question in my mind is about the need to reformulate ourselves.

First Theme
Part II

The new Content of Contemporary Construction Teaching: how is the 'new' related to the other(s) (specialisations and subject areas)

What forms of collaboration with other subject areas will have to be invented in this new context?

Will new specialisations emerge from these collaborations?

How could the new content in construction teaching reinforce the relationship between design and construction?

Would the design studio serve as the appropriate milieu or should other niches be defined?

How can the teaching of construction incorporate the continuous developments in innovation?

How does this (new) content affect student competences and skills necessary to practise architecture?

C. Stangel, *Gliwice Faculty of Architecture, Poland*

M. Malindretos & K. Oudatzi, *Aristotle University of Thessaloniki, Greece*

V. Echarri, *University of Alicante, Spain*

J. L. Zamora Mestre, *ETS Arquitectura del Vallès, Spain*

N. Manou, *Aristotle University of Thessaloniki, Greece*

N. Papamanolis, *Aristotle University of Thessaloniki, Greece*

F. Muzzillo, *Second University of Napoli, Italy*

A. Magliocco, *School of Architecture, Genova, Italy*

Krystian Stangel

Theory, Design and Realisation Practice in Initial Teaching of Construction in the Faculty of Architecture

Silesian University of Technology
Gliwice Faculty of Architecture
Poland

The initial process of teaching construction in the contemporary digital era is not so different than it was before using traditional methods. The use of computers accelerates the design process and 3d modelling allow students to understand better and quicker how construction works. However, the overall method is not different from the ways which have been used for decades.

To teach theory in relation to design is always the most important issue in the process of construction teaching in architecture faculties (just like in the case of other technical disciplines). It would be very important to continue this learning at construction site work placements, where students could improve their knowledge while taking part in realisations of projects, which had been worked on with student's participation during previous office work placements.

This task is difficult to achieve, because schools universities usually don't run project studios, not to mention construction companies. That is why initial processes of construction teaching do not have direct continuing in real design, and in buildings realisation in particular. The construction teaching at the faculty of architecture in Gliwice begins in the 2nd term of studies. Classes are taught by architects, faculty's employees. During that term students get to know different construction systems and build their own models with different materials. Those models allow to form space imagination and perception of resistance.

In the following terms, in the curriculum there are more specialised construction courses, for instance: General Building, Buildings Static, masonry construction, concrete, steel and the so called special construction, which is the subject of realisation during the last (10th) term of studies, together with preparing the diploma. Those subjects are taught by experts – the faculty of civil engineering.

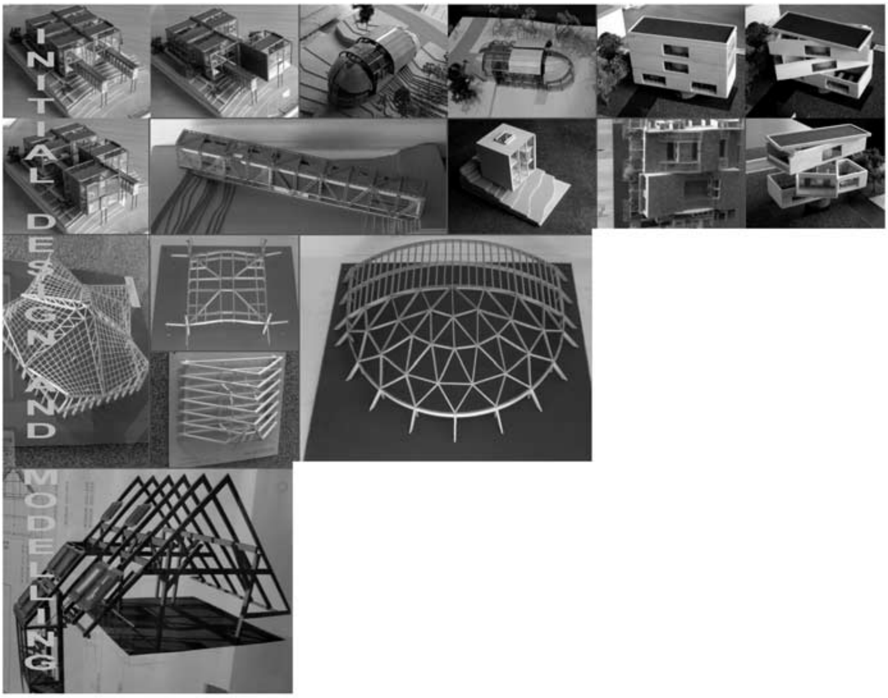
In the curriculum, according to the so called 'minimal requirements', there are internships that should provide students with opportunities to polish their design skills. Students can do these internships in different architectural practices, often run by architects – teachers at the Architecture Faculty – and construction internships in different construction firms, usually with no connections to the University. Students participate in the process of building, mostly detached houses. Although many architects run their own architecture studios alongside the teaching at the Faculty, it is not common for them to run construction companies.

The example presented below concerns the author's experience as an architect, teacher at the Faculty, who is also an associate in an architecture office. In this office, in the late nineties, an original project was developed within the framework of a Polish competition for 'affordable housing', run by a major architecture and building magazine – "Murator". The construction of the house was based on a screwed wooden frame. The project was published for four subsequent years in Polish single family houses catalogues, and in the following years, several 'mutations' of the original design were developed. These are single family houses of different sizes and external materials; only the basic construction principle remained unchanged. The project have been developed with co-operation of students, within the *curricular and extra-curricular internships.*

Within several years since the original design, a building engineering company has specialised in constructing these homes and producing the wooden frames, which are now manufactured very precisely – all that needs to be done in the building site is to put together the numbered elements, connect them with screws, and to stiffen the ready frames. With all the realisation experiences, the technology have been modified and improved. There now around sixty such houses in and around the city of Gliwice.

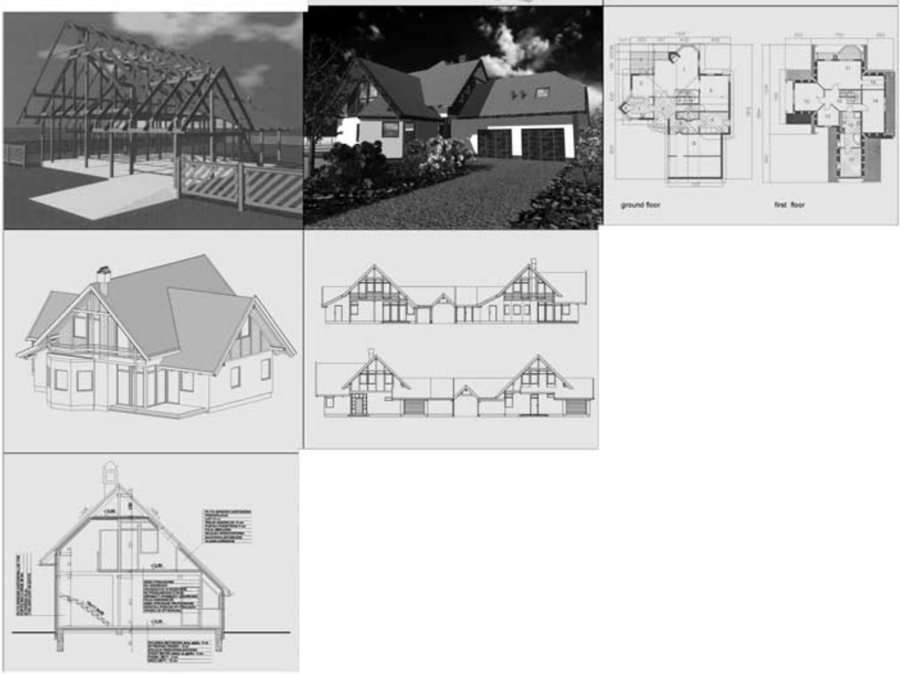
Students of the Architecture Faculty can do the internships in the construction firm. They have a chance to get ‘hands on’ experience with mounting the wooden frames and observe the construction not just on models, but on real scale buildings. In such a way, *the principle of linking the theory, design practice and construction practice* comes into being.

Within the largest project, a housing estate in Wilcze Gardlo, Gliwice (Poland), 25 buildings of different size were constructed with the same wooden frame technology (S-W) and various external and filling materials. The wooden frame construction of the house was based on two types of timber elements: pillars with 10 X 10 cm section, and beams with 15 x 5 cm section. The buildings have no cellar, and have two floors – the ground floor, and the usable attic story, allowing for flexible arrangement. Such solution is driven by economic factors such as the roof to overall floor space ratio, foundation surface to floor space ratio, overall floor space to building volume. All of these factors are much better than for comparable building in a traditional way.



Besides the factors mentioned above, the advantages include:

- light construction
- speed of assembly – it takes just a few days to put together the frame on a previously prepared concrete slab (foundation or cellar roof)
- after putting together the frame, roof is put on top, and all the next work is done undercover
- the flexibility of internal division of the house – this is particularly important, as the experience shows, that the function is the element of building which becomes outdated the fastest (at last once every generation)
- the flexibility of locating the windows in walls, allowing the end user to take the decisions in real scale and real settings
- no need to paint the wooden construction
- the esthetical values of the wooden construction visible inside the house
- low material consumption due to in-depth analyses resulting in the used dimensions, sections and other construction elements
- low overall cost in comparison with other frame constructions or traditional building methods



The manufacturing detail and care in producing the frame elements are crucial for the advantages above mentioned – from drying the wood (14-16% humidity) to precision of manufacturing and drilling (max.1mm tolerance), to the quality of wood according to the position of each particular element.

With few exceptions, most of the building are being built with no basement, on a cement foundation base, cross reinforced, strengthened in the places where the columns are set. The ground floor walls are tightening the construction, and are usually built with concrete blocks, with an external layer of Styrofoam or mineral wool (or, alternatively, cell concrete blocks, such as YTONG). Buildings with external wall of natural stone have been realised, too. The roof floor walls are built with two stiff layers (wood-waste board from inside and siding or other filing from outside). Light interior walls with light metal frame construction. Additional elements for the roof beams are used to stiffen the construction. The construction is visible from inside. Interior circulation – wooden stairs (15*19*25). The wooden roof construction is a part of the prefabricated frame, and the roof cladding can be light (steel, etc.) or heavier – tiles require additional wooden construction. The interior elements and all instalations depend solely on the investor and site infrastructure. The buildings are facilitated with modern chimneys, which are used for heating. Also, floor heating and convector heeting in the attic are used.

Conclusions

1. The initial teaching of construction in the Faculty of Architecture should be realised by architects, members of academic staff, to show the students relations of construction and function to the form of the object.
2. 2. There are no special differences between the initial teaching of construction in the 'new digital era' and before. The differences are based on using computer programs and films showing how the structure works. Students can also use the software to help in modelling. More developed stages

are run by constructors with teaching and design experience, using advanced software, showing constructions designed by famous architects all over the world.

3. The initial teaching of construction starts from practice modelling, then theory, and architectural design practice which is connected very often with realisation practice at the site where the buildings are erected.
4. In the initial period of teaching of construction teachers are chosen among architects with experience in teaching, designing and realising designed buildings.
5. The initial teaching of construction should be realised on simple examples such as single family housing, which are easy to design for the students. Then in advanced construction subjects teachers (meaning constructors) should be encouraged to limit the number of time devoted strictly to calculation, but extend the analysis of modern structures, which would allow teaching students to choose suitable modern structures and evaluate sections required for architectural objects.
6. Teaching construction should be based on visual effects appealing to imagination. This may include films showing disasters caused by mistakes in building structure, as well as analysis of destruction following natural disasters.

Michail Malindretos
Kyriaki Oudatzi

New Technologies and Teaching Methods

School of Architecture
Aristotle University of Thessaloniki
Greece

The effort for taking advantage of new inventions in building and for the construction of monuments and great scale works dates since the Assyrian, Egyptian and Ancient Greek era. For instance, in the Parthenon (and world-wide admitted) the accuracy, the methodicalness, the fidelity and the consistency in perfect adjustment of shapes, dimensions and strength, is impressive. In this way we want to show that the evolution in technology is not independent from culture of the human being but is the result of a very long process of work and of discovery steps and counts since the prehistoric era. Evolution progresses simultaneously as a result of culture, science and technology. Thus, in every historical moment designing, materials and construction detailing of major works go together with the total exploitation of every possibility and capability of modern technology. When talking for the reality of our country, today, in the information and the techno-electronical era, building construction is one of the few sections where new technology has not been applied widely.

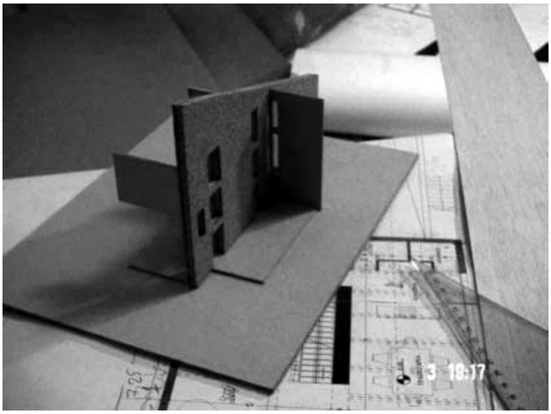
The problem begins even since the five-year basic training of architect students. Here, students take only few and carefully selected modules where very randomly are called to solve complicated construction problems. Furthermore they never face real problems as these emerge in every day practice. In today's hard and very competitive labour market, the architect does not have the luxury to get trained but he has to be ready and competent to stand on his feet and start a career. In practice, it is proved that graduate architects can not take on board complex projects and therefore they become simple designers in big constructing schemes. Professionals have already realized that an architect has to be a supervisor himself of the constructing phase of his own designs. He has to be capable of recognizing construction problems that have to do with the builders and their manipulation, with the constructing procedure and the materials to be used. Especially for the latter, he has to decide which material he has to use according to its nature, its durability, its aesthetics, its compatibility to other materials or to hard weather conditions and according to "extraordinary" designing. For instance, it is not enough for an architect to choose an impressive glass panel which he discovered in a fashion magazine-sometimes the only training for some architects. Choosing a material like this, initiates a whole procedure. He has to contact with the manufacturer, to check its cost, its properties, its resistance in difficult conditions, its aesthetics and its compatibility to the other materials and the correct ISO guarantee. And if he still desires its use, he has to know the constructing details for its application in order him to guide the workers and not let things going in any way. In a few words, even a new architect should be ready to hold a project manager position, capable enough to manipulate the different working teams and construction companies in order to complete perfectly his project.

So, comes as self-evident that the target in architects' education should be the production of properly trained scientists in both architectural synthesis and construction, capable enough to supervise the application of plans during construction procedures, having the best knowledge in materials and construction details. They should be fully experienced and be aware of qualities, characteristics and descriptions of structural materials, structural elements and their application techniques that modern technology offers in order to evaluate and use the most appropriate.

The aim of this presentation is not only to discuss the relationship between architectural synthesis and technology but mainly to re-evaluate the methods and the quality of introducing modern technology in an academic architectural curriculum.

Although, technology is taught at architectural schools in Greece, practically graduates are not capable enough of practising construction and they have to be trained, working in big construction companies, wasting time from their own career. Changes in industry of modern materials and construction elements have influenced construction methods used to materialize an architectural plan. In ordinary constructions, continuous evolutions do not change essentially the classical method of teaching construction. However, in building of special demands and prescriptions the applications have shifted away from traditional materials.

It is primarily important for students to understand the relationship between architecture and knowledge of technology. Every expression of art needs technology in order to be done well. Any architectural project as marvelous as it may becomes, disdains a bad structure. The same exists for the structure, because if a construction is technically competent but has no value in architecture-no concept and emotion, then it is completely useless. The architects-to-be, acting according to the international standards, focus to the unique aim of the ambitious level of synthesis ignor-



ing-due to lack of contact to the "construction" reality, the demands and the rules of modern market- that a "brilliant" synthesis can be achieved and completed following two steps: the first step is to have and complete the "inspiration" and the ideas. The second step is to "filter" this intellectual work through a thorough detection of materials that will enforce and support the idea-in both theoretical and practical level. When the architect has a full-scale knowledge of materials, when he/she is able to choose, among the plethora of products, those ones that are compatible with the synthesis materials, when ISO checked products guarantee the quality in construction then it is certain than the second step is completed. A successful choice of materials is a guarantee that a proper construction will follow. Unfortunately, academic studies fail to recognize and support the above steps. On the contrary, they worsen the defect in technological knowledge and practice since they are built in the prospect of creating the "competent" composer, independently from the construction skills.

Currently, in our university, the level of studies in technology know-how aims in covering briefly those elements considered necessary for the students in order him to have the basic knowledge of the construction methods concerning the separate elements of a building while academic lectures support the designing exercise. At the end of the technology lessons students should have knowledge of: a) basic materials, b) ordinary and commonly used construction methods and c) application of methods in designing-return and updating of designing plans.

During the second semester of the first year of studies, it is attempted the students to become familiar with the idea of "materiality" of architectural synthesis. Using examples, students learn how someone can use a single design and produce different structures. They also learn that using different materials can make a single structural element. By the end of this period students should be able to create these structural elements proving that he fully understood this procedure. Students should understand that the same basic architectural element could be different depending on the material proposed each time. The exercise is supported by a series of lectures that give the theoretic part of the course. During these lectures a number of basic building materials such as concrete, masonry, timber, steel, glass etc. is presented. Finally, during this stage, defects in basic knowledge on purely designing level- essentials in organizing plans such as dimensions of tables, symbols etc.- are covered.

During the second year of studies, students focus on creating a complete designing project. This annual exercise concerns the designing of a small dwelling(fig.1) at the first semester and its construction – design of details at the second semester(fig. 2,3,4). At lectures it is presented the construction details and structure of external and internal walls-light panels, stairs, roofs and balconies,floors, wall coverings, electrical and mechanical networks, WC, kitchens e.t.c. The main characteristics and typologies of the above are analyzed at each lecture.

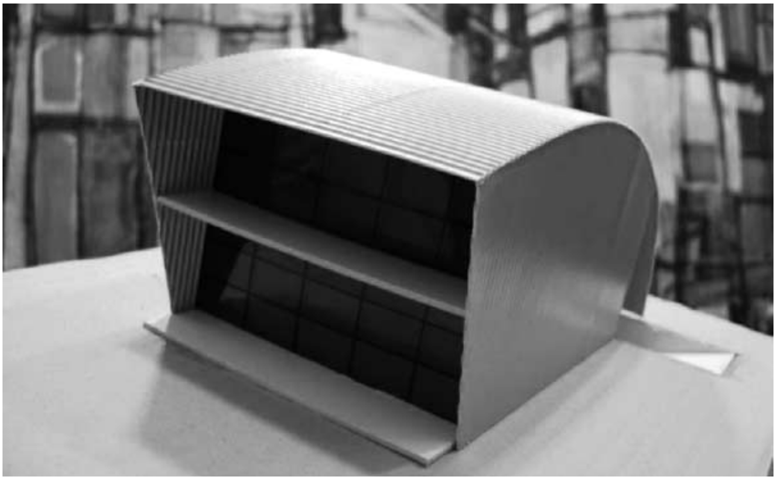


fig. 1

Contact of students with ordinary materials like concrete and metal structures is limited to a general knowledge of these materials without entering in practical skills that can be gained only through practice.

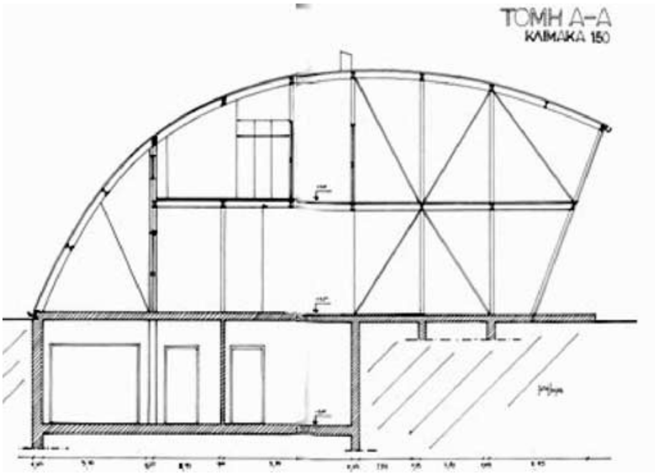


fig.2

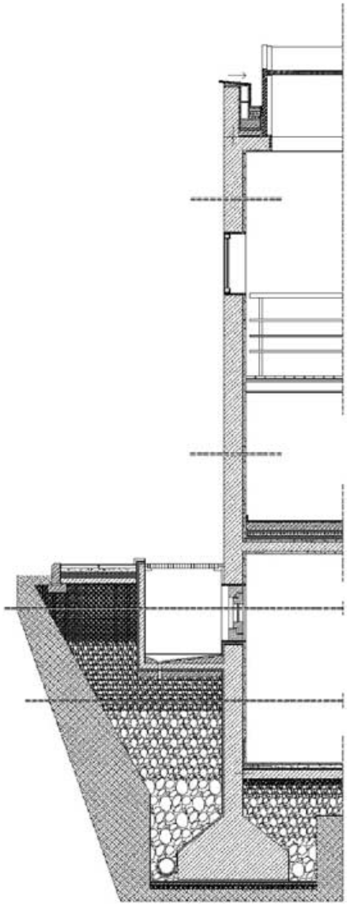


fig.3

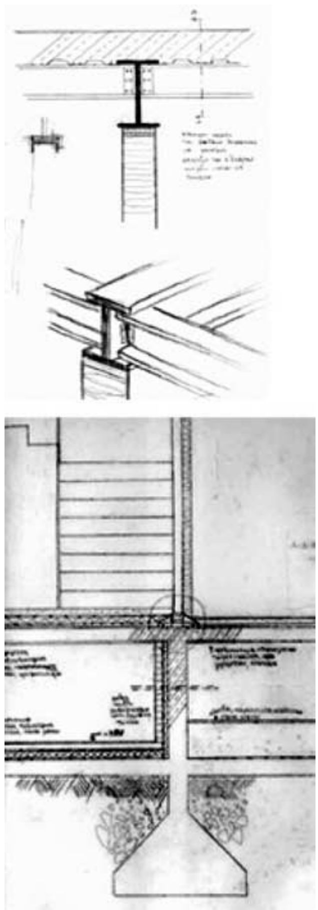


fig.4

Contact of students with ordinary materials like concrete and metal structures is limited to a general knowledge of these materials without entering in practical skills that can be gained only through practice.

Experience shows that students feel anxious when they deal with construction details because they believe-probably due to insufficient information- that someone else is responsible for the animation of their project.

Contact with reality, proves indisputably that achievement of balance between architectural synthesis and application, theory and empirical applications is the golden standard for the creation of mature architect-composer-engineers and is the condition that should be posed within the completed educational procedure.

The aim is to redefine the educational program, in order the modern education to-be-adapted-to the new demands. Thus, properly educated architects can emerge, capable to get through the modern increased demands of the globalized labor market – and the everlasting research and self-training-need. Students should understand that the knowledge of usage, properties, utility of new structural materials and of the application techniques that modern technology offers, is the powerful design tool which defines the profile of a modern and properly educated composer-architect who achieves the "proper" structure, completing the "brilliant" synthesis and vice-versa. At the same time, new prospects for the increasingly demanding user are created. Changes in material and structural element industry have influenced building methods. As a result, the classical method of teaching architectural technology should be reconsidered, especially for buildings of great complex, demands and strict prescriptions where the construction methods and applications are not only different from the conventional ones but also very complicated on both material selection level and constructional detail application level.

The role of the teacher for the architects-to-be: teaching in a modern technology era

Standard teaching of ordinary should not be abandoned but, on the contrary, should be enriched with new knowledge and experience on both theoretical and application level. Classical teaching of technology should continue to present the conventional and widely used materials and the ordinary building methods. Students should continue learning how to solve constructing problems that seem "simple" at first sight but are proved to be very difficult and important. Problems with moisture, thermal and sound protection, relations between building and ground or weather and in general the building materials and the load bearing elements, the concrete or steel structure.

All academic lectures about materials and construction should be supported and connected, directly and specifically, by laboratories (indoor or outdoor) where theory will applied in practice. Bibliographic research and research in big constructing companies where real construction happens are essential complimentary methods in teaching. At the same time theoretical lessons should be oriented in helping solving the problems that emerge when students try to complete their exercises in laboratories and not just describe things that students have to find by themselves. It is important and essential that insufficient knowledge in construction should not become the brake that will stop an architect in his career. The architect has to understand the complimentary and interactive relation of composing procedure to the completed knowledge of proper construction. Construction is not an accessory to architecture or something that happens afterwards. It is at the very core or essence of architectural thought.

The architect of the next day has to learn to function through a continuous demand and search of new technologies that will act as a "dictionary" in his hands. New technologies and materials have to be understood and used in the best way by architects-composers.

In our modern era of information and marketing, the contribution of industry is determinant to all levels: in research, designing and production of complex building elements and in networks of products distribution which help in information and knowledge of the characteristics of each product and building element.

The approach and appropriation of industry by the students and the discreet contact-introduction in an educational system contributes determinately to the completion of the educational aims. This approach should be done either by representatives of big companies or factories that produce quality products or by visiting such industries where experts will explain the way quality products are produced, their properties, the little secrets someone can use in order to detect quality by himself and finally the indications someone may use in order to have the best selection. In fabrication and new technology era, the contribution of industry is determinant in all levels-research, designing and production of complex structural elements and materials. Of great importance is the continuous information and contact not only with visual and designing presentation of structural elements but also with the fully understanding of their prescriptions, technical characteristics and utilities and simultaneous knowledge of the research results and the laboratory measurements which concern the static of the construction – as a result of combination of different elements and materials.

Conclusively, what is proposed is the direct link of the architectural synthesis-laboratories to the architectural technology-laboratories and construction areas (where students can have their first application experience such as construction area organization, management, measurements, problems in construction, emergencies and solutions etc) but, as well, to a number of already constructed buildings where students can "palpate" the construction problems. It is also proposed to be linked to research laboratories, to production chains (visits and guidance to industries where they can be informed for new technologies but also establishment of a way of access to updated information), to measurements laboratories, to the production and control systems of quality and prescriptions. Furthermore, it is proposed not only the contact but even the organization, function, control and management of the ISO systems, by the university laboratories for the whole of the building section. In this way, university will contribute to products research, will drive forward the development and use of new technologies and materials in construction, will be the reference point for the creation and management of the quality control systems, will give the experienced human resources for the inspection of constructions and even for the creation of a national list for constructing companies. It is proposed the creation of a system that will interchange knowledge and information with all relative European institutions-in a spirit of mutual support and cooperation- and at the same time will inform by every accessible information the public-consumer about the way to enjoy safe and nice-looking products.

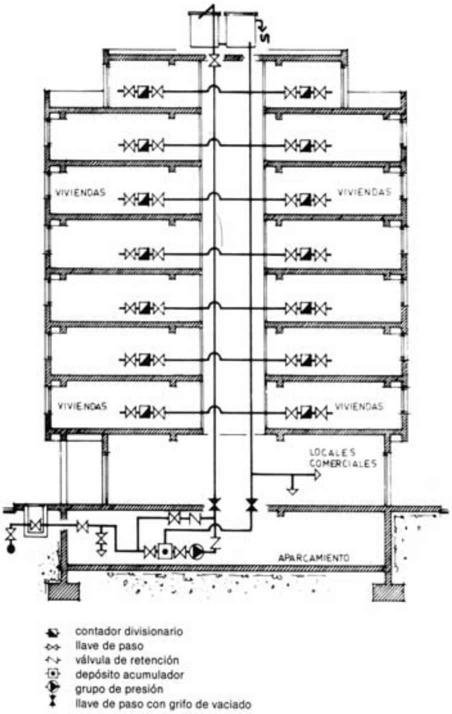
Victor Echarri

Complementary Digital Visual Manuals of Installations under Construction

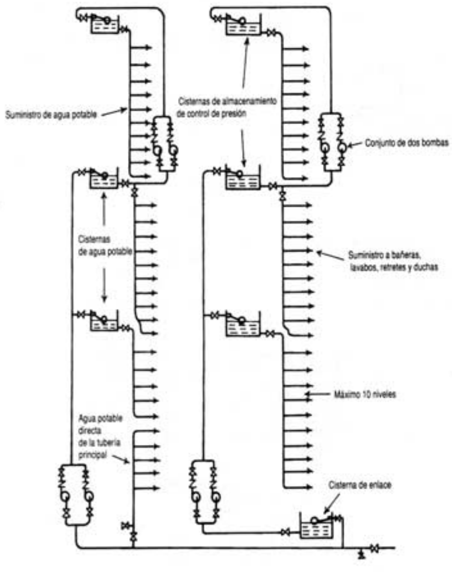
School of Architecture
University of Alicante
Spain

For years, the teaching of installations in Architecture in Spain has been characterised by the use of methodologies based on theoretical presentations complemented by manuals drawn up by the teaching staff themselves. Everything related to the design of initial diagrams tailored to the requirements and spatial characteristics of buildings and later sizing of the installations was normally resolved in practical classes.

The positive values of this methodology are:
1. The in-depth treatment of the design criteria of the initial diagrams.
2. The relationship between the basic physical characteristics of the fluids transported in the installations and their implantation in the conduits of the building.
3. The appropriate presentation of the demands of national and local regulations to be applied to the installations.
4. The easy theoretical and practical development of the scaling of all elements making up the installation.



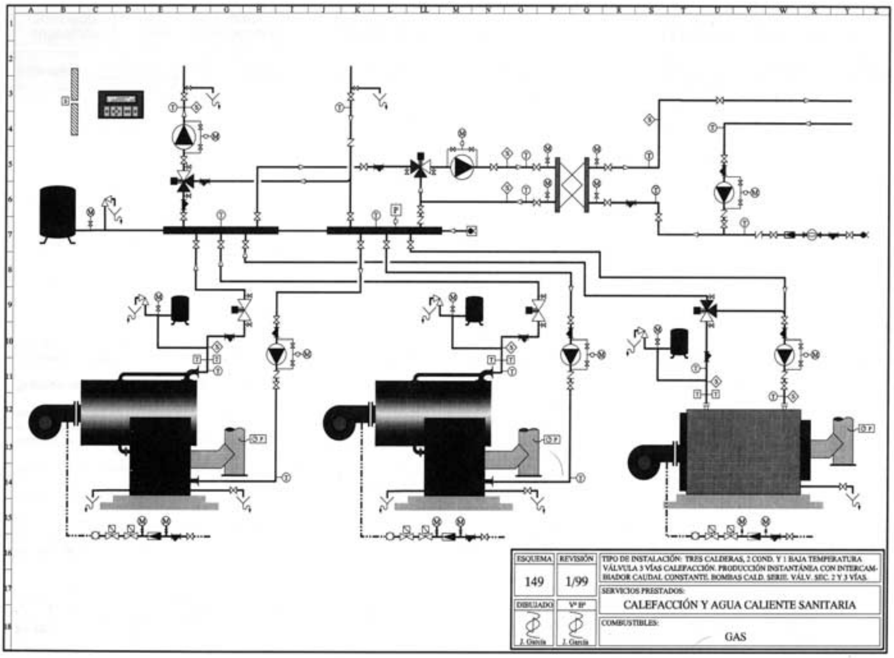
Esquema de instalación con grupo de presión y depósitos en terraza.

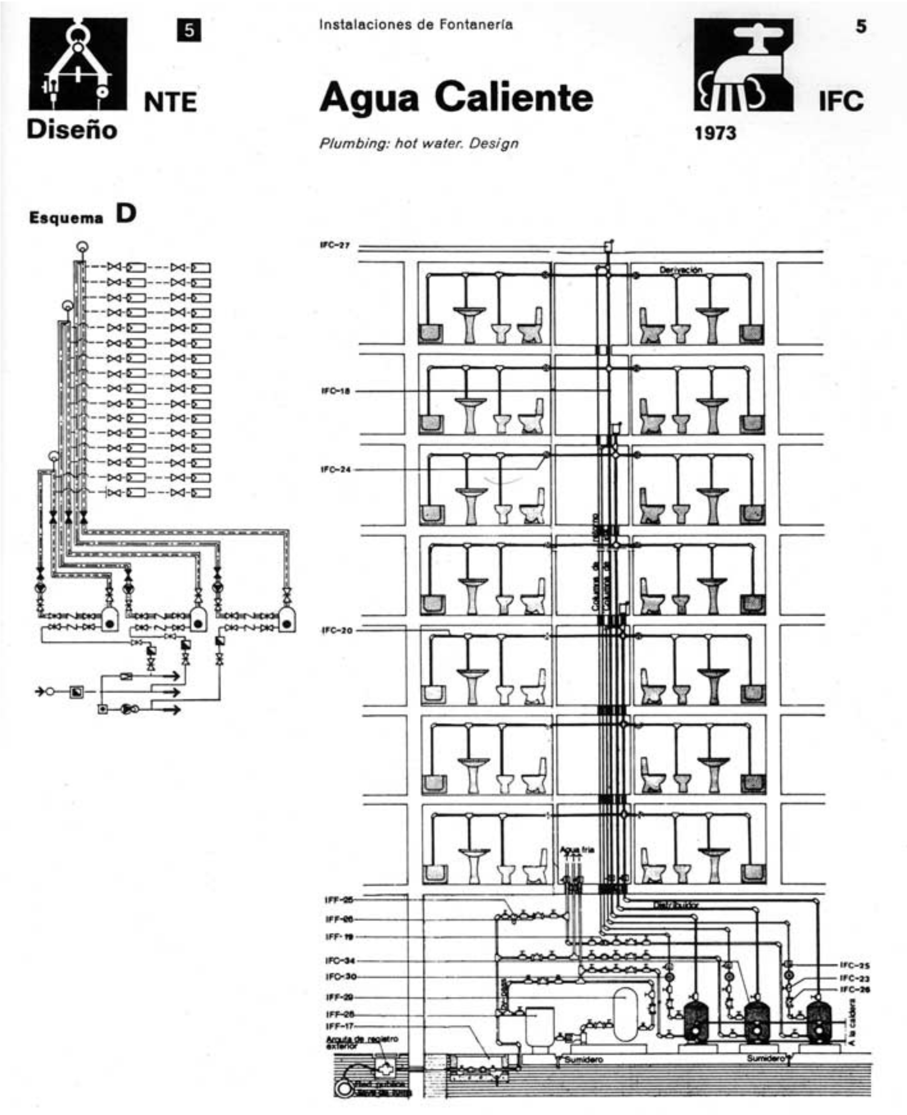


Sistema de suministro de agua para 30 niveles.

However, I have identified certain deficiencies in my experience as a teacher and I believe that my opinion is shared by many of my colleagues:

1. Its assimilation as a teaching methodology for Industrial Engineering and Architecture degree courses, with a total absence of its implications as regards architectural design: floor to ceiling height, false ceilings, the appearance of visible installations, etc.
   Here I would like to mention that, in practice, this terrain is shared by both degree courses in Spain, although the Architect is responsible for the project and the execution of said installations, often shared insofar as civil liability is concerned. However, the Architect, as is my case, can take responsibility for 100% of the installations, except for the Common Telecommunications Infrastructure.
2. Calculating the spaces required to house the equipment, conduits, consumption measurement devices, their arrangement on each floor, service shafts, etc.
3. The absence of training in those aspects associated with the physical execution of each of the installations and their later validation and legalisation, as well as their integration in the overall process of the works and their coordination with the rest of the installations.
4. The problems involved in understanding and following complex initial diagrams, due to the impossibility of enlargement, the use of colour, the limitations of the symbols used, etc.
5. The lack of correlation between the installations described in the manuals and the real elements, mainly due to the lack of images and their low quality.





Six years ago, concerned with the above-mentioned failings, we at the Installations Unit of the Architecture ETS at the University of Alicante began a number of complementary teaching activities aimed at bringing students closer to the reality of the material execution of the installations and their implications for architectural design:

1. Site visits for small groups.
2. Visits to especially interesting buildings on the campus itself.
3. The creation of an installations laboratory with some didactic panels in the Architecture building itself.
4. Photographs of our own works and certain buildings, especially interesting for their height, design quality, the presence of services galleries, etc., in order to facilitate student understanding, etc.

The result of the introduction of these teaching tools was positive, especially as regards air-conditioning, plumbing, sanitary fittings and natural gas. However, we soon came up against the problem of implementing the site visits in the light of the substantial increase in the number of students in class: it simply became impossible for us. In addition, the laboratory is clearly unable to replace said visits, and the same is true of the photographs. The latter are highly didactic but they have no continuity over time: students cannot handle them personally to learn through carrying out their own tasks later. Even if they did have them, they would be able to extract very little information from them.

Aware of the emergence of new teaching technologies, we soon began to research their application to teaching installations in Architecture. We presented our proposals to the call made by the University to foment the use of new technologies in creating new teaching manuals. The Vice-Rectorate for European Convergence and Quality financed the project entitled "Visual Teaching Manual for Plumbing Installations in Building", which I had the honour of directing and that we finished last March. The tools used mainly consisted of the Macromedia Flash program, a digital video camera and a digital still camera.

The aims of the project were as follows:

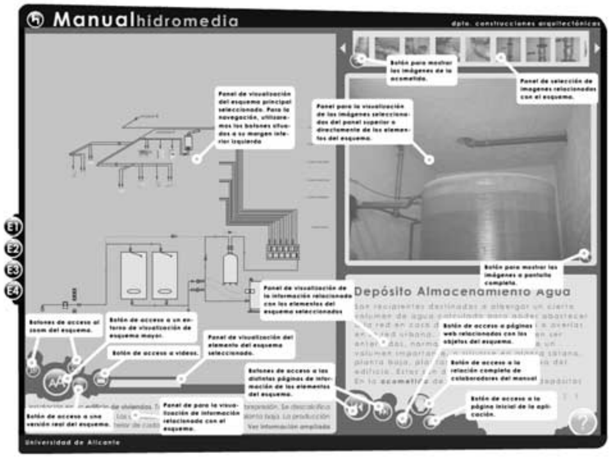
1. Firstly, to complement the teaching manuals with real images of all the components in the facility in an interactive way by using the corresponding "initial diagram", the explanatory texts and the photographs, thus greatly facilitating access to the on-screen information.
2. Secondly, to explain the process of executing these facilities in all their stages with these images, relating them to the construction of the different parts of the building, taking into account spaces for storage, circulation, etc.
3. Thirdly, to experiment with a new teaching methodology, in which the student has the same tool on his computer as the teacher uses in his theoretical explanations in class, so that he can follow the explanation with his laptop and experiment personally.
4. Finally, to give students access to the websites of product manufacturers and all the technical information that said websites usually offer. All in all, to take full advantage of the abundant information available concerning technical specifications, functions carried out, dimensions and costs.

Given the fact that it would have been very ambitious indeed to try and cover all the installations in the project, we simply decided to create a digital manual that complemented those already available for cold and hot water. This experience allowed us to assess its effect on the learning process for the next steps: sanitary fittings, air-conditioning, natural gas, heating, etc.

I would also like to underline the fact that, in my opinion, those being taught in the Architecture department are used to using computers intensively and having access to all kinds of information on Internet, and demand new methods of teacher-student interaction, other ways of transmitting knowledge, other means of becoming involved and interested in the unknown and they have to discover for themselves that something is worth making an effort to do so. In this sense, we considered the type of teaching tool chosen to be the right choice.

At this time, I think it would be best to show some images and aspects of the manual we created, so that you can get a more tangible idea of the features that I have described very briefly in the previous slides.

There is a general introduction and a help button that explains the structure of the manual and how information can be accessed through each of the buttons.



The manual describes four independent installations, each with their respective initial diagrams:

1. A building for dwellings, with a ground floor and five upper floors, with storage tanks, hydraulic pump unit and centralised array of meters. The whole installation is pressurised. Hot water is produced individually in each dwelling.
2. An office building with a ground floor and twelve upper floors, with part of the system under direct pressure and part pressurised, flush valves in the toilets and sanitary hot water with storage.
3. A hotel establishment with descaling throughout the installation, cold water storage tanks for the network, centralised meter and centralised hot water production with storage in tanks. Said sanitary hot water production is combined with

hot water heating by radiators in bathrooms and fan-coils in shared areas and bedrooms. The whole network is pressurised.

4. A tall building, possibly designed for use as offices or as a hotel. Given its complexity, said initial diagram is divided into two. In the first place we have included a very simplified diagram that helps to understand the working of the pressure stages and the production of sanitary hot water. The second diagram is much more detailed and describes a real installation in a 52-storey building, with four hydraulic pump units, four sanitary hot water production boilers and sanitary hot water storage tanks on four service floors at different levels.

The technical difficulty increases with the initial diagrams. Each contains a brief description that shows their key organisational and operational elements.

All diagrams have in common a photographic description of the layout of the urban infrastructures and their connection to the installations into the building.

The whole installation is photographed according to the order of its elements, meaning that it can be accessed by means of a strip from which you can select and view each of the images. In certain cases the installation can be viewed as it is being executed, allowing students to recall all the explanations given in the theoretical classes and organise the different stages required for implementation. Later, a large number of photographs show the final status and finished condition of said installation in normal use. We can see this in Diagram 1, showing the building for dwellings.

Diagram 1

It is interesting to analyse the way the information is accessed from the initial diagram. The zoom provides flexibility and allows the diagram to be studied in detail. Each element is linked to a real photograph of said element, a text explaining its function and other technical specifications that should be borne in mind and, finally, direct links to the websites of the manufacturers of the elements described.

An example of this can be seen in the installation diagram for the building for dwellings. Next image shows a centralised set of meters. As well as the photograph and the explanatory text, we can follow a hyperlink to view the technical specifications of a particular manufacturer.

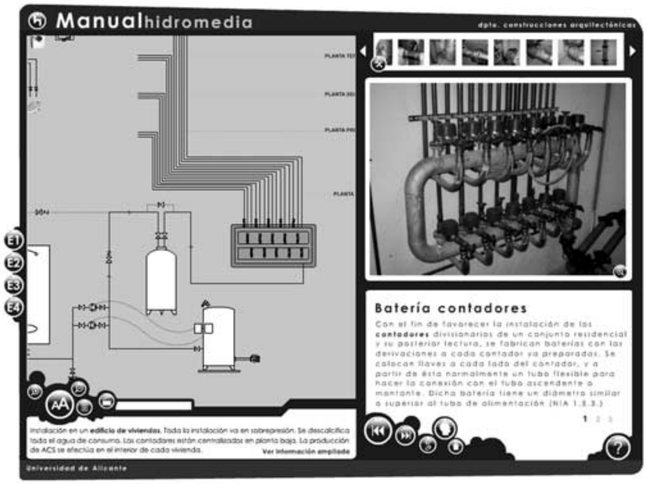


Diagram 2

Diagram 3 refers to a hotel with centralised sanitary hot water and heating by hot water radiators. All the diagrams include videos of the installation rooms. They allow students to get an idea of the scale of the spaces and volumes required to house the installations, as well as their organisation, pipe crossings, space required for boiler maintenance, etc.

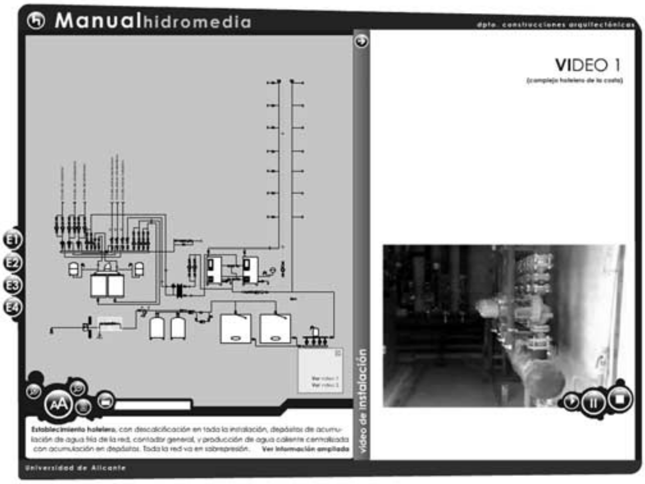


Diagram 3

Diagram 4 is the most complex of all. As we have already mentioned, it refers to a tall building. It has been divided into two diagrams. The first is simpler and is aimed at giving students an overview of how the initial diagram is organised. The second shows the complete installation as it really is.
For example, we can view a video of the room housing the pressure arrays, which are very complex in this case, with water at pressures of 6 Kilos, 10.5 kilos, 14 kilos and 18 kilos. The first array consists of six 25 m^3/hr, pumps, the second has three 13

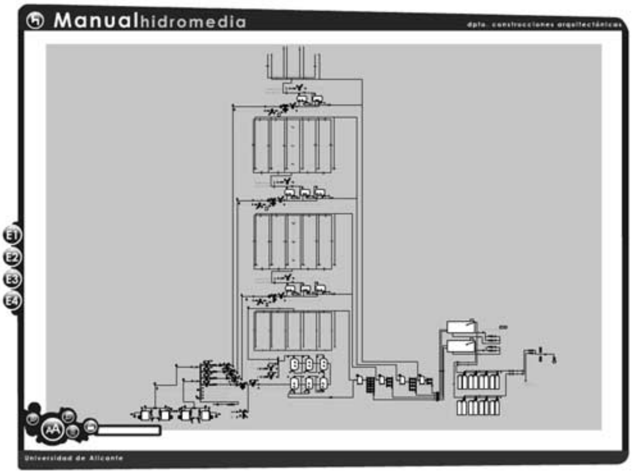


Diagram 4a

m^3/hr. pumps, while the third has four 13 m^3/hr. pumps and the fourth has two 15 m^3/hr. pumps.

We can access the pumps through the initial diagram, with hyperlinks to the web-site of the manufacturers - Salvador Escoda, or to the hot water storage tanks, with a capacity of 5,000 litres each.

I think it is not necessary to carry on browsing the manual, so to conclude I would like to say that up to now we have been unable to apply the manual to a complete academic year – we will start using it as an educational tool in the year 2005/06.

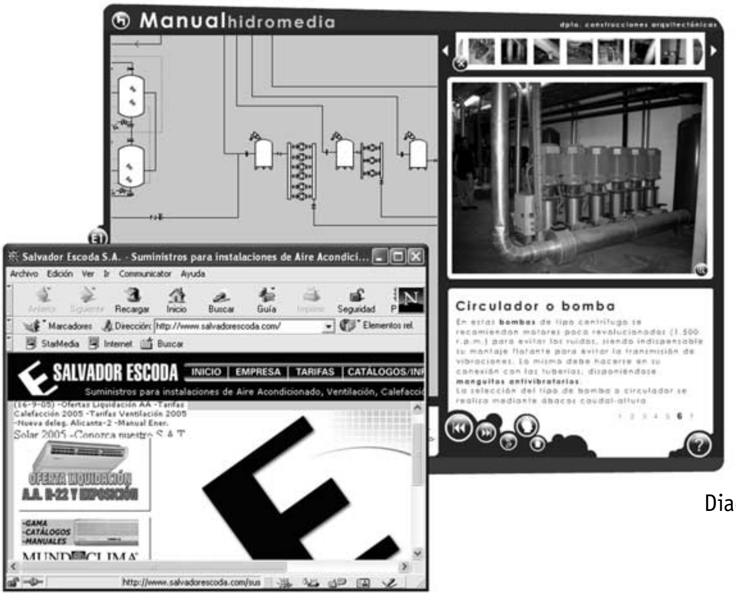


Diagram 4b

However, we have been able to verify its effectiveness with a selected group of students.

We evaluated it using our normal evaluation systems: the drafting of a water installation project for an existing building chosen by the student – a work published in an architectural review – and in the practical work carried out in the workshop every week.

Here I would like to enlighten that at the beginning of every academic year we post on the virtual campus all the practical exercises students have to submit at some stages during the year. Besides these specific exercises students have to design all the installations included into the subject through an initial diagram tailored to the requirements and spatial characteristics of a review published building, and later to size the installations previously designed. They also have to draw these installations over the floors and elevations.

As a teaching and practices complement our students have also to fulfilled two reports about the physical execution of each of the installations which should include initial diagrams, photographs and constructive details. A personal analysis allows to evaluate execution quality, validation and legalisation, as well as their integration in the overall process of the works and their coordination with the rest of the installations. Reports should also include a working description of elements and equipments.

In my opinion this teaching evaluation of installations in Architecture should take into account the following bullet points:

1. Student learning degree about basic concepts related to the installations design.
2. The sizing of all tubes and pipes, machines and equipments, installations rooms, ceiling heights, ducts, etc, included maintenance and accessibility to pipes and equipments.
3. The knowledge of legislation both basic and recommended, and technical regulations.
4. The integration and coordination of these installations with the building design and the rest of construction.
5. The control of correct execution of all the elements, valves, meters, etc., pressure and watertight proofs.

I am sure that these complementary digital visual manuals are very useful to improve installations learning. We hope it will be showed in next evaluations we will carry out during the current academic year.

After carrying out this new educational experience, we will compare it with previous courses and draw conclusions on how to improve the tool. Indeed, we believe that to be one of its most significant virtues - it's very easy to update and to complement with more and better information.

Joan Lluís Zamora i Mestre

The Role of Architectural Competitions within the Framework of Construction Technologies Education: a Local Experience

School of Architecture
Sant Cugat del Vallès
Barcelona
Spain

Introduction

The subject CONSTRUCTION VII started in the academic plan of architectural graduated studies from 1993 in ETSAV. This subject develops the knowledge and abilities about design and execution of interior claddings and finishings throughout 15 weekly sessions of 3 hours. The ETSAV criteria is that evaluation exercises must be run in the academic period and not in extra time. Already from its beginnings it considered that the evidence that evaluation exercises was not only a point of control for the pupils but also a pedagogic opportunity, especially if the control is run on scholar time.

The subject is planned to offer 3 evaluation processes:

1. Individual exercise consistent in the follow-up of an interior building site work, that the pupil carries out on his account out of the school timetable and during 15 weeks. He presents the final rapport in the 15th week.
2. Individual examination test type of theoretical contents, which is carried out the last day of class.
3. The last of the 3 evaluation controls considered in the course work is to join a team in order to participate in an architectural competition as pupil's teams, oriented to construction design, in this case sponsored by a commercial firm, KNAUF. The final result is presented on the 7th week.

This educational experience to mix one of the evaluation exercises with a corporation competition has already attained 10 years continued and now it is appropriate to make a reflection on the attained results.

Competition description

In 1994 when the university and Knauf Corporation undertook the first edition of the competition ahead it was proposed that this initiative had to be positive both for the corporation and also for the university. To such effect we decided that the competition:

- Must be made to measure of ETSAV: every year the teacher responsible of Construction VII chooses the bases and object, together with the representatives of KNAUF in Catalonia.
- Must be circumscribed to the pupils of ETSAV (compulsory for those of Construction VII and optional for the rest), if it was wanted to imply them and to create a positive educational effect.
- The participation can be carried out individually or in formed groups by a maximum of 3 pupils.

Competition object

The object of the competition of every year focuses on approaching a type of interior space like offices, gymnasiums, libraries, restaurants, etc that is characterized for the wealth and complexity of its inner space. In the course of 7 weeks the pupils have to bring up an interior generic prototype for this contemporary use, exploring the application possibilities of KNAUF SYSTEMS to the utmost.

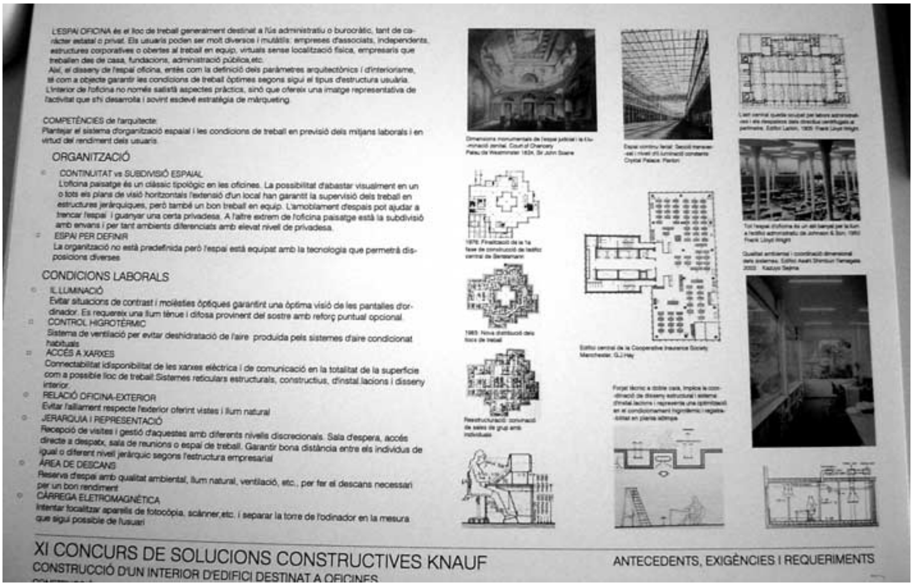
KNAUF give 3 prizes to the best prototypes and the prize-giving is made carried out in the ETSAV hall room the next academic course in a public act.

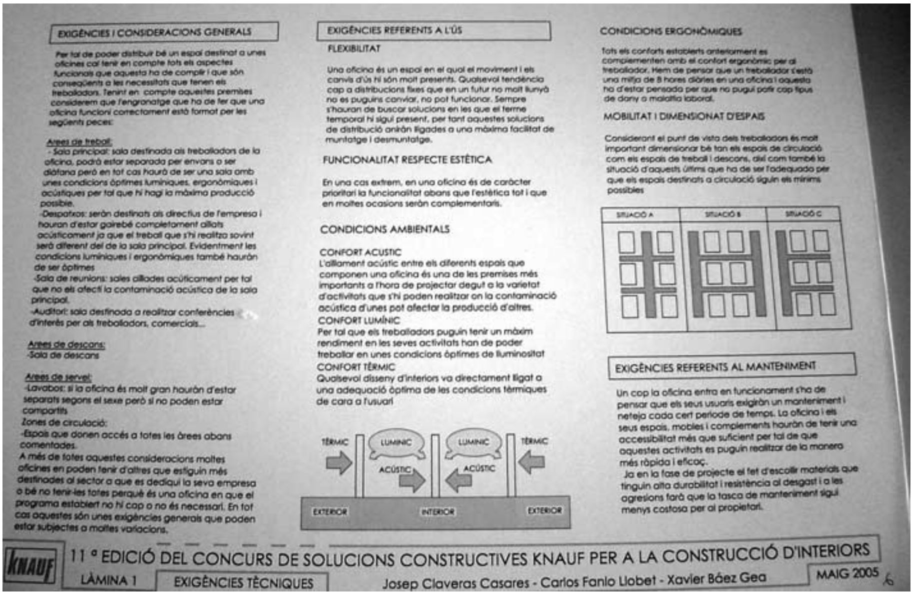
Final materialization of the works presented in the competition

To homogenize the work of the pupils in the aspects of contents and presentation the following materialization is carried out:

Poster DIN A3 n°1

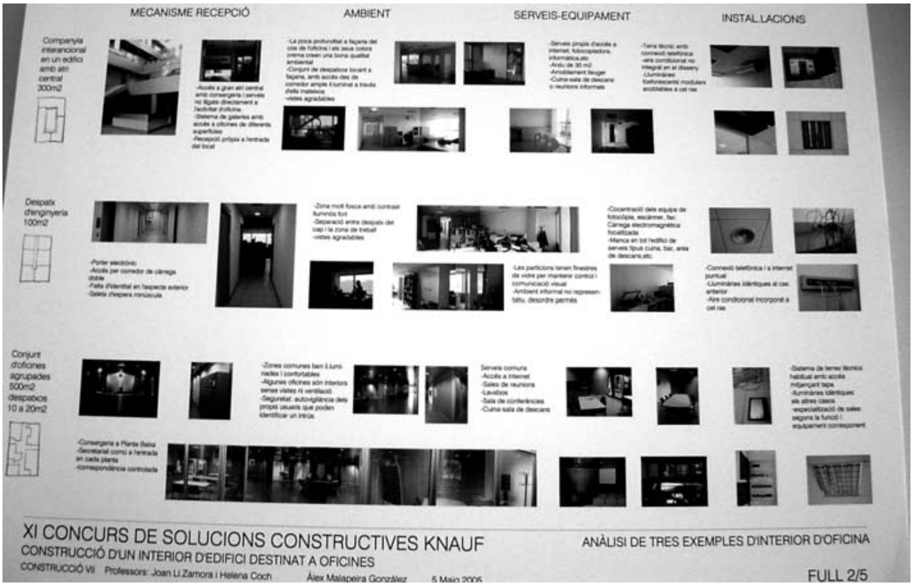
Representation map and justification memory of the considerate technical demands in the design and construction of the considerate type of building:

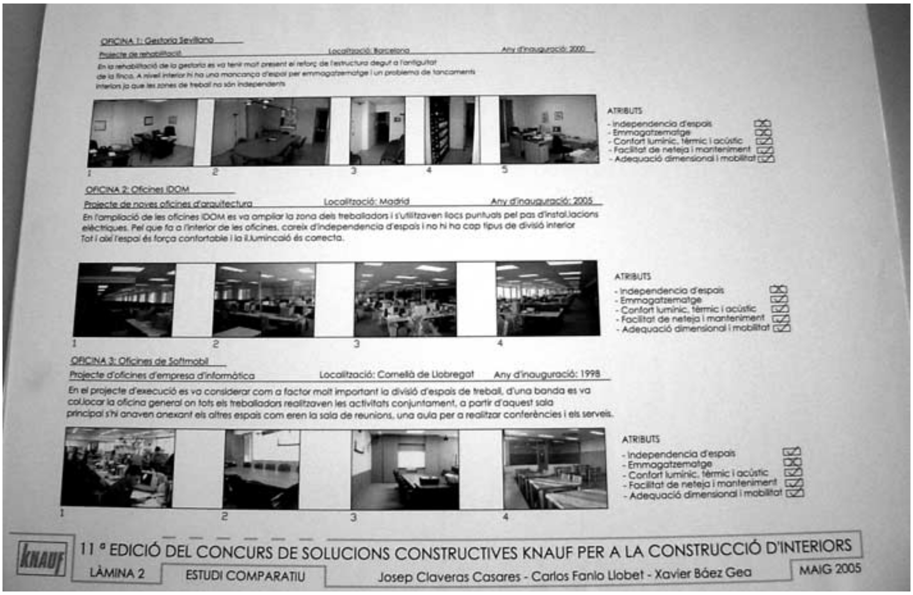




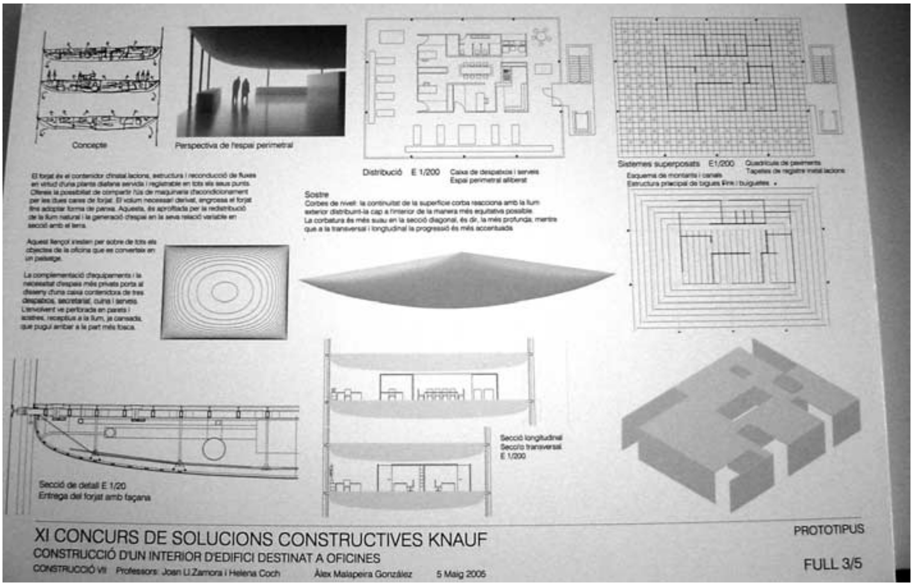
Poster DIN A3 n°2:

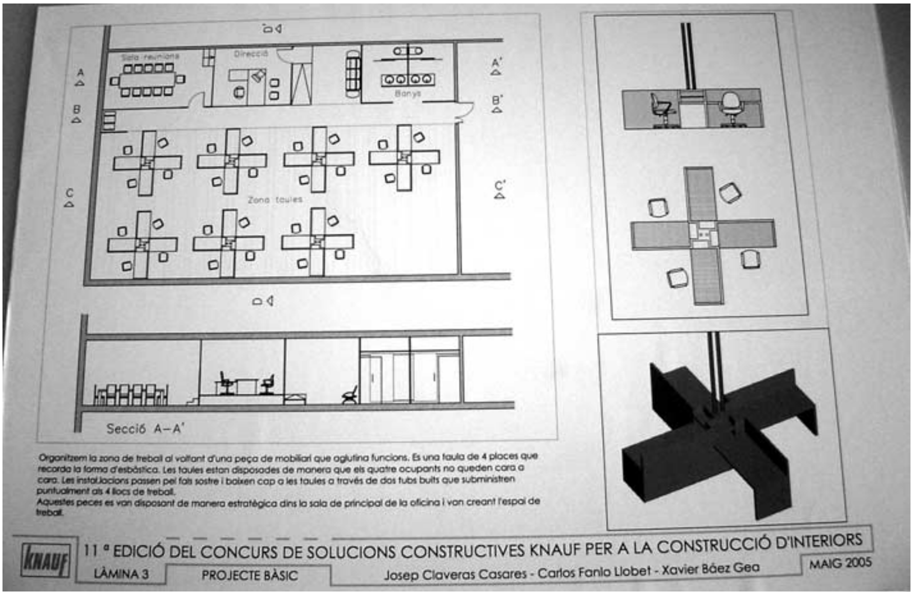
Comparative study of 3 real cases of this type of building visited by the pupils.



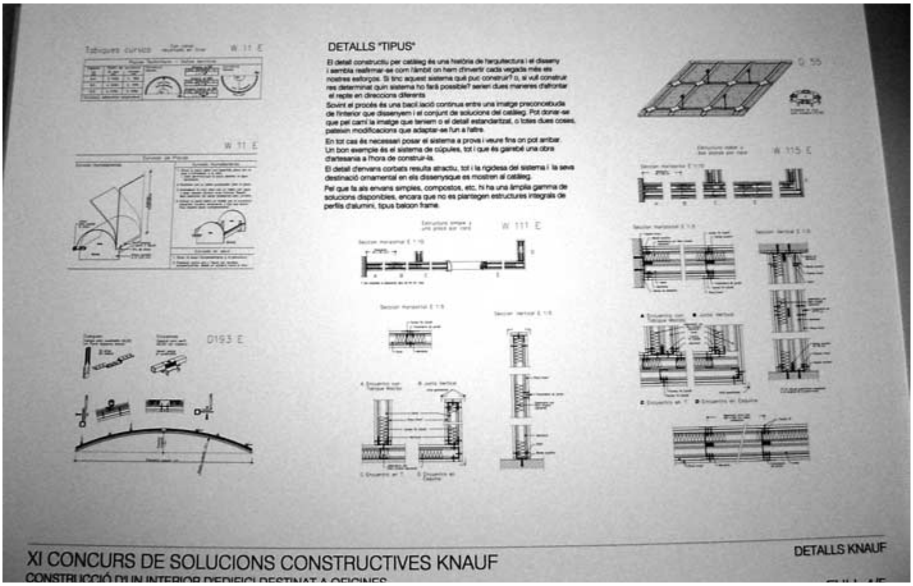


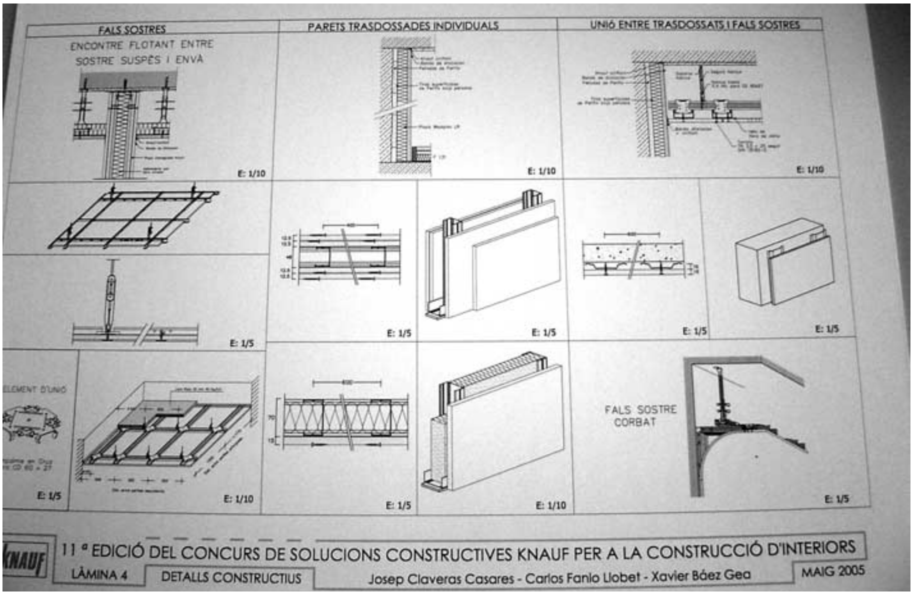
Poster DIN A3 n°3:
Representation map of generic type prototipus as concept design.



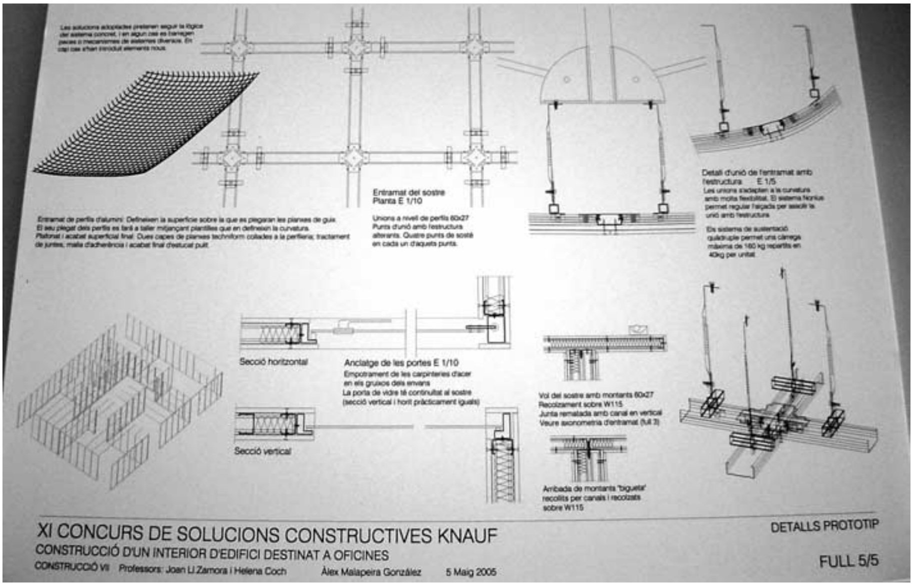


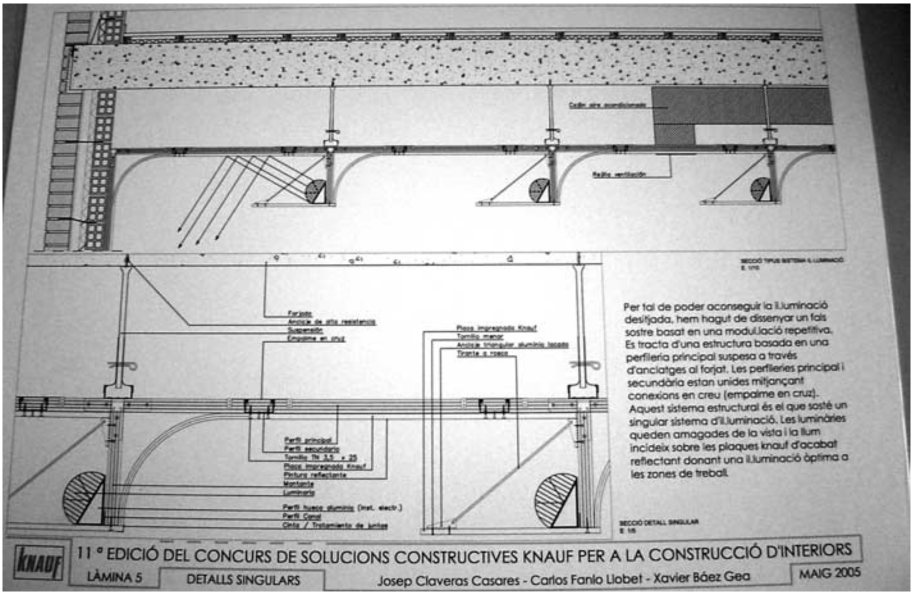
Poster DIN A3 n°4:
Description map of constructive solutions standards of the applied basic systems KNAUF.





Poster DIN A3 n°5:
Description map of the singular construction details (details non usual and not solved by the manufacturer of the system).





Jury

The presented works are examined by a mixed jury formed for:

President:
a senior professor of the 1st Architectural Construction Department.

Secretary of the competition:
Joan Ll. Zamora, professor at the 1st Architectural Construction Department.

Vowels, 2 persons from KNAUF corporation.

The verdict is made public in the course of the month of June of every year.
We establish the following prizes

1st Prize: 750 euro
2nd Prize: 450 euro
3th Prize: 300 euro

Academic development of the competition

The competition is summoned by an academic course, even though it develops in two editions four-month consecutive that they share the same subject and bases.

On the occasion of the course acts of support are carried out:

- a visit to a singular building, which use is related to the subject of the year competition.
- company KNAUF comes to ETSAV a morning and presents in a session open to the hall room its products and it makes a practical demonstration of application. The other period of four months the pupils are those that travel to the show room of the company Knauf.
- the teams finds themselves out of the school schedule to elaborate their proposal. In each school session is reserved some 30 final minutes for that the 2 teachers of support give answer to the questions that the pupils bring up.

Balance of conclusions

The insertion of the resolution of the problem brought up in the competition in the academic dynamics allows the following positives aspects:

1. Establishing direct communication with the world company (lectures), with real buildings run on (visits) and to learn to sail for digital systems of commercial communication.
2. Bringing up an exercise of concept design that normally is not presence in the conventional subjects of projects. Is interesting to improve the students opinion about future problems that they shall to resolve.
3. Helping to create a curriculum of prizes for the students before graduation.

4. Working in team for students simultaneously in aspects of formal, functional and technological design.
5. Keping collaboration between corporations and university in the field of education and not to encircle it exclusively in the research or in the transfer from technology.

The insertion of the resolution of the problem brought up in the competition in the academic dynamics can propitiate also the following negative aspects:
1. That the company abuses its presence at university and projects an image with commercial interests.
2. That society interprets that the education is delegated in the companies.
3. That the presence of only one corporation undertake the technical contents of the competition.

Final

It is evident that the education of the technology in Architecture has to be modified in the area of the agreements of Bologn and that it is necessary to renew the methods and pedagogic dynamics in order to make them more attractive and efficient.

Since a hundred years ago there has been a new agent that generates and administers technological knowledge and that is the company.

A shortage of means and resources results evidently from the public university suffering around European countries that pushes towards the establishment of collaborations with professional, social, economic entities and of the public administration in order to continue ahead.

Niki Manou-Andreadis

The Production Process of the Study of Technical Projects and the Cooperation Mode of the Multidisciplinary Study Team

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Aristotle University of Thessaloniki
Greece

The study and execution of technical projects is the object of a multiclisciplinary cooperation that is a cooperation among the essential disciplines, each one of which has to exclusively, but not always, deal with its own scientific field.

Therefore, the concept of a study team is a requirement for the "rationalization" of all procedures aiming at the production of technical projects. The Greek reality, in relation to European directive for EEC countries regarding the training of a single system of unification, recognition of vocational skills and qualifications etc, stimulates great interest in the technical world of Greece.

Hence, taking into consideration all these highly significant and urgent issues, candidate engineers should be taught both the mode and the methods of multidisciplinary cooperation, for, as it widely known, everything begins from education.

I should first mention that after completing my studies at the Civil Engineers' Department of the Aristotle University of Thessaloniki, I went on with my studies at the School of Architecture of the same University and also I work as an architect for 25 years.

As a result, I had very well developed the potential to perceive the viewpoint of both the civil engineer and the architect and, in addition, to conjecture more or less the viewpoint of the mechanical engineer.

There has almost always been some kind of debate which is not at all constructive for the study project. And then, at some point, may even come the time when they cross their verbal "swords", in order to have the situation settled.

Furthermore, the *concept architect* does not fully complete his study by integrating it into the implementation stage and it is not himself who supervises his own project. Lastly, the *construction manager* very often entrusts the architectural, static and mechanical implementation study of the project to independent engineers of his own choice, without bringing in contact the involved engineers.

The outcome deriving from this reality is the production of large or small projects without any technical integration and, as a consequence, a lot of them totally lack inspiration, architectural spirit and expression. Furthermore, they are detrimental to the environment and aesthetics of cities and citizens, composing a uniform landscape with numerous structural problems, bad quality constructions and, after all, an environment deprived of any kind of interest and aesthetics.

The harmonious coexistence and cooperation of all disciplines involved in a technical project constitute a top priority for the educational sector.

It is from Technical Universities where should begin the effort for mutual respect among various disciplines and the promotion of the mentality that a "piece of architecture" is based upon the close co-operation among Architects, Civil Engineers and Mechanical Engineers. And this message should be conveyed to competent agents and bodies, so that rules and regulations will be professionally, technically and socially redefined. Only in this way will the essential conditions be created to achieve the "optimal" vocational practice of all engineering branches.

The relationship between architects and civil engineers seems to be in a constant controversy, which significantly stimulates architects' discussions in a number of countries in the world, as well as in our country.

Since the early years of operation of the Technical University in Greece, there has always been the discussion about whether the architect should be taught some Civil Engineering subjects and whether the architect should professionally function as a civil engineer, too.

However, hardly ever was there any discussion about whether civil engineers should be taught architectural subjects and have the right to practice architecture.

So, multi-disciplinary cooperation aiming at the production of a well designed, well studied and well constructed technical project is a matter of education. This education should not simply include transmission of raw knowledge, so that, after their 5-year studies, engineers-graduates from Technical Universities will be efficiently educated and competent, not only to practice their profession but also to cooperate with engineers belonging to other branches.

Until recently, there has been the impression that the Civil Engineer is the Professional Engineer who renders the building stable and solid, whereas the architect is characterized as the "artist" who is, therefore, not necessary.

The common impression was, and probably still exists today, that the Civil Engineer, i.e. the *engineer*, is a professional who fully satisfies all the needs of the project.

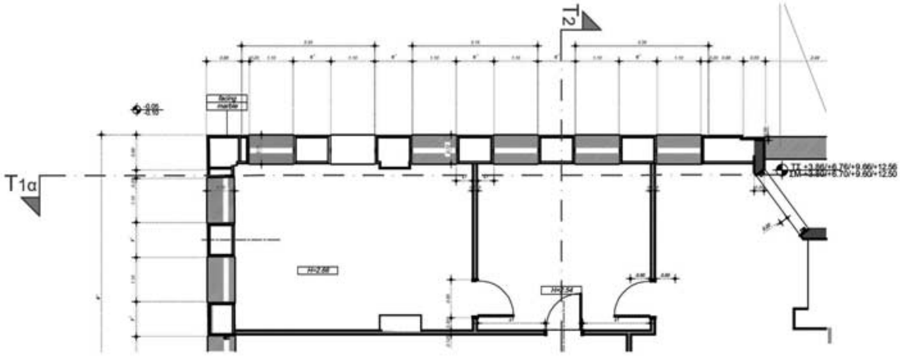
So, this general mentality is expressed in civil engineers' vocational rights, allowing them to practise their vocation in all fields of the construction industry, and mainly architecture, without having clear borderlines set.

However, during the last years the complexity and increased demand for "architecturally designed" buildings have gradually excluded Civil Engineers from designing the architectural parts of a building, mainly in large scale projects.

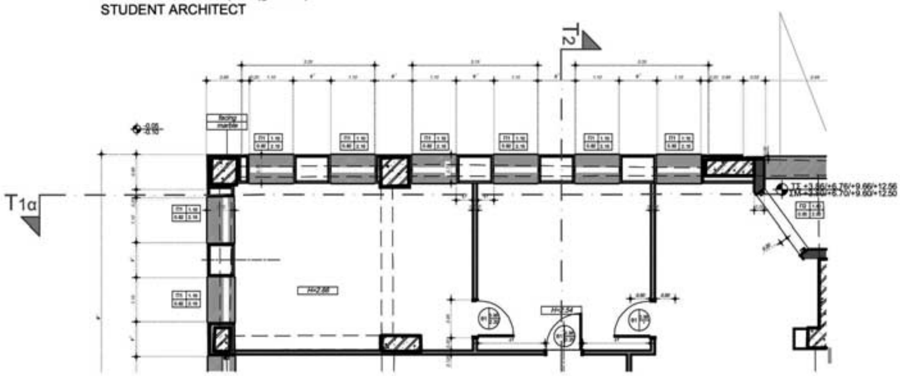
When providing information to future students of echnical Universities, special focus should be placed on determining clearly and accurately the object, vocational activities and borderlines of each distinct discipline, so that future engineers will choose the profession that they really want to follow. Among other objectives to be achieved during their University studies, students should develop a common communication "glossary-code" and undertake trans-departmental assignments (along with their corresponding professors). In the following examples, the various stages for the study of a technical work are presented (part of a plan of the study of an office building). The successive interference of each related disciplines is presented.

It is highly significant for them to become familiar with a kind of *connective* knowledge which will be taught and cultivated during their studies because there is no doubt that this is all a matter of cultivation-culture.

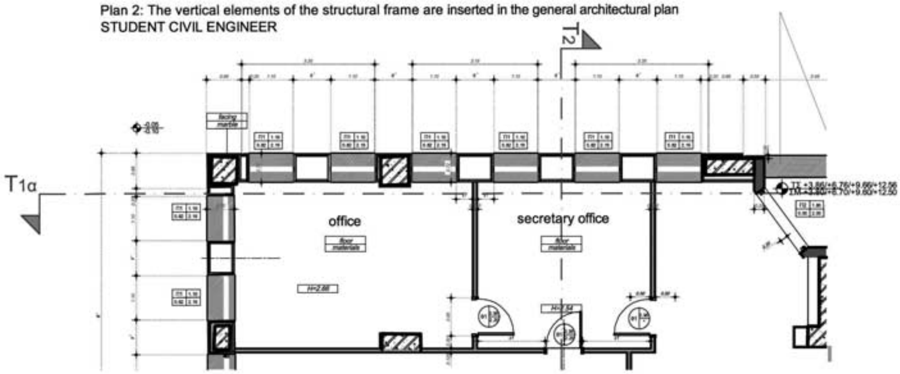
We believe that this will provide liveliness, interest and enthusiasm to all our students and, to some extent, it may give them an idea about what their vocational life will be after their graduation, as well as their relationship with colleagues from other disciplines.



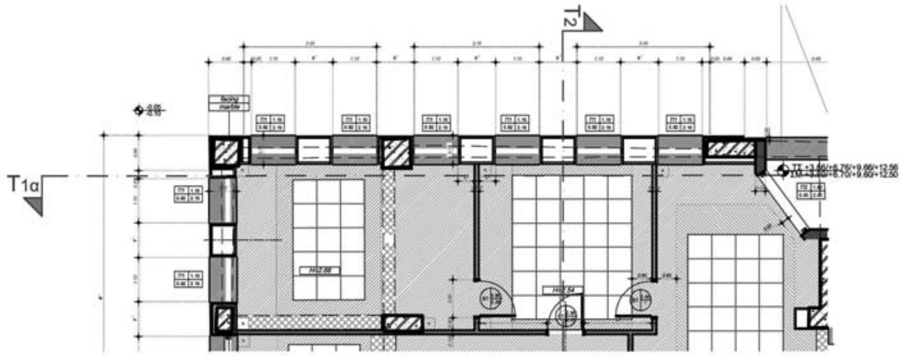
Plan 1: Architectural plan (general)
STUDENT ARCHITECT



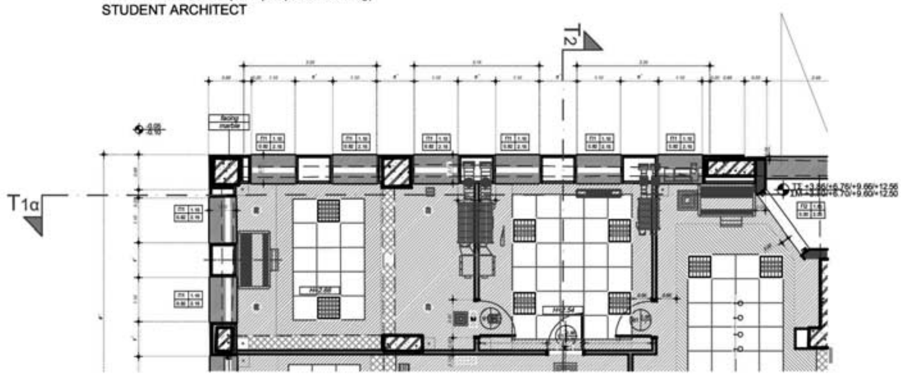
Plan 2: The vertical elements of the structural frame are inserted in the general architectural plan
STUDENT CIVIL ENGINEER



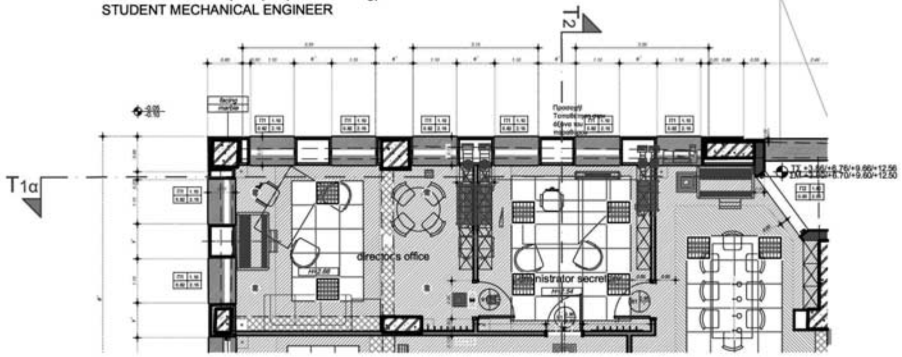
Plan 3: Architectural plan with the list of materials and the different spaces



Plan 4: Architectural plan (suspended ceiling)
STUDENT ARCHITECT



Plan 5: Architectural plan (suspended ceiling) and the E/M installations
STUDENT MECHANICAL ENGINEER



Plan 6: Architectural plan with all the previous and the interior design

Nikos Papamanolis

The Environmental Factor in the Teaching of Architectural Technology

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Climatic and environmental conditions, in general, differ from place to place. This differentiation, insofar as it is reflected in the characteristics of the interaction between buildings and the parameters shaping the above conditions, has to be taken into consideration in the process of building design and construction, in any part of the globe.

Ignorance of this fact, even though as long ago as the 1970's it was pinpointed as a problem with serious consequences in the energy and environmental behaviour of buildings, continues to exist, partly as an effect of globalisation in building construction (construction and insulation materials, products and techniques are created and used indiscriminately around the world). It is also perpetuated and, indeed, to some extent intensified by the incorporation of similarly indiscriminate approaches in the teaching of construction to currently active or future building engineers (e.g. use of materials and construction techniques unsuitable for, or even harmful to, the buildings in the place where the students practise, or will practise, their professions).

This paper examines the problem of the incautious ways in which the environmental factor is incorporated into building design and construction, particularly in regard to the teaching of Architectural Technology. It pinpoints some of the reasons why this problem continues to persist and, wherever applicable, suggests ways of addressing them.

Introduction

The teaching of Architectural Technology (A.T.) ought to take into account and present the factors that determine the environmental and energy behaviour of buildings. These factors shape design and construction choices and aim at utilising favourable environmental influences and cancelling out negative ones. In order to be effective in achieving this goal they have to be compatible with the environmental and particularly the climatic conditions of the place in which the relevant building is located. If a building designed to be built in a particular part of the globe were constructed in an area where different climatic conditions prevail, it would generally retain its functionality but would soon prove more vulnerable to environmental influences and problematic in terms of its role in securing comfortable conditions for its occupants. Apart from the climate of the wider surrounding area, an important factor in the formation of the web of interaction between a building and its environment is the microclimate of the area in which the building is situated, particularly those characteristics shaped by the parameters of temperature, humidity, sunlight and wind. An important role is also played by other factors, the most prominent of which are those which influence building construction methods in the local area, such as the availability of building materials, the relevant legislation, cost, traditions and so on. The fact that many of the factors mentioned above have a clear geographical connection and also change slowly over the course of time results in buildings of the same type displaying many common characteristics over a wide geographical area. A typical example of this is residential buildings. For example, the buildings in a London suburb resemble each other a great deal but differ considerably from the buildings in a small African town.

Findings like these were much more obvious several decades ago before a global tendency towards uniformity in the structure and appearance of buildings emerged. Although this particular tendency reflects a form of globalisation in the building construction sector (similar designs, similar materials, similar construction methods), it cannot easily be seen as representing progress in the art of construction.

This paper examines the importance of the above observations in A.T. courses. In particular, it studies the importance of the environmental factor and its incorporation in the teaching of these courses. It examines how this is achieved in practice and what the consequences might be if it were ignored. In addition, on the basis of the findings to which it is led, it suggests, wherever applicable, measures and practices that might improve the way in which the environmental factor is incorporated into these courses and make its incorporation more beneficial.

The environmental factor in the teaching of A.T.

The environmental factor is incorporated into the teaching of A.T. mainly through the following methods:

a) The presentation and explanation of climatic and, more generally, environmental factors and the mechanisms via which these interact with particular buildings. Examples of such factors are temperature, sunlight, wind, humidity, noise, air quality etc.
b) The presentation and explanation of the choices through which these interactions are dealt with, both at the design and construction level.
c) The presentation of examples of completed architectural works in which these interactions are successfully dealt with.

According to current practice, the knowledge provided by these methods is assimilated through exercises and assignments. These assignments might focus exclusively on the management of specific environmental influences or they might concern other topics which, with the addition of relevant parameters, are enriched with the environmental dimension.
In the above methods for incorporating the environmental factor into the teaching of Architectural Technology there is scope for making mistakes. These mistakes concern the misunderstandings that might be produced in the minds of the learners regarding the context in which the material they are taught might be applied. To be specific, with respective reference to the methods mentioned above:

a) In the presentation of environmental factors some might be included which do not concern or are of no particular relevance to the area in which the learners are practising, or will practise, their profession. Conversely, certain factors might be ignored that are of greater importance to the same areas. One example is seismicity. There are some parts of the globe where earthquakes are unknown and so have no bearing on the design and construction of buildings. In seismogenic areas, on the other hand, antiseismicity ought to be a basic parameter in building design and construction.

This group may also include factors which vary considerably from one area to another, in terms of the intensity and consequences of their effects. One example is solar radiation. In areas at high latitudes the sun is always welcome and architects focus their efforts on utilising the solar radiation that falls on the surfaces of buildings. In contrast, in areas at low latitudes (e.g. the tropics) the sun often causes discomfort and in these cases solar protection measures are taken.

b) The solutions, which are proposed for managing specific environmental factors, may be inappropriate for the area they are recommended for. One example is natural cooling and the measures it includes to utilise the wind. The practices, in both design and construction terms, that favour natural cooling in the interiors of buildings are welcome in hot climates. The same practices, however, are inconceivable in cold climates.

c) The examples of architectural works that are presented may, in environmental terms, be inappropriate for the area under consideration. One example is a building with light insulation and large openings presented in an A.T. lesson for an area in a cold climate (even if the issue in connection with which the particular example is presented is irrelevant to thermal protection, there is a danger that it might, even unconsciously, cause misunderstanding). In this respect, it would be advisable to stress that distinguished architectural works, and by extension those most often encountered in books and journals on architecture, have gained such a reputation because, amongst other things, they have successfully adapted to the character of the local environment.

Similar problems could also be caused by exercises and assignments designed to consolidate teaching that are inappropriate in environmental terms. In this respect, when setting a particular task simply failing to provide environmental data for the area on which the exercise or assignment is supposed to focus can cause the mistaken impression that it is not important. Apart from this, it is also wrong to provide environmental data that is inappropriate for the particular area of reference, e.g. temperature bands, humidity rates, wind intensities and directions, and direct solar radiation rates and directions. An extreme but typical example is an assignment that was given to students at a School of Architecture in Australia in which they were asked to make provision for solar protection on the south faces of the buildings. This assignment was evidently an unwisely chosen copy of a similar assignment at a School of Architecture in the northern hemisphere. And if this is an extreme example, it might be accepted that even small changes in the character of the insulation layers in a building (e.g. their thickness) resulting from erroneous data might involve extensive changes to the way in which it is constructed.

Such mistakes as those described above, which might lead to misunderstandings about the role of the environmental factor in building design and construction, do not occur only in the teaching of A.T. courses. They may clearly also occur in other architectural courses. Indeed, the problem with the other courses is that they unconsciously introduce messages of this kind into the minds of the learners. For example, if the buildings of famous architects that are quite rightly presented and promoted in architectural courses do not suit the conditions prevailing in the area where the learners will eventually practise their profession, it is possible, if this fact goes unremarked, that erroneous models might be produced.

The cases set out above, together with the negative examples of their practical consequences, provide a taste of the problems that might be caused by incorporating the environmental factor into the teaching of A.T. courses in an incautious or inadequate manner. The worst thing is that the consequences of such omissions and errors merely add to a whole set of negative factors already burdened by the symptoms of a globalising tendency in building construction. This tendency, which first began to appear in the early 1970's, is manifested in the application of similar approaches and practices in building design and construction, and even in the use of the same building materials and components, regardless of the conditions prevailing in the area where a particular building is being constructed. As a result, buildings that are constructed in different parts of the world and different climatic zones look almost the same. Such similarities, which represent different manifestations of the same globalising tendency in building construction, may also be observed in relevant items in books, journals, prospectuses and even specimens of ready-made building components in computer programs that are circulated and used indiscriminately all over the world. This tendency, apart from producing problematic buildings, has other, wider negative effects as well. For example, as happens with other commodities, it creates the impression that building materials and components from other countries with a long tradition and well-developed industry in that field are better. There is no guarantee that a window manufactured in Germany will be just as suitable in a Middle Eastern country, even if its specifications cover the conditions there.

Suggestions regarding ways of incorporating the environmental factor into the teaching of A.T.

The problems presented in the previous paragraph indicate the care with which environmental components ought to be treated in the teaching of A.T. courses.

Dealing with these problems by restricting the teaching matter to the narrowly perceived interests of the learners is not right either from a practical or a didactic point of view. Moreover, these interests are generally not known. Nowadays, with the wide exchanges of teachers and students that take place, it is highly likely that A.T. classes will contain individuals from different parts of the globe. Also, the high mobility of professionals (in this case architects) that also characterises our age does not permit us to predict where exactly each learner will eventually practise his profession. It is quite likely that many students attend A.T. courses at institutions situated in areas where the prevailing environmental conditions will differ from those in the place they eventually settle in. Similarly, students studying architecture in a particular location may well find themselves practising their profession in an area where different environmental conditions prevail.

Consequently, the problem of how to do a proper job of incorporating the environmental factor into the teaching of A.T. appears to be more complex. One way of dealing with it might be to make a balanced presentation of the relevant subject matter so that it covers the whole range of environmental influences on buildings while also highlighting those elements that are relevant to a particular area of reference. The latter could be the area in which the course is taking place. This is an area whose environmental conditions are familiar to both teachers and students alike and as such provides a common basis of understanding. In addition, logically and statistically, it is more likely to fall within the area in which the learners will eventually practise their profession. Taking this idea further, another suggestion is that the teaching of A.T. courses should be of a more general nature in terms of its theoretical content while, as far as the practical side is concerned, it should be geared more towards applications that are suitable for the local area. For example, the completed architectural works that are presented and discussed in these courses should be chosen mainly from the local area and display characteristics that reflect interaction with its own particular environmental features. Also, the assignments that are given to consolidate the knowledge taught on the course should refer to the same local area: in other words, the environmental data that is supplied should relate to that particular area. In this particular case, a good practice would be to ask the students to gather the data they need to use in the exercise or assignment themselves.

The suggestions outlined above contain many gaps, of course. However, insofar as they might help the environmental factor to be incorporated into the teaching of A.T. courses in a better, more systematic way, they are worth investigating and developing further.

Conclusion

If A.T. includes the interaction between buildings and the environment as a topic in its course material, it ought to ensure that the environmental factor is properly incorporated into its teaching. Its incorporation is hampered by the fact that environmental data differs from one area to another. As a result, a student taught A.T. from the perspective of the environmental conditions prevailing in a particular place will have difficulty and problems in applying his knowledge to a place where different conditions prevail. (It is worth noting that this problem is much less evident in other components of architectural studies).

This paper contends that the first step in dealing with this problem is making both teachers and students aware of it. And this is its basic conclusion. However, it also proposes a rationalistic incorporation of the environmental factor into the teaching of A.T. courses, one that seeks to combine the need to give full coverage to issues relating to the interaction between buildings and their environments with an emphasis on matters more directly related to the particular area of reference. The incorporation of this factor, to the extent that it is achieved, will help A.T. courses to become friendlier and easier to understand. Also, more generally, it will help architectural design to make a fuller contribution to the protection of the environment and energy-saving.

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Rossella Franchino
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Theory, Design and Realisation Practice in Initial Teaching of Construction in the Faculty of Architecture

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Abstract

New frontiers of sustainability have radically changed the way of realizing architecture with regard to technological systems and formal imagine at the same time. The introduction of natural elements into architecture has become a fact, but as regard as construction teaching these materials, because of their natural substance, need a systematic approach. It is important to preview performances with natural elements, considering their flexibility and the capabilities of having different behaviours in consideration of the context. The article affords a range of problems connected with green and water as building materials and it forecasts a more scientific approach which could be useful for introducing into teaching these living materials. In order to let students formulizing not only considerations from an aesthetic point of view, the relation which bounds green and water to construction is afforded in its complex relations with the environment. The need of a computer aided simulation of different behaviours into time of these living materials is also afforded with indication of different solutions which combine water and green with building.

Flexibility into nature and materials

The consideration of greenery and water as building materials encourages students first of all to consider materials in generally with a special attention to their possibility of being flexible.

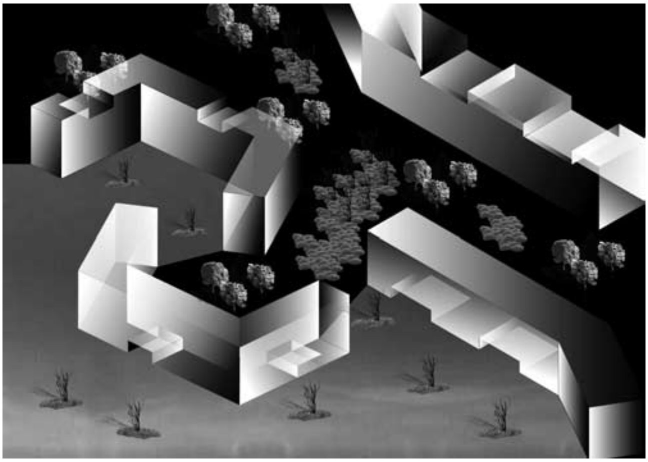
Naturally we can imagine that there will be various difficulties bounded to the fact that green and water are dynamic materials into space and into time and it is complicated to think into terms of finished work. Moreover other difficulties arise from the fact that students such as architects cannot find experiences codified into handbooks.

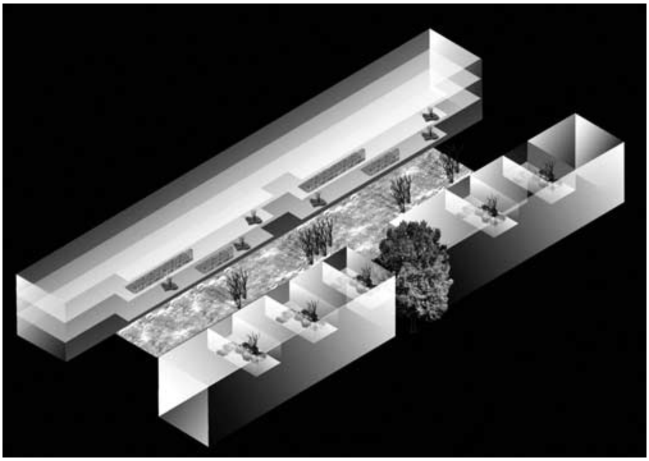
But methodologically we don't move without any help. We could systematize already designed shapes, considering different component of context, in order to realize an agile instrument, a preview of prevailing conditions in terms of common forms.

The simulation of these variables is made possible by the elaboration of useful simulations of virtual schemes in large number with which we can value at least the preventive quantitative relation between natural elements component and traditional materials component. We on this basis could individualize common denominators of different typological combination and compare them. Naturally this preventive work should be very systematic, with relation to natural elements and traditional materials combination also in relation to various considerations like the possibilities[1] of having a better internal microclimate and a sufficient sustainability of building.

Different mutable prevailing conditions are given by the nature itself of natural components, which are dynamic into aggregation. And it is also true that often historic net of streets patios and plazas, with water courses and trees, is what reminds this sensation, with variable composition of areas and interconnection.

With a system of design methodologies it is possible to recreate a situation similar to historic configuration of European cities and villages with continuous alternate of entrance and exit.





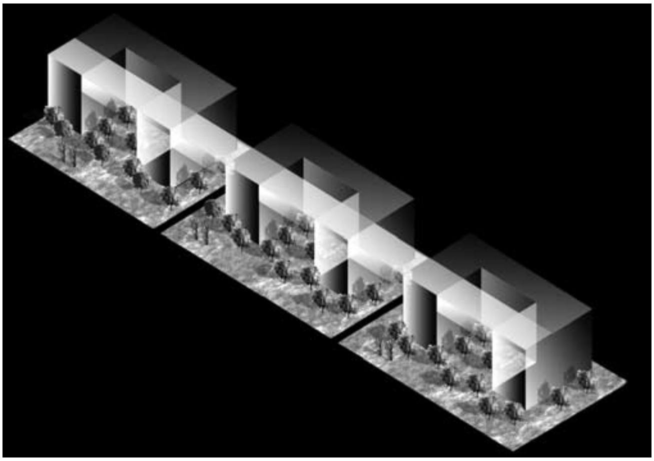


fig. 1,2,3. General schemes of aggregation of natural elements and architecture

An adequate ecologic residential model should contain the changeable composition into unique shapes realized aggregating simple elementary unities in variable way. And this fact can have consequences also in the social relation among people, as voids, green spaces and water attractions are capable of attracting a certain amount of persons.

A general management system of natural components should be correlated to a list of requirements codified into very carefully organised and well researched valuations.

Natural elements such as green, water and soil may be considered fundamental elements in order to have mental imagines of a community put together. These elements have importance not only under the aesthetic and ecological point of view, but also for the consideration of their capacity of attracting young social interest[2]. This is very important for teachers and for their desire of interacting with learners and young component of a society, in order to have a better collaboration in designing.

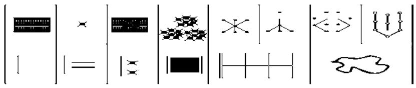


fig. 4. Green disposition, homogeneous, punctual, linear, compounded

Computer simulations need to be very much comprehensible and the quantitative data need to be understood, especially because speaking of natural elements the debate is articulated on quantitative elements, because of the difference between construction and natural elements in terms of economic results.

Contemporary architecture, even if sometimes it is spectacular, not always is able to put inhabitants together into natural space, and it obliges to a solitary contemplation. There is the need of new social interest into teaching which could correspond to an idea of collective desire for naturalism.

Fairly new technology such as a computer assessment can be used to evaluate the layout of an environment so the architectural project is not an end in itself but is considered in its relationship of revitalizing environment.

Naturally this permeability involves also the building which with its envelope closes spaces never completely and a kind of filter surface is to be studied.

Natural materials are to be introduced into traditional materials in a construction with a regular cadence so that position, characteristic, performance could be mixed. A research prospective is so open in this course.

Water as a topic for advanced research and teaching

Through the centuries man has paid always a major attention to the design of water systems for transformation of his physical environment, which have contributed to assure a safe exploitation of land and resources of whole regions. For example one could refer to the many hydraulic works, aimed to land protection and its profitable usage, carried out from very old times, including water navigation channels, coastal land reclamation, aqueduct constructions and polluted sites remediation.

Beside such scopes, water has also been used for mechanical energy production purposes in older times, such being the case of water mills, and electrical energy in more recent times, that being the case of hydropower plants.

With the development of knowledge and architectural technologies applications, it has become necessary to upgrade skills and capacities of facing the different aspects of water presence not limited to usage, prevention and protection, but also as an element, if not a complex component or system, in extremely diversified problems of the modern habitat.

One could cite the houses that protect themselves in case of flood emergency by a lifting, operated by mechanical systems, or houses that close hermetically any opening up to the maximum presumable level of inundation, in order to avoid penetration of water inside, as presented in some advanced building technology proposals at the recent Rotterdam biennale exhibition.

Such proposals open further perspectives, as studied by the author, which in particular deal with:

- noise barriers by water linear cascades, which mostly mask outdoor noise frequencies by modulating height, width, flow rate, impact surface at ground or at water pond;
- spray ponds which achieve evaporative cooling of condenser water coolants employed in air conditioning plants;
- storage and recycling of rain to be used for irrigation of gardens and lawns;
- seasonal energy storage by cold and hot water alternatively in underground aquifers;
- air flow humid filtration to capture polluting gases in taking air from outside and letting it pass through water spray device;
- self protected houses built with a floating capacity in case of floods.

Some details of the above mentioned items are discussed further on.

Noise barriers can be applied in motel or service areas premises along high ways to mask the steady noise of the nearby vehicular traffic, that is definitively a major disturb to the relaxing landscape and architecture that must characterize the settlement.

Spray ponds substitute mechanical cooling tower which often feature a large volume, a rough industrial shape and heavy fan noise; the efficiency of spray ponds is just a bit lower of that of towers in completely saturating air by inlet water, heated by cooling refrigeration (or heat pump) condensers (or evaporators), thus obtaining a lower outlet water temperature.

Storage and recycling of rain is obtained by draining rain water from roofs, after disposing first rain that always contains dust and other contaminants, into underground or open air tanks from which it can be distributed to an irrigations system, that is operated automatically when the soil is detected dry by a sensor.

A seasonal energy storage coupled to refrigeration equipment features water raised from an aquifer to cool condensers and pumped back down in a second well to be placed upstream, at an appropriate distance, in order to recover warmer water again in the first well for space heating purposes.

Air filtration has been sufficiently described, while floating houses must be constructed with naval techniques and must be anchored by capable chains to the ground to tolerate a flood lifting without being drained away by the flood stream.

All items discussed above needs a systematic approach for an effective teaching and that requires an intense work of research and application.

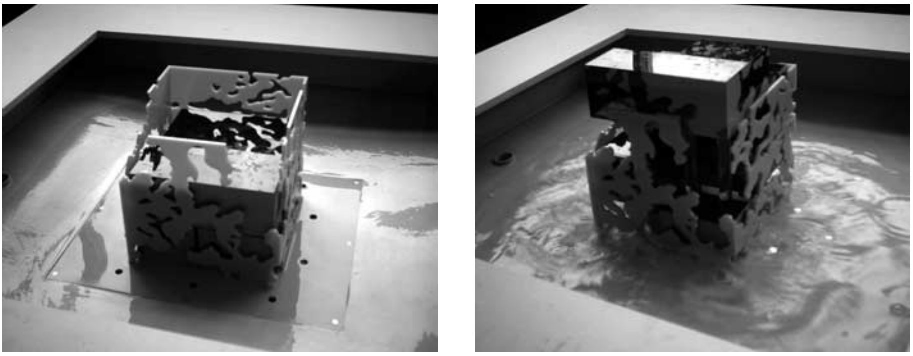


fig. 5,6. Flood resistant house seen at the Biennale of Rotterdam the Flood

Vegetational elements in the requalification of urban structure

At heart of our observation there is the remark of the endless, mutual and continuous process of action and reaction between green and housing shapes: this asks for a survey on the multiform and variable relation, from which gathering operating procedures able to raise quality of life.

The resort to systematise meaningful examples, allows a confrontation to deduce an evaluation criteria for integration between vegetational elements and building. The process concerns different spatial and technological solutions, such as screening effects, ventilation ducts, shading and thermic and hygrometrical control, useful to valorise climatic and vegetation resources, distinguishing also innovative components to give back social and psychological identity to living[3].

Then observation concerns green as a dispenser of multi-sensorial feelings and as an element, changing with time, of the urban scene.

About urban environment, a classification of possible approaches, also of social type, creating green spaces, goes back to 1992, when the Ecology Institute of the Technical University of Berlin (TU) together with London Ecology Unit, English section of European Academy, has defined European Community strategies of nature protection to act in the town of Berlin.[4]

In addition to urban parks, they have been distinguished: collective gardens, plots always conducted by small communities, typical of urban environments where vast areas to destine as parks aren't available, urban farms, typical of places with horticultural tradition, where it is desirable also to have an economical fall out, urban forestation, useful in case of need of bioclimatic benefits, road plantation of trees and green corridors, for the thermic and hygrometrical rebalance on pathways, building greening, that is the criterion to adopt vegetation as a building material, making use of bioclimatic protection features.

In parallel, the concept of urban ecosystem, reference for assessment of environmental conditions and where different elements interact, has been introduced in the study of the contemporary town and of relations between its phenomena. This scientific approach allows to check sustainability of settlement and productive processes, as fluxes of matter and energy, to provide tools, indicators and methods for the rebalance of the general system.

It has also been defined the ecological footprint of a town, as the productive area necessary to feed its population (Rees, 1992), assessing the influence of the urban zone out of its boundaries and inductions of exploitation of resources of matter and energy.

General purpose of ecosystemic rebalance are, then, both reducing ecological footprint of towns, giving a strategic role to virtuous phenomena that is possible to activate in urban environments, and to improve the microclimate.

In this frame, for urban territories where the presence of naturalness is rarely significant, the role of the control and management of the resource of vegetation concerns the interrelation with the constructed system, pointing out the thermic, hygrometrical, acoustic and depurative changes that the vegetal system may produce on built environment.

It is required then to apply criteria able to improve environmental comfort, through regenerative capabilities of the vegetational system, stimulating them with appropriate choices; the chance is to create active systems to regulate meteoclimatic effects, such as for example, curtains for shading or shelter from winds, bioecological corridors.

Green areas inside the town have been distinguished[5] into urban parks, public gardens with trees, private green with trees, rows of trees and flower-beds with bushes, assessing the contributions of different systems relating to protection from wind, noises and sun, besides of atmospheric regeneration.

Those systems are flanked by new (but old) typologies of uses directed to ecosystemic balance, such as green fronts, useful to regulate thermic exchanges of façades of new or renewing buildings, or paths with pergolas. In each one of those cases it is obviously essential to choose appropriate species for the place, as well as it is important to verify features of the roots, that may damage the surrounding superficial layout works.

Vegetational elements constitute regulation tools of urban microclimate with regard to shading, through which they can produce effects both positive (during summer) and negative (during winter).

Positive effects on soils concern protection from excessive transpiration, creation of rest areas or of refreshed paths; positive effects on walls consist in avoiding overheating opaque surfaces helping thermic comfort, or passive solar systems, that otherwise necessitate mobile screenings.

Negative effects on soils show up as obstacle to rain water evaporation, giving place to too wet areas, or in case of winter too harsh temperatures, to ice crusts; negative effects on walls are

reduction of insolation for opaque surfaces and passive solar systems, together with the chance to encourage condensation phenomena.

Shading vegetal barriers, then, must be made with tress with caducous leaves, disposed southward the building or the place to protect, to maintain positive effects in winter and eliminate negative ones in winter.

Urban microclimate may be influenced from vegetation also relating to wind, through creation of wind-break barriers, the effect of which is function of height, physical nature, distance, height from soil where speed needs to be reduced, planimetric direction of the barrier.[6]

Another valuable contribution is the noises reduction, for which it is efficacious to position double rows of trees, with staggered order; best results (reductions until 10 decibel) have been reached with big fences made from plants with permanent leaves.[7]

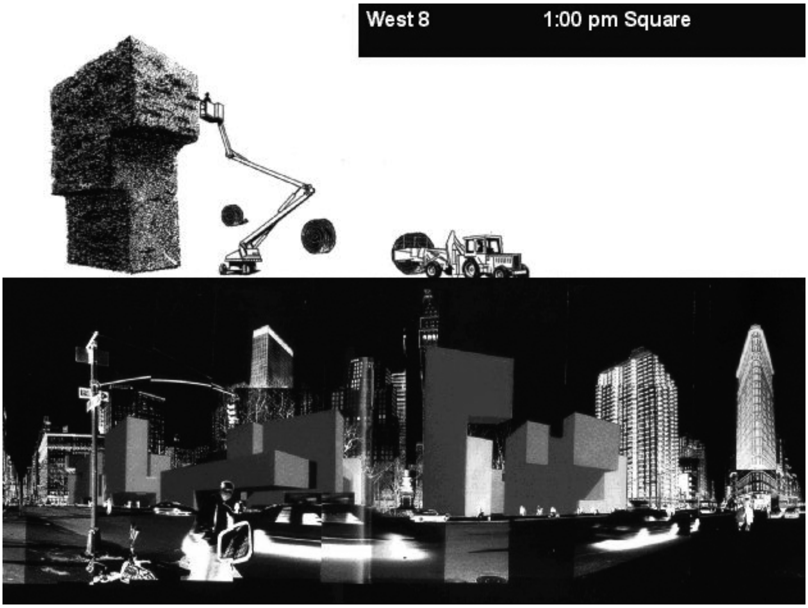


fig. 7. West 8 1:00 pm square, New York
(From Quaderns n. 217, ed. Font y Prat, Barcelona)

Further bioclimatic contribution of green system concerns atmospherical regeneration capacity, due both to photosynthesis (chance offered in significant way from vast green extentions) and to the possibility to fix noxious dusts suspended in the atmosphere. Also this last feature is more evident in the tree vegetation, particularly when leaves move less with wind and their surface is not smooth.

Concluding, regarding to a literal interpretation of green as a construction material, two provoking proposals for greening of New York, dated 1996, by the dutch team West 8, are reported; the first of them refers to Madison Square and the second to the plot back of the Seagram Building at Park Avenue[8].

Both are projects of vertical urban green, supported from a steel structure that draws the shape: natural artifices expressing an uneasiness to find formal and technological stylistic features in the intervention to requalify the town.

fig. 8. West 8 Vertical Park, New York
(From Quaderns n. 217, ed. Font y Prat, Barcelona)

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Adriano Magliocco

The Environmental Quality of Products and the Technological Choice

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The classification of construction elements in accordance with an essentially object-based logic, suggested by construction habits and a subsequent tight relation between functional elements and technologies for execution, is now outdated, even if its logic of communication is still used for some groups of elements. It was replaced by the logic of performance, where the supply of performance for satisfying needs comes before the material definition. Obviously the object description is not outdated owing to its basic role in the formal control of the object, but sometimes the logic of performance prevails, as it is more suitable to create innovative solutions, or just cheaper solutions, in order to solve problems where the conformity with prescriptive minimum standards stands out among other needs.

So the classification into constructive elements was replaced by a system of classification (I'm referring in particular to what Italian UNI prescriptions define, but essentially this classification mirrors a peculiar way to conceive buildings) which offers the technological system broken into classes of performance (classes of technological units, technological units, classes of technical elements). In fact even this kind of classification cannot get rid completely of object-based references; even though some technological units consistently start with the logic of performance (closings, inner partitions), others do not, and they are shown as parts referring to predictable elements (eg. services supply systems).

At any rate, in the end, you get to the technical elements, which are depicted quite traditionally. After all, the so-called "analogous solutions", that is technological solutions made up of descriptive elements based on the logic of performance, refer to familiar and preconstituted constructive modalities. On the whole, the difference between the main concept and operative result does not bother much, as in planning, the attempts to break up connections among form-fuction-element seem to have had transitory results (from deconstructivism onwards), limited anyhow to the world of formal experimentation, clashing with the insurmountable problem of the force of gravity and the basic requirements of ergonomics which allow us to serenely use the planned spaces. Anyway, from a teaching point of view, this kind of classification features great potentialities and is apt to stimulate students to regard the technological solution as a "solution" to a problem rather than an undiscerning offer of prepacked solutions.

But which changes are taking place today? A new range of requirements which are to be satisfied is overbearingly entering the world of the built environment planning. The ever growing problem of the environment – either connected to the question of materials and energy resources supply, or to the pollution following the whole object lifecycle, from production to disposal – will define a new class of services to be supplied. Nowadays it's not enough to satisfy functional requirements alone. When planners make their technological choices, they will have to select materials and products by respecting some basic principles: use renewable resources; use recycling-derived material as much as they can: employ in turn easily recyclable materials (and this involves both the use of materials inclined to this second transformation, and easily planned elements so that they can easily be dismantled or monomaterial); unrenewable resources employed will have at least to be widely available on earth; products will have to be selected among less energy-containing ones, not only as for production, but also for the realization and maintenance in progress; elements will have to have adequate durability in their lifecycle and if necessary to be easily replaceable; elements will have to be produced locally in order to reduce energy costs and the amount of polluting substances owing to transport and so on.

The changes taking place in the current world of building professions – the outlined model has at the moment few locally prescriptive confirmations, but it accounts for the near future – are just a soft echo of what is happening in the areas of research and legislation in EU, circles where the identification of criteria and instruments for the environmental quality assessment of materials and products are most active. Environmental certification systems are helpful for this tough activity of comprehension and selection, notably ecolabels and EPD (Environmental Product Declaration).

Environmental labels are classified in accordance with ISO 14020 suggestions, that is into three groups. Kind 1 labels are supposed to conform to the limits of environmental performances (peculiar criteria on pollution standards, energy waste,and so on) established by the body in charge of the mark itself: for example, for the European Ecolabel, these values are defined by the European Committee after a path which includes a deep analysis of LCA (Life Cycle Assessment) of the product group into consideration. Therefore a type 1 mark cannot be conceded for all products, but only for those whose criteria have been defined.

Type 2 marks are based on the producer's self-declaration, which is neither validated nor certified. Type 3 marks assure that information contained in a product environmental declaration correspond to reality as they are drafted in conformity with specific reference prescriptions. The Environmental Product Declarations belong to this category. So type 1 marks are mainly aimed at products for the wide public who will be able to choose them only by the presence of their outstanding logo. Instead type 3 marks are suitable to professionals who can understand the meaning of the producer's information and make a choice targeted to the context.

It goes without saying that all the ecological labels – apart from the 2 type label in some cases, when it might as well partially contain information which the company is accountable for – have an LCA procedure as their starting point, defining input and output as regards resources and emission of polluting substances. It is clear that major hopes are placed in the promotion of the EPD marking procedure, which would allow to outline the environmentally sustainable features of any product launched on the market, without creating technically incomplete presumptive lists of merit, wrongly disproportionate in the market.

So, in spite of the great interest in the subject, many problems are to be solved yet. What surprises most is that whilst in industry it is comparatively easy to define – through LCA procedures leading to different kinds of certifications – the main features of a product about the energy it contains, the polluting emissions brought about by energy mix used for production, and so on, as the final object is usually well defined, in the building industry all the products contribute to form variable systems in accordance with the assumption that "with the same ingredients, if you change the recipe, you may prepare different menus". This means that the final element performances are not only dependent upon each sub-element used, but also upon their layout, their fixing methodology and so on, even by their position within the macrosystem of the building. So the quality of environmental sustainability of the completed element will not only be the simple sum of single amounts. It won't be enough, in other words, using high-quality products to obtain high-quality final results.[1]

How can these aspects affect the teaching of technology? Teachers might explain the reasons for the upcoming need to assess the environmental quality of the building product; they might try to trace the basic standards for quality definition – and even quantity standards if they are skilled – of the product eco-sustainability , they might compare the products and their performances.

But it is different to make an absolute final comparison, a sort of list, which through the input – product certification which can trace the main features of environmental impact, physico-chemical performances, role in the building element in which it is going to be set, performance of the inner macrosystem of the building, durability, etc. – allow us to get the output, the technological choice.

This might be only possible by deciding a presumptive gerarchy of goals that at present is still far from the world of planning (but it might not as well be clear to the world of environmental science): the reduction of CO2? Or of sulphates? The privileged use of renewable resources? Priority to the products with low energy content? Luckily most of these standards are interrelated. But how can we let the designer (it does not matter whether he is a student or a professional) assess the element at work? Research is showing that it is possible (with surprising results and the abolition of some prejudice about the either so-called "ecological" products and those commonly regarded as highly impact products) but very difficult: anyway results are uncertain and deeply dependent upon the point of view adopted by the choice of analysis. So it seems difficult to imagine the creation of assessment systems within reach of the average professional who often – at least in Italy – keeps existing. This is the way, but at the moment, we walk in pure research.

Note

1 As a matter of fact this happens all the time, and not only in world of eco-compatible products.

Debate on the Presentations
First Theme, Part II

Chair:
Ramon Sastre
Vallés, SPAIN

Chair: Ramon Sastre

The new digital era, which has a relation to other subjects in our schools, is always present in our discussions; the question is how we – in this case construction, but other subjects as well – relate to design studio and other subjects. For nowadays, when we have these new themes, these new materials, these new ideas, these new projects, we have to have a new relation with the other subjects taught in the schools. This, then, is the theme for our discussion.

Sabine Chardonnet

I was interested in the point that Emm. Tzekakis raised before, and in the last question about what is new and what is changing. I understand from what you presented that you are trying to understand new knowledge; and I would just put another question on the table: is it knowledge that is changing or is it the context, the way we capture and use knowledge? I, personally, would say it is the second. So I do not completely agree with the classification you made because, from my point of view, in most knowledge areas history and modernity cannot be separated. They cannot conflict, and you cannot say that contemporary culture today is a break from the past. There have always been breaks in history; and I think that historical knowledge and culture-based knowledge are fundamental – as fundamental as technology. So I think that the question, the classification you made, could perhaps be put in a different way. Even if you are brilliant in the use of Information Technology and brilliant in design forms, you will come a cropper on the question of energy and some other questions – just see what a hurricane has done in a few days in a fantastically technologically advanced country. We have to face different questions, I think, so the classification I would propose would be different. I would, of course, keep the classification of all the things that constitute a field in themselves: structure and stability and the internal logic of matter and forces and space. Then I would put beside that what I call immediate context, which is water, insulation, thermal problems, which form the immediate context of the building. Then there would be a larger context, larger in time, larger in environment and larger in goals, which would be energy exchanges, post-cost, security and risk. We have to face these questions and these fields; and the attitude of the architect is more comprehensive regarding these fields than that of the builder or the engineer or the civil engineer, because the architect has to think not only about how he is going to build that building now but also about how that building is going to live and, because metabolism can be another way of thinking, about how that building is going to be transformed. Because the first day the building is opened, it is going to be transformed, and this is a new change in context. It is a rapidity of transformation, of adaptation, of changing of use, which is something that has changed in the context. You speak about speed; but speed is not only in the resolution of calculations with a computer: speed is also in the rapid transformation of use and of organisation of society. But the building can remain, while the context is changing very quickly. So I think that we have to open doors now to these questions, if we really want to build construction.

And then we also have to be rooted in history, because it is fascinating to see how many of these questions have been considered in the past. Not resolved in the same way, but the questions were there – maybe in another definition, but there. I was telling my neighbour that last year in the North of Italy I came across a pre-historic site where they have discovered engravings on enormous rocks, and they have tried to build a building that was designed on those rocks. This building, which might have been one of the very first wooden structures in Europe, is an incredible lesson in architecture and construction. Those people had nearly nothing, only the simplest of tools (this was in the Iron Age); but – and this is the point – they could build an incredibly self-sufficient building, a building that is a fantastic lesson. I took a picture of it and the next week I showed it to my students in the course of a lecture; and there was an engineer in the room, who was astonished, and said that it was an extraordinary example of resolution. Our classification is problem-solving, but problem-solving is not an addition of pieces that seem to change.

Another thing, on the list that you gave, for example in building skins, you did not really speak of the question of energy, which is an essential matter. Our students will have these questions in front of them, and in twenty years everything will be different. So how can we teach without having that at the very bottom of everything? I think that this is what is changing. It is not IT as a tool: it is the tremendous change of consumption, of energy, of space and of social resources. This is changing enormously, and we will perhaps have to reinvent ancient solutions with a completely new resolution. Because if you just think of building, that would be inadequately productive, positive. This solution used to be tried in the ancient past, by the Greeks and the Romans and other peoples who had few tools and little capacity for building but who had incredible resolution and reasoning. So that is why when you build a curriculum I think that you should think that way.

Emmanuel Tzekakis

Just a few words. First of all let me say that I am very happy that I stimulated this reaction. What we proposed as a new way to see a known structure of how to teach, how to see a building these days, is not unique, or closed: it is just a proposal to stimulate discussion. My idea is that it would be very good to start this discussion now, and perhaps finish it next year, to see what comes out of it, to see what new concept of building science we can come up with that represents the answer to today's problems. I totally agree with you that energy problems and material problems and environmental questions, etc., exist, are there. As for history, while I like history very much we have, however, to discuss whether we need today a new concept of what we know as construction teaching in order to give future architects a new concept of how they should see the building and not what we have known up to now.

Maria Voyatzaki

It is very difficult to really respond to all your points, there were so many of them; but I will try to tackle the ones that really struck me. Regarding the question of context, I think that context has a very important role to play; and one should not see changes in the context and in the building as two separate things, because the building is within the context, and so when something changes in the context the building is affected as well. If you only see it separately you think that the one changes and the other has to follow. That is one point. The second thing is the perception of the building as stable. If a building is a form that conveys, devours, digests and aborts information, then it is precisely this ability and property of the building to be able to adjust and change following the changes or implementing the changes that Information Technology can offer. So it depends on how you see the building. If you see it purely historically and you decide to copy it as an example – and there is nothing wrong with copying, copying is a very useful exercise – that is one way to use or exploit the concept of a sustainable project. We saw that back in Seville, with Grimshaw's British Pavilion, where there was a simulation of how you cool a building by using water. This is an old practice, where you follow up a principle; but precisely because we have this discussion about information transfer, it is this concept that can be transferred through data. It is Information Technology, as neither a representation tool nor a designing architectural form tool, that enables you to use the building to transfer data in order to simulate from the history of architecture a sustainable attitude towards cooling, heating, etc. So I think that it is very difficult for most of us to say that thankfully we were not trained as an architect in the Modern movement, so we do do not put things in pigeon-holes. Our students – to go back to our argument here – do not pigeon-hole things and do not classify them as either stable or unstable, historic or new, etc. Our students have layers in their lives; they can listen to classical music, while they also listen to rock and pop music, etc. And this also goes for their architecture, for the information systems of the buildings allow many things to happen concurrently, and they use the building as an assembly of nodal points where this information meets and gets re-directed.

Herman Neuckermans

I would like to address one question to Victor Echarri, our colleague from Alicante, and one to Professors Manou and Tzekakis from Thessaloniki, and it is about the depth of this course. First I will address our colleague from Alicante. You showed us a lot of diagrams on installations. My question is, how far do students understand what is happening? Because I can go in for – sorry for using the same term – a very fundamental approach, which starts from physics, fluid mechanics, hydraulics, building physics and then installations; that is the normal sequence, if you start from the real beginning. So my question to you, and you can answer me afterwards, is: where do the students come into this course? Do you teach right from the physics, or is it more technologically oriented?

For our colleagues from Thessaloniki, as civil engineers as well as architects the question would be similar. You say, in your diagram at least, that you incorporate building physics. Of course there is building physics and building physics, and some things are very simple while others are very complicated; but I personally feel very unhappy when I have to do things and use things that I do not understand. Of course, maybe other people have no problems with that; but let me come back to the model of the manager, or what was said yesterday about the role of the architect who has to play the director of all the participants in the game. I do not know if you saw last week in the newspaper that there was a report that the polyethylene tubes we use for supplying water to houses – the water that you drink – release phenols. Now, you could say "so what?" This is new knowledge, because we did not know it before. We could wash our hands of it, on the basis that we did not know and it is not our job. But the more we face these sorts of facts, the unhappier I feel and the more arguments I find for knowing things in depth. Using things with IT, pressing buttons in a PowerPoint – is that interesting knowledge? I think that it is not at all interesting. My argument is again in fact an argument for the fundamentals. I was happily surprised when you said building physics, because that governs where to put or not put a vapour barrier. Of course, on a philosophical level the vapour barrier is not in the discourse; but in your building it either is or is not, and it is either wrong or right. So I think that if we are talking about construction, and we can discuss construction on the philosophical level as well as on the tactical and practical level, but on the practical level I think that we have to know things. And we have to know what we do and why. That is the basis and that is the context. We still need to develop competences, and I am arguing that what will remain are the fundamentals, while the shapes, the materials, and so on, change.

Victor Echarri
Students of architecture in Alicante begin to learn physics in the first and second year, and they have some courses in construction in their first two years, as well as later. Installations we start in the third year. They do not know anything about pipes and installations and such things before that. So we study that in classes with the other manuals I showed in my presentation; and I think that this one is just a complementary manual for the execution of the installations. They do not have any idea about installations.

Emmanuel Tzekakis
Let me start by saying that I am very happy with your comments, because after finishing my studies at the school of architecture, ages ago, I went to another university to study an area of building physics, and specifically acoustics. So I know the difficulties of what is described under the umbrella of building physics in general. And recently I have tried to understand thermal insulation, condensation, and things like that. It is truly very difficult. However, a building today is a complex thing, so we have to decide whether we are going to take fifteen or twenty years to produce architects who know everything or whether we will find a way to establish a balance between the knowledge they are going to need and what we teach them. In this we must be very careful, because there is knowledge that is dangerous not to be able to verify and there is knowledge that you can fairly safely delegate to others. Take this room, for example. I do not know who designed it, but although everything seems to work very well, nobody that knows anything about acoustics would have put up this ceiling, because although the room is small enough that we should not need microphones to listen to each other, we do need them because somebody put absorbant material in the ceiling, and as we constitute absorption down here, we find ourselves between two absorbing surfaces (top and bottom), plus curtains on either side. Thus the need for microphones, that you normally would not need in a room of, say, 500 cubic metres. So we have to make decisions about what to teach and what to leave out. My suggestion is that in this era of freely flowing information you can find – for acoustics, for instance – very nice and easy-to-use tools on the Internet, that will help you make some basic decisions so as not to have to leave everything to the specialists. Because if you leave everything to the specialists, it is they who will make the room, and not you, the architect. The same goes for civil engineers: if you design a very large room, the civil engineer will probably decide how to make it stand there; so your form will cease to exist. I think that the problem you set for us is very much to the point, and I am sorry I cannot answer every aspect of it, but I certainly believe

that it is a good basis for discussion.

Dimitris Papalexopoulos

I have a few comments to make. The first has to do with the three-part structural skin for interiors, which I liked very much. I do not think it is incompatible with energy problematics. I have an informal sort of proposition, that in fact we have skin interiors and structures, because structures are also part of the skins of the interiors, although they are different categories; the same action that poses a problem in construction also poses a design problem, that is, a problem of enclosure, of definition of locality. So we have skins, interiors, or a solution to the problem of the skin. My second note here relates to Victor, whose intervention I liked very much. I would like to propose to keep this for tomorrow, for the conclusion. With regard to what you proposed for an electronic manual: maybe in other schools of architecture they are trying to structure electronic manuals. I have been trying to make one for traditional construction in Greece, and maybe this is a trend for all of us here to emulate, and to try to see how we could put together an electronic form for circulating knowledge for all the schools of architecture, relating to both theoretical and practical questions, such as whether this information is local or trans-local, very practical questions, or if it relates to several countries, as for instance the seismic factor does in a certain area.

Then, to go on to my third point. I was really very surprised by the intervention of Professor Zamora about Knauf. I am still surprised, and my surprise will continue. I am all for connecting education with industry, but not with a particular industry. I could be very polemical about that, and I am trying to fight it. Evaluation controls for a huge industry, for 2000_ in the bus? Why do we need to do that? We face that in Greece. Have you had any legal problems yet? No? It is very curious, because another industry can sue you for making potential users. (That could be an idea, to make money here.) So I do not think that we have to enter into this problem. I repeat, we have faced that in Greece, twice in the Polytechnic of Athens. Once was with AutoCAD, when we had the lawyers of AutoCAD in our hair, saying that we were guilty of making users, and the other was with Renovat (Ceresit), who had a different approach. They had said that they would finance us for one project; and when we said that there were going to be other industries involved as well, Renovat said that as long as other industries could meet their standards, ISO standards, they would finance them all. So I think that we have a very delicate problem there that we have to look into. Thank you very much.

Joan Luis Zamora Mestre

I would just like to say something so that you will not be so worried. We have twelve years of experience in this, and the law is not after me yet. I explained it very fast and very simply, because there was so little time. I cannot explain my whole course in thirty minutes, but in it we do two evaluation problems. Each student has ten evaluation concepts, and this is only one of the aspects. This is only one small example of our experience with industry. The problem is that we must think of which industry to select. I can select a furniture industry that is behind the school, for example, and I am also in contact with MBT and SICA. I use every sort of expertise or every profile of industry in different aspects of my subject. This is good for competition, and it may be good for our books, as well – it is good for everyone. I use the abilities of the industry. Of course there is a boundary, there must always be a boundary. But, and I suppose that this is true in Greece as well, we have no money. I have only 100_ for fifteen weeks to educate my students, so I often need some help from industry; but I must use this help within the limits of a deontology, so as not to have problems. It is very important, then, to have a good company; but do not be afraid, the chemical industry does the same thing, the furniture industry also – all industries do the same kind of thing. This is not America, you know, the 'Coca-Cola Diversity'. We do not like this kind. But, for instance, the information technologies all have a sponsor, at least in Spain. It is impossible to do anything in computers, for instance, without the help of IBM. Our university has the third super-computer in the world. Who paid for it? Our ministry? No, IBM of course. If we are able to use such technology it is because of IBM. And I think that we must have an approach to industry, everyone from his own position, with a deontology, but without always being afraid of it. We must work with it. Industry needs us and we need it. I like to go from building to pedagogy, but also from pedagogy to building. We can talk more about it later if you wish. Thank you.

Emmanuel Tzekakis
I would like to add something if I may. To overcome such problems industry has invented associations. So, you have an association of window manufacturers, door manufacturers, whatever. If you use an association, instead of a specific industry, you are on safe ground.

Antonino Saggio
I would like to make a short contribution, following the lines of the end of the presentation and the first observation. Some of the key concepts are didactics, pedagogy, and how we can reshape the field of construction because of Information Technology. And this is what I would like very briefly to talk about, after the very inspiring presentations, particularly by Tzekakis and Voyatzaki of the Aristotle University of Thessaloniki of Greece. Now, before starting, I want to address a provocative question I heard yesterday. One of our colleagues said that he had yet to see software that can protect us from a thunderstorm. And within the context that certainly seems impossible. But in reality, of course, we know that exactly the contrary is true. We have buildings now that can react, through software, to different environmental conditions, not only thunderstorms but also sun, wind, etc. Already **we are already talking of a generation of buildings that can, again through certain software, cope with emotions, and are able to inter-react emotionally with users. So it is absolutely crucial to try to answer that question, because we are now in a different world; and as teachers I think that we have to decide how to position ourselves vis-a-vis the crisis of this new era that is already with us.** In the informal conversations we had yesterday different positions arose as to how to tackle these new things. There are many possibilities. One, which is my point of view, is that these changes create a major crisis in our universe and we have to reshape it.

The second thing that I wanted to say before beginning my little intervention is that we are at a point – and I agree with Maria's description – where we are as close to God as we have ever been in our history. This fact, of being closer to God than ever before, really has to do with information. **We are in an epoch in which the key aspect of thinking is the capability to create a hypothesis, to have key-words and interrogation. That is something that traditionally has to do with our relationship with divinity. Divinity was the entity to be interrogated, and we know how difficult it was to interrogate somebody in the past, how many efforts were made to interrogate an important person, and how complicated it was.** Many books were written about the difficulty of interrogation and how to get answers. Today, we are in an epoch when if we have a hypothesis we can interrogate Information Technology and get answers. This is really incredible, and it has completely changed the attitude of the new generation. It is important to start framing a question, and then we can get the information. We can get our answers, basically, through Information Technology and variations of interrogation systems. And you know, Google is one of the most important things that have happened in the past five or six years. This brings us to an important point, which you made clear during your presentation, and that is that we are in a changing paradigm. And this is clear, because all the systems that you depicted in the beginning were clearly analytical systems: there are different parts, components, that you then have to deal with in an analytical way. Basically that world is not our world any more. The old way of thinking, the amount of knowledge and the capability of interrogation systems are completely different. So I totally agree with you that we have to move our pedagogy towards a different system. What you proposed is certainly very fascinating, because when there is a reality everyone has to react to it. And that is why I liked your intervention in particular, because you react to something that is real. It is a proposal that is real, and so it is important to make a start. I think that yours was a very important contribution.

There is one more thing that I want to add. Another very important thing mentioned yesterday was ‘blurred thinking’, that we start to think in a blurred way. All our thinking today is like that: we start from hypotheses that are like clouds, and then the clouds come into focus, merge into reality, quite slowly. But at the start our thinking is blurred. I think that is a key concept, and a very insightful one, too. So, being closer to God than ever before, our hypotheses, our blurred thinking, our areas of thinking about building, do not start from the components but start as issues, large issues. And I may agree that these are the three largest issues we have to deal with. I do not have enough time right now to think about whether those are all, or if there are more than three; I will just accept what you said. So there are three large areas: the first is how the building stands, the second is how the building reacts to the outside, and the third is how the building is shaped inside. Now, we have these three areas: can we teach these as three different systems, and how do we separate them? If we use these three categories, what will be extremely interesting to understand is how buildings today break barriers even between these three fields. If I look, for example, at some of Gehry’s buildings, he makes structures that become a skin in the old way and at other times he makes other buildings that are completely different, with skins that are kind of independent of the structure. So it will be very important to have that kind of critical thinking. I say large categories, because the students have to understand that there are issues, and there is physics and there is philosophical thinking, together, connected to this; but at the same time these three things, these kinds of clouds of thinking, can be constantly changed, even in their nature. The only way that in my view we can start to rethink this approach is through the concept of individualisation. It is very difficult for us to face any kind of general system in these historical phases, while we can start from case studies. Case studies once again become the keys to the complexity of things. Many case studies, different case studies, showing us that these three different concept areas are constantly interrelated and changing. And also because we are facing a generation of persons who are completely different from us, and who are exactly the type of people whom you described, Maria. Basically, **if they start with curiosity, and then add the larger areas of understanding, the new tools, the new capability to interrogate and the sense to understand how many possibilities there are, they will be on their way.** As we were. Our teachers taught us only a small fraction of what we know. We basically did everything by ourselves, and they will do the same.

Alrun Jimeno
I want to congratulate Joan Luis Zamora, because I think it is a good idea to bring industry to the classroom and the classroom to industry, because if we want to build we need industry, so this way is a good way to gain experience, even with all the problems that could accompany it.

Athina Stavridou
I want to add one little thing. The question here, and the objective, is how to teach construction in the digital era, not how to bring companies into teaching. The new technologies change the way we teach, and we misunderstand the usage of the Web if we use it as a prospectus. I think that the Web is about relations; I do not really care about Knauf or other companies, but I do care about the relation of the three categories – the ceiling and the wall, the roof and the ground – so I believe more in the example of our colleague from Alicante that uses this kind of thing.

Ole Vanggaard
I just wanted to make some small comments on the question of industry being involved within the schools. I am sure that this is a trend that will expand everywhere; but I wanted to direct your attention to the fact that it is not only industry: there are examples of Apple, etc., in Britain and in Denmark and everywhere else, offering free advice to architectural students. This is not, of course, just because they really want to help: it is for the benefit of Danish or British architects, knowing that these firms have engineers who are very good at collaborating with architects. I think that this is something that we have to face, and therefore I think that it is also a good thing that it was brought up in this audience. I have no real answer. It is a nuisance, but I think that we will have to accept it and take the benefit of it when it is there.

Donal Hickey
I think the question is how we engage with industry, not whether we do. Can we engage with industry in such a way that we upset the apple-cart, in terms of how they think about how they do things? Certainly, the industry wants to engage with universities and students, because they are going to be the future. I know that in most schools of architecture you find architectural practitioners who will go and work in schools, because they want to get the pick of the next generation to work in their

offices; and the same goes for industry. The question is how we engage with them, and not whether we do. Thank you.

Maria Voyatzaki
I would totally agree with Donal Hickey on this. I think that it is not a black or white situation; it is just a matter of setting up the right rules for avoiding misconduct. That, I think, is the important thing, because we have to realise – and we will probably get back to this when we discuss research – that there are many occasions where research is funded by industry or is undertaken by industry – just look at medicine. With nanotechnology, aerogels and all sorts of nano- and micro- kinds of materials emerging, giving possibilities to this generation of architects.

Second Theme

Part I

The New Teaching Method(s) of Contemporary Construction Teaching: Pedagogic Stances

How do changes in the content of construction teaching affect the teaching process?

Do they affect the aims and objectives of the already established modules and courses?

Should new teaching methods and pedagogic strategies be invented for this new content to be transferred more effectively to students?

How will new technologies – nowadays indispensable means of transferring knowledge– become even more creative tools for the teaching of construction?

F. Hay, *Napier School of Interior Architecture, Edinburgh, United Kingdom*

O. Wedebrun & O. Vangaard, *Royal Danish Academy, Copenhagen*

F. Makovényi, *Szent István University Ybl Miklós, Hungary*

Rosatelli-Franco, *University of Genova, Italy*

N. Panagiotopoulos, *Aristotle University of Thessaloniki, Greece*

R. Raiteri, *University of Genova, Italy*

J. Gorski, *Warsaw School of Architecture, Poland*

N. Juzwa, *Gliwice Faculty of Architecture, Poland*

M. Tziztas, *Athens Technical University, Greece*

Z. Hunyadi, *Budapest University of Technology, Hungary*

B. Wowrzeczka, *Faculty of Architecture, Wroclaw University of Technology, Poland*

Frazer Hay

Illuminating the Utility and Philosophy Collision

School of Interior Architecture
Napier University
Edinburgh
Scotland
United Kingdom

Introduction

Teaching construction in the new digital era is an exciting process where a balance between utility and the designer's philosophy can be achieved.

Due to the evolution of computers and in particular 3d modelling, architecture has been revolutionised in regards to its exploration of an architectural philosophy and the resulting aesthetic. In an environment where all seems possible, the designer can digitally create all manner of forms and experimental structures whilst exploring the latest materials and technology. The building, however, will still need to function well once constructed. This can be ensured through an equal amount of energy being spent on solving the more utilitarian issues faced by a modern architectural expression. These issues can be found in abundance when dealing with the space created within the structural envelope. The Interior architecture requires the same degree of design intent and exploration expressed in the creation of the exterior. The language of materials, detailing and structure should be rolled out through the entire construction, unifying both philosophy and utility throughout the process, thus producing a successful building with integrity.

To produce a design of integrity, and in order to compete within the architectural profession once qualified, the students need to be taught the relevant skills. This is important, not only to gain employment, but also to quickly engage with the new technology of a modern architectural practice when employed. It is essential that education embraces this new digital era and tailors the students learning accordingly.

Projects that engage the students in regard to the implications faced when producing cutting edge architecture [architecture that looks fantastic on the computer screen], need to be written in order to equip the student with the means to identify and provide design solutions to potential problems which will be encountered in practice. A project is required, which encourages the student to carry forward the philosophy which has driven their initial concept, and apply it to all other aspects of their architecture.

Research has shown that in practice it is the interior that often suffers most from the neglect of a continuation of the architect's original design intent. The interfaces of the mechanical and electrical services in particular seem the most effected by this. In order to combat this issue it is necessary to focus the student's attention to a specific element of the service interface problem. In doing so, once the student has engaged and formulated a method of tackling the design issues posed, it is a simple process of applying the method or technique to all other elements of service interface.

Lighting is the obvious area to explore in regard to a student project in that lighting is used both externally and internally. Lighting can interface with a whole host of materials, and in all manner of locations, from ceilings, walls and floors, to partitions or even doorframes. There are many types of luminaire to contend with: pendant, spotlight, up-lighter, wall washer, emergency and task lighting, for example. All of which require a detailed interface solution. This solution can be generated from their initial design intent, and a project is the best means from which to explore this process.

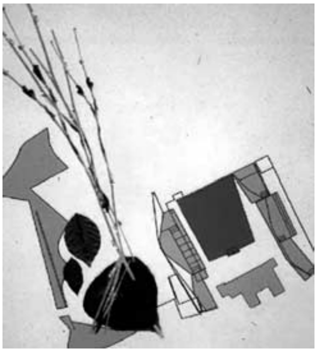
On completion of the project it is hoped that the student will have used the new digital tools at their disposal to test, and formulate a strategy to deal with, the implications of a digitally enhanced design process.

Case Study Introduction

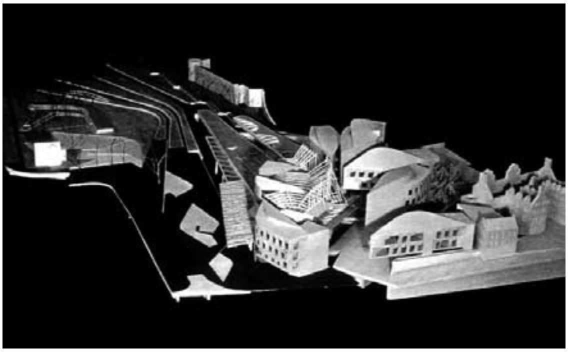
Enric Miralles's philosophy for the New Scottish Parliament [visual 1] tests the boundaries of architectural expression. Gaining his inspiration from Scotland's rich diversity of landscape and history, Enric Miralles set about designing a parliament based on a montage of upside down boats, sticks and leaves. The upsides down boats were later to become the committee room towers and debating chamber. The leaves were later to become the forms that dictated the foyer space. The sticks shaped the landscape and punctuate many the project's exterior and Interior forms. This complicated design and strategy required a dedicated design team using the latest digital software to ensure the design intent became a reality. 3D Visualisation was used to communicate the design to the client, contractors and engineers, whilst enhancing communication within the project design team.

The 3D Software was a key factor in delivering an interior that reflected the initial design intent whilst at the same time facilitating the countries parliamentary requirements. The Interior had to combine both architecture philosophy and Utility.

"The Parliament sits in the land. We have the feeling that the building should be land, built out of land. To carve in the land the form of gathering people together" [1]



1. Concept for The New Scottish Parliament Edinburgh. Enric Miralles EMBT/RMJM



2. Physical Model of the New Scottish Parliament Edinburgh. Enric Miralles EMBT/RMJM

Case study 1 [Concourse]

The MSP [*Member of the Scottish parliament*] concourse space was created from an initial design intent that reprises the notion of boat hulls and leaves. Twelve leaf shaped rooflight structures were to dictate the shape and spatial form of the concourse. The tilted vesica-shaped rooflights were designed to capture and funnel northern light whilst facilitating all the artificial lighting, ventilation and fire detection requirements. The concourse space linked the four main structures, the MSP offices, Queensbury house, the Debating Chamber and the Committee Room Towers. The space was to become the social heart or the parliament.

By using 3Dimensional tools the design team were able to model and test the concourse building and its interior spaces. In conjunction with their primary 2Dimensional drawings skills the design team used 3 Dimensional modelling to solve complicated detailed design issues. The lighting for instance required a sensitive and detailed approach to how it interfaced with the architecture. The computer software could model detailed junctions, showing construction methods, cladding materials, fixing techniques, cable management and the service interface.

Once tested digitally the design team were able communicate their detailed design intentions 3 Dimensionally to the engineers and contractors. With this level of understanding and communication the concourse was built beautifully.

Each complicated rooflight with its glazed, steel and timber structure connected seamlessly. Internally clad with stainless steel and timber panelling the rooflights contained an array of services from fibre optic lighting to fire detection. The concourse space is clear evidence that philosophy and utility can be unified successfully when explored, detailed and executed using the latest digital equipment.

3. 3D CAD Model of the Parliament's Foyer

4. Main Staircase leading into the foyer

5. The Foyer space

Case Study 2 [Committee Room]

There are four tower buildings that rap around the Debating Chamber building. Externally, their reinforced concrete shells are clad in granite and oak. The roofs are shaped like upturned boats and are covered in stainless steel. The Parliament's six committee rooms are located in Towers 1 and 2.The committee rooms were designed as individual spaces to accommodate and facilitate political debate. All the committee rooms differ spatially, each housing a dramatic plaster vaulted ceiling of varying geometric complexity.

To create these committee room ceilings the design team relied on the latest digital software. By using a 3 Dimensional drawing package the design team were able to model the space in order to visualise the ceiling form and potential construction techniques. [6] Once a contractor had been selected to build the ceilings [a construction company that specialised in boat construction], the designers created further 3Dimentional models of each ceiling type. These models generated accurate geometric exploration in regards the dimensions required to fabricate the structure.

Once fabrication methods were understood and tested in part, it was clear just how difficult it would be to practically facilitate the functional aspects of a committee room. A parliamentary committee room would require a specific quality of acoustics and lighting required for broadcasting the debates. [7] In addition the rooms would have to cater for normal working conditions related to a social space, such as, ventilation, heating, general lighting and fire detection. All of which could have the potential to destroy the elegant architectural forms generated from the initial design intent if not detailed sensitively.

6. 3D CAD Model of the main committee room

7. 3D CAD Model of the committee room lighting design

8. Completed committee room ceiling showing lighting interface.

The design team modelled each detailed scenario digitally in order to generate a sensitive method of dealing with each service interface. By using the digital software packages to combine the unique architectural philosophy of Enric Miralles with the practical requirements of a parliamentary committee room space, the design team were able to realise an exceptional spatial quality both aesthetically and practically. [8] A clear indication that philosophy and utility can be unified successfully, when explored, detailed and executed using the latest digital equipment.

Project: Philosophy meets Utility (Student Tectonics Project)

Aims of Module

This module aims to introduce the student to:

- Detailing and Detail package management
- The principles and practice of three dimensional and orthographic drawing used to explain construction methods, material use and service interface

Learning Outcomes

On completion of this programme the Student will:

- understand the requirements of a production information package
- demonstrate an advanced understanding of the language of materials, components and connections
- demonstrate an advanced understanding of the specification of materials
- understand advanced detailing problems and propose solutions
- demonstrate advanced orthographic drawing skills
- demonstrate advanced 3d CAD Modelling skills
- identify and solve detailing issue using digital medium
- demonstrate skills in communicating design intent both verbally and 3Dimensionally

Description of Module

The module is delivered as a series of set projects that engage the student with the world of detailing, material manipulation, construction, and drawing package management within the new digital era.

Introduction

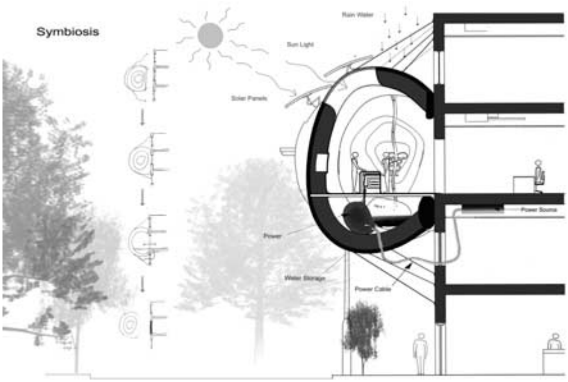
"The necessity to become a little mad is not part of an architectural education. To dare to put forward ideas, to offer up visions to realise the unexpected requires pushing the imagination. But how crazy should we get? Not too much: people still have to use the costly stuff that we produce. Not too little: lets be less boring in the future. The architectural imagination is a combination of utility and philosophy. It responds to specific needs and situations, but keeps in mind that architecture is also a thought about how we want to live in our world. These two, utility and philosophy should not drift apart. The secret is to unify them and to always let them be mutually enforcing" [2]

Due to the arrival of the digital era, architecture has become globally more diverse. Architects/designers are free to express themselves through the exploration of shape, form and materials, which are easily tested and visualised using the latest computer software. It is important however to realise that these digital tools at our disposal are not only to express superficial architectural philosophies, but to create exhilarating buildings with depth and character. In order to ensure this depth and integrity happens, the architect/designer should apply the same degree of energy in all aspects of the design process. The same philosophy and method used to create the exterior should be employed when creating the interior detail.

By using the digital software available, the architect/designer is able to visualise every construction scenario. In doing so the architect/designer can:

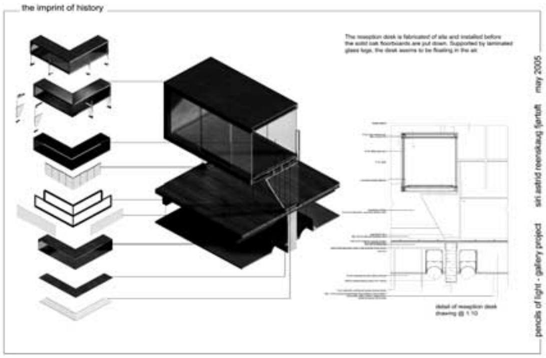
Expose and solve potential detailed design issues
Express their design intention to an Engineer
Explain the project in depth to the client
Aid in the tendering process
Enhance communication within the project design team

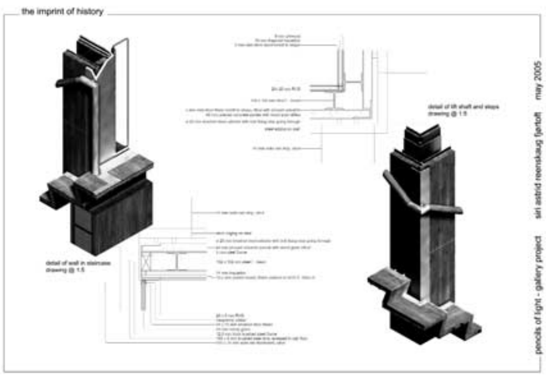
This 3rd Year programme is an extension of the main 2nd Year Design Theory and Practice [DT&P] programme. The submission for the DT&P programme is based on drawings and models designed for client presentation.



9. 10. Student Project by Christy McGarry, Napier University, Edinburgh Scotland

The 3rd Year Tectonics students will inherit the 2nd year designs and will concern themselves with the development of a ‘production information package’ based on a series of working drawings and 3D modelling designed to convey detailed information which is sympathetic to the initial design intent .





11. Student Project by Siri Astrid reenstaug Fjortoft, Napier University, Edinburgh Scotland
12.

This ten-week programme provides the opportunity to expand a design project and consider key detailing issues, which include:

- Materials
- Specification of components [Luminaire units, conduit, ballast, ventilation requirements and protection from the elements]
- Finishes
- Incorporation of lighting
- Methods of fixing
- Incorporation of services

Brief

Architecture of any size and complexity would require a relatively large package of production information, (including general arrangement, assembly, component, mechanical, electrical and structural drawings and detailed specifications and schedules).

Information would range in scale from large structural components down to keyhole escutcheon plates.

The brief is to consider one area of the second year project (approximately an area covering an A1 sheet at scale 1:20) and produce a comprehensive set of working drawings and 3d visualisations. The selection of an appropriate area is essential; it must be complex enough to provide several detailing 'challenges'. For example, a standard stud partition wall would not be an acceptable element to detail, but a 'complex' wall that included storage/display/reception/seating/lighting etc. may be sufficiently challenging.

Once an element of your design has been chosen a detailed three-dimensional CAD Model is to be constructed, materials and lighting attached.

Choice of element must be made by week 02, and 'revealed' at tutorial

Submission

There are two assessment points within the project:

Submission 1
At this crit, all design work must be complete. Drawings pinned-up must be complete drafts ready to be turned into final drawings for the presentation crits
(1:20 layout section & plan (extent approx. A1 sheet), showing the layout of space, objects, and finishes)

Submission 2
A full set of complete working drawings (as described in submission requirements) is required to be submitted at this crit. To be presented alongside the original 2nd year project
JPEG views of Element should be printed in colour and presented as an integral part of the presentation showing not only the complete detail but also an exploded version.

Workbooks, showing development, should also be submitted.

Assessment Criteria

This program represents 75% of the submission requirements for DM30017
Allocation of marks between the submission components is as follows:

1:20 Plan and Section	15
1:1 / 1:5/ 1:10 Assembly Details	25
3D Model	40
Workbook	20

(Based on the following: Innovation, development, functionality, presentation & Technical competence)

01 1:20 Layout Section & Plan Checklist

Section to include the following elements:

- structure
  all fixed furniture and fittings
  handrails and balustrades
  suspended ceilings
  lighting luminaires
  door furniture (handles, kickplates etc.)
  skirting and trims
  air delivery grilles/ducts etc.
- Hatching (where materials are cut through)
- Grid Lines (and key dimensions off grid lines)
- Finished Floor & Finished Ceiling Levels
- Cross Referencing information to assembly drawings
- Title Box to include: job title
  drawing title
  drawing number
  scale
  revisions
  drawn by

02 Assembly Drawings Checklist

Drawing set must include 1:10 plan and sections of an element within the space (e.g. a reception point, bar, etc.) With cross-referencing to 1:5/1:1 details of key junctions and connections. Drawings to include the following information:

- Hatching (where elements are cut-through)
- Dimensions
- Title box for each separate drawing
- Annotation describing: components
  materials
  size
  finish
  colour
  method of fixing

e.g.
42.4mm ms CHS handrail welded to 15mm* ms rod bracket all powder coated RAL 3001*

*42.4mm**	*(Size)*
ms CHS handrail	*(material & component)*
welded to	*(fixing)*
*15mm**	*(size)*
ms rod bracket	*(material & component)*
all powder-coated	*(finish)*
RAL 3001	*(colour)*

03 3D CAD MODEL Checklist

- Model must include:
- Lighting
- Materials
- Cabling
- Method of fixing

04 Workbooks Checklist

Work books should show a day by day documentation of detailed design development i.e.

- Sketches
- Specifications
- Text
- Reference Images
- Dates / times
- Detailed exploration of interface solutions

Schemes of interest

Sverre Fehn	Bishops House Museum, Hedmark, Norway
Carlo Scarpa	Castel Vecchio Museum, Verona
Carlo Scarpa	Querini Stampalia Foundation, Venice
Zumthor	Sheds for Roman Houses, Chur, Switzerland
Wilfried Bruckner	Schwabish Hall, Baden-Warttemberg, Germany
Lamott Architecken	Public Library, Landau, Germany
Edward Souto de Mooura Humberto Vieira	Hotel in Former Monastery of Santa Maria do Bouro Braga, Portugal
Massimiliano Fuksas	Tuscolano Museum of Roman Archaeology Frascati on the outskirts of Rome

Reading List

Architects' Working Details, Volumes 1 - 7, Susan Dawson, Emap Construct
Detail, Review of Architecture Journal
Building Construction Illustrated, F D K Ching, Van Nostrand Reinhold
Mitchell's Internal Components, Alan Blanc, Longman
Construction for Interior Designers, Roland Ashcroft, Longman
Interior Design Illustrated, F D K Ching, Van Nostrand Reinhold
Working Drawings Handbook, Keith Styles
Architect’s Pocket Book, Charlotte Baden-Powell

Company Lighting Catalogues of interest

Zumtobel
IGuzzine
Louis Poulsen
Bega

Sites of Interest

Carlo Scarpa	http://www.studiocleo.com/gallerie/scarpa/scarpatitlepage.html
David Chipperfield	http://www.davidchipperfield.co.uk
Sverre Fehn	http://www.pritzkerprize.com/pritzpho.htm
Norman Foster	http://www.fosterandpartners.com
Mies Van der rohe	http://www.bc.edu/bc_org/avp/cas/fnart/fa267/mies.html
Rem Koolhaas	http://architecture.about.com/library/weekly/aa042200a.htm
H. Hertzberger	http://www.hertzberger.nl/index_intro.html
Eva Jiricna	http://www.ejal.com/PAGES/00MENU.html

Marking scheme

A (70-100%)	outstanding
B (60-69%)	excellent
C (50-59%)	good
D (40-49%)	adequate
E (30-39%)	needs more work (fail)
F (0-29%)	fail

References

1 El Croquis, 100-101, Enric Miralles + Benedetta Tagliabue, 2000, pp144-145
2 Imagination Liquid Politic, Ben van Berkel & Caroline Bos 1999, p21

		Computer Lab		Notes
Week01	Introduction to Project	Project Launch 2^{nd} Year presentations of recently completed design project to the 3^{rd} Year	Students are to pair-off into Project Groups	3^{rd} year are to quickly familiarise themselves with the inherited project with the help of the 2^{nd} year designer
Week02	Project Groups meet for "Question and answers"	Tutorials	Relevant lecture programme	
Week03	Project Groups meet for "Question and answers"	Tutorials	Relevant lecture programme	
Week04		Submission 1 [Presentation of 1:20 Drawings]	Feedback	Feedback [marking up the drawings with red pen]
Week05		Re-Submission of Student drawings after feed back session		
Week06	Project Groups meet for "Question and answers"	Individual Tutorials	Relevant lecture programme	
Week07		Detail Surgery		Detail Surgery is a drop in facility where the lecturer will answer questions as they develop the students are required to bring photos, sketches and work books that explain the problem and show location and structure
Week08 02-05		Detail Surgery		
Week09		Detail Surgery		
Week10		Submission 2 Final Presentation by project group [Ref to the Brief]	Feedback	

Ola Wedebrun
Ole Vangaard

Navigation in the Network
Conceptual Consistency
and Complex Constructions

Royal Danish Academy
Copenhagen
Denmark

The new digital era makes it possible to create networks, to conceive concepts and to follow these from sketch to construction and solution. The network of complex constructions is neither reality nor fiction. Parallel to mind and reality it provides a space where concepts are introduced and maintained and navigated with consistency throughout the project. Thus information tectonics become tool, method, market and space for the network of complex constructions.

The design formulated by the student in the digital media has in itself no physical content. A conceptual formulation of the structural and technical content is necessary, for the ideas to reach the ground. The conceptual approach is important also, because a concrete formulation that comes *too early* ***might*** restrict the student's imagination in the search for new ways. The dynamic development in architecture and technology due to the introduction of digital media has to be understood and grasped by the architectural student, regardless of his/her future role.

Traditionally, construction design is perceived as an assembly from given systems. The process is continuous and more or less "one-dimensional". In a modern building process, the input comes from many different sources, each of which wishes to optimize its own input. The result is often inconsistent solutions, where the architect's input ends up as merely a surface. This is unsatisfactory – technically, economically as well as architecturally.

However, with the introduction of the digital media architectural and structural consistency can now be reached. Through the network it is possible to handle complexities and to navigate by the guidance of concept. Below we have illustrated this with a built example designed by architect Tage Lyneborg, professor at the Architect School in Copenhagen.

System vs Network

In a teaching situation, where most of the "external" inputs come from the tutors, it is important to make the students aware of the conceptual approach to not only the architectural idea, but also to the technical and structural character of the concept.

The teaching of architectural construction is normally a process that goes from detailing to totality, a fact which might have seemed reasonable in a time where technology and architecture followed given guiding directives. Solutions based on given systems could then act as guidance for the scheme.

But system solutions no longer carry the same meaning. The experience of the present chaotic world and its myriads of virtual possibilities not only calls for new approaches to design but also for new ways of addressing and operating with architecture, technology and production within an emerging network.

The situation is a result of a radical change, in the industry as a whole as well as in the society, due to the development of the informational technology. It is not only the physical change in the architectural design studios, and in the production, but also a change in our minds, and in the relations we have to each other.

We must follow this in our teaching. Accordingly, emphasis moves from a concrete and rigid approach , into a way, which enables us to handle many possibilities in one grasp.

An overall understanding of structures is much more important than a detailed knowledge of possible solutions. The classical scientific way of teaching structural mechanics must be more or less overlaid by understanding reached from experiments. (fig. 1)

Some would say that you have to be able to calculate the bending moment in a beam, if you will make a realistic scheme. We say, that proportioning is often better than calculating – we have even developed diagrams for that type of problems. The IT media may become even better, but it will have to end with proportions instead of dimensions. (fig 2) The introduction of the small series of diagrams called "dimensionsskøn" [1] has been a great assistant in our teaching. The question often not "how big?", but a discussion of the structural approach and concept.

Network – Clubhouse Undløse

A competition entry for a clubhouse in Undløse, Denmark, with limited economy and high architectural demands was developed by Professor Tage Lyneborg at the RDA-SA in Copenhagen with the assistance of some of his students. Here, the development of the roof structure was the main issue. The structural engineer (Ole Vanggaard), and a timber producer were invited to secure the economy of the design. A network was formed. The architects' conceptual starting point was a nondirectional grid of slender timber beams. (fig 3).

The structural concept had to be one of an assembly of one-dimensional tim-

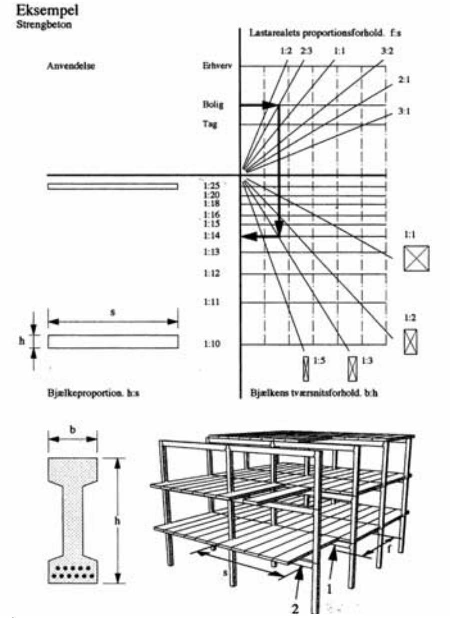


Fig. 1

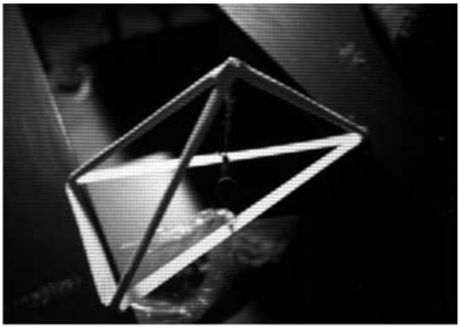


Fig. 2

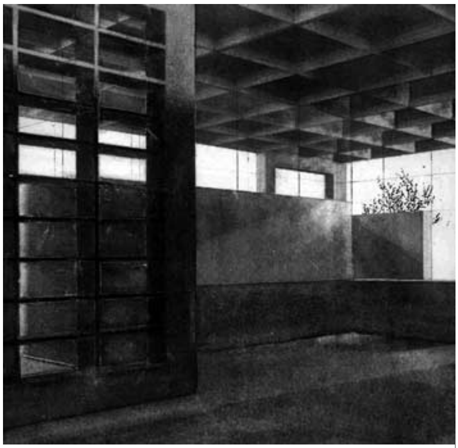


Fig. 3

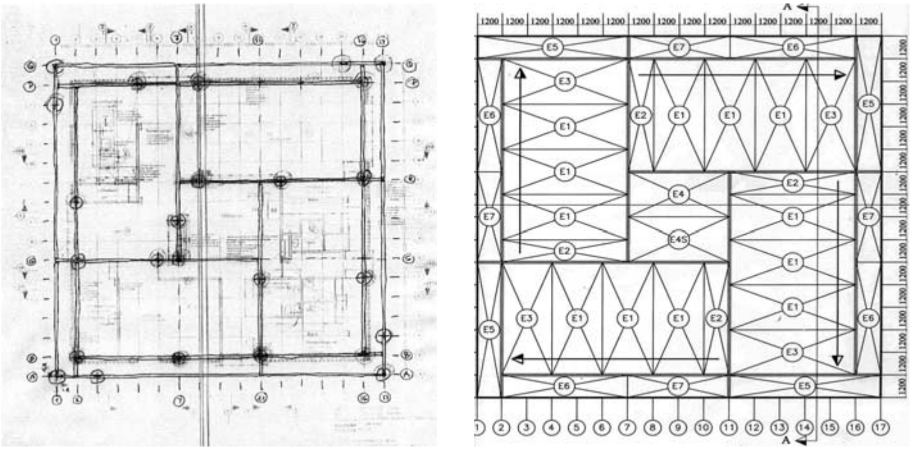


Fig. 5

ber beams. A wonderful timber structure from the Alhambra (fig 4) was introduced as concept, for the structure and transferred into a swastika system (fig 5) supported upon 5 frames. The structural calculation proved the realizability of the system, but also, that it was too flexible. A concept of supplementary supports, where columns were possible as part of walls, lead to a concept of an "ad hoc" structural approach within the original architectural concept. This is not what engineer Cecil Balmond of Arup engineers, in his Berlin "manifesto" from 1995 calls: "ad hocism, which is collage". It is more a non-linear approach to the formal grid system in his terminology.[2]

Fig. 6

The producer's conceptual entrance was one of industrial timber elements spanning one direction in between the main beams of the swastika. (fig 6) Because the architectural concept was loosened by an ad hoc approach, and the old structural swastika concept made it possible, the concept of the producer could be fullfilled with very little extra material by means of thin non-structural ribs. The final (fig. 7) solution won, both architecturally and economically, due to the holistic approach to the problem.[3]

Fig. 7

Acting within the Network

The digital network makes it possible to handle the input of many different actors. Thus, the network becomes a field of construction, where the project evolves as the result of the interdependence of its actors. The role of the architect is to function as the manager of the concept, the navigator within the network, that safeguards the development of the concept – as a virtual and physical construction.

The teaching of architecture, of construction and network will introduce the mean of how to act. Teaching could be paralleled to simulation or game. In this way, the use of the digital network becomes a valuable help when it comes to learning and teaching architecture, to the development of experiences and the establishment of interdependent relations that will eventually be presented as constructions and projects. Different actors will be introduced in the digital network. Their actions will affect the project in different way. For the architect, to act within the network means to nourish the concept, to develop and experience effects and consequences of the concept. The architect ensures the consistency throughout the project, establishing the concept as a project of interdependent relations. The architect gathers and considers the input from the different actors of the network. Eventually, the concept becomes a project and establishes its own actions.

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2 Cecil Balmond: Informal, Prestel, ISBN 3-7913-2400-4.

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Ferenc Makovényi

Building a New World?

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The Lame Conductor

The profession of architects has long tradition from the ancient times. During the centuries the function has changed from the trustee of the king to a rusted bureaucrat. But why has the role of the architect changed permanently? Being aware of this fact, we have to analyze the role of the architect in the construction procedure.

As it is known from the RIBA report 2000, ("architects and the changing construction industry") architects have lost their traditional role in the construction procedure: comparing to the 1980's, when more than 70% of the constructions were developed traditionally by architects, this rate was less than 40% in 1998.

In the public sphere price competition is dominant, and the obligatory public procurement killed the trustee relationship between the architect and the investor.

If nothing else, this fact should be analyzed in a general survey. What happened, what has changed so rapidly, why are architects unable to control the construction procedure?

It makes us to think about the redefinition of our profession; who are we and what is our purpose? What is our added value, what stimulates society to use our services, instead of taking the interest of the developer or construction companies?

Designer architects are the new actors in this play, who are responsible for publicity, form, advertisement and show. Yet the civil engineering society forces our profession into the role of decorators. If we accept this new position, we could become the simple contacts between the investors and the authorities, who are allowed only to manage the building permit, and be responsible for the façade colouring.

The growing market of ready-made houses (Fertighauser) offers a wide variety of design program for individuals. "I can do it myself, why shall I employ an architect?". The enormous amount of materials, the financial tricks of the construction companies made our professions uncertain. Do we have any certain and exact knowledge? Building material producers have such a chemical knowledge, that we can not be competitive any more (let's think about the thousands of new plastic materials in the field of insulations). We can't even give up to date financial advises to the investors as banks have better services.

The British architects were indignant at the comparison of construction activity in car manufacturing and also at the suggestion to use a similar method to theirs. (Who on earth knows the name of the designer of Toyota Avensis or Ford Mondeo, or has anyone heard about the designer of the space shuttle Columbia?)

I understand the indignation, I believe there is some truth in it.

In the car factory, workers (robots) are responsible for making different products, which finally come out as a car. The largest manufacturers use the same types of brakes and all of them use the same type of shock-absorber. All these are only products, which are produced and assembled on certain plans influenced by the customers, who decide the type of the upholstery, the engine, the climate system and all other parameters for their comfort. At least there is an illusion, that customer is involved in the design process of the car.

Let us not over view the strict rules of mass production. Industrialization is not a good or a bad thing; it is a matter of fact, and it will work out his own remedy. At the same time there is a growing demand for individual clothes, houses, as people want to be independent from the mass production, too.

It is hard to argue with the mass production. Why is that so obvious that the investor negotiates with the financial manager, the contractor, and at last with the architect?

The civil engineers answered this question in a very practical way. All measurable activities have been regulated on the basis of quantity, and they play the role of regulation controllers.

No one doubts the calculation of the statical engineer for the reinforced concrete column section because it is based on approved professional regulations. Inviolable rules and regulations protect the fire security, the acoustic planning and the building physics. All measurable components of the construction belong to the territory of the civil engineers, we can only argue with some remaining functional conventions.

It seems that our profession nasn't got its own rules because it cennects to such dubious ideas as the environmental quality.

What is my suggestion? The architects should take their part in technical, financial procedure of the construction.

How do we Learn?

It is necessary to analyze at least some of the fundamental questions of human thinking. Here there are the same different types of approaches as previously mentioned: the analytical method of the European societies and the holistic method of the eastern societies. I feel a lot of similarity in the way of the construction and in the language. Grammar of the language is the way of the construction, and it is reflected in every small details of life.

The starting point of the survey is that fact that human can recognize and use no more than 50-80000 schemes and this is a general observation from chess masters to botanical experts. I will explain the different steps of problem solving activities, and I will prove, that the commonly used methods of iteration, dialog, brain storming, analysis, and morphologic boxes are important during the process but not obligate elements in the problem solving. Construction teachers often face the problem of complexity. How is it possible to find adequate answers to a construction problem, if thousands of firms offer thousands of solutions on the internet? It is slightly impossible even for experts to follow the technological development in the industry - let's think of the various materials and chemicals used by the flat roof manufacturer. How is it possible to stop the so called "paste-copy" method at a construction drawing?

Let us imagine the situation when we learn chess from a book and we don't use the board and pieces or learn how to swim without a swimming pool, or learn music without sound. Most of what we thoroughly know has been learnt by observation, trial and error, and exactly this is the case with our construction education.

At the beginning of our profession architects could touch and smell all building materials and all material features. If we touched all construction materials nowadays, the whole procedure would last over one year even if we didn't touch one piece longer than 10 seconds! This shows the absurdity of the wish to know all the information about construction materials.

Let's have a look, how other professions react to the fact that they have to deal with huge amount of information. As an example we can take the clinical diagnostic problems of the doctors. The first problem is that the definition of the problem requires more information than initially available. Here we have to refer to the problem of the architectural education, where we speak about walls, stairs, foundations, but there is not enough information about the whole building, and the student can not put his new knowledge into the "net of experiences".

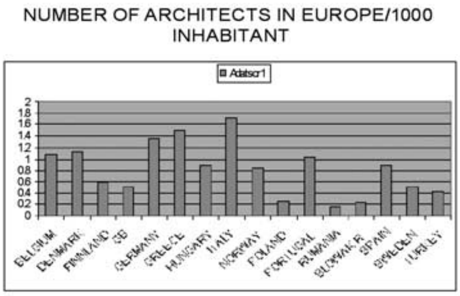
Going back to our original medical example, the problem changes immediately after receiving new information. We have the same experience in our professional field where new and newer information appeal from the client and the contractor and these information continuously modify the plan. We have to state, that our systems are not only complex, but they are permanently changing complex systems. Still we have to make decisions even though we know that our knowledge is not enough. The decision making without certain theoretical fundaments is similar to the politician's habit, which is ready to decide immediately and find the arguments afterwards.

What could give some hope in this hopeless situation? The fact that the information is not everything! It's not the amount of knowledge that differentiates an expert from a novice, but the richness of the connections among the pieces of information. The richness of the interconnections makes the information more useable (e.g., recognition of those situations in which the given information can be used) and more accessible. There is a chance to find good solutions when we utilize our experience, the network of knowledge. The other method is that we work in team, and each member of the team gives their input to unfold the problem.

Education Methods in the Building Construction

There are basically two general teaching methods in the building construction education. One of them is the traditional method of the induction, where the separated building components are listed and grouped as foundation, walls, slabs, roofs, windows, etc. This method shows all possible solutions of the construction component, as an encyclopedia.

The other method of construction teaching is the deductive one. In this method the teacher explains the specialized building component and the reason of the cho-



sen solution to the students through the analysis of a given complete building. Here is the general method, to analyse the effects which resulted this solution. Effect analyzing is very useful, and gives the students much more general information than the simple listing of construction methods.

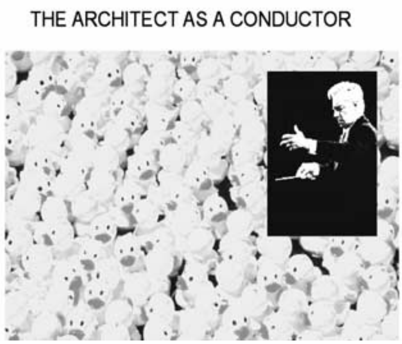
The building construction education has been based on written and drawn materials in the last fifty years. My survey on the number of pages and drawings in the building construction books proved that the basic sources for this field are rich in Hungary. Professor Gábor and his department published a four volumes serial, which contains more than 1000 sheets and 5000 drawings! Just from the point of view of information mass it is still one of the most completed editions in our professional record. Through the analysis of these books we can see that the information amount is permanently increasing. More and more books are published for different building components, or construction problems. One of the typical method for grouping is developed on the basis of the construction materials, (books about brick, steal, wooden and glass constructions) the other grouping method is developed on the basis of the building components like windows, roofs, staircases, etc.

The third type of the construction books is based on the architectural products, where the building is being analyzed in detail as a product. The newspaper DETAIL is a good example for this attitude, which is very close to the architects.

There is a fourth way as well, which is very effective, but it’s a time consuming and expensive method: building a 1:1 model. Only a few institutions could afford to use this educational tool, which is much more effective, than any other method. Our professional field is based on materials, what else could be an effective method of construction education if not the real construction practice?

Detail or/and Whole?

The product designer – who is a new and important actor in the mass-production society- is interested to fulfill the needs of the clients. Where are the borders of the profession, when no experts are responsible for the whole process, but all of them are responsible for their own professional details? This fact makes us to rethink of our profession, and naturally the education process, too. One possible solution is to refer to the standards, and this is exactly the way that civil engineers follow. Architects could not work out their own methods to help themselves in functional and



technical issues. In our profession one of the main values is freedom, and any kind of regulation could destroy this. Still I believe that in general cases standards navigate us in everyday problems, and only extreme cases are exceptions. The civil engineers made a clear decision: they have professional rules for almost everything. When a civil engineer declares a verdict about the size of a column, no one dares to question his opinion. When architects try to argue about a different size/ form/ material of column, the real argument can be either defined on natural law, or on the belief of the competency of the architect. If the client does not trust in the architect any more, and it is clear that only pure financial or/and natural rules have relevance, than our profession should analyse the problems and changes of the last twenty years.

I have more and more the impression, that our professional practice of building different products together has created a bad image and an uncertainty. We can not have enough (if any) information about most of the materials, and even less about the products themselves. We can see the same sort of problem when the ship designer rigs up a cruiser from separate items without having any exact professional knoweledge about the details of the engine or the air condition system . A conductor is generally able to play on at least two or three instruments, otherwise he cannot be a good conductor. Even the orchestra is with its 50-80 members transparent. How could the conductor be in a leading position, when the orchestra has several hundred members, and he can play only one or two instruments? How can an architect be a reliable advisory person in a procedure, when he is uncertain in most of the issues?

As a summary of my proposal here are the conclusions I made:

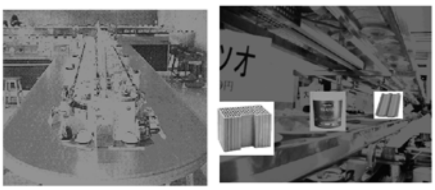
- If everything is fragmented, who is responsible for the whole?
- No one is able to use all materials and constructions
- We have to learn handling complex systems
- Cooperation is the only way to handle sophisticated matters
- Not the amount of knowledge that differentiates an expert from a novice, but the richness of the connections among the pieces of information
- We have to learn again how to deal with money

BUILDING CONSTRUCTION BOOKS REWIEW

¥ AMAZON.COM 14.527 BOOKS FOR THE SEARCH ´ BUILDING CONSTRUCTIONv

AUTHOR	TITLE	YEAR	PAGE	DRAWINGS
G¦BOR	FP† LETSZERKEZETTAN	1959-68	1050	5050
MITCHELL	ELEMENTARY BUILDING CONSTRUCTION	1959	391	500
SZ?LL	MAGAS PP‡PSTAN	1967	910	1664
JANARDAN JHA, SINHA	BUILDING CONSTRUCTION	1981	604	600
SEFFER	MAGAS PP‡PSTAN	1966	411	420
DIERKS, HERMANN	BAUKONSRTUKTION	1990	737	1200
SCHMITT - HEENE	HOCHBAUKONSRTUKTION	1993	753	3850
FRICK-KN LL	BAUKONSTRUKTIONSLEHRE		1580	1589
CZESIELSKI	LEHRBUCH DER HOCHBAUKONSTRUKTIONEN	1987	630	934
CHING	BUILDING CONSTRUCTIONS ILLUSTRATED		480	1100
DEPLAZES	CONSTRUCTING ARCHITECTURE	2005	504	1200

VIRTUAL REALITY
SUSHI CONSTRUCTION



IF YOU WOULD TOUCH ALL CONSTRUCTION MATERIAL WE USE IN OUR PROFESSION, AND EVERY ITEM WOULD TAKE 10 SECONDS, THE WHOLE PROCEDURE WOULD TAKE ONE YEAR!!

Giovanna Franco

Teaching Construction in a School of Architecture: The Importance of Connections and Details

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Italy

The paper regards three important questions relating to the content of construction education: *1) How could the new content in construction teaching reinforce the relationship between design and costruction? 2) How can the teaching of construction incorporate the continuous development in innovation? 3) How does this new content affect student competence and skills necessary to practise architecture?*

The paper regards recent experiences carried out at the School of Architecture of Genoa (Italy) in two different courses, one workshop (atelier) concerning Construction – Technology of Architecture (second year of the first level) and one traditional course (Technological culture of architectural design, at the fourth year, second level).

The bases of the way of teaching Construction and Architecture nowadays are the new conditions imposed by the economic and cultural environment. Inside this new frame and looking at the actual situation of the Schools of Architecture around Italy, it is possible to distinguish many various tendencies, in some cases more orientated towards the relationship between construction and environment, in other cases towards the relationship between new construction and built heritage, in other cases, still, towards management and maintenance processes of the built heritage.

The specific attitude and purpose of the two courses above mentioned are, in some way, more focused on the traditional meaning of the discipline, that is a reflection over the world of techniques, especially in its complex relations with the theory and the practice of the architectural design process. Even though many years passed through, it is still actual the idea of Giuseppe Ciribini, who marked the difference between technique (method), intended as the way and the object of doing, and technology (science), intended as the way of thinking or, in other words, the theoretical reflection around the techniques (CIRIBINI 1984).

In our contemporary culture, the building market is rapidly developing, both producing new materials (or traditional materials added with new ones in order to achieve better performances), and testing new construction techniques. This condition in one way enriches the catalogue of available solutions but, on the other hand, may direct the teaching towards the presentation of different and various techniques, never really up-to-date, because under fast evolution; in such a way the contents of teaching become a sort of collection of a catalogue among which the student could choose, at the end of his design process and with more or less indifference, materials, details and building techniques.

The second premise concerns the relation between the teaching of Technology of Architecture and Architectural Theory and Design, especially inside our faculty. Although the two disciplines should cross each other, in many cases they remain parallel, without getting in touch; this fact obviously impoverishes the way of teaching. Architectural theory often forgets the materiality of the buildings; technology of architecture assumes an "interned" role or, more dangerously, doubles the design teaching, leaving again a apart its fundamental theoretical approach.

For these reasons, also "swimming against the stream" in respect to actual tendencies that prefer diversification and specialisation it has been assumed to come back to the foundations of the discipline, that in some way have been lost, especially regarding the correspondence between the *idea*, the *concept* and the *way* of building.

A few years ago Giancarlo De Carlo was writing: «decorative and constructive details leave the stage. We are no more able to connect correctly and with competence two or more different materials, neither to solve naturally and with elegance the transition from an horizontal or vertical plane to a sloped or curve one» (DE CARLO 1995, 22).

On the other hand the numerous architectural magazines propose a lot of images that, in the work of the student and thank to the use of digital technology, tend to rapidly substitute technical manuals edited in the last part of 20th century. The risk in the use of images, elaborated with digital technologies, is similar to the collection of a repertoire of shapes (false images) that could be proposed in different situations, out of context and loosing the real meaning od concept.

As a matter of fact this risk was been marked, prophetically, by Italo Calvino during a cycle of conferences held in the United States, concerning literature and culture. With regard to the «inflation of prefabricated images» (typical effect of the contemporary society, that is a society of images) he warned against the danger of the «recycle of the images used in a new context that changes its sense» (CALVINO 1993, 107).

Consequently nowadays it seems necessary to hardly propose again, as one of the main purposes of the teaching, the knowledge and the comprehension of the physical feature of architecture, in its complex material, constructive and linguistic meanings. Architecture, in fact, has always been the art and the ability to join different shapes and materials, dominating the mutual relations in the technical and constructive sense and solving, in morphological terms, the functional role inside the building. The entablature of the Greek temple, the Gothic moulding, the Baroque shelling, the research of building detail by the great architects of the 20th century, the contemporary envelopes divided into different layers are not only the result of a will of shape but often translate the solution of technical, structural, stylistic and functional problems, not enough enquired and taught.

Pointing on these considerations a new research it has recently started, and is in progress, strictly linked to the teaching experience, that aims to look at architecture and building within the complex relations between "intention" and "building convention", "sign" and "practicability", "image" and "intentional thought", working specifically on architectural details, that express the way and the shape to join parts, elements and materials.

Certainly the practice of assembling, huge consequence in the building market of the last industrial revolution, often completely modified the design process, turning it from the work of an artisan into a section of a more complex working structure, that is progressively depriving itself of the poetic content and delegate to specialised enterprises the choose of one, among the possible, detailed project (CAMPIOLI 1993).

However it still remains a wild space, also in the post-industrial society, to conceive architecture as a synthesis of *shape* (in the Aristotelian meaning), *function* and *executive technique*, in its turn conditioned by the material and the language.

The research is therefore based on the words and the shapes of *connection* in architecture, with a strong recall to the original meaning of the terms. In the Platonic and Aristotelian meaning *shape* is, in fact, necessary essence or substance of the things that have matter, that also means intelligible and conceptual character of material things. In the classical philosophy shape is not opposite to matter (as often

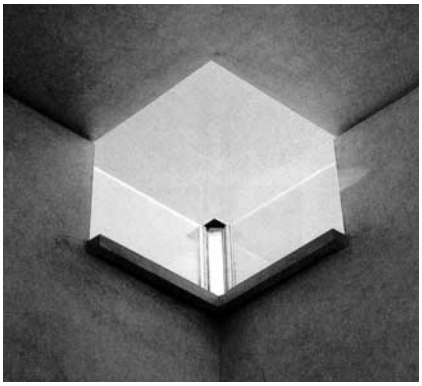

Fig.1
Carlo Scarpa, "Gispoteca Canoviana" in Possagno (TV), Italy, 1955-57.

Fig.2
Gerrit Rietveld, glass pavilion, Rijksmuseum Kröller-Muller, Arnhem, The Netherlands, 1965.

Fig.3
Traditional rural building in the open air museum near Gdansk, Poland.

occurs in contemporary architecture), but recalls it, assuming a role of priority. The matter, in fact, hold only the possibility of a shape, while the shape is the final cause of each substance, because, following Aristotle, it is possible to discuss of each thing as it has a shape and not for its material appearance. Therefore becomes very strict the relation between *shape* and *concept*, intended as term that express the necessary essence of the things.

Every great architectural masterpiece is based on one or more concepts that have been expressed through the choise of the material and the ways of connections, not banal, not repeated, able to confer uniqueness to the work. The architecture of Carlo Scarpa is an example of the conceptual research that subtend the design of details, for example in the glass dihedrals of the "Gipsoteca Canoviana" in Possagno (TV), where the shape of connection between two vertical planes (corner solution) is solved with the insertion of another glass slab rotated, on the horizontal plane, of 45°, making the angle free from the metal frame. In this way he obtains, using building techniques suitable to his time, a transparent prism anticipating the structural glass technology and, above all, the concept at its base. Scarpa, drawing this particular solution of the corner, was guided both from a poetic idea (to cut out the blue of the sky) and a functional need, becaude openings in the corner reduce the effect of glare the derives from the contrast between the light of the hole and the shadow of the wall.

In the same way, the glass pavilion glass pavilion by Gerrit Rietveld in the Rijksmuseum Kröller-Muller in Arnhem (The Netherlands), shows the concept and the research of the maximum transparency and lightness using simple glass, wood and glazing putty, many years before the innovations introduced in the building market by the production of laminated glass and structural silicone.

The research started with the enumeration of the words used to express ways of joining elements and parts made of different materials and shapes (as an example "to draw near", "to superimpose", "to lean", "to embed", "to stratify") and from the collation of the meanings of the terms from different sources. Starting from this base different images have been gathered (both graphic and photographic) regarding details of existing buildings that express different solutions of the terms, both made of various materials and shapes and historical and geographical areas.

For example one of the first part and detail of the building that has been explored is the connection between the vertical support (a column or a pillar) and a horizontal plane. This geometrical junction could be solved in different shapes, in some cases conditioned by the use of materials, in other cases independently from them. The different shapes are directly expression of technical words. This kind of connection could be solved by simply superimposition of elements, or by partial or complete gain. Consequently, the way of connection changes depending also from structural and technical problems: in the case of the superimposition, as it

Fig.4
Gunnar Asplund, Skogskapellet, Cemetery of Stockolm, Enskede, 1918-20.

Fig.5
Traditional rural building in the open air museum near Gdansk, Poland. Detail of the connection between the wooden column and the roof.

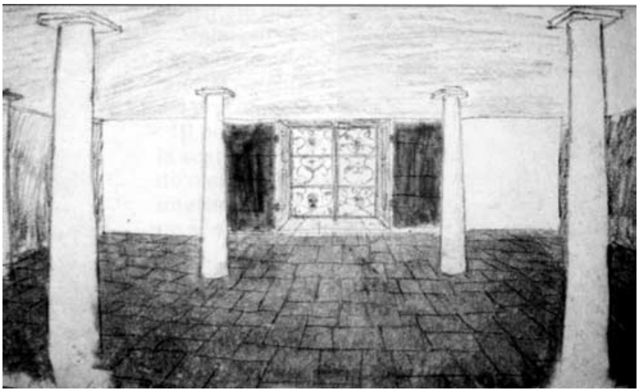

Fig.6
Gunnar Asplund, Skogskapellet, drawing showing the detail of the connection between the wooden columns and the roof.

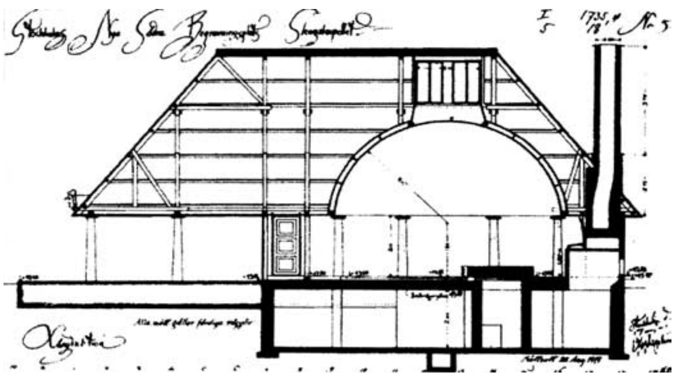

Fig.7
Gunnar Asplund, Skogskapellet, vertical section.

Fig.8
The corner of a Doric temple. Detail of the capital.

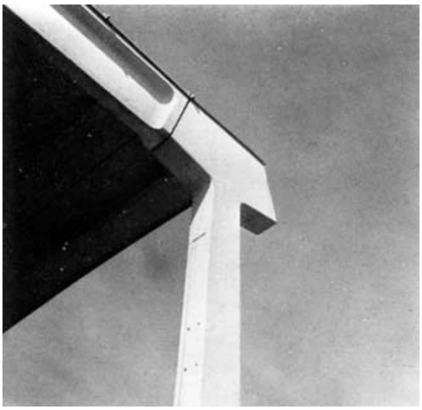

Fig.9
Angelo Mangiarotti, industrial prefab building in Milan, Italy, 1964. Detail of the connection between the concrete pillar and the beams.

is clear, often the junction is solved with the insertion of other elements able to better transfer vertical loads to the pillars, avoiding the dangerous inbond load (as an example the use of the capitals in classical architecture, that became a sort of archetype in the history of construction).

As a first approach they have been chosen masterpieces of the 20th century that, also for their constructive innovations, represent a high level of architectural language and expressions, in spite of some defects raised after time.

The research becomes very interesting and amazing, especially comparing the different solutions: it is possible to isolate the analogies and the differences, always effect of a particular architectural concept. There is an impressive analogy between the whole shape a rural wooden building in the north of Europe and that of the famous Skogskapellet in the Cemetery of Stockolm, by Gunnar Asplund. The woodland chapel is in fact a small natural construction, erected in the woods, among the vertical rhythm of the tree trunks. Approaching the building the differences between Asplund's work and the traditional one become evident. The particular way to solve the connection between the wooden columns and the ceiling (the beams are hidden by the ceiling and the junction is made of a slight wooden slab) make the wooden-shingled roof seem like an abstract floating pyramid supported by a triple row of little Doric columns. The baseless columns, placed only a few meters from the same trees that it is clear they imitate do not seem to be holding up the low ceiling of the portico because their little capitals seem detached from the horizontal plane above them. New materials make possible to convert the shape of the connection between a columns and a beam from the superimposition (simple or improved by a groove-and-tongue joint) to the planar joint or the gain, especially working with reinforced concrete or new plastic materials, as it could be seen in the research of Angelo Mangiarotti, in the second part of 20th century. In his work the capital becomes a part of the vertical support and changes the way of connection into a gain. Of course, following such a language, the head of the pillar, inserted in the thickness of the roof, looses its original predominance; that is the reason why Carlo Scarpa, a sophisticated artist, decides to remark with different signs (a gilded collar on the head of the columns and the square "slot" on the surface of the concrete ceiling) as a memory and a modern interpretation of the archetype of the classical capital.

The collection of numerous images allows the reflection over the different relationship between the shape, the material essence, the technical and structural problems, the conceptual and stylistic ones. These images, now under implementations, allow to show to the students, each time, a rich heritage of architectural details and, moreover, a rich heritage of meanings and signs, to be re-interpreted and not simply copied.

During the workshop (especially linked to Architecture and Technology Construction Course) the students is

Fig.10
Exposition pavilion at the "Fiera del mare", Genoa, Italy, 1963. Detail of the connection between the concrete column and the roof.

Fig.11
Carlo Scarpa, "Banca Popolare di Verona", Italy, 1973-81. Detail of the connection between the concrete columns and the ceiling.

invited to explore "small architectural themes" (a roof structure, an opening, a staircase...), to choose autonomously materials and building techniques studying also in detail the relations between built shape, materials and way of connecting different parts and, of course, concepts and ideas that support the architectural choices.

Furthermore the student is invited to carefully reflect over the implications and the consequences of its personal choices on the field of the possibility to construct, the economic feasibility, the inclination to physical decay, the duration ad, at last, the way of future maintenance.

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The Challenge of the Digital Era

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As an Introduction

To question the usefulness or adequacy of digital technology regarding teaching methods at public educational institutions is as futile and nonsensical as to question the automobile or the television. These technologies are there; they are part of our lives and they are here to stay. Whereas students have already fully embraced digital technology in all the aspects of their life, teachers, including those who are involved in construction lectures, still appear reluctant to comprehend the full spectrum of digital technology offered today, much less train themselves in order to put them to use and exploit their potential. In fact, in a rapidly changing world, teaching methods seem to have changed very little over the past 50 years.

A Review of Recent Developments in Building Technology

During the last EAAE-EHNSA meeting the team of building construction teachers of our Department endeavoured a first approach to the current situation in building construction[1]. I would like to enumerate in brief the major tendencies being in progress, as they have been postulated at the above meeting, namely

1. The shift from manual labour to ready-made industrial products
2. The assumption of building research by institutions outside the universities.
3. The new approaches to building design governed by digital technology.
4. The emergence of Information Communication Technology (ICT), which is likely to revolutionise teaching, as we know it today.
5. The establishment of resource management in buildings as a major tenet, due to recent environmental and political developments

In the following pages we are going to discuss the various ways, in which digital technology addresses building design and construction and point out the advantages but also the dangers ensuing from the adoption of this technology. Next to that we have to raise the question whether and/or to what degree Universities are prepared to deal with these new demands. At first it seems worth the while to review the types of building design technology available today and its applicability in the field of building construction.

Building Design Technologies

The Software

Geometry-based Software

This is the geometry-based CAD technology used by engineers for several decades. These applications provide drafting automation quite effectively and with little effort. However, in order to meet the demands of more complex objects, the levels of necessary effort become much higher. In addition, layer and naming standards must be introduced, when interaction and use of databases is required.

A standard 2D CAD-package requires relatively little storage capacity and hardware potential and offers a number of possibilities, such as exporting drawings in a variety of formats to other applications as well as the web. In addition, these formats, e.g. DXF facilitate the interaction with databases

Object CAD Technology

Object CAD Software simulates building components in a CAD-based environment, focusing on the 3D geometry of the building. From the 3D geometry it derives 2D documentation and provides information about quantities and object properties. Object CAD technology is based on CAD and is therefore relatively easy to implement. Still, its effectiveness is contingent on user discipline and reliability and often fails to provide a high level of integrated information on the building's features.

This technology facilitates a better understanding of the building, especially to students and can be effectively applied to coordinate the various representations of the building. At this level of CAD technology, certain traditional tasks, such as the modelling of stairs and roofs become things of the past. The student can easily conceive the spatial features of a building and in addition save time and energy that can be invested in dealing with more complex tasks within the building design process.

The crucial issue however is whether a student using such software really makes use of its potential in order to fully understand the numerous aspects of the building process or merely exhausts his creativity in exploring the capacities of the software itself. Students very often tend to succumb to the 'lure' of photo-realism. Very often photo-realistic imagery is devoted to the satisfaction of the epoch's appetite for photography. It does not state much about the real building, its materials and much less how it is going to perform in the long term.

Photo-realistic representations require a lot of storage and Random Access Memory.

Parametric Building Information Modelling Technology

This is a new generation of design packages. They combine a data model consisting of geometry and data with a behavioural model (change management), which is supposed to simulate a real-world system, such as a building[2]. This technology introduces a radically new approach to building design. The basic features of this type of 'intelligent' software are:

- An integrated database with information about the entire building
- An instant feedback of any change to the relations among objects on the rest of a project.
- Availability for user definition of all relationships within the model.

The use of intelligent 3D models instead of paper drawings is likely to pervade all building design sectors. Still it calls for second thoughts.

This new approach implies a notion of building design very similar to that of mass-produced product design, e.g. cars and airplanes. Yet one must keep in mind that the above products are subject to laws of economy very different to those of building construction. We are dealing with different production scales, amortisation costs, transportability and dependence on on-site construction. Even when architects propose products involving customised mass production, they stand against a great number of conflicting laws and regulations, varying standards and different mentalities of local trades[3]. The crucial issue regarding buildings is to determine which quantities can be considered parametric (variable) and what can be taken as a standard or constant.

Innovation in building certainly entails digitally enabled manufacturing. Still, the key prerequisite to achieve and profit from such innovations is not more digital design technology. What is really needed is to establish practical strategies for the purposeful exchange of meaningful information between the many tools applied to building processes. The essential requirement, given that building design and data computability are resolved, is the so called 'interoperability', that is making the information accessible to the relevant parties involved in the building process. There are a myriad of design tools available today and moreover there are numerous applications that operate on design data and provide analytical insight. This is not a negative aspect, as it is unlikely that one CAD system alone can provide all of the means necessary to deal with the diversity and breadth of design and analysis problems in the building process. Monolithic data models and software that are meant to do everything most of the times fail in their ambition to do so. We finally come to realise that purpose-built data models and applications are more apt to meet a designer's needs. Innovation proceeds more quickly with loosely coupled, purpose-built applications than with large, interconnected, interdependent ones. A practical strategy today in order to communicate between various applications relies upon the use of commonly accessible conduits from one application to another. An example are .DXF formats, a protocol to transfer data from a CAD application to others, such as acoustic design applications or the .gbXML Format that exports model data to an energy analysis application[4].

Purpose-built Applications

Structural Engineering Software

These packages mainly address civil engineers, but are also quite useful to building designers to gain an overview of the loads, dimensions and masses involved. These applications manage loads, design beams, walls, columns, girders etc. and allow non-graphical editing using spreadsheets. They cover most of the construction materials, such as concrete, wood, hot and cold rolled steel. There are also packages managing tensile structures. Sufficient skills and knowledge are required and there has not been yet an effort to coordinate the numerous products on the market, so as to allow for better coordination among designers.

Building analysis software

As energy management in buildings has unequivocally become a dominant tenet in building design nowadays, this kind of software deserves closer attention. These products feature a more or less designer-friendly 3D modelling interface, integrated with solar, thermal, acoustic and in many cases cost functions. The value of these applications lies in the support of conceptual design, apart from a final stage validation. This means that, even before the building form is definitely considered, one can already draw vital design information using simple sketches. This information includes available solar, light and wind resources and choice of materials. In this way the designer can avoid abortive work on inappropriate design options. Building analysis packages have an interactive approach to analysis that allows for testing orientations, shapes and materials and comparing changes in a building's thermal performance, acoustic response and light levels. These applications offer the possibility to meet important decisions from the very start of a project.

Web-Based Databases

Databases originate from various sources.

Industry

Today a large variety of building components and subsystems are factory-built, using mainly digital processes: Doors and windows, fabrics and carpets, furniture systems, mechanical equipment, elevators and also entire roof and façade systems. It lies in the interest of the manufacturers, besides advertising their products, to offer information including images, CAD drawings and technical specifications. However neither professionals nor students are yet able to extract much value from them. The reason is the deliberate use of representation styles. Even drawings in DXF or DWG format are hard to handle, because of strongly varying drawing and layout standards. But the greatest danger lies in the temptation of a random, non-critical adoption of ready-made drawings. It does not take long for one to realize that no matter how perfect the product; there is no guarantee that its performance is satisfactory. Very few firms offer mounting details and even then, they do not take any responsibility about a product's adequacy for a particular project or the interoperability between different building components.

Independent Institutions

Several institutions publish information and databases on the web all over Europe and the entire world. These institutions are research centres and teams, unions of engineers, trade branches, local and national authorities, non-profit organisations, institutes etc. Their purpose is to disseminate objective and practical information on all aspects of building, construction, engineering and research. Without any intent to question their objectivity, one cannot overlook the fact that, as far as building construction is concerned, all information is based on local standards, regarding climate, construction methods and codes. This creates certain disparities between the north and the south. In southern European countries we observe a backlog on research and correspondingly a lack of analogous information pools. In these countries, any direct adoption of information originating from central and northern European sources would harbour the danger of being non-applicable or even misleading, since there are considerable differences in climate, building practices, available materials, actualities and regulations between northern and southern Europe.

Universities

In face of the deluge of information streaming in from a multitude of sources, many teachers, individually or as a team, are already attempting to compile databases consisting on articles, basic construction details and bibliography. Many pools of information come into existence. These 'in-house' resources are useful as long as issues are concerned regarding local conditions and standards. However, no institution can claim to possess all the information or knowledge required to meet the demands of an increasingly globalised society and economy. Information cannot remain stagnant; it has to be continuously renewed, enriched and diffused. For example, guiding students to Internet resources and the use of book publishers' web-based resources could be a viable alternative to creating 'in house' resources. This brings one step closer to the next issue, namely the potentials of e - Learning.

ICT Technology

E- learning, as part of the broader spectrum called Information Communication Technology (ICT) is not really a new paradigm in education. It is a technology arriving at a crucial time to underscore the necessity of a shift in pedagogical methods and mentalities. Practically, technology is being used to re-interpret the pedagogies of traditional teaching, namely lecture, seminar discussion, testing etc. The methods do not differ substantially, only the delivery is notably different[5].

Initially the software used to convey knowledge was one for 'drill and practice'. Thanks to technological advances in informatics we have had a considerable evolution of e–Learning technologies. Artificial intelligence techniques and methods allow a personalisation of the interaction that takes place, of exercises and responses. Systems available today range from simple exercise programmes to multiple-environment systems supporting micro worlds, exercise tools, communication environments, simulation systems etc. ICT is likely to precipitate a re-engineering of familiar systems and processes. It facilitates an improved library and research environment with instantaneous access to on-line journals and resources. Universities use web-based platforms as Learner Management Systems in an attempt to support and enhance traditional methods of teaching and learning in the belief that efficiency gains and flexible modes of providing knowledge may be achieved. Another aspect underlying this method is a potentially increased transparency at a time when rigorous academic quality assurance and accountability are demanded.

At first one can mark the differences between e-Learning and face-to-face learning by considering the below basic elements:

Acquisition of information

e-Learning brings the process of information acquisition more directly under the control and responsibility of the learner. The teacher acts merely as a mediator and is either non-existent or takes up a role of counsellor.

Transformation of information into knowledge

The learner enters a world of almost infinite sources of information with little or no guidance. With no one there to judge, evaluate and elicit information, the transformation process is open and subject to individual choice and judgement.

Validation

There is only a small difference between e-Learning and other types of pedagogical methods. The issues and techniques remain more or less the same.

As e-Learning is putting an extra pressure on the institutions, once again we come face to face with the question: Can technological tools guarantee knowledge all by themselves?

In fact, learning is learning. Educationalists ought to concentrate on the learning component rather than the 'e'. Undoubtedly, e-Learning, as a methodological instrument, is by its nature highly visible, public and democratic. But, in order to enable these methodologies, educational institutions must be sure that a reliable and adequate technological infrastructure is provided, that the pedagogical and graphic design of the content is of high quality and that the level of interactivity is appropriate. Undoubtedly, a single institution cannot achieve these goals all by itself.

The Role of The Teachers

Technology keeps moving forward without pause for reflection and consideration of the outcomes for learners. As is does so the question that arises is: If everything can be done on-line, do teachers at public universities still have any function? The answer lies in comprehending the rapid changes education is subjected to by a rapidly changing world. The processes taking place slip out of both the learners' and the teachers' grasp. Information Communication Technology, the Internet, CAD applications and whatever technology besieges educational institutions may speed up evolution, but they are not the initial reasons for change.

A long drawn educational debate has evolved around problem-based learning, situated learning, process writing, differentiation, project based work etc. All these issues are part of this debate because the world is changing and learners as well, not because the Internet was invented. Most academics lack the insight and the frameworks to analyse digital technologies and apply them to their educational processes. They are only able to use the methods by which they themselves were taught. The attractiveness of the auditorium is dwindling, not at last because of teachers' traditionally acquired habits. Shrinking budgets, quality control processes, reorganisations and consequences of earlier important decisions have taken away motivation to engage in anything else but just trying to prove that one is a good teacher/researcher. Many teachers have not yet accepted the challenge of digital technology and many are not yet aware that new generations of students are totally different in this respect.

Given that the process of information acquisition is open and subject to individual choice and judgement, it becomes both challenging and dangerous. There is a serious risk that digital technologies can establish surface habits among students instead of deeper learning. This openness of information transfer may facilitate students to access information first and apply it without judgement and evaluation.

Traditional contents of construction teaching become obsolete, since software does it faster and better. CAD Software eliminates time and opens possibilities for a most global vision of the building process.

As industry research advances, technologies considered to be up-to-date a few years ago are meanwhile outdated. It is essential that teachers be prepared to constantly acquire information, evaluate new data and assist students in their effort to transform information to knowledge.

Educationalists should realise these facts and acquire sufficient competences to utilise all these tools and channel learners to the right path. If learning is considered as a mere transfer of information, it is of no value. There is a need for academics to see themselves as teachers, facilitators and mentors. Teachers need to analyse and evaluate the learners, understand their needs, requirements and preferences before they immerse themselves in technology. At the same time, they should be aware of the dramatic shift of tasks and roles taking place on an almost daily basis.

Changes in education must not be brought about by the technology, but by an interaction between teachers and students, technology and learning.

As a Conclusion

Innovation and knowledge are increasingly becoming the decisive sources of wealth. They are also the main sources of difference between nations, businesses and people. The acquisition, analysis and effective use of information will be the key to promoting and sustaining competitiveness.

The globalisation of society and the rise of a knowledge-based economy have combined in the past decade to impose drastically raised expectations upon higher education institutions. The vision of the new university emphasizes more than before the role of market forces in shaping the institution, the urge to respond to peoples' needs and the necessity to deliver knowledge continuously through lifelong learning.

Are universities prepared to take advantage of modern digital technologies, to collaborate, to exchange products and expertise, to acknowledge study programmes and credits from each other? The majority of public educational institutions are still unprepared to reorganize themselves to address these new demands.'

Notwithstanding, universities should not become supermarkets for modules and popular courses, delivering 'pure e-learning' in competition with private enterprises. They should take advantage of their solid academic basis and introduce study programmes that add something positive to the existing situation.

A way to achieve this goal is the collaboration among institutions, the exchange of courses, staff, expertise and students, thus increasing their attractiveness and variety of courses available. Collaboration among universities and with media organisations eliminates wasteful duplication and variable quality of courses, material and resources and achieves lower cost, flexibility, involvement and high quality of peer review. Combinations of on-line learning and physical meetings with students may be a preferable way of organizing study programmes. Each student then still belongs to an academic university, not an anonymous e-learning institution.

Unless the public sector educational institutions are able to offer greater openness and flexibility, they will be challenged by other alternatives, such as for-profit private universities and technology driven virtual universities. As long as the Internet and global distribution of courses and learning material keep on expanding, the old universities will lose power and status unless they enter the bandwagon.

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The Teaching of Constructions: Virtual or Material

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Learning by doing?

In teaching construction there is frequent opposition between the procedures of "learning by doing" and "theoretical" learning. Generally speaking the first procedure seems to be supported by a somewhat archaic view of "doing" architecture (including its process of feasibility), which is limited, owing to practical needs, to simple structures produced by simple technology.

This kind of teaching method enables the students' involvemnt, who are willing to passionately participate whenever they clearly see the object growing through their manual work and it is rewarding for their teachers too. Yet the risk of giving a slightly distorted view of the real professional procedures does exist because out of necessity, most of the problems related to the building process and its responsibilities are omitted and, however, the complexity of the real operative context is mitigated: through experience students get some familiarity with the problems related to the *subject* (at least one subject) constituting architecture and its tendency to get under way (junctions, measurements, behaviour under stress, finishings, surface treatment, workability, production limits, etc.).

In my opinion this is the most important aspect: however partial, experience produces a mental attitude capable of creating the coming up project and makes us aware of what is happening in the passage from an abstract and conventional representation to its reification (*embodiment*), thus using all necessary corrective feedback coming out during the building process. The acquisition of such awareness and sensitiveness is even more precious, because the tendency to replace any direct experience by sheer virtuality is bothering (without they can realize it) new generations since children's games, which are more and more neglecting any form of manual skill (who can still build a bow or a sling?) and any chance of using space tangibly.

However simplified it might be, experience is not replaceable and at the planning stage, that is in thought before action, it involves also the need of foreseeing and rationally solving the sequence of the activities which are to be organised in a building yard.

Moreover, the prevailing employment of computerized representation systems tends to deceptively replace the three dimensional control of filled and empty spaces in the architectural work, by favouring the object representation (its image) rather than the object itself. Illusoriness is due, among other things, to scale reduction (the object is perceived "from outside") which cannot replace the perception of real space (without turning to highly adulterating means) and of sensory stimulation (except visual stimulation, partially), only given through the experimentation of the real object.

Virtual representation enables and favours the creation of forms which are totally independent from their real possibility of achievement and this, mostly at a learning stage might be very dangerous.

In other words, the nature and inner essence of the planning stage themselves can be distorted and adulterated

On the basis of that, I think that the learning by doing method might (or even must) become an important formative stage as long as it is not regarded as the only achievement of the present architects' building culture. Yet, there is a serious obstacle to this approach: the number of potential students for arranging direct experiences is necessarily limited, and experimentation costs quite high (material supply and direction of operations).

Anyway we need to deal with everything which is left apart from the learning by doing; the knowledge of the whole building process and the variable dynamics arising among its actors: purchasers, industrial production, regulations, available resources, operative methods of complex bodies, relations with building contractors, relations between building contractors and producers, awareness of environmental impact of design choices, etc.

This short preamble helps present some remarks about the changes and problems that, without the learning by doing method, come out with the exponential growth of computer instruments. The irruption of computer science in our culture undeniably plays a major and irreversible part even in the changes in construction theory teaching and teachers, who should cope with them, but are often totally unprepared (this lack of preparation is also evident among architects by profession).

Computer and design/construction

In theory, one of the major advantages brought about by computers in architecture's operative process is, among others, the continuity between the idea and the achievement: the transmission of numerical data from the planning idea to the means of fabrication, that can be travelled over within design, is in fact interrupted by the interposition of building contractors and by ever changing necessities of the building yard. However this potentiality is more and more present and implicit in the world of architecture too.

In one of his writings M.C. Lorier (an interesting issue appeared in "Techniques e Architecture", September 2005) reports the description of the main stages in recent history about the role played by computer in structural engineering made by engineer Jean-Marc Weil. In the early 20s an engineer who wanted to display a building behaviour had only statics' equations at his disposal; calculus was based on finite elements, starting from the data of materials' strength from a mathematical point of view. What happened in nodes and articulations was at the core of the analysis: basically, the object was to be comprehended before being calculated.

Towards the mid-50s the rise of computer science in building engineering enables to start working by dispaying the object and its behaviour. But since the early 80s three dimensional modelling gradually develops and computer is working "without us", on the basis of our hypotheses and insights, but making calculations itself, and only by ethical choice does the engineer keeps the computer's mathematical reasoning under control.

Significant engineer Weil says: "on the screen the structure looks like a field of constraints, with colours, shapes, movements, 3d images, here loses its shape, there it moves. It's so beautiful that we often forget we aim to build an object". And also " you can create a complex shape, look at what the computer says, and then "carve" the model.

This means that the objects we create are not ther same we would have conceived without computer, neither structurally nor morphologically. It does not matter if the creator himself does not check scientifically the use of these tools. Just think that neither Eisenman nor Gehry are able to use them directly: the computer's potentialities are now part of their mental form and the identification of the possible solutions.

Ms Lorier rightly notices that all this needs a redefinition of relations between engineers and architects, who can rely on a much more fluent system of communication, allowing them to communicate on new principles of shared and enriching freedom.

It obviously exists the other side of the medal: if you completely separate the creation of forms from their constructive development, that is if the architect supplies the engineer with complex forms, totally free, as if it was like "a statuesque attitude" following a software or a formula, so that the engineer should make it constructable and feasible, your procedure would be intellectually doubtful, even though not impossible. At least economically speaking. And this is happening more and more in the world of well-known professionals (who are given much more freedom than it is granted to unknown designers), and obviously, in the academic world, where there is no real threat of feasibility assessment, but where the threat of an incorrect approach, which is very difficult to be treated from, does exist.

It is crystal clear that digital technology can presently offer an unprecedented formal freedom, freeing architectonic forms from orthogonality. The past gives us examples of architects who have avoided simple geometry even if they committed themselves completely: just think of Gaudì's architecture, who, however was said to maintain with iron hand the constructive sense of forms he was about to plan. In his speech for his admission to San Fernando Royal Academy of Fine Arts (Madrid, January 16th 2005) Rafael Moneo says that"...we must outline that Gaudì is an architect who did not care for arbitrariness... he endeavoured to show his architecture was not arbitrary and each form is the careful result of construction... Form is born from construction procedures which use geometry as their support, and by following them, it looks like something unexpected and innovative". And more"...the invention of form coincides with the invention of the construction process".

In the past the evolution of forms took mostly place under the pressure of the new materials evolution and the new knowledge of structural behaviour. Just think of Frei Otto's tensile structures and his innovative insight, completely devoid of digital calculation; he schematized deformation and movement of tightened membranes by carrying out study models: a paradigmatical example of inseparable link between form and matrix, so to speak (through an unpopular and ambiguous word nowadays), functional.

In his speech Rafael Moneo asserts the sovereignty of arbitrariness in architecture, by arguing his case with ancient times works (the genesys of the Corinthian capital told by Vitruvius) and by quoting Claude Perrault (one of the founders of the Academy of Science in Paris, 1666), he says that architectonic elements are the result of a transformation from arbitrariness to familiarity: routine leads us to regard what in the past was arbitrary as a natural thing. Paradoxically, in our times, the logical consequence of this assertion might lead us to say that nothing can appear arbitrary to us in architecture, since we have got used to not finding nothing extraordinary and astonishing in the most bizarre and useless forms (however pricey they might be).

But with time passing great changes have affected architecture and construction. If it goes without saying that the equation form=function belongs to a deterministic and absolutely undemonstrable view, as there is an inifinite range of possible forms in the same program (use) - but the program itself may have many aspects – and owing to constructibility needs, I think it is exaggerated asserting the total indifference of one towards the other, or even the possibility that form might, consciously or not, make use and constructibility too difficult.

Computer and innovation in teaching: a future in research

Let's get back to the first remarks about the connection between computer science/planning and computer science/construction, so to what this connection involves in the teaching process: in the end, this thesis tends to outline what is already clear, even though not completely systematized, or not so settled as to turn into teaching subject: it goes without saying that the coming of the digital age and the heritage accumulated, even distressing in its progression, has also revolutionary effects on architecture and construction for those who deliberately or for age limits keep away from the secrets of computing. But in this area, applications and tools have been developing accidentally, in accordance with the type and importance of several needs: so they range from the systems generating complex forms to systems simulating visual perception,from calculation programs of any kind,to various databases, and so on.

These resources differ for the function and importance they may have in planning, but should find their own collocation, as if we were to deal with many kinds of consultancy.

On the other hand, bear in mind there is another great demand of innovative approach: side by side with the development of computer science a sense of diffuse awareness of environmental dangers for the territory has been growing, regarding them as a problem strictly connected to the settlement process, and which cannot be neglected by those who, broadly speaking, deal with architecture (...).

This makes diagnosis, analysis, forecast and control more complex at the stage of planning choices first, and then in the whole lifecycle of the building, including environmental costs of direction and maintenance, as far as casting off costs and methods. Moreover, as everybody knows, costs and environmental impact must be studied as regards pollution and electical input of materials and products used.

This means drawing one's attention to a longlasting and complex process to be controlled on the whole. As a consequence of that computer science can offer precious aid.

It is clear that the whole system of resources of computer must be systematised with a view to what it can supply throughout the course of the process of intervention, use and maintenance of what one designs and carries out.

At the moment computer is used little and badly in schools of architecture, resorting to it as a form generator (object representation), and at most, having recourse to any kind of calculation programs, applied like dots. On the contrary everything regarding information acquisition and management is much neglected, even though it is currently a very interesting aspect, since handbooks are virtually unserviceable and sources of information from production are too filled with advertising to be reliable and taken as they are. On the other hand, sector databases are more often than not produced for different purposes and with very few references to practical use for those who deal with building planning and environment.

Of course we cannot study this subject in detail here. I just want to outline that for people who are involved in construction teaching, computer science instruments in their multiform manifestations are one of the most innovating areas whose importance has not been fully evaluated so far.

This is a line of research we should devote our time to and care in future, not so much by getting specific skills in the subject (personally I would be terrified), but nor leaving it alone to those who have a mathematical kind of computer skills or in a particular area (structural calculation, physico-technical calculation, environmental assessment programs, and so on). This would emphasise the gulf, currently remarkable, between overall objectives at the base of planning and a harmonious targeting of the instruments which are about to form. In other words, we ourselves must get and let students get, the attitude and the language suitable to interact with the new extra-expert, in the same way as it has been necessary to interact with various consultants and professionals who contribute to the right conception and feasibility of what is planned. I feel we are late anyway.

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The New Teaching Methods of Contemporary Construction Teaching

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Constant changes of political, economic and social matters cause also great modifications in building industry and investment process. In such situation the architectural education should equip the future architect with the competence and skills necessary to understand actual professional reality and adapt oneself to changing circumstances. Adapting of the content of curricula and teaching methods seems to be a constant preoccupation of most of the teachers within the architectural education area. Adaptation concerns two areas: one - changing and developing of essential content and second – improving the teaching methods by utilizing modern tools (software, databases, websites etc.)

All improvements and modifications in education follow or happen parallel to those in external professional world. In case of architectural education it replies to occurrences in architectural design area and its adaptation to new possibilities of presentation. In digital era we use all contemporary equipment as obvious useful tools despite a psychological resistance appearing in some cases. Architects of older generation remember introducing rapidograph as a new tool for technical drawings and resistance to it from conservative designers who maintained the opinion that previous tools like graphion and graphos had given sharper and uniform line. But technological progress cannot be restrained and criticism caused only improvements in the new tools, not retreat. The same happens nowadays in the area of computer equipment connected with designing. Both hardware and software constantly change making work easier and quicker and results very effective. But all of that concern preparation and presentation aspect. Design in its essence being an intellectual and artistic act of creation is unchanging whatever tool is used for its presentation. In all times good or bad result depended on talent and knowledge of the designer. In some respect facility given by modern equipment may cause even the danger of design quality decrease by using uniform solutions and details.

The changing conditions of real life influence all modules of architectural education: architectural and town planning design studios, construction and structure units, even historical subjects. Exchange of experiences and close cooperation between teaching units within the school system is very important though not always work well due to organizational division to many separate units as it is in our school. Also amount of work within the units connected with number of students and necessary concentration on own subject prevent frequent working contacts between members of different educational divisions.

Architectural Design Studio

Looking at students' architectural concept designs prepared in an architectural design studio one can see that in most cases they imitate examples of contemporary architecture following its external forms and trendy material solutions. Students have easy access to all information concerning examples of modern architecture through the Internet, looking at illustrations in professional magazines, sometimes reading text. Having this as a basis of information students usually imitates an external view of architectural objects. Using computer they may achieve in their work very attractive form shown at coloured elevations and visualisations. Effective vision is not always connected with high quality architecture if it does not correspond with proper functional and technical solutions. But there is also a positive aspect of such presentations. Computer demands decisions concerning colour, facture, and size of elevation units and in this case students are forced to think about real materials.

Visiting real buildings would be the best way of becoming acquainted with a wide spectrum of aspects like scale, feeling of space, relation with surrounding objects, materiality, details seen in close distance and checking in reality the functional solutions. Imagination developed on the basis of pictures can be false in comparison with reality. I experienced such situation visiting with students the Piazza d'Italia in New Orleans. Knowing this object from coloured photos in magazines and books, shown there without any people on the picture (scale), I found it much smaller than I imagined. Also used materials and details looked differently, simpler than on pictures.

Travelling is much easier nowadays but the time aspect is crucial, so still the simplest way to observe happenings in modern architecture is by looking at pictures either in printed way or through Internet. Even if the presentations of architecture incorporate analytical comments and technical details, students mostly notice the visual effects from pictures.Rational analysis of the interrelation of functional and technical contents in existing objects and the visual and spatial results arising from it are very rare. Such analysis of existing buildings would introduce rationalizing at the stage of an architectural concept decisions. Rational decisions cause that architectural concepts are more real and will not be much changed at the stage of further structural and constructional development, it means, the final view of realized object would be very close to the original concept.

Construction Teaching

In case of Construction, we, teachers of this field have to observe and follow all modifications in building technologies and incorporate new information appropriately to the existing educational curricula. Along the changes and development of knowledge content also the means of communication, presentations and design preparation, which are more effective due to electronic digital aides, should be modified. Both these aspects affect the aims and objectives of the already established modules and courses.

In the past the number of construction materials and building technologies was limited, thus the lectures and exercises at school and students' hand books were sufficient sources of necessary knowledge. The changes were very slow and technical solutions and constructional details learned at school could have been used in the professional life for some years after finishing study. Nowadays because of the enormous amount of new materials, technological details, complex infrastructure and services and also fast changes and improvements in technologies, there is no sufficient time to cover this wide spectrum of information within the school course. Especially fast changes and modifications have to be taken into consideration, as students will start their self-dependent professional life some years after their construction course in already modified technological reality. In this respect we should give them the basic knowledge and the method of finding current information, analyzing obtained particulars and adapting them to the actual needs.

Being aware that students have now ample opportunity to get information easily via the internet, from technical literature (now usually at CDs) and by contacts with manufacturers, we may reduce the amount of detailed technical information and put stress on basic information and unchangeable rules. This would help to explain how the building works as a complex object where elements of structure, physical performances, functional arrangements, and visual effects are combined in one system. This basic knowledge would be a sort of guideline for students helping them to use the external sources of information in rational and purposeful way. While teaching this essential knowledge we may and in fact we must use all modern aids like computer presentations and animations so that we can communicate with students using tools to which they are accustomed. Young people use a computer from early years treating it as a natural tool. It is very easy for them to improve their skill learning at architectural school how to use the CAD programs to prepare presentations of their work such as 2D and 3D working drawings, visualizations, combined presentations etc. During the lectures illustrations supporting the speech should be attractive in form of coloured pictures, animations short films, etc. The practice proved, though, that carefully prepared presentation delivered in mechanical way might after some time put students' attention and comprehension to sleep. Generally the speaker feels the level of perception within the audience. To check it some control questions may be also asked. Very often it is necessary to return to some points and to clarify them returning to traditional method and using blackboard to make sketches, graphs etc. while speaking.

In teaching and learning such subjects like building mechanics, structures and building physics, calculations were substantial part of students' exercises. Nowadays teachers give to students appropriate calculation programs. In this situation calculation itself takes less time so more time can be spent for essential problems of technical design such as general concept, settling the initial data and valuation of results in aspect of expected architectural form.

The areas of structural mechanics, structures, mechanical and electrical services are essential for architectural students in view of future professional practice but rather for effective cooperation with engineers of these specialities. Technical architectural design, working drawings, construction details prepared in professional practice by architects themselves are closely connected with content of construction teaching and with rules of building physics. This division has a reflection in our school in organization of teaching units.

Studio for Building Materials and Construction Technology and Studio for Building Physics and Services are parts of the united Division for Technical Basis of Architectural Design.

As a member of the Studio for Building Materials and Construction Technology I will present a content of construction teaching in our unit and ways of dissemination of appropriate information to students.

When developing the program of Construction course the use of computer both at teachers and students sides must be taken into consideration. Digital aides are very helpful and effective but also bring some dangers. Because of easy access to suitable sources, the students' works consisting of construction details seem to be per-

subject	school unit	teachers
Structural Mechanics: Reactions and inner forces in several structural elements	Division for Mechanics of Structure	Structure engineers
Structures (design and basic calculations – timber, masonry, concrete, steel), Structural design	Division for Structural Design	Mainly Structure engineers, architects
Building Physics Building Services Utilities and Urban Infrastructure	Studio for Building Physics and Services	Service engineers (researcher/theoretician, and practicians)
Building Regulations Cost calculations Investment Process Organisation	Division for Building Economy	Architects
Construction Technology and Materials, Technical design: working drawings, construction details	Studio for Building Materials and Construction Technology	Architects
Elements of Mathematics and Descriptive Geometry	External University Unit	Mathematicians (for Descriptive Geometry cooperation of an architect would be advantageous)

Table 1. Area of technical knowledge and building economics

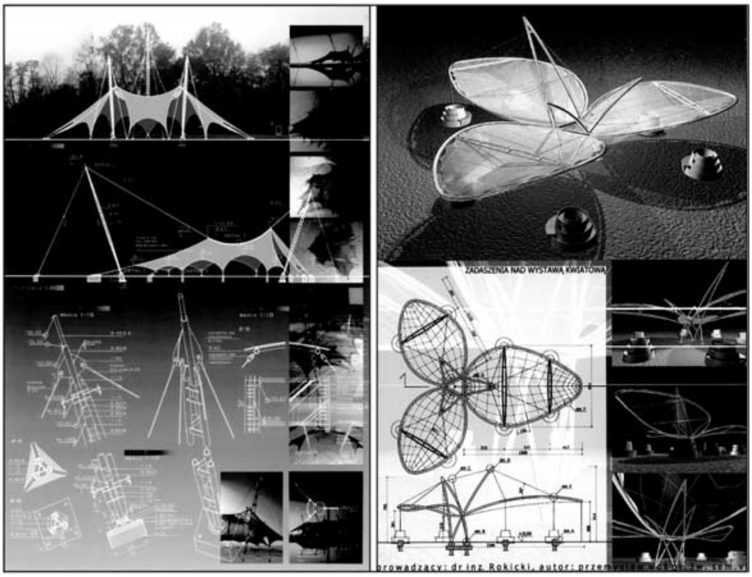

Fig. 1. Examples of Structural Design

year / semester	content	type of didactic action	hours per semester
I / 1 I / 2	Students analyze the construction elements of a small scale building from the foundation to the roof considering various materials and systems, concluding with the preparation of construction documents detailing their understanding	*lecture* *exercise* *lecture* *exercise*	15 30 15 30
II / 3	Finishing details and more advanced building systems such as curtain walls, external cladding	*lecture* *exercise*	15 30
II / 4	Preparation of documentation booklet containing drawings and specifications similar to those submitted when applying for a building permit; the building is based on the concept deriving from the architectural design studio done in the previous semester. This semester concludes with a practical examination demonstrating students' ability to make and document technical decisions.	*lecture* *design* *exam*	15 30
	Two weeks practice at a building site		summer brake
III / 8	Elective lecture concerning contemporary construction technologies	*lecture*	15
III / 5, 6 IV / 7, 8	Construction teachers take part in the design studio and first stage (bachelor) diploma design	*consultations*	24
Master degree stage			
I / 1	Elective seminar concerning development of architectural details.	*seminar*	30
II / 3	Contemporary construction technologies	*lecture* *seminar*	15 15
I / 1,2 II / 3,4	Construction teachers take part in the design studio and Master degree diploma design	*consultations*	24 24

Table2. Studio for Building Materials and Construction Technology

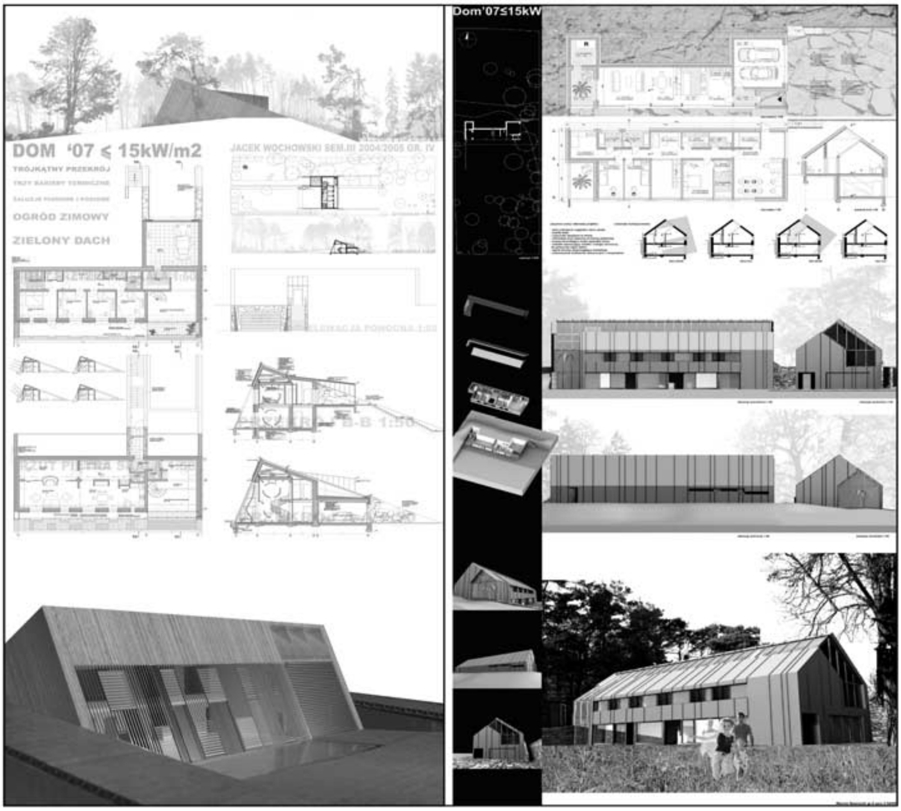

Fig. 2. Architectural concept design of a "Passive House"

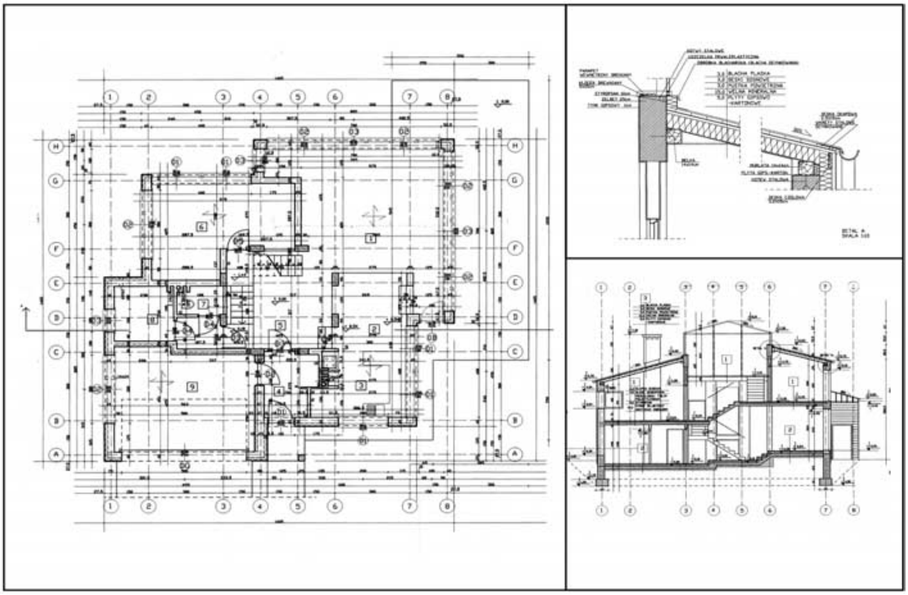

Fig. 3. Example of the technical Building Design

fect. In fact they are often traced drawings straight from manufactures' digital libraries or from catalogues with no connection to the actually designed building's construction and with no imagination of spatial arrangement. In this case developing of working details should include a form of primary hand made sketches and subsequent to it final details, both in axonometric view. Sketches are very instructive tools for conscious creation of construction details where the technical solution and visual effect are instantly visible. Final drawings prove that attempted vision is satisfactorily achieved.

In Construction teaching stressing the interdependence between material and technological solution and architectural form is important. Starting from the simplest detail drawings done at the beginning of the course, students have to be aware that every line at their drawing causes spatial, visual effect. Also analyzing existing building elements and transferring it to the form of the working drawings is very instructive.

Interrelation between Construction teaching and Design Studio

The basic part of knowledge should be introduced to students as early as possible within the program curriculum. It may help them in rational developing the concept design in the architectural studio. At the later part of the course when students are more experienced in architectural concept design and they hopefully still remember basics from Construction primary course, the introduction of more advanced and complex technological solutions is possible. In our school at this stage we introduced a series of lectures relating to modern technologies often with participation of the manufacturers' representatives. Another activity is an optional seminar dedicated to formation of an architectural detail in two aspects: - formal, considering proportions, colour, facture and - technological showing materials and technical solutions undertaken to achieve the assumed visual effect. Students at this seminar work in two stages. First they analyze details of existing buildings and investigate modern technological possibilities and second they prepare their own proposal of the detail – possibly as part of their design done at the architectural design studio.

Another example of integration of technical attitude and visual effect is the Structural Design prepared by students for termination of structural course. Again students have the opportunity of showing their abilities in both – technical knowledge and developing of architectural form. The objective of this task is to design an architectural object in which the structural part is dominant and has an impact on architectural form. Students are choosing one of such objects like exhibition pavilion, sport hall, footbridge, entrance canopy, observation tower. Preparation of the design includes dimensioning of structure (calculation), drawing of whole structure and chosen details, 3-D view of the object in form of physical model or computer visualization.

The concept design of single family house done in an architectural design studio in the third semester is a basis to students work in later semesters during courses of Construction, Internal Installations and Building Economics. Construction course in the fourth semester consist of preparation of documentation booklet containing drawings and specifications similar to those submitted when applying for work permit of the building based on above mentioned concept design. Students have to analyze

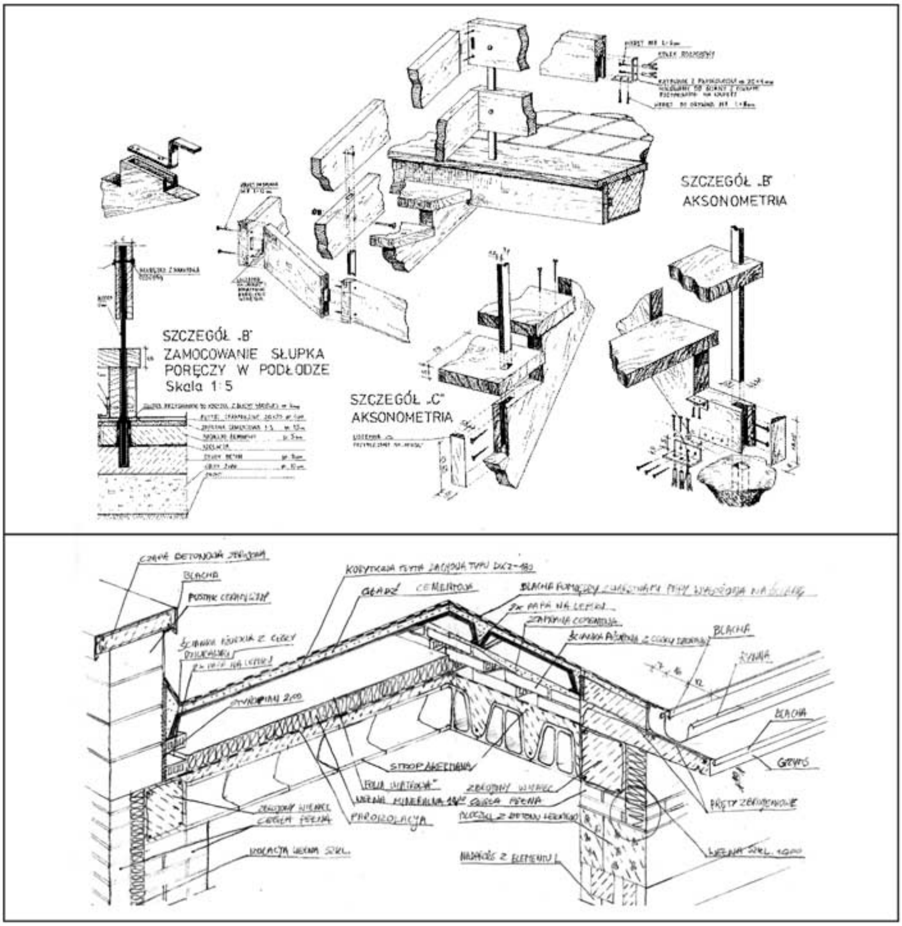

Fig. 4. Examples of students' detail drawing and freehand sketch

the structure, determine materials and make decision regarding construction. The method of instruction is tutorial with teachers working individually with students in the development of their construction booklet. Brief lectures are given regarding specifications and standards of documentation preparation. Students sometimes find difficult to solve technical problems of their over free concept (fascination of deconstruction, imitation of Gehry etc.) and have tendency to simplify their design. We oppose to it and require keeping technical design as close as possible to the concept and introduce only necessary modifications. This is connected with an easy access to conventional construction details which cannot be applied in such individual situation. The same happened when a group of students had prepared concepts of "passive houses". In this case designs were very orderly, fulfilling rules of environmental requirements. Their form were simplified but content was full of specialized technical equipment and elements necessary from building physics point of view. Again some students accustomed to tracing conventional, easy accessible details were helpless in developing individual arrangements.

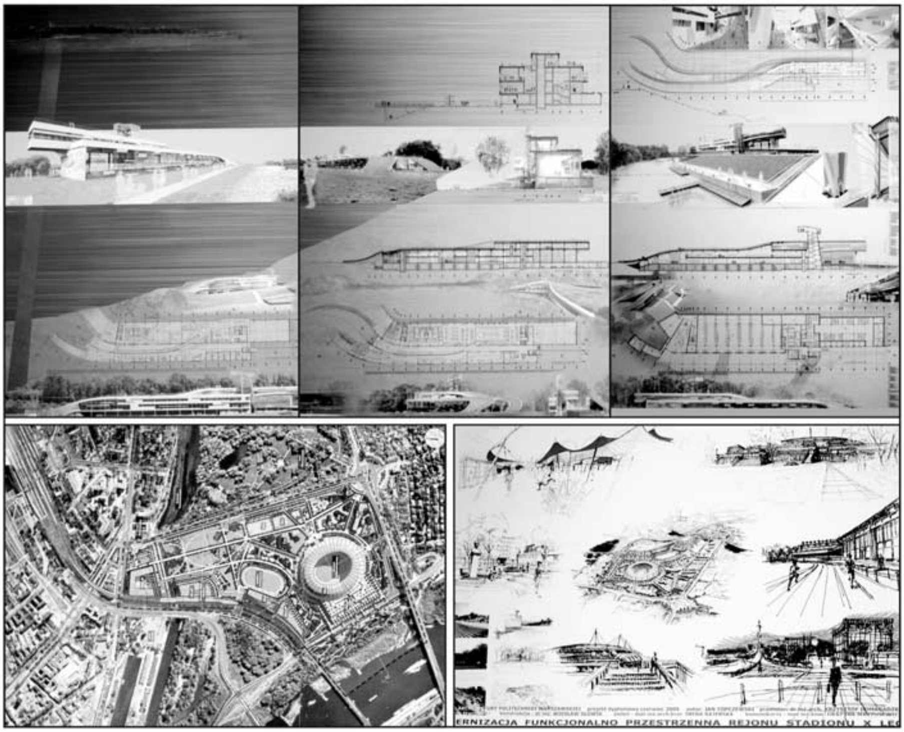

Fig. 5. Presentations of diploma architectural designs

Working together, architectural design and construction teachers, within the design studio would be very effective. It would resemble real design office where school type divisions do not exist and specialists work in one team. Previous attempts undertook in our school were not successful. It was caused partly because of luck of interest from some design teachers but mostly because of organisational difficulty. Division to separate units and especially sharing limited didactic time was a problem. In the new proposal of program curriculum, special time for technical consultation within the architectural studio was provided. The teachers of Construction, Structures, Building Physics, Services suppose to take part in design classes giving necessary advise in provided and secured time. Organizational problems suppose to be settled, but previous trials of such arrangement showed also essential didactic difficulty. Most of students working on their concepts were not ready to discuss technical problems up to the end of the term. Design teacher should settle appropriate time schedule to improve cooperation and take advantage of structure and construction specialists' help. May be this time we will work out satisfactory arrangement.

More successful are the consultations given during the diploma design. Diploma students are more aware of the importance of the reality at the designing and they keenly take opportunity of an access to any information, which can improve their work. Architectural idea, formal and functional arrangement are vital parts of their work, but they have to determine structural and materials solutions. They are also required to show an individual architectural detail and its technical and material solution characteristic for the designed object.

Nina Juzwa
Adam Gil

The Construction in Architectural Design Teaching – mock-ups as tools for shaping an architectural idea

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Architectural design is a creative process connected to a transformation or formation of a new reality. Methodically, there are two equivalent design methods: a thinking process leading from detail to a general concept, and the other way round – leading from a general concept to the detail. However, there are always three elements present – three stages of action:

1. Analysis – Synthesis – Evaluation, or
2. Synthesis – Analysis – Evaluation.

Both models are coherent and they constitute a symmetrically distinct approach to the design process. They also divide architects, 10% of whom are on the one side, and the other 90% on the other side of the thinking process. The ideal architect, though, with equal ease begins with detail and finishes at a general concept, or begins with a general concept and finishes with the detail.

In addition, for the didactics of the architectural design process, it is important to teach students two abilities, namely:

- The ability to come up with an IDEA – it is necessary to have an idea to suggest a hypothesis. Although an idea is everything but the look of a building, it is the idea that helps in the creation of criteria, possibilities of evaluation, and formation of an architectural concept
- The ability to VARY an idea – variation of ideas teaches an unconstrained movement within the two models of the creative process: "from the general to detail" and "from detail to the general", which is particularly important at the stage of the concept formation.

The most characteristic feature of architectural design is its complexity. Any design project, also the school one, is a response to the given functional program presented in a material form and in the form of a uniform architectural vision. In the teaching process, the complexity of architecture takes on various forms:

- architectural concepts operate with ideas and symbols, at the same time unifying a body of specialist knowledge stemming from various disciplines,
- the language of architecture connects symbols and emotions enabling their development into many levels of meaning, and it enables posing existential and social questions,
- intellectually, architecture taking advantage of many fields of contemporary knowledge and technology strives to develop complex construction and technical systems; at the same time architecture favours solutions simple in form and spatial arrangement.

In this context, questions of construction are very closely connected with technology and technique and they take a central position in architectural design.

The incredible geometrical forms of buildings designed by the architectural avant-garde (partially designed in a traditional way and partially using computer techniques) become a fetish of modern architecture. They are also a tempting path for students of architecture in their search, supported by youthful courage and freedom.

This even more increases the responsibility of the teachers, who should appropriately direct the actions of their pupils. The more complex (untypical) is the geo-

pic. 1

metric form of the building, the stronger the necessity for carrying out research of the construction solutions already at the initial stages of the design process. In order not to interfere with the creative process, the construction studies must be smoothly incorporated in the architectural design. Therefore, it is necessary to investigate the potential of tools that will enable the inclusion of thinking about the construction in the early stages of architectural design. Attempts to a "gentle" introduction of construction (without a radical change of classical tools and the sequence of design) indicate that help should be sought in the area of tools universally used by architects at these stages of design. Such tools include a sketch, mock-up, and a computer solid model.

In the face of growing geometrical complexity of designed buildings, a sketch on its own turns out to be an insufficient tool. Sections and projections are incorrectly interpreted, and vista drawings give a false and wishful picture of the designed building. Mock-ups and computer models are becoming much more efficient teaching tools. In this work, I will limit myself to the analysis of using mock-ups as tools that enable the introduction of construction problems in the early stages of design.

The fact that a mock-up is not used during the creation of any design project implies that there are stimuli that urge the architect to use this tool.

One of the unquestionable reasons for using mock-ups in design is a complex form of a building. This is confirmed by the observation of the work of avant-garde and traditional architects.

There are many examples of a creative use of mock-ups for simulations of the static properties of buildings. These examples include "reversed" models of the cathedrals by Antonio Gaudi using chain-curves; construction studies of Nicolas Grimshaw; or idea mock-ups of the group Coop Himmelblau, which in the chaos of deconstruction reveal static tricks.

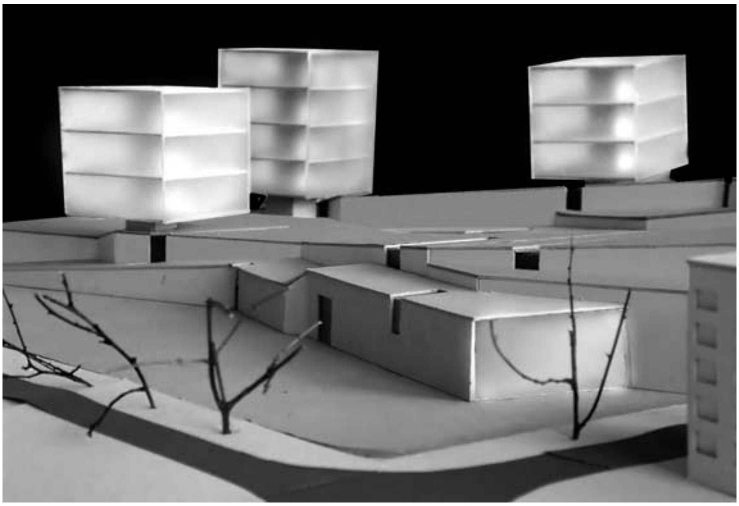
A mock-up simplifies information management. Architects are not forced to control continuously the coherence of the model in their geometrical imagination. They can devote themselves to other design problems – also to creating more complex geometries. We can risk a statement that there exists a feedback – a mock-up is used in the case of spatially complex buildings, but at the same time the use of a mock-up can encourage the designer to create more complex geometries. The examples of such creators as Rem Koolhaas, Zaha Hadid, or the group Herzog and deMeuron seem to confirm this rule.

Regardless whether the complex form of the designed building arises from reasons independent of the architect (e.g. a complex form of the plot of land, complex program of the object), or from the architect's convictions, a complex geometry is a sufficient stimulus to use a mock-up. For an architect (and a teacher-architect), three consequences of a mock-up use have a particular importance:

- A mock-up as the only model type, is a physical object. All other models are created in an abstract, “imagined” environment. A mock-up is built similarly to the object it represents.
- A mock-up is a spatially coherent model. The freedom of observation reveals deficiencies of the idea and leads to unexpected discoveries.
- The building of a mock-up simplifies construction analysis (mainly in the scope of statics) and enables connecting of the method of model construction with the static scheme of the designed object.

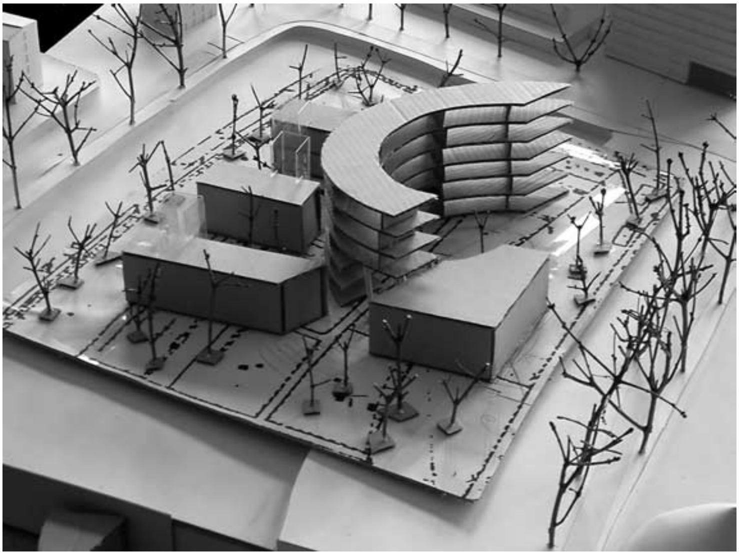
A mock-up is a real object; it is subject to gravity and therefore it has to be executed to withstand its effect. There is a direct similarity to a real building that has to be constructed to withstand the effect of gravity. This results in the fact, that in most cases a mock-up is a fast, efficient (and sufficient) verification of the constructional correctness of an idea at the initial stages of design.

However, this similarity of a mock-up and the building is sometimes equally useful, as deceptive. This is due to the fact, that a mock-up is a synthetic image, in which abstraction and reality, aesthetic and constructional visions are intertwined. It is important that the student learns in the didactic process to distinguish such records. A mock-up is constructed from materials of other physical properties then a real building. The size of the mock-up influences its static properties. As a result, it does not have all physical properties of a real object, and at the same time, the observer (student) subconsciously assumes that a mock-up is a constructional equivalent of the modelled object. It is a false assumption; the difficulty lies in that the geometrical equivalence of a mock-up is not intuitively separated from the physical equivalence – on the contrary, in the eye of the observer they melt together. The conviction is so deep, that the failures stemming from it affect not only non-professionals and young, inexperienced architects, but also famous exponents of this profession [See: Rem Koolhaas SMLXL 1996].



pic. 2

Because the vision of the designed object in its initial stages of design is simplified, the architect often records in a sketch mock-up (similarly to a sketch) the whole concept he has at that time. With the progress of design, the subsequent records become more conscious and the need for a selection of represented elements arises. As a result, mock-ups often have two-element contents. One of the elements is always an approximated geometry; the second element is constituted by one of the constructional, functional, material or aesthetical solutions. This allows combining a chosen property with the spatial form of the architectural object. In these cases, wireframe or "layered" cardboard models are created; they reveal the structure and main spatial divisions of the building.

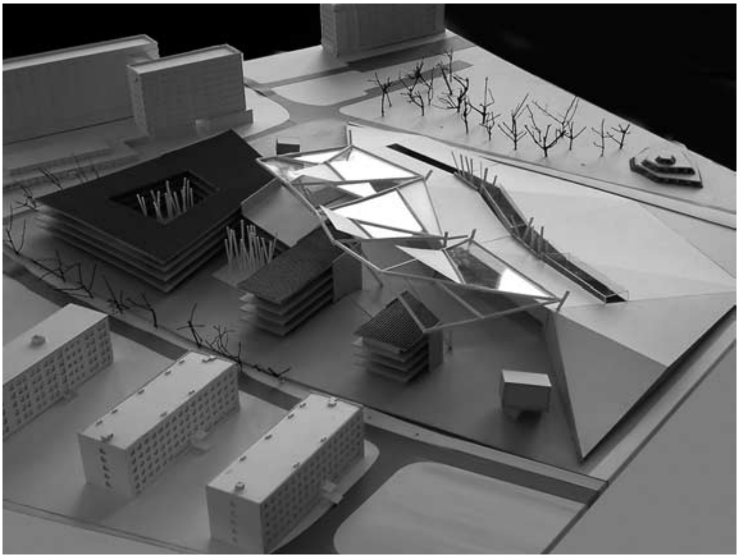


pic. 3

The fact, that a mock-up is a geometrically coherent model enables students to investigate partial visions (usually noted in sketches) and subsequently it enables an evaluation and the choice of design solutions. The analysis of the model allows seeing the "side effects" of the initial ideas. The coherence also allows discovering such areas that escaped the student's attention at the time of sketch creation. The existence of such areas is inseparably connected with design – at the beginning of design work the majority of the project is a big unknown; with time, it fills up with a specific vision. The existence of such grey areas is a condition for unexpected discoveries being made (Goldshmidt, 1989; Gero, 1989; Suwa, Twersky, 1997) – observations which direct thoughts onto new tracks. The discovery of such undefined areas is typical for the initial stages of design. A mock-up allows then obtaining answers to many questions; the observation of a three-dimensional model allows a fast dispelling of doubts and makes the decision-making process easier.

Among the published pictures of mock-ups, it is difficult to find examples of analysis mock-ups; the exceptions are construction models. Mock-ups build for the purpose of construction analyses usually concentrate on the static building structure – geometrical arrangement, knots, joints and its rigidity. Most of the time these are wireframe models that frequently constitute the basis for later building solutions.

The creation of such a model gives an idea for the constructional feasibility of the solution.



pic. 4

It has to be pointed out, that in the early stages of the design concept creation, construction analyses are almost always done without calculations; only certain arbitrary loads are assumed depending on the functions of the building (e.g. residential building, library etc.). The functions influence the type, "density" of the construction structure and hypothetical profiles of the construction. At this time an intuitive analysis of forces is performed. At this stage, teacher's help is particularly important since being experienced teachers can make reliable suggestions to the student.

Literature studies that concentrate on investigating construction solutions in objects of similar function are also useful here. At that time, sometimes attempts are undertaken to reconstruct the investigated construction using a mock-up in order to understand the construction principle.

In the case of other mock-ups that are not created for the construction analysis, the mock-up building itself requires an analytical approach. In order to create a mock-up, the architect has to analyse its structure that is often equivalent to the analysis of the structure of the designed building. Most frequently, the analysis is performed through the observation of the behaviour and, subsequently, a modification of the shape and placement of the elements of the mock-up. The elements are moved, detached, glued on and replaced with new ones. The student observes the changes, which enables him to predict the potential effect of design decisions. Building the mock-up by himself, he "learns" the structure of the building.

The same complex geometry of the object, which is the reason to use mock-ups can make a mock-up unusable in cases of extreme complication of the geometry (e.g. as a result of a strong deformation of the building shell – in such cases it is questionable whether such a model can help to understand the construction). In cases when the construction arrangement is devoid of a legible structure, the only possibility of a verification of the construction is a specialised computer model. Since the mid 90s of the 20th century, in schools computer models CAAD compete with mock-ups. The popularity of computer models increased significantly with the propagation of design methods based on the transformation of forms used by the avant-garde. The avant-garde architects, however, use software that is not intended for architects, to model such geometries. Such models take into account a multitude of physical parameters such as weight, gravity, inertia, rigid body kinematics – increasingly often the main construction principle of a building can be invented from scratch by the architect supported by appropriate software. Currently, the application of such tools is quite difficult due to the complex operation. Undoubtedly, the future belongs to similar simplified interactive simulation tools (e.g. such as those created by Kaas Oosterhuis for concept design using Virtoos and Pro-E). However, they require further development.

In architecture, the importance of practical knowledge, as well in teaching as in the profession is beyond doubt. A good tradition in most schools is the concentration of teaching curricula around a person recognised for their professionalism. It is particularly important, where a pupil has to trust the teacher; especially during their first contact with new problems during the initial stages of design. The architect H. Ciriani – a practitioner and a teacher – says that the most important, for a student and a teacher alike, is the curiosity which seeks the answer to the question "what will happen if ....?" (H. Ciriani 1995) – a curiosity which leads to searching for more interesting solutions on the one hand, and for new tools and teaching methods transformation, on the other.

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Miltiadis Tzitzas

Researching and Redefining the Content and Methods of Teaching Construction in the New Digital Era

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The teaching method

Our concern as construction teachers, is to make students (and to some of our colleges in the design studio) understand, that buildings are composed from *materials*, that form *components*, the assembly of which, define space, organize circulation and meet other design constrains. Finally, construction affects the design process, *influencing the Architectural proposal* and materials with their substance and characteristics, *determine the tectonic quality* of the building.

Its crucial for students to realize, that materials do not only specify the texture of various building elements, such as walls, floors, ceilings or by covering the exterior surface of them. Materials *participate* in the assembly of the building itself, *shaping* their structure, *defining* their volume and *contributing* in their final appearance.

Even if students have been taught about materials as individual elements, or are kept informed about new ones and all new construction methods, the *key issue* is the understanding that construction is an *important part* of the design process.

New technologies also and their potential, should be gradually introduced in the content of construction teaching. Drawing on a paper or a screen, is two-dimensional and therefore, difficult to grasp the sense of volume, an indispensable tool to start feeling space itself. Virtual models, for instance, will not help students understand volumes in a three-dimensional expression on a computer screen, as the construction of a real model will do.

An approach to construction teaching

To make students understand construction as a design process is a difficult task, but a challenging one.

The *analysis* of a building in its components, focusing in selected areas, going from the essential to the more complex, could be a starting point. It is important that the construction details have to be of the same building, in order to recognize them as part of one entity.

The *synthesis* process by designing a simple building or construction could be the continuation. The construction teaching should be more *elaborated* by programming tasks defining construction problems of a simple but qualitative nature. The design effort should be more concentrated in resolving complicated construction details, rather than other design parameters.

Models in the design process could be decisive in understanding volume and space. The make of *models with simple materials*, at various scales, gives to the students the opportunity to gradually comprehend volumes. Also the difficulties they meet in *building* their models, obliges them to invent ways of *supporting* the elements they use for the model as a first step towards the understanding the complexity of a structure.

As students mature, new technologies became indispensable, as tools that help understand implement and research the design process. They can use intricate software for drawing purposes, as they will command it to their full extend, visualizing the three-dimensional models of their design, not as spectators, but as creators.

Obtaining *information* with the help of new technologies should be available to students, from the very beginning of their studies. Their involvement in searching information will be moderated from a simple search of materials to a more complex one of construction methods.

The research

The creation of a site where we as construction teachers could contribute with information about experiences from our teaching might be a useful tool to enrich our expertise. We can simply keep in touch, research together or collaborate in making common or parallel projects. Opening our schools among ourselves, might improve our teaching or just making it more fun.

Zoltan Hunyadi

How the Curriculum and the Teaching Methods follow - in our new Digital Era - the Emergence of up-to-date Facade Constructions

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Budapest University of Technology
Hungary

Introduction

The quick development of computer studies opens up not only the almost limitless solution of appropriation of the Internet, but originate enormous opportunity in architectural representation. The evolution of digital era accordingly suggest the pretence of conformation. On one hand this means the search for utilisation of possibilities, on other hand the necessity of conformity to the new circumstances.

The development of teaching methods, the freshening of transmitted specialised knowledge - irrespectively to that also - was a matter of course of all times. Nevertheless in the course of developing the curriculum we must not lose sight of fundamental aims, thus the adaptable methods and those which ought to be applied should aid to attain goals, the possibilities should not become decisive. Despite the blessings of the New Digital Era, it does not seem to be helpful to let the technical opportunities dominate.

Probably the essence of Building Construction knowledge could be explained by the means of all knowledge we can construct and assemble in given circumtances, accordingly to given formal (architectural) requirements, given type (function) building, accordingly to determinate order (functional and structural requirements). In the course of training adaptation of more and more compound constructions, we should give a hand to more and more complex building. It is impossible to review and teach every building type determinative constructions, every type of constructions total construction-joints, but the main goal is really different. In the course of teaching building constructions in that sence, we have to help student to get appropriate to attend their further tasks, to enable them to evaluate constructions and calculate the assumptions of products, to be able to make decisions.

Our institute is in for a curriculum reform. At present a 5-year-term architect education takes place, which will transform into a linear, more-cycled BSc-MSc system as a result of the Bolognia Process. The programme of the new education is yet in the inchoative stage. The phrasing of the architect education conception is only possible with the progress of the complete curriculum, with consideration of the demands of design subjects using the knowledge of building construction. Yet it is sure, that we are going to emphasize the orientation in the information of the spreading assortment of building products, improving creative skills and an architectural-constructional way of thinking.

The necessity of edifying traditional constructions

It is a basically important question, how deep is it necessary to know traditional building constructions. We only emphasize two from the several aspects:

- The students have their own experience in traditional constructions, so that the transmit of basic knowledge is the most efficient this way;
- The design principles, the directions of development, the evolving construction problems - caused by the natural development of building constructions - can be followed this way.

It can be proved by the example of a residential building from the first decades of the previous century, that the improvement of some constructions and the changes of demands caused by the alternation of lifestyle make it reasonable to discuss traditional constructions, and it warns us, to what extend it is reasonable to yield the most recent results and constructions among the essential parts of the curriculum.

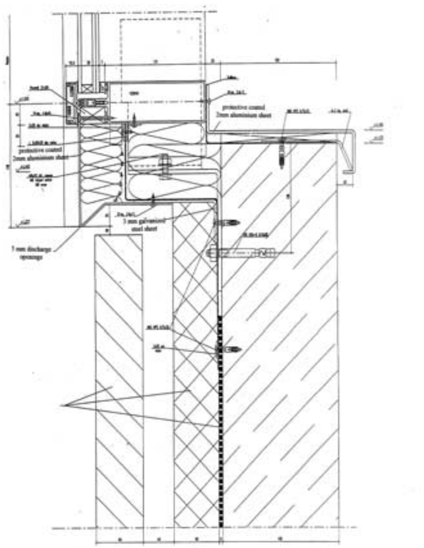
In the last turn of the century and the following decades in the city centre the longitudinal wall system, inner court residential buildings were frequently applied. They were built with traditional (small-size) standard-brick walls, at the beginning steel-beamed, then with reinforced-concrete beam floors. The apartment-separation walls, standing between longitudinal walls were traditionally made of 12 cm wide brick walls. They met the requirements of apartment using customs of the time, as the lack of television, radio and other communication engineering equipment, the only function of the wall was to reduce noise. The other boundary constructions, being heavier, have higher sound reduction. The noise control of facade walls, and rather double-layer windows also ensures an adequate protection against low rate outer noises. But at the same time a walling elements get hollow-core and light because of the demands of heat isolation, and the self weight of slabs also decreased because of the cancelled filling. So the sound reduction of both the walls, both the slabs, whilst both the usage of apartment, both the street noise level started to increase significantly. The result became an alive problem beginning from the 60's to date – not only in residential buildings – the question of sound reduction. The noise control demand standards were issued only at the end of the 60's and in the 80's, and, according to the new directives, the edicts. Developing the determinative part of walling elements was motivated only by heat isolation demands, while during their application, there is no possibility to ignore the fulfilment of sound reduction demands. The limitation of heat casualties of the building, the increase of heat isolation demands, the appearance of new, strict requirement values effect that applying one-layer constructions will not be enough from heat isolation causes.

Design of residential buildings, which is the main part of building tasks, encourages the architect to solve new problems even in case of rather traditional constructions. Lifestyle, alteration of architectural products and requirements demand the detailed discussion of traditional and up-to-date constructions as well. These questions are even more important for those students, who will not work as a designer, but as property developpers, investors, contractors, technical controllers, administrators or at the authority department in the polity, at a building industrial service company, at a dealer company, as a property market or insurance expert, or at building maintenance and reconstruction.

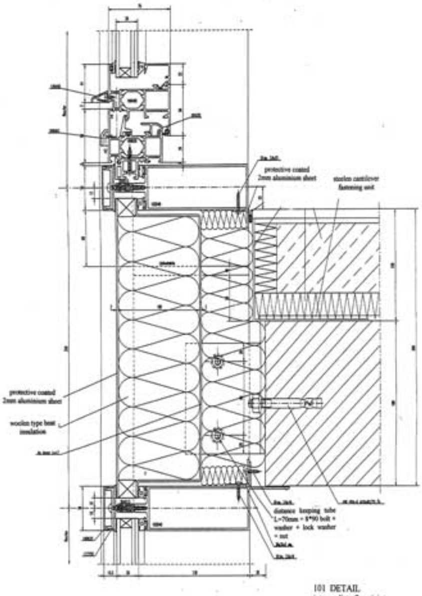
Education of widely applied and produced facade constructions

In the third year of our present education – after an encyclopaedic review (1 semester) and discussing traditional constructions (construction of master builders, coatings and waterproofing; 4 semesters) – we edify constructing of skeleton frames and their facade constructions. The education mainly covers the review of the widespread 'up-to-date traditional', pre-cast facade constructions, the method of choosing construction, and the practice of applying the constructions. The fourth year of education provides a facility to get cognition about pioneer building constructions. This

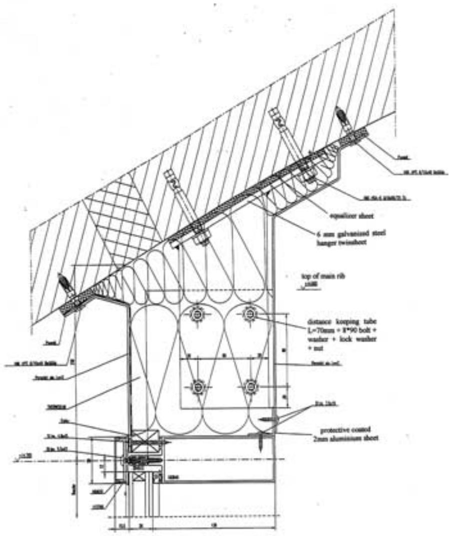
PARTIAL ELEVATION
settlement of curtainwall elements



105 DETAIL
joint to RC breast (footing) wall
the bottom movable joint of rib



101 DETAIL
intermediate floor joint
rib lengthening: hanging fastening on the bottom
movable joint on the top



110 DETAIL
joint to topmost floor
hanging fastening

realizes partly within the confines of elective subjects, and partly within the subject 'complex design'. Both subjects relies on the individual interests and open-minded to novelty of the student.

We also spend 2 hours of lecture and 2 hours of practical lessons on edifying constructions. The lecture presents the construction types – review and systematize –, constructing principles, and detailed analysis of constructions. We put a great emphasis on the presentation of constructing principles and methods. The lectures go on by means of illustrations, partly drawn on the board, partly projected. According to our experiences, the more diversified and multiple information can be solved by projecting, the more difficult it is to make notes. We consider it really significant in the procedure of study to make notes, to draw sketches about the constructions, so it causes a serious dilemma whether to use projected illustrations, which provide significantly wider summary, but sometimes result less thorough – documentary-character presentation.

The students have to solve a coherent semester project, which is prepared according to the model solutions presented step by step during the practical lessons with workshop exercises. The first phase of design is preparing a study about the most important technical, architectural and constructional demands made of the facade. The study considers the most important four technical demands: fire protection, heat loss, moisture protection and acoustics (protection against outdoor noise). In the section of fire protection the number and size of fire compartments, the attendance of compartments on the facade; the bars against horizontal and vertical spread of fire should be determined according to the function and other technical demands of the building. Their buildup possibilities must be examined in the case of sandwich panels, crust panels and curtain walls as well. In the section of heat loss the average heat loss factor must be determined by the function, the heated volume and the heat transmitted surfaces of the building, and secondly the rate and buildup of the heat insulation of the main construction parts must be processed by sketches considering the compact and glazed surfaces. In the section of moisture protection the temperature-depending and relative humidity content value must be determined. The student also has to calculate the humidity balance applyied to one unit of the facade. The aim of the analysis is to determine the neccessary rate of air-exchange ensuring the humidity not to increase in a harmful degree, and whether the air-tight windows ensure the required air-exchange, or other air-inlet systems should be designed. In the acoustic section the sound reduction demand of the facade must be determined by the outdoor noise charge and the function of the building (room). Also the rate and buildup of sound reduction in case of compact and glassed facade surfaces must be worked out, so that they meet the requirement of the sound reduction demand. In the section of building construction summary all the technical solutions in prospect should be collected. The students have to prepare sketches of 1:200 scale about all the alternatives. These alternatives must meet the requirements of the technological demands mentioned above. The most favourable alternative, according to the results of the study - ensuring consultations with the tutor - should be processed in a working drawing. The project contains a facade overview, sections, a partial layout (1:50) and 6-8 representative details (1:2 – 1:5).

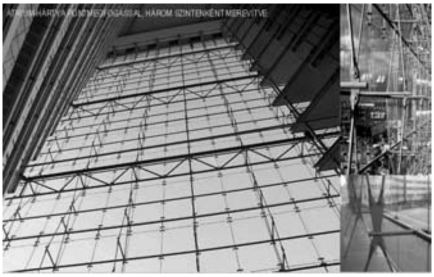
Preparing the structural solutions of all the main constructions (sandwich panel, crust panel and curtain wall) we present a workshop exercise about their design principles and solutions at the blackboard, or rather also completed with projecting in the last few years. The students copy the projected drawings, which are broken up to phases, design – illustration steps, and completing with the tutor's explanation they prepare a workshop exercise in 6-8 A/4 sized pages extent, and handing it in for check/acceptance on the next lesson. This paper focuses only the design practice of constructing an aluminium curtain wall.

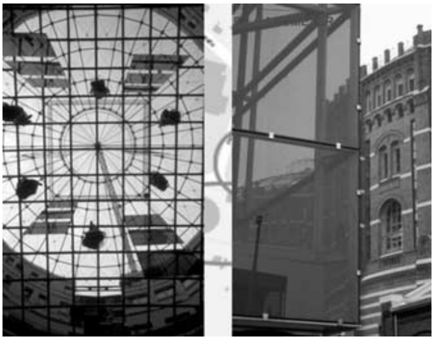
The presented traditional curtain wall is a cold-bridge-cut, visible-mullion aluminium construction, which consists of two storeys high suspended elements. With the help of this construction demonstrating the fixing points and elongations allowing the heat movements, and the cross-sectional sizing method of mullions, the relation between horizontal and vertical corrugation. We fully explain why is the suspended and down slider attach more favourable, than the opposite solution. The construction documented with facade, section and partial layout is completed with 6 details. The first detail the fixation of a mullion, the possibility of 3 directional set, section directional elongation, covering the floor slab and the built-in method of different inlay elements (door, glassing, compact element) The footing detail presents the water-outlet, the bottom fastening of mullion, humidity barrier and heat isolation of ribs. The connection to the heat-insulated, brick-covered own building mainly reviews the consequence of applying the two technology (bricklayer and locksmith) at two different times, the solutions of humidity- and air- barrier, and the function of the drainage system in water resistance. We also fully justify the solution of double ribs applied at the upper reinforced-concrete wall, the nearby firewall connection and in front of the cross wall of the building. These double mullions ensure the correct separation of nearby accomodation.

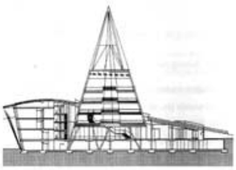
The students solve their semester project leaning on the example-solutions of the workshop exercises. The design questions of curtain walls and glass walls can not be understood without the design principles and demands of traditional walls. All the students solve a separate, discrete assignment. According to the logic of workshop exercise example they can apply other products, other construction and realize their own idea. For the realization of the task we ensure 1 tutor for consultation for every ~15 students, and one has resort to about 12 hours of consultation time during the semester (the others are design practice, test, task announcement).

The structural glass walls, double-coat glass facades, special glass walls are in elective subjects, or rather the complex design subject covers them. So the principle is to edify the common, typical constructions widespread, while we edify special, discrete (at least not yet multitudinously applied constructions) in the frames of elective subjects, or beside individual consultations.

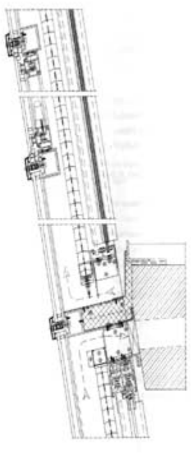
The students interested can get cognition about pioneer examples of special facade constructions at a facultative subject called Glass Construction. The accomplishment terms of the subject of - 2 lectures a week extent – is to prepare a study and to solve an indoor test successfully. In the frames of the subject we arrange every year a field trip to Vienna to visit 8-10 novel, special facade glass walled building, eventually to visit the exhibition Glasstec exhibition. Special glass products: heat insulation, heat defendant, sound-proof and special fire barrier, multifunctional glasses, passable glasses, after the review of connecting constructions glasses without frames and suspended glasses, glass covers, structural glass walls, glass lamella is presented. We review the double-coat facade glass walls, air by-pass facades, incommunicable air



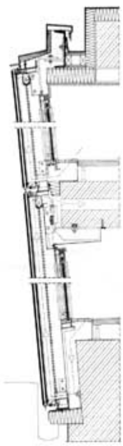




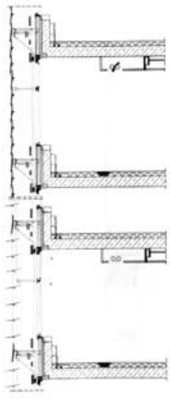
Delft, Műszaki Egyetem Könyvtára 1



Delft, Műszaki Egyetem Könyvtára 2

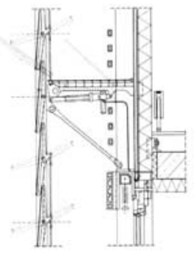


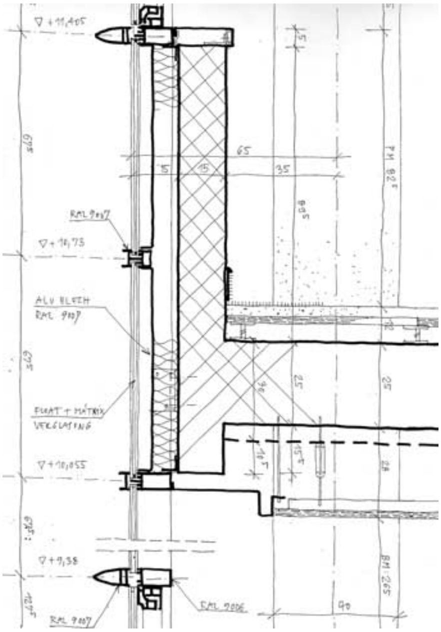
Bp., Paulay Ede u. irodaház 3

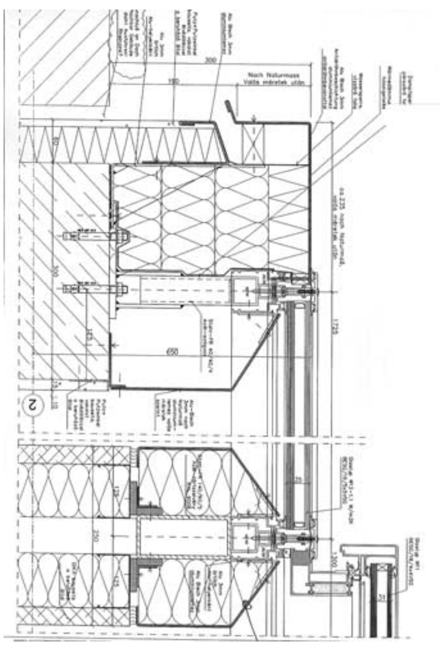


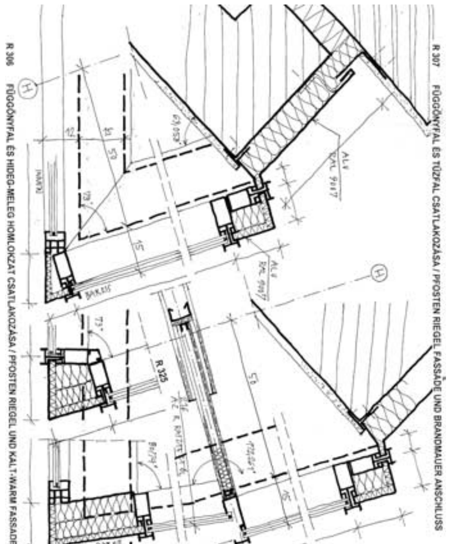
Berlin, Potsdamer Platz
„debis" Zentrale,
csomópont

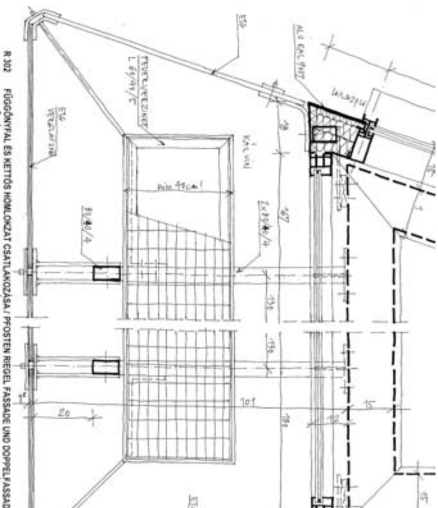
Berlin, Potsdamer Platz
„debis" Zentrale








R 306 FÜGGÖNYFAL ÉS HIDEG-MELEG HOMLOKZAT CSATLAKOZÁSA / PFOSTEN RIEGEL UND KALT-WARM FASSADE ANSCHLUSS M=1:5
R 307 FÜGGÖNYFAL ÉS TŰZFAL CSATLAKOZÁSA / PFOSTEN RIEGEL FASSADE UND BRANDMAUER ANSCHLUSS M=1:5


R 302 FÜGGÖNYFAL ÉS KETTŐS HOMLOKZAT CSATLAKOZÁSA / PFOSTEN RIEGEL FASSADE UND DOPPELFASSADE ANSCHLUSS M=1:5

space facades, cold-warm elevations, passage elevations and hybrid facades. We are engaged in the solution of penthouses, canopies, winter gardens, glass roofs (rib and other constructions, bar husks), together with the design of beams, wallsupports, the basic principles of loadbearing glass construction design and its safety matters. Considering that glass barriers, stairs, suspended and point-fixed glass constructions are the attractive construction of an inner area, their detailed design also comes in turn. Although the tution of this subject realizes in the form of lectures, the department ensures 2*2 hours of consultation for preparing the study. The field trip and contractor experiences have a great significance because of the novel form, constructional sizes, and material usage of the edified constructions, which radically alter from the traditional building constructions. The indoor test asks about the basic functioning principles, the construction and application conditions of connection types, necessary information for construction decisions, boundary conditions and most common constructional examples and buildings. So the subject 'glass constructions' concentrates on the systematization of knowledge, presentation and evaluation of development directions, presentation of architectural aims and possibilities, not on practical work, not on student activity. The subject 'Complex Design' makes this possible.

The 'complex design' is a compulsory 2 semester subject, which comes off with the co-operation of 4 departments. The students solve a separate architectural design problem as a basic task, side by side with frame, strength of material, building construction, and building technology partial tasks. So there is a possibility for the student to design the detailed construction of his own idea of architectural situation. Here, with the help of the architect consultant support, there is a real possibility for creating novel, avantguard constructional types, between adequate circumstance. The task of the first semester serves the creation of the harmony between the architectural conception and constructional solution. First, the student prepares a study about the environmental effect on the building, analyses the constructional demands altering from the common ones, and collects his proposals according to all these. The student has to explain his own, unique construction, which is established by the tructural solution found during the collection of data. The task of the second semester is the working drawing of a smaller part of a building. This one is always a characteristic, architecturally determinative part of the building. Hereby architectural forms altering from the common, parts of the building containing novel solutions can come to front and the students can fully work them up. The task the detailed presentation of three constructional parts. Two of them must be a determinative part from the aspect of the main form (outer wall, roof slab, basement-isolation), the third must be an architecturally demanding part, a piece of a furniture, or an installation. So the task generates a great significance for applying new development results, original, creative, architectural, constructional solutions. During the 'complex design' most students work at architect offices occasionally or as a part-time job, so they can get experience from the inland building-design practice.

Boguslaw Janusz Wowrzeczka

New Teaching Methods of Construction Teaching

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Wroclaw University of Technology
Poland

The Problem

The challenges of the new digital era in the field of construction at Architectural faculties may be listed as follows:

1. What will be the impact of the ongoing globalization on the methodology of teaching *construction*?
2. What will be the influence of implementing internet communication and specialized software on teaching *construction*?
3. What influence on teaching construction will the implementation of research results in *construction* solutions have (in projects and revitalization).
4. The role of the architect as the designer and leader of the development process is slowly loosing in importance. How to counter this phenomenon, how to revive the dominating role of the architect, how to train him/her in the field of *building structures* to take the role of a leader?
5. What will be the impact of the changes in building methods on teaching *construction*?

The future of building structures – trends of changes in the methods of teaching construction at the faculties of architecture.

The answer to this problem is complex and connected with other related issues:

- the industry producing for the needs of construction is likely to remain similar;
- the architect will still be the designer, and the contractor will be the contractor but the cooperation between them within one company seems probable;
- the typology will not change: residential houses, service facilities, public facilities, motorways, bridges, airports as well as all the structure types currently under construction;
- there will be a different process of designing, outsourcing, investment supervision, and different materials and technologies.

The greatest changes forced by commercialization of research will occur in the following areas of knowledge which are all part of the teaching process of *building structures*:

- designing building structures – changes in methods of design
- development of constructions for sustainable architecture and for new, extreme environments;
- introduction of new building materials and strengthening the existing ones;
- changes in the proportions of new investments, renovations and rehabilitation of existing facilities to the benefit of the latter;
- the lack of qualified engineers and architects combined with an increasingly complex knowledge in this area will necessitate permanent education, intensification of higher education enrollment and changes in the methods of education (implementation of e-learning);
- changes in the processes of outsourcing and cooperation between the designer and the contractor;
- changes in the scope of work of contracting companies, their globalization neces-

sitates the changes in the scope of knowledge of engineers regarding world cultures, environments and building technologies (low-tech, medium-tech, high-tech);
- changes in the organization and monitoring of construction works – it will be necessary to establish a regular payment plan for work performed.
- the costs of contracted work will be determined by the quality of work performed and its value to the user – purchaser, and not by its function and brand as it is today;

The changes in the educational program of *building structures* at architectural faculties should include the following issues:
- preparing graduates for the ongoing globalization;
- designing and implementing new educational programs which employ new methods of teaching: computer-aided design, long-distance education (e-learning);
- establishing new methods of teaching that enable education of a large number of students (e-learning);
- establishing courses designed to educate engineers of architecture for work in other cultural regions (for the needs of the international market);

Changes in the content of courses

The comparison of the content of current and future courses in the context of changes in the construction industry leads to the following conclusions:

The context of globalization
The current educational programs lack introductory courses. Uniform European construction standards, unified codes and standards for construction drawings. Globalization and the resulting exchange of students necessitates the uniformization of the content of courses in *building structures* so as to make them comparable (also in the field of ECTS).

The environmental context
In the current program there are none or few mentions of standard prefabricated solutions for *building structures* saturated with electronics and sensors – the so called intelligent structures. Modern constructions, especially those implemented in complex buildings – such as skyscrapers, vast halls, engineering facilities and those designed for extreme environmental conditions. Extreme environmental conditions in which we will be designing in the nearest future, require new, complex scientific knowledge that stems from research. Development of ocean surfaces, underwater habitats, orbital stations in space and on neighboring planets, planetoids and moons. We are experiencing the evolution towards balanced, ecological and energy-based architecture... intelligent architecture based on the rule of synergy of all its elements. The *construction and building* solutions are crucial, both passive and active.

The integration of *building and construction* elements with the installation equipment for electronically controlled facilities is the criterion which will determine the quality and usefulness of architectural solutions in the nearest future. Therefore it is necessary to expand the educational program by teaching students how to use software which stimulates the behavior of facilities with respect to energy.

We should also introduced the issues of recycling of building materials into the educational program of *building materials*.

The context of designing

The content of courses in the field of *architectural design* is currently limited to solving elementary construction problems, usually out of context, i.e. staircases, rafters, terrace, etc. There is, however a connection between *architectural design* and *construction and building design* in the form of a course in *designing single-family houses* during the 4th semester. But the drawback of such a course curriculum is the implementation of solutions for single-family houses to other facilities characterized by a much greater level of complexity, in which case such solutions are wrong. It can be stated that the operational knowledge of students in the field of *construction* is limited to a traditional single-family house.

Integrated design, solving design problems at a much quicker pace in cooperation with the contractor and by implementing a specific technology.

The use of CAD software in designing is growing in popularity. The ability to use these programs is crucial in the field of integrated design.

On the other hand the amount of research is growing and so is its application in contracted work – this requires a much greater flexibility and receptiveness for new technologies. We can observe progress in the field of construction typology, which is currently divided into:

- traditional technologies
- prefabricated technologies
- unique technologies

Today, there is a tendency for classifying facilities according to the level of technological advancement:

- low advanced buildings technology
- medium advanced buildings technology
- high advanced buildings technology

These changes result in changes in the educational programs. Additionally the necessity to erect increasingly taller buildings alters the scope of *building and construction* solutions as well as the contents of the program.

The Internet opens the possibilities for creating long-distance designer teams. Internet-based team design should be a part of the educational program and at least one design task should be carried out in this manner.

The context of new building materials

There should be a radical change in the educational programs with respect to the content of the course in *building materials*. Apart from traditional materials, such as wood, steel, reinforced concrete, ceramics, whose strength characteristics will be optimized in future, new materials will be used. These new materials will be based on nanotechnologies and will possess characteristics of intelligent structures allowing them to adapt to changes and external needs. Polymer materials will be widely used, reinforced with glass or carbon fiber, composites. New alloys of aluminum will emerge characterized by increased strength. All materials will be completely renewable. Such radical changes in the field of materials necessitates including them in the content of the courses: presenting the characteristics of new materials in laboratories and in computer simulations.

It should be underlined that the implementation of nanoparticles in new materials offers the possibilities to create intelligent architecture. Nanotechnology implies changeable states of matter at the level of nanoparticles. Most substances such as metals, ceramics, glass and semiconductors completely alter their characteristics. Those, which are normally solid become liquid. Metals may be semiconductors or color pigments, ceramics may be transparent or become an electric conductor, glass may be transformed into absorbable material. Nanoparticles possess characteristics which no other material possesses. These materials are manufactured in the process of Sol-Gel – a non-organic type of chemical synthesis which allows the creation of nanoparticles with controllable surface characteristics.

These surface characteristics serve as a significant criterion in the production of new composite nanostructures and coatings. Implementation of these technologies enables production of materials which may be used in construction, i.e. glass with special surface characteristics, etc. Some technologies of manufacturing nanomaterials are ready to use in industry.

Revitalisation context

In view of the tendency to decrease the number of new building investments it is necessary to expand the educational program of construction by introducing issues related to revitalization and renovation of existing buildings. This problem requires acquainting students with the investment process – which is very different from the process of building new objects (much more complex), as well as with appropriate building technologies that are implemented in designing transformations in existing facilities.

Due to the complexity of these problems Architectural Faculties need to start specialization areas with an extended program in the field of *construction, building* and *building physics* related to renovations and transformations of existing facilities. At the Architectural Faculty of Wroclaw University of Technology (the only one in Poland) there is a specialization area of this kind. The program includes courses whose content is significantly expanded in the field of revitalization and renovation of existing facilities. The following courses address the problem of revitalization, conservation and transformation of existing architectural objects:

- conservation material studies
- construction (mending and reinforcing structures)
- chemistry of materials
- modern inventory techniques
- conservation, architectural and technological projects
- the project on revitalization of postindustrial facilities

Methods of teaching

The context of globalization

The development of computer technology, software and internet communication causes changes in the tools of work and methods of teaching *building structures*. Due to globalization, the designing and building process is beginning to involve more and more participants that are scattered all over the world. On a global scale the building industry is moving towards the creation of an integrated system of communication and information exchange, which would allow close cooperation between the participants of the investment process at different levels: designing, building and investment management.

Today the Internet is conceived as the basic communication tool in the design process. Both the designers and contractors can e-mail drawings or technical documentation, which allows rapid exchange of information and time-saving cooperation.

The Internet offers the opportunity to e-mail information related to technical specifications of a building, as well as those related to designing standards. This type of cooperation on all levels of the investment process requires teaching methods that employ the use of the Internet which should be implemented already at the basic level of education. Designing tasks in the field of *building structures* may be carried out by means of software designed to create 3-D models, i.e. Archicad , Autocad, Microstation, Nemetschek, VRML and other.

Designing context

Introduction of computers into architectural design and installation of specialized software opens the door for effective team work, quick exchange of information, alternative designs, quick alterations and corrections. Using detail, brand manufacturers of building materials, and especially 3D simulation of architectural facilities, their construction detail, and the process of building and utilizing the facilities with their installations. Computer software which integrates all stages of the building and utilization processes will be the basic tool of the investment process in the nearest future.

Adapting the software to the needs of education is necessary. For those students who are becoming skilled in using computers, the Internet offers the opportunity of interactive education through chat rooms, team work on designing tasks, presentation of their designs, conducting research as well as using the resources and experience of higher education institutions.

The environmental context

Already today at some architectural faculties there are experimental educational programs whose main goal is to teach designing in extreme environmental conditions. In Texas at the Faculty of Architecture there is a MA study program: Experimental Architecture. This program focuses on research and designing problems of habitats in experimental environmental conditions and at the same time is characterized by limited availability of work force, materials and basic living conditions. The study program is mainly based on designing new habitats by means of computer simulation and specialized software (Meduza 2D and 3D, MegaCadd).

The problems of environmental conditions beyond our planet (space), i.e. the lack

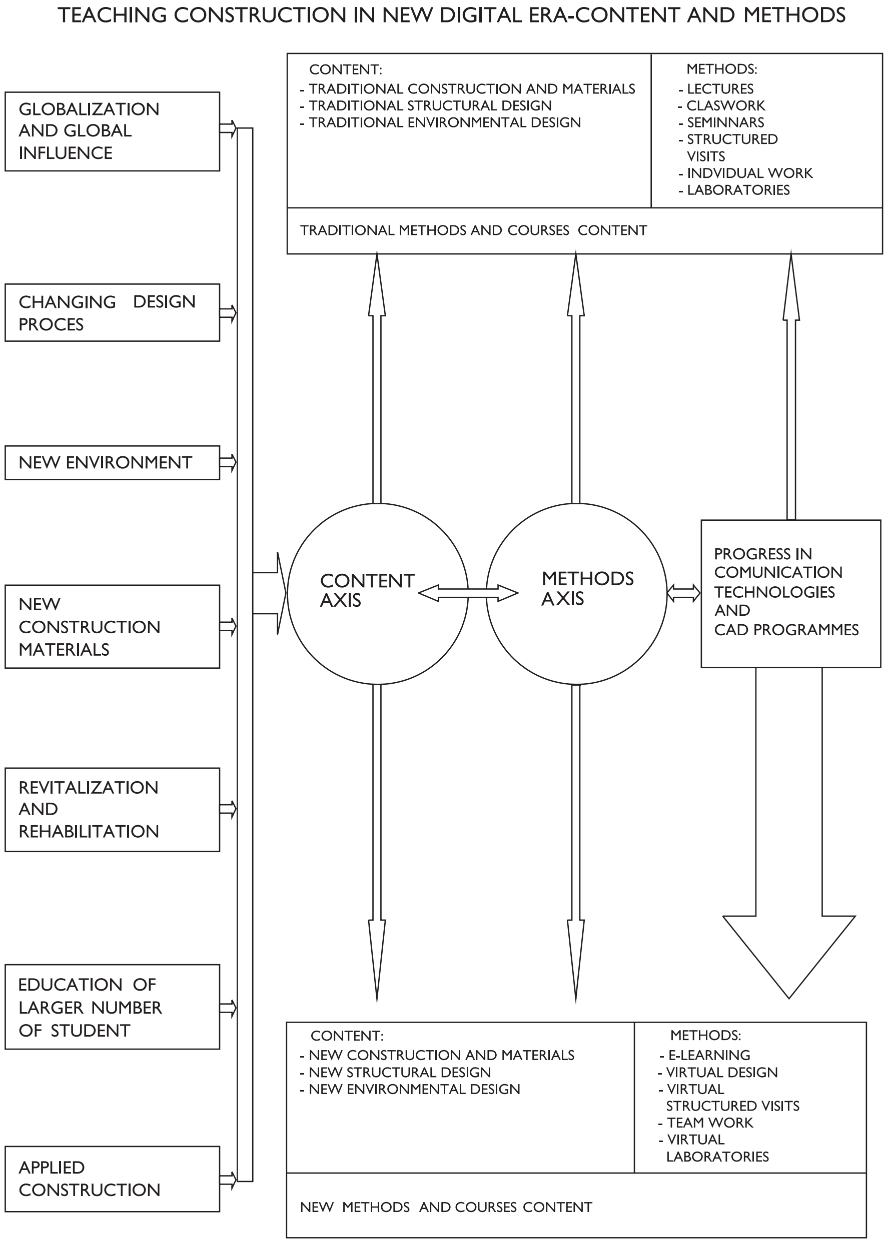

Fig. 1

of atmosphere and gravity, no protection from high temperature and solar radiation, completely change the requirements for *building structures*. It is necessary to carry out simulations of the specific space conditions in laboratories.

Due to the international range of operations of building corporations designers need to study new climatic and cultural environments. One of the possibilities to achieve this is to take part in scholarships for students at other Universities and in designing internships and research trips to other countries. Students of the Faculty of Architecture at Wroclaw University of Technology participate in internships in most EU countries. They take part in research expeditions to European regions and cities in which major building investments are made.

Conclusions

Mass computerization, internet communication, and computer-aided programming have a significant influence on the educational programs and methods of teaching. Implementing these tools in the process of teaching *building structures* becomes a necessity in view of the challenges of modern civilization for the construction industry: globalization, internationalization, commercialization of research results, the need to educate a high number of engineers.

In the context of these phenomena it is necessary to revise the educational programs of *building structures* at architectural faculties and introduce courses which address the problems of internationalization of design and investments as well as their level of complexity and the necessity of team-work (fig.1)

At the Faculty of Architecture at Wroclaw University of Technology *construction* is being gradually adapted to the mentioned phenomena:

- e-learning methods are being introduced into the course in *designing building structures;*
- the faculty runs specialization areas in the fields of protection and rehabilitation of building facilities, and revitalization of postindustrial facilities;
- new optional courses have been introduced in the field of *designing "intelligent" structures;*
- CAD software is commonly used in *designing building structures*, already the 1st year students are taught to use this software;
- Students leave for building and design internships to different European countries, which greatly widens their knowledge about different cultural environments;
- the system of consulting specialists from different branches is being introduced.

Surely the program and teaching methods need further enhancements. Especially in relation to the content of courses and their availability on the Internet, as well as the insufficient number of studies in virtual design and virtual construction of facilities with the application of necessary software.

Debate on the Presentations
Second Theme, Part I

Chair:
Donal Hickey
Dublin, IRELAND

Donal Hickey
I would like to begin by posing a question to the people who have spoken. It is, I suppose, an issue of confidence, and I think that I would like to tie all the speakers together. My question is, who or what do we have confidence in? Our students, ourselves, or some sort of machine or programme that will allow the future to happen?

Nikolaos Panagiotopoulos
Why is it necessarily a question of personal confidence? Yesterday Prof. Christiansen, I think, said that he would like to be a lighthouse, so that he could help students to navigate. My main question at that point was, is a lighthouse needed, or have things changed so much that lighthouses are no longer necessary and what we really need is traffic lights, or something like that. And I thought I would be glad if what we needed was traffic lights. There is no lack of personal confidence, if you get my drift, it is just that, like everybody else, I am a little bit at a loss as to how to cope with all the changes and developments; and that is natural, I think.

Ola Wedebrunn
I think that we have to have confidence in ourselves, and we have to have confidence in the students. We live in a culture that is very much a child of the enlightenment. We believe generally in enlightenment ideas. We think about the nature of science, and we believe in nature – but what is nature, exactly? By nature do we mean unspoiled nature, something that we look back at, some archetype of nature that we think of as 'nature'? But what is it? Culture is also a part of nature, or nature is also culture; and we have to have confidence in culture. We have to believe in the things we inherit, we have to believe in heritage; but we also have to believe that things will change, and we have to believe in changes. And so, inside ourselves, we have to form a core that we can believe in. We have to find a character in ourselves, and we also have to make this dialogue with the people around us. And we make that through this kind of medium, as perhaps I could call it, this idea of new technology or technologies, which are a way to integrate nature and culture. And we have to have confidence in that ourselves, and we have to have this dialogue with others to bring this confidence together somewhere.

Ole Vanggaard
I believe that the apple will fall down, and we will have to have a new way of describing it.

Karl Christiansen
I would just like to make a correction. I did not say that I want to be a lighthouse for the students: actually, I said the opposite, I want to work together with the students. What I said was that as institutions, both in education and in research, we should be lighthouses to light the way and not just do what the outside world demands of us.

Herman Neuckermans
I would like to go back to the issue of IT. **Several speakers have shown how much information is available on the Net. I would like to say that, indeed, this is true,**

but on the other hand it increases the need for critical judgement. Of course, this is not only linked to the Net; it is also linked to what we saw this morning, the magazine *Detail* that shows details of architects, without criticism, which is their goal. But we, when we teach students, must teach them how to look at these things in a critical way. Students tend to copy things from the Web, or from a book, assuming that what is published, whether in a book or on the Web, is true. I have seen this in many cases. And there are plenty of mistakes, both in books and on the Web. So this is something that worries me.

Henk de Weijer
I have a question which perhaps you could answer, and I would also like to give a reaction. Today we have been listening to a number of explanations and suggestions, and my feeling is that much of what we have heard seems to come from a linear way of thinking. I get the impression – and I would like to give a correction, although I may be entirely wrong – that the future is going to be an exploration of the past. And I get the impression that the computer is being watched like a machine that needs to be helped to emerge, instead of as a tool. It seems that what we know today is becoming more and more and deeper and deeper complicated; but however complicated it is, it may be predictable. It takes more time to think through, which the computer is better able to do. But when we talk about a new paradigm, then the future is not predictable. How do all the systems that you are thinking of deal with this unpredictability and, as I think Ole was saying, the question of who is going to be the leader? You said, I think, that you do not want to be the leader of a team. I think that what is very important is that there is a vision; and maybe part of the new paradigm, a part which may not be realised at the moment, is that the vision needs not come from the person who is in charge of form, who is in charge of synthesising things. The new paradigm may come out of the confidence of "I would like to be a traffic light". If the new vision is not just in the hands and minds of architects, if the new vision is in the whole group and in the solidarity and the competence of the group, then, maybe, even the new vision for new forms and new interactions may not come individually from any one person. I would like to give one example, and I think that many of you may also have had this same experience: when I am talking about a problem with two or three people and an idea comes to my mind as the solution, soon after I have thought it I find that someone else offers the same solution in his or her own words. For me this is an indication that if we are together, thinking about a problem or a way to deal with things as a group, the solution will come forward, and it does not matter who expresses it. So, please, could you give me some clues as to how you are thinking about it?

Donal Hickey
How to deal with the irrational, the unpredictable, the soft, and the break with or continuation of the past? Would anyone like to respond to that?

Per Ola Wedebrunn
First of all, you spoke of linear thinking, and I think that this is something that you could really question with the possibility of working in a network, because you have the possibility of returning and going further and returning and making a lot of

changes, and you get a lot of possibilities for modulation in a network situation that you would not get perhaps in the same way in real time. I do not want to get into what time is, because that would be very difficult; but going into a network situation you might question what time is, and that would be a very philosophical discussion. Turning to what you said about sources: we need sources, sometimes we need sources. Treatises in architecture are needed, not because they state the only way of doing things, but because we need to have something to work with; and this is perhaps the way that we should understand it. I believe that we can get the heritage from architectural treatises. But perhaps with time things change, so there is a linear reality that we are facing that will be related to culture. You referred yesterday, Dimitri, to Manuel Delanda. He introduces the idea of different technologies existing in parallel to each other, that will always be existing in parallel. We can ride a bicycle and talk on the telephone, and those are different technologies working at the same time. Geology is always there, too, as a technology – a technology of nature. So we have these kinds of different parallels of time that co-exist, and we can discover them and leave them and discover them again. And perhaps we could do the same with culture: we could return to some of the sources that we appreciate very much and discover something new in them. But it is really the time question that perhaps brings new technology in relation to heritage, which would be a very interesting subject to discuss a little, but I do not know if we have the time for that now.

Anders Gammelgaard
This meeting is beginning to be a bit too academic for my taste. I cannot help returning to the presentation that Joseph from Dundee just made, which I think was the best presentation so far, because it managed to show what it is all about in a very direct manner. It is about architecture, and this meeting is about construction in architecture. And I think that we are overcomplicating things here. Joseph has showed very directly that, as the saying goes, 'there are talkers and there are doers'; and it is a matter of just starting to do. And with this very simple house that he made with the students, addresses construction and architectural problems on a very high level. I know that this is a terrible thing to say, and I run the risk of oversimplifying things, but I think that we are sidetracking at the moment. We are not staying with what is important. After all, we are here to discuss ways of teaching construction that can be helpful for all of us.

Herman Neuckermans
If I could quickly make a comment on the time issue: I think that our perception of time and space has changed considerably due to the IT revolution, but the fact remains – and this what we call a boutade in French – that I will never sleep in my computer. I also have a short question for the people from Gazimagusa about your expert system: is it meant to be used by students too? And if so, do they use it as a black box, or do you explain how these different constraints and performance requirements act together and are put together by you?

Ozdeniz Mesut Birol
As I explained in the presentation, we did a survey, we collected data from professional architects, and we input this data into the system as a default value. So inex-

perienced architects can use it and accept it, and it is a good thing for them to have. Experienced architects can change it according to their expectations and what they wish to achieve. So, yes, that is possible.

Sabine Chardonnet

I do not agree with the position presented, because I think we need both situations. **The discussion about individualisation of knowledge, or individualisation of behaviour towards learning and doing things, is very true.** More and more amongst our students we have people from different cultures and different backgrounds, and they will take the same curriculum but in different ways; and we now have to face this question of negotiation – negotiations between the teachers and the students and negotiations between a future or collective approach and an individual approach. In my opinion, perhaps the best thing we can do, in order not to make mistakes when we teach, is to give students both experience of negotiation with an abundance of knowledge and tools with which to get close to it and to get it out of the black box, as well as one-to-one experimentation, because it is from the confrontation of both that they will understand in the end that they are not alone when they become architects. In the end you can experiment with your hands and be more clever than going to the black box and taking all the information that is around us. So I would really think that a school of architecture could be a place where you have one-to-one experimentation with time and areas and curricula, and also tools to self-conduct your road through education. For me this is what IT brings: necessity for validation in one-to-one experimentation and the question of going back to information.

Dimitris Papalexopoulos

There are three short comments that I would like make. The first is on the question of the BS; I think we have hit on a very critical issue, which is that in the end the main problem seems to be not how to construct a building but how to describe a building. So the question is, how do we fragment a building, how do we describe it? In Greece, we have a database called 'building memory'. The main problem was not informatics: rather it was in us architects – how to deconstruct a building and where to stand in relation to different theories. If you try to describe something, it is in a way like constructing it, like putting down the whole theory of architecture. So maybe this is an issue for us all to discuss in the future

My second comment is that I totally agree that we have to accept that there will be coexistence of different technologies – both the conventional and the high end – and that **our work is not to narrate the story of how we pass through a new era but how we may make the different things co-exist. We have to accept that things are changing by micro-changes, and someday we will have a totally new image; but they do not change by rupture – that is too Modern to happen.**

My third comment is for Joseph. I just wanted to say that I and two colleagues in Greece have for six years taught a class on construction, and what we found out is that it is not really a question of master-builders or of comprehending construction, but rather that there is a kind of process going on there for the first time in these students' lives. They pass from an idea to the built form; they are condemned to pass or else they will fail, so there is a fear, a common fear, on the part of the teacher and on the part of the students. And when you finally succeed in passing and constructing you are trapped, you are an architect.

Henk de Weijer

I would like to come back to the academic problem. **I completely agree that it is very essential to be committed and to be not only a thinker, but to be a thinker and a doer at the same time. My concern is that if we think too much in terms of systems then we have to realise that any system, no matter how broad, will have limitations. And what we need to deal with is the unpredictability; we need to be able to have the freedom to step beyond any system that anybody can think of.** I know that what many of you have been doing is showing that any system of teaching construction can be dealt with in a completely unexpected new way. This is what I wanted to say about thinking in terms of systems; and of course we can go back to emotions and creativity and all these flowing parts that we all have, but again it is very important to realise that systems have their limitations, and I think that this is not an academic question at all.

Herman Neuckermans

I just want to make a small comment on model-making, on real building-making. I think that there are several ways of experiencing architecture. One is the one you showed, by doing things; and what for me distinguishes this way of working from other ways of experiencing architecture is that you have the feedback, the immediate feedback from the doing to the thinking, which is not in the model when we draw. So, although there are some risks, which I do not need to go into now, I fully agree with you on that. The other way that I experience architecture is by watching others do it. I do not necessarily have to do what others do; I do not necessarily have the skills to do what other people can do; but maybe by watching very carefully I can experience it. In this case, though, you do not have as much feedback from the doing or making to the thinking. And if you go to the virtual models, I think that they still lose the battle compared to actually being in the space. Whatever technology you use it is not the same thing, and that is another thing that the real model brings.

And I have one last comment to make – forgive me for taking up so much time – on your model: I think that you did not solve the lateral truss, and I think that you did not see it because the roof did not weigh anything.

Second Theme

Part II

The New Teaching Method(s) of Contemporary Construction Teaching: Teaching Examples/Practices

What tools and vehicles will be employed in the new construction teaching?

How will new information on innovation, new materials and construction methods, become known to construction teachers?

How could this information be taught and disseminated to students?

What tools would facilitate this dissemination? What tools would respond to this need (software, databases, websites etc.)?

What are the necessary initiatives our Network should take towards strengthening this new form of information exchange and towards enriching and improving the process of teaching them?

N. Soceanu, *Ion Mincu University, Bucharest, Romania*

H. Neuckermans, *KU Leuven, Belgium*

A. R. Jimeno, Xavier Pouplana, *Polytechnic University of Catalonia, Technical Superior School of Architecture in Barcelona, Spain*

M. B. Ozdeniz & H. Z. Alibaba, *Eastern Mediterranean University, Northern Cyprus*

Josep Llorens, *ETS Arquitectura del Vallès - Sant Cugat del Vallès, Universitat Politècnica de Catalunya, Barcelona, Spain*

O. Fritz, *Liechtenstein University of Applied Sciences, Liechtenstein*

Zina-Andreea Soceanu

Databases for the Complex Materiality of Architecture – a training method

University of Architecture and Urbanism "Ion Mincu"
Bucharest
Romania

"Off the shelf" architecture

The present-day architectural practices and building techniques have been in use for a long time, accepted and acknowledged today by an expanding market whose most significant feature seems to be, in Romania, a matter of quantity.

The overall aspect of the newly built mirrors the strikingly limited offer of half finished products and available construction materials: the "off the shelf" architecture. A kind of "ready made" architecture is rising, simply by seasoning the buildings with (not so) various finishing details within a meagre set of products, found everywhere on the Romanian construction market. The only choice required is to pick them out from the other products available "on stock".

The same tendency can be observed sometimes in the choices the student architects make during their design studies. Throughout the theoretical construction courses (building materials, finishing details, building physics etc.) the students get familiar with concepts and principles, formulas and typical details. When it comes to integrate all those acknowledgements into a valid construction element during practical design courses, exercise that must refer not only to the underlying construction theory but to existing, available products and materials, the choices are predictable and resume the references made by the teachers to illustrate theoretical aspects. The students easily and too often end up by using on and on the same pattern for solving different building design situations, once they have found a valid set of materials or products to match the first call. Once they have found a correct way to use a certain membrane let's say to isolate a terrace, their search and study will end up there.

In fact, this can be regarded as a direct way towards simplifying the materiality of architecture, tendency that could be converted into a "do it yourself! but better" attitude. The ubiquitous white PVC window frames and 30x30 cm ceramic floor tiles can be found nowadays from churches and historical monuments to chalets on the top of the mountains. The contemporary architectural product could be enriched if we are able to find a way to show the students, the young architects to be, the real content of the shelf to look on.

The Internet tool

Although the building materials and techniques market does not exceed in dramatic changes everyday, the students have to get used to the idea that it is indeed more complex than it shows. One sure (and becoming more and more easy, even in Romania) way to keep track of what is available throughout the world is the Internet. Producers, manufacturers and dealers post information on the products they have to offer, at various levels of detailing. Members of universities or other third parties develop databases, posting more specialized and structured information. End users communicate among themselves on forums, supplementing the existing information with personal opinions and practical experience in dealing with certain building products.

The way students relate themselves to the technological architectural aspects could be improved profiteering by the passion raised amongst the young generation by the use of the computer, chatting and surfing the Internet: better or more complete documentation, the curiosity as a working method, a way of continuous personal training, a method for making a motivated choice.

The student's technological background

During the first academic years, the students learn within construction techniques the theories concerning different basic matters: first contacts with technical thinking as an introduction to the general internal logic of the built shapes, distinctive features of the most commonly used materials and building products, criteria for structural design techniques, underlying principles for elaborating finishing details etc.

The internal coherence of all the technical disciplines becomes visible as an object of study only later in the student's active life. In the last years of study the students are stimulated to patch together the diversity of technical data they possess into integrative curricular activities.

Technological design studios have the most integrative practical approach. Students are supposed to elaborate complex buildings and building systems in a creative way. They are encouraged to use different existing materials and products, making the best of them accordingly to their technical specifications. When a new product or a building material with interesting intrinsic qualities is proposed as part of a construction design detail, paradoxically often it is put into work the same way as a traditional regular one.

In terms of overall efficiency, the students have to adapt the design to the new material situation, in order to have a correct and equilibrated technological result. It means that they will have to thoroughly analyze the materials and products proposed as part of a technical solution. It is not an easy task to accomplish. The technical data usually offered by the dealers or producers is often hard to be interpreted in terms of a correct use of the product.

Problems and deficiencies, different or restrictive fields of application, durability and real life time of the materials and products are non-explicit issues that usually come together with the practical working experience.

The students must be prepared to build for themselves this complete stock of objective technical-practical data. As during the study years they tend to credit with the same value of truth the information from a producer's brochure and the models offered as an illustration of the constructive principles by the teachers, the students must be helped to make the correct connections between theory and the complex realities of a building construction.

Goals and achievements to insist upon

Individual personal working methods are configured during the study years. If the students do not find the time nor the need to search the NET for the latest news and pieces of information, they will hardly start to see this documenting stage as a prime necessity when they will begin the practice as young architects.

Distinct competences are therefore to be built within the first years of construction architectural study, that is: the knowledge of acquiring complete, accurate and objective data about construction materials and architectural products; in good time understanding of the connections to be established between construction technical detailing design and the available materials and products, that is the connections between basic theoretical principles and their practical translation into a real building.

Methodological steps

1. For a more *accurate and objective knowledge about construction products* the students during first years of study could use the multiple searching options *via* Internet. They will be able to find primary information about the products within the technical documentations offered by the dealers and producers. This first step could lead them to deal with different aspects of specific products, in an integrative way: material characteristics, multiple possible joints, building physics – multiple theoretical issues illustrated by a very specific practical solution. This documentation will supplement the theoretical aspects discussed within different construction disciplines.

   Specific to the Internet is the way it stimulates the communication. The discussion forums constitutes a kind of virtual public spaces, where information is exchanged at a rate never met before. Questions revealing different approaches to new materials and products just appeared on the market could lead to unexpected answers, unfolding characteristics and deficiencies, harmfulness and noxiousness, limited use possibilities, and so on. The students should be stimulated to pose questions on discussion forums about different construction products, questions raised from their own theoretical studies or simply to listen to the questions-answers dialogues posted on the net.

   Another integrative way of gathering experience is to deepen the study in an intensive search through existing databases. Given a technological building principle or a typical construction material the students could perform comparative analysis in order to structure the information existing on product characteristics from different product ranges.

2. (Re)establishing the *connections between theoretical principles and real buildings* implies in fact finding out real building's features, its characteristics in the making. The moment a construction is built (or a project is designed), it is ready and the owner moves in (or the student gets a mark for the study) – this is the exact moment from which the architect (or the student) begins to know nothing more about his /hers own work. Questions as material durability and the way it grows old are to be posed only when it comes to dismantling or refurbishing. It is partly a matter of theoretical approach but also could be subject of personal interrogation and direct study.

   The students must be able to recognize a building's needs in terms of: correct relationship between its overall form and materiality of its building structure; direct relationship environment – envelope – internal comfort; damages of the building due to incorrect choice or a particular way of ageing of the construction materials and products.

New tasks for the students

Both surfing the internet for valuable information and the analysis of existing buildings from the technological point of view are merely training methods for better understanding the complexity the architecture relies on.

The Internet documentation phase is an activity that could be performed within all the building construction disciplines during the first years of study: building materials, building structure, finishing details, building physics. Finding examples of construction materials and products to illustrate various theoretical principles could be centered round typical characteristics, comparative analysis or experienced deficiencies. These individual studies could be part of each discipline as a compulsory paperwork.

Later during the years of study, each student will already have a personal archive of existing products or available materials for better knowledge of what to propose as a translation of the principles into technological design studio detailing work.

The building construction set of features describing a house could be subject of a real 3D analysis of objective data such as its structure and constitutive materials, but also subjective data interpreting internal (dis)comfort due to: material degrading and ageing, structural damages, shape and orientation of the building. For an efficient and creditable result, the analysis could be performed on each individual's home – as a place anyone knows better than any other building. The Romanian specific situation is that more than 70% from the population lives in blocks of apartments with multiple stories. Observing and analyzing this building stock could be useful for better understanding of the reinforced concrete and /or masonry built structures – also disciplines beginning from the first year of study at UAUIM. Bearing masonry walls, reinforced concrete panels and prefabricated beams and pillars, concrete standardized elements with their specific technological construction details could be easily inventoried by the students, their users.

The relation between the inner characteristic of one block's structure, its constitutive materials and other materials finishing the building could be an interesting study within building construction integrated disciplines during the last years. Constructive problems appeared in time could be subject of inventory, trying to find connections between mostly spread problems and deficiencies and the technical solutions used in the original project or through later construction interventions.

All the knowledge and useful observations regarding mass housing characteristic features and properties could be used for supplementing a database initiated on blocks of flats – the product of a research project conducted by UAUIM University.

The practical approach characterizing the latest years of study could offer the possibility to the students to benefit from the digital archives and to deepen the study on the real building features and deficiencies. Observing the problems could lead to finding out possibilities of remedy. The solutions provided could put the student in a position which is quite opposite to everything he is prepared for: he becomes the architect and the beneficiary at the same time. Maybe this could help the students understand the overall implications of theoretical choices they make during construction building design – choice of different materials with different aspects, the problems inherent to construction sites during existing buildings, financial and logistic aspects.

Finally, optimal choices in terms of overall efficiency in the construction design could be seen as major accomplishments of the digital archive and the understanding of the building through its whole life-time.

Logistics /implementation of the new training methods

Like written or digital materials and manuals conceived by the teachers to guide the students through their individual study, it will be necessary to offer them means to have access to digital information such as the Internet and databases as mentioned before.

The Technical Chair at UAUIM University is about to open the doors of a digital working studio. The Internet will be available on the computers we already have and groups of ten-twelve students could work in the same time.

A research project developed in the last years at our University has built a database in construction, architecture and urbanism – BICAU (www.bicau.ro). The information is structured upon a classification of the products related to their place and function within a building. Multiple types of search could pick out materials and products, depending also on the providing or manufacturing companies, code number, quick search using key-words or simply displaying in alphabetical order the classification of the products and construction materials. A detailed description is offered for each product and company (with respect to the Romanian market). Technical documentations are available, and in most of the cases pictures and CAD details supplements the information on a specific product. All items are linked together by similarity principles. From a specific construction material connections can be made to all the materials in the database having similar characteristics and possibilities of use within a building. Also you can find all the companies (hosted on BICAU, of course) that could provide that specific type of material on the Romanian market.

Another research project "The Rehabilitation of Large Scale Housing Estates – An Interdisciplinary Approach" has initiated the building of a digital database for the inventory of the blocks of flats built between 1950-1990, huge number of buildings in a very poor material condition. Teachers from UAUIM and other Universities from Bucharest, together with ATU (www.atu.org.ro) – NGO on architecture and urban planning gathering young teaching assistants from different universities are working together to draw up the complex picture of the living conditions in Romania. The database on the blocks of flats is under construction right now and it deals with technical building characteristics such as volumes and forms, structure and construction materials used, most frequent damages related to different building situations. The accurate estimation on the real number of blocks with similar construction features and their exact position on the territory are still missing but most necessary studies.

Competences to be achieved

The awareness of the possibilities offered by the Internet as a powerful working tool is to be awaken in the earlier stages of student's academic training. The architects-to-be must know how to keep track of all new technical solutions provided by a very dynamic market. Useful information is not always at hand, a good practitioner or even an expert must know how and to whom to ask questions about aspects not always described in the technical documentation and commercial leaflets.

Sometimes the simple curiosity leads you to other sides, unexpected, of the same problem.

The students must understand that together with a new solution – a new problem could be born. They will eventually end up by always trying to find less convenient aspects about a product (even if all they could find at a certain moment will be its high price..).

Understanding the diversity of the product ranges accomplishing the same theoretical needs is absolutely necessary for a good technical solution. The students will be able to be aware of the whole set of implications their construction detailing solution will have for the real life of the buildings they will design.

Databases will become an indispensable tool for the continuous architectural training, the students getting used to how a database is being built, what could be the aspects to take into account and then how to find them in this type of digital structure.

The investigation of the relation design project – built environment through the understanding of the constructive principles of a well known construction – the student's own home - is supposed to develop the understanding of the processes that lead to a good or a bad behavior of a building.

Although the mirage of newly built contemporary architecture is a strong call, the students have to realize that there are many quite old buildings in Romania having problems waiting to be solved, not only by drastic actions such as demolition. Architecture could be seen by them as a possible new "resource for architecture". Speaking of contemporary architecture, not all the students will have the opportunity to build with last minute techniques or materials. Nonetheless, all of them have to be prepared to offer building designs and architecture of certain quality. Ordinary materials have their own rules of being put into work, the student has the duty to know where to find these pieces of information and to put them together, at the proper time.

As a teaching assistant at UAUIM, being part of the Technical Chair, my working experience with the students is limited and distributed into small pieces. But the chance that I've got (together with the other teaching assistants) is to be able to have an overall look, working sometimes with the same students but with different theoretical or practical approaches. Therefore my proposal is not about another technical discipline, it is a thin but continuous and perseverant intervention in the traditional academic training methods throughout the years of study.

Some of the practical works I have supervised have shown that analyzing and criticizing their own home and then making proposals to "cure" it with full knowledge of the case made the students put passion there where technical aspects were to be considered. On the other hand, the students appreciate the Internet and the information it could reveal, it is just that they do not yet think of mixing together the game with the study.

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DYNAMO: an on-line collection of architectural precedents in construction

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Introduction

Teaching in architecture relies heavily on the study of precedents. Precedents are the repository of experience and design knowledge from the past and therefore the necessary condition for architects to function as competent practitioners in today's society. Information and communication technology (ICT) offers new opportunities to store, accumulate and disseminate precedents.

Learning from design precedents is the essence of Case-Based Design (CBD), a theory and technology in the domain of Artificial Intelligence. Firmly rooted in the Theory of Dynamic Memory (Schank, 1982), the CBD approach propounds that people's knowledge does not only consist of abstract, generally applicable principles, but also of specific experiences, so-called cases (Riesbeck & Schank, 1989; Kolodner, 1993). Moreover, it claims that human memory is dynamically changing with every new experience. Several years of observing and analysing people's remindings have nurtured the hypothesis that experiencing, understanding, remembering and learning cannot be separated from one another. Our understanding grows by trying to integrate new things with what we already know. As a result, understanding causes us to come across old experiences as we process new ones. A significant side effect of this process of understanding is that memory never behaves exactly the same way twice, since it changes as a result of its own experiences. As experiences are recalled and used, memory gets an opportunity to try out the knowledge associated with them. This allows memory to re-organize and re-define itself dynamically, in other words to learn from its experiences (Kolodner, 1993).

Learning from experience can occur in various ways (Riesbeck & Schank, 1989). New episodes are stored in terms of old expectations generated by previous experiences. Eventually expectations that used to work may have to be invalidated. Indices to unique experiences that were once useful will cease to do so because similar experiences have been encountered. In short, memory learns from experience by acquiring new cases, grouping similar cases, or re-indexing cases stored improperly at first.

A dynamic architectural memory on-line

In order to provide students and teachers in architecture with cases at any time of the day and the night, we have built a growing case collection conceived as a dynamic memory on-line (Segers, 1998; Heylighen & Neuckermans, 2000). This collection, called DYNAMO and developed during the past seven years at the CADLAB of the K.U.Leuven, contains almost 600 projects, documented with photos, plans, source material, texts, ...represented by all together more than 7350 files and indexed by 1680 keywords. Projects have been introduced in the collection depending on the pedagogical needs of our school, related to the design studios as well as to the courses and seminars on architectural theory (Heylighen et al., 2004). From a technical point of view the collection is structured as shown in Figure 1.

The access to DYNAMO is free, but controlled by a system of passwords for copyright reasons. Users automatically receive their password via e-mail after registering on-line. The interface is written in English and today version VI is on-line. The address

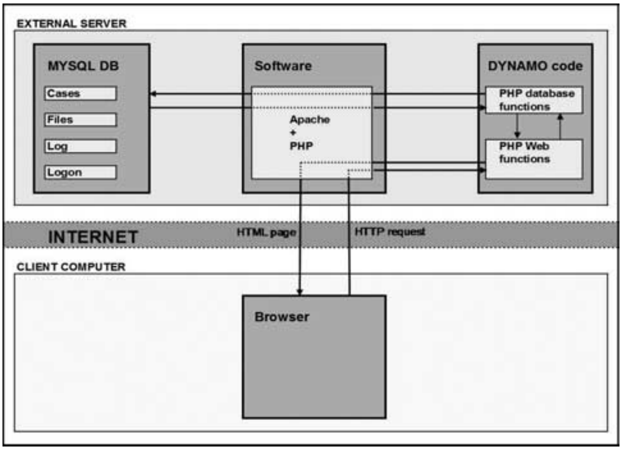

Figure 1: DYNAMO from a technical point of view.

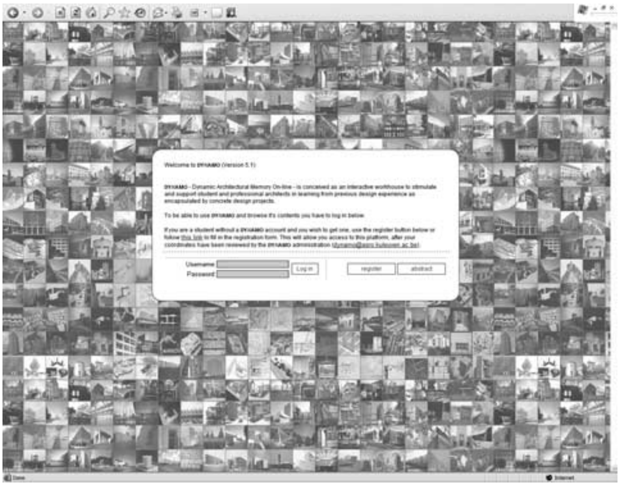

Figure 2: DYNAMO’s log on screen

Figure 3: DYNAMO’s main navigation screen

is http://dynamo.asro.kuleuven.be and the opening screen shows all projects in the collection, plus a dialog box to log on or to register as new user (Figure 2).

After logging on, the user is confronted with the main navigation screen as shown in Figure 3. The main features are home / browse / search / feed / check / help. Besides this, there is a dialogue box left from the search command allowing direct access to the requested data by typing a keyword related to the searched item.

DYNAMO in action

In order to show the potentialities of the collection and especially its search capabilities, we describe briefly the < BROWSE > and < SEARCH > functionalities. The best way to learn about DYNAMO is and remains to log on and explore its features.

The BROWSE function allows wandering in the collection without a specific request in mind; it is conceived as "a dive in an architectural bath". The browse button opens three possibilities: project list / quick browse / slideshow.

- *Project list* provides a list of all projects in DYNAMO sorted alphabetically, by id (i.e. chronological order in which the projects entered the collection) or by rating (i.e. frequency of consultation).
- *Quick browse* presents a completely random list of projects, providing the user a refreshing view on DYNAMO's contents or a foretaste of what the collection has to offer. Each time the quick browse function is started, the projects are reshuffled. Flipping a page, however, will not change the order.
- *Slideshow* automatically displays on-line images of projects one after the other, which can be further explored by clicking on the image itself. This action leads to the main screen of that specific project.

The SEARCH button gives way to two possibilities: *category search* and *advanced search*. Both rely on a dynamic indexing system that allows retrieving cases in multiple ways. Every project is indexed with various features that serve as filter criteria during retrieval and as links to projects with analogous characteristics. These features are grouped into three windows*, which represent three different ways of looking at the project collection: ID (identification), design, theory (see also Section 4). In order to avoid confusion, a clear distinction should be made between categories and values. The term category refers to the name of an index, e.g. *spatial configuration*. Each category provides a place for a case to characterise itself with one or more values, e.g. *cluster, linear, radial, 'plan libre'*. A value thus refers to the concrete realisation of a category for a certain project. It characterises a specific project but can, and in many cases will be the same for several projects. In other words, whereas categories are chosen generally and shared by all cases, the values for these categories are assigned to each case specifically. For some categories, *materials* for instance, a single case can have multiple values.

- The category search shows a screen where 20 categories can be chosen: e.g. *building programme* (i.e. current function or use) (Fig. 4). The number of programs displayed in the list can be chosen as well as the number of projects shown at once on screen. Clicking on *museum*, for example, will produce five screens with 18 museums each (Fig. 5). Clicking on an image leads to the main screen of that particular case as shown in Figure 6.

- The *advanced search* allows combined search. It allows a user to select various values from different categories and combine them with < and > or < not >. To start such a search, select a window* and then a category. This action results in the values popping up in the scroll box to the right. Select the desired value and use < and > or < not > to search for it. In the same way multiple values can be combined. Up to three values of categories even belonging to different windows* can also be selected (Fig. 7).

In all basic navigation screens, the dialogue box allowing direct search remains available.

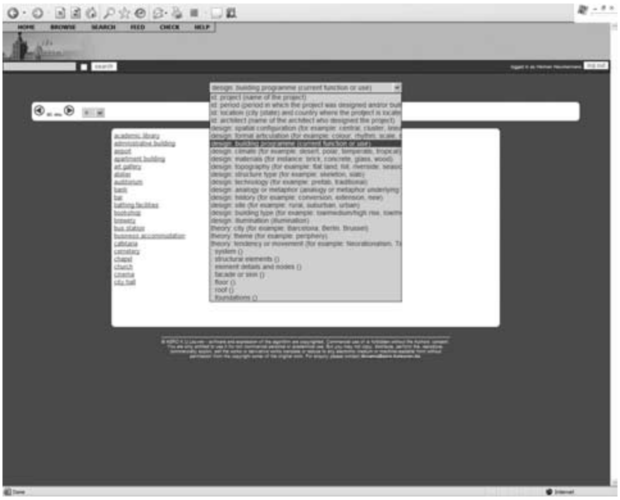

Figure 4:
category search

Figure 5:
search result when looking for projects with building programme 'museum'

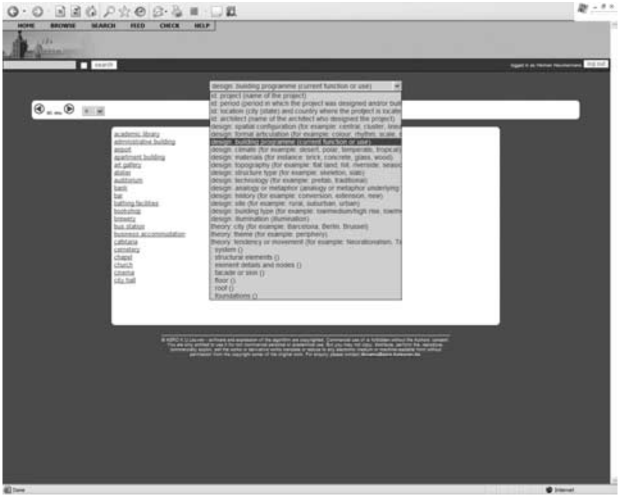

Figure 6:
zooming in on one
specific museum

Figure 7:
advanced searchallows
combining search terms

Basis and condition for a project to be in DYNAMO, is to be introduced as a case or a precedent. Courses, as such, cannot be submitted. In principle any user can introduce a case, but so far all information has been introduced either by teachers or by students in the context of an assignment and selected by teachers to be good enough to be introduced. New information will be checked by the administrators and eventually validated or rejected. In the context of an assignment, teachers may also request for a 'monitor' profile, which enables them to check and validate or reject the material submitted by their students. A status bar shows whether or not the information is already validated. All information has to be referenced: it means that each single bit of information (photo, drawing, text, etc.) has to contain a correct reference to the source of the info as well as identifying the person who introduced the info in the collection.

Windows

The collection can be consulted via three windows*, each containing an elaborated set of indices: ID (identification), design and theory. Each window allows to approach and select cases from a specific point of view. ID comprises basic characteristics that allow identifying a project. By contrast, the design window adopts a designer's perspective and approaches cases through aspects of form and space, construction, function, etc., while the theory window enables theoreticians to select projects by tendency or movement. Future addition of extra windows for other perspectives (e.g. conservation or reuse) is still possible.

In order to give a flavour of these windows* currently available, we list here the categories (search keys or indices) in each window*.

- ID:
  - project (name of the project)
  - architect (who designed the project)
  - period (in which the project was designed and/or built)
  - location (city (state) and country where the project is located)
- design:
  - form: formal articulation, spatial configuration, illumination
  - function: building programme, building type
  - construction: materials, structure type, technology
  - context: climate, topography, history, site
  - concept: analogy or metaphor
- theory: city, theme, tendency or movement

A window on construction

The presentation at the workshop shows DYNAMO at work on-line and proposes a new window* that focuses on construction. Figure 8 shows how it could be structured along the following lines: structural systems, technology, detailing and materials. A 'dummy' version of this new window* is presented in Figures 9, 10, 11,12 and 13.

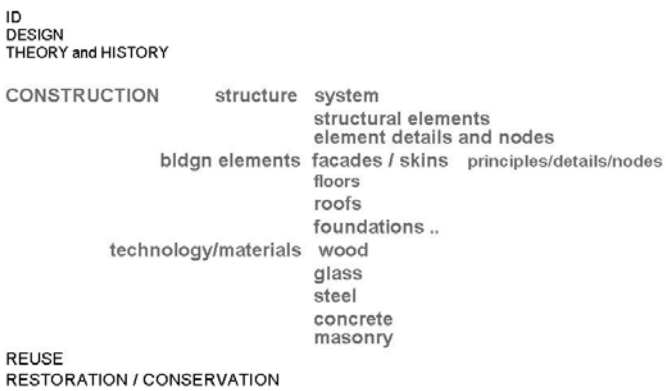

Figure 8

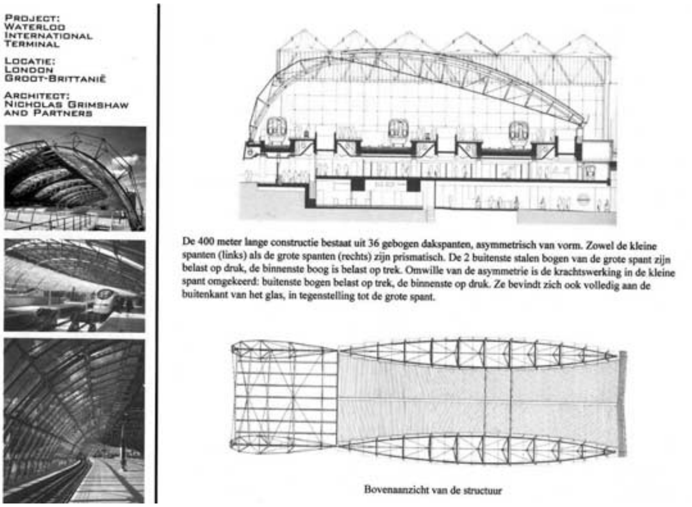

Figure 9

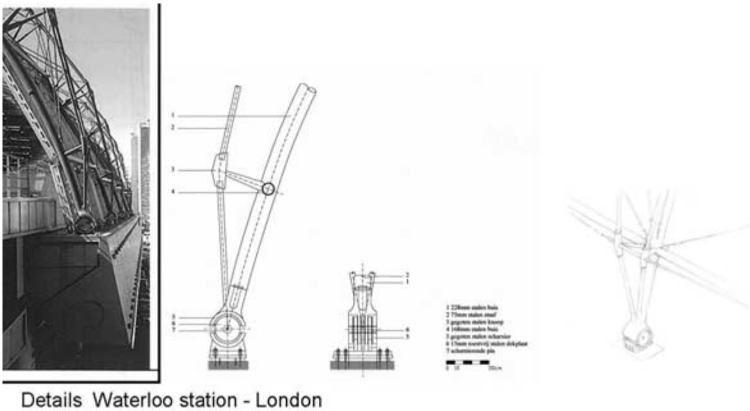

Figure 10

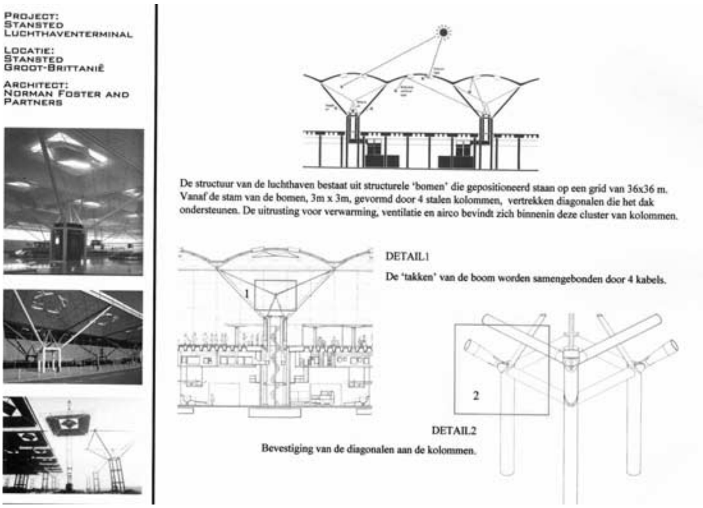

Figure 11

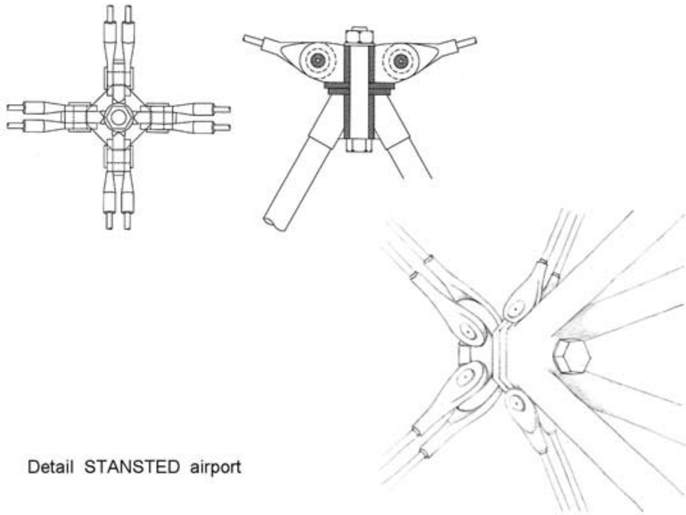

Figure 12

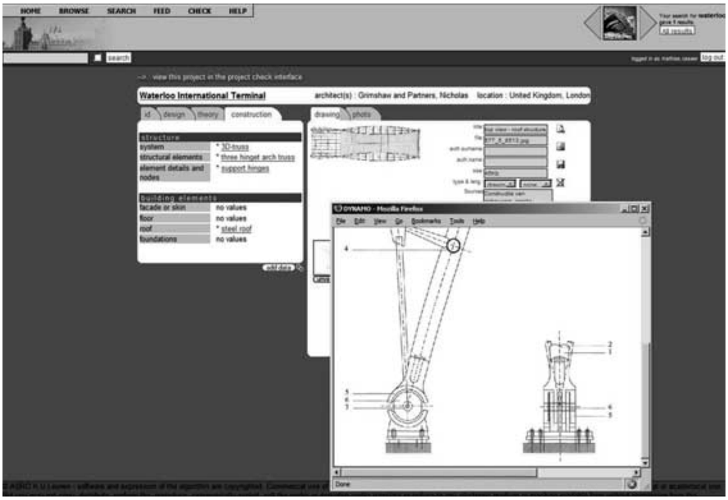

Figure 13

Figures 9-13: ‘dummy’ screenshots of a possible construction window

The number of windows* in DYNAMO depends on the number of users interested in such a view on DYNAMO.

It is the idea to build a didactic instrument for teachers as well as for students and to invite interested schools to contribute to this common source of information in a collaborative effort. All schools, as well as all users, subsequently will have free access to all precedents. Doing so, each user will benefit from the effort of each other, knowing that the whole is more than the sum of all parts.

Acknowledgements

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Dynamic & Interaction Teaching

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The call will present the experience of a different form of teaching construction. The basis consists to confront one project to begin a constant interaction between students, professors of the architectural school and lectures from the industry of building, using a dialogue through the computer and all its applications: internet, intranet, e-mail, auto cad, power point..., the oral expression, the events of the city or territory, being as much an possible in the sustain line. The come and go back between students, professors, computers & technician, open the curiosity of how we can build the architectural idea in eco & present method. The students begin to be interested in construction science.

Alrun Jimeno & Xavier Pouplana are two teachers at ETSAB-UPC (Polytechnical University of Catalonia – Technical Superior School of Architecture in Barcelona). The first is teaching in the specification construction, (Construciones Arquitectonicas 1) CA1-704 and the second in architectural projects, (Proyectos Arquitect_nicos) PA-735.

Both teach in equal proportion and impart the course "Design of Architectural Elements"= DEA. The teaching period goes along four month every year, in the 2on fourth trimester (Q-P) and it has the value of 4,5 credits.

With this little introduction we want to expose the origin & the evolution along the 10 years of history.

HISTORY OF etsaB-upc

- From the generalist architect to the specialist architect.
- New plan studies 94.
- Credits reduction.
- New structure of studies: O, OP & ALE
- But maintenance & growing up the education level.
- Great efficacy in knowledge transmission.
- Olympic Games 92 & Cultures Forum 04 Approach to Superior Education to Europe Space EEES
- Open to mobility programmes (SOCRATES, TEMPO, SICUE, SENECA, AMERICA LATINA & VISITING STUDENTS)

The new STUDIES PLAN 94 (08.09.94) written on the B.O.E 238 the 05.01.1994, propose a different system of studies. The superior teaching must approach the city & the territory.

The eventual happenings like the Olympic Games 1992 or the Cultures Forum 2004 help to find a rapprochement between Barcelona and Europe. Our school etsaB-upc will participle in the Superior Education to Europe Space EEES, with the plan reformed.

Let's see what it means

- Reduction of credits in all the disciplines
- More efficacy in the transmission of knowledge

The reduction of credits doesn't allow the teaching of all the historic knowledge to all the students.

STRUCTURE OF STUDIES

- OBLIGATORY (O): UPC EEES SUPERIOR EDUCATION IN EUROPE SPACE
- OPTIONAL (OP): ETSAB, different specialties.
- FREE ELECTION (ALE): Teacher, complementary education.
- OP: DEA design of arquitectural elements
- Requirements: 1st cycle complete etsaB + mobility programme students
- Look for: effectiveness & good results, but with less resources & short work.

So, the studies plan will structure the disciplines in three categories:

- Obligatory "O" the basic disciplines for all the students
- Optional "OP" specifics
- Free election "ALE" complementary education

That means that the new PLAN allows the student to choose in different OP or ALE. The studies of the OP + ALE depend directly from the etsaB. The system may change some disciplines, easy, to get students specialists in a different field.

What will the plan obtain?

- A new model of specialist architect is appearing next to the ancient model of generalist architect.
- The OP is helping to favour the transversality through the different departments (because the theme would be proposed by the etsaB & it is easy to make one change or innovate by the O & ALE.)
- The need of scientific knowledge, open the curiosity of the student in technique problems: graphic expression, construction systems, static & dynamic, comfort, sustainability…
- Those concepts (need & transversality) allow the introduction to the discipline, project in the first course, because of the *conscience of the lack*.
- Exciting the student to learn construction & other disciplines.
  This anxiety stimulates him to learn the technical disciplines that will give him security in front of the competitor and the society.
- Looking for the creativity generates the motivation
  The PLAN of Vallés prefers the tranversality before motivation, ETSAB is the contrary.
  Any way the three points are: efficacy, transversality & motivation looking:
  - to be more efficient in the professional area with less study hours
  - at the project as the axe who will open the motivation makes the possibility to reduction O and be complete with the OP
  - to have sustainability considerations like un important factor of the global vision of the necessities of a society in transformation.
  - To approach the architecture building to the industrialisation of elements or systems. This evolution goes very fast & need to act constancy
  - To open students exchanges to the main goal Socratres/Erasmus programme that encourage European cooperation in the field of education

- IN THIS CONTEXT WAS BORN DEA LIKE AN OP.

HOW CAN WE GET THE OBJECTIVES?

Elementary project in workshop seminary
⇩
Developed until it could be produced
⇩
CONSCIENCE OF THE INSOLVENCE
⇩
Motive
⇩
The necessity of others disciplines
⇩
Transversality of departments and industrialists
⇩
Acquisition of technical knowledge theory & practice.

In 1995, Alrun and Xavier, did promote the interdisciplinary course, called "Design of Architectonic Elements", DEA. DEA pretend to offer to some students an integral formation, theory and practice in project field until this obtain the construction definition for to be produced.

The teaching method needs the assessment of more people, some coming of others departments from de upc, (structure, condition, construction) others coming from the industry, that means, techniques with special formation always with the actuality known.

The course is organized like a seminar workshop with our presence & other teachers. The student has access to technical information with the team of lecturers, journals, books and programs computer. We offer the way to get engines to develop integer the project with fewer recourse and minimum effort.

Alrun and Xavier, do propose one little project, every year different that can be done in four months. The subject proposes some necessity of knowledge that the student opens the interest of the different disciplines of the studies. It begins the transversality through the department (graphic expression is an instrument to expose the idea, structure for holding the elements that need the construction to be able to the union of all, the condition to get a comfort, mechanic to assemble and to clear away many times...)

The education is done by

- theory
- practice

Knowledge

- The theory normally is making over monographic themes: steel, aluminium, composites, glass &manufacture, silicon, polycarbonate, textile, lift, stair, photovoltaic, zinc...,
- The class can be theory-practicum that means that after the speech the students can handle the material zinc, silicon with engines brought by the industry.

- Architects will expose the investigation of real examples: The translucent house done by Alfons Soldevila, The "world flower", the Venezuela pavilion in Hannover EXPO 2000. The lives can be open and close. There principal material is textile & steel. Or a new geometry of photovoltaic cell that allows obtain curvilinear forms, investigates by Rogelio Leal a doctoral architect.
- To assist at actually events like Construmat, (in our city it happens every 2 years), Forum (we get one at the 2004) helps also to grow the construction knowledge.
- Commentary & consulting the bibliotheca, journal, and web make an amplification of the teaching.

  Any way DEA is a life discipline.

How goes one course?

- Every year the theme is different
- The first day there is an exposition of theory and practical activity
- One little project is proposed
- Presentation and criticism of examples that we choose
- Show & discussion of models brought by the students
- The students write or design their idea
- It could be a new model or make much better an existing one
- It fixes a constructive system
- During the evolution theory and practice goes together, lessons & corrections private & public
- The project grows until it could be produced
- The instrument is the computer with the programs that will be necessary and the model.

What themes have we proposed?

- Deck plan transparent with domestic large
- Tram station
- Fire stair
- Bridge between two hypothetic building
- Hall-porch the upc-chapel "Torre Girona"
- Exterior box lift going up to the top of a gothic church
- Rural bus station
- Window for the etsaB
- Beach kiosk
- Industrial public interior stair

The program of a year

DEA - DISEÑO DE ELEMENTOS ARQUITECTÓNICOS			
FECHA			**ACTIVIDADES**
Febrero	8 martes	XP-A	Presentación de la asignatura. Tema "escalera interior pública que sea industrializable".Análisis de la Normativa. Presentación de ejemplos de ilustres". Ejercicio en clase: definición de necesidades. Croquis rápido de la idea emplazamiento, tipo, elemento, y materiales."adjetivos"
	15 martes	XP-A	Análisis y crítica de ejemplos aportados por los alumnos. Selección de adjetivos semejantes. Agrupación de alumnos por afinidades Idea de sistema de trabajo de una escalera."Jordi Maristany"
	22 martes	A	Materiales adecuadas para: estructura, peldaño, pasamanos, antepecho Formas de apoyo o fijación: cimiento, viga, pilar, pared. Comentario de los croquis rápidos. Visita de casos reales. Biblioteca Campus Nord- Gabriel Ferrater.
Marzo	1 martes	A	Criterio de diseño de los elementos portantes. La madera: natural o laminada. Las barandas opacas y/o translúcidas. Ensamblajes. El vidrio. Aplicación al peldaño y/o a la baranda. Ejemplos.
	8 martes	A	El acero: galvanizado, pintado o inoxidable. Los cerramientos metálicos opacos o translúcidos. Sistemas de unión: tornillos, remaches, soldadura. Otros metales: cobre, aluminio, zinc-titanio...
	15 jueves	XP+A	1ª entrega. Presentación del anteproyecto. Planta escalera, sección, alzados anterior y posterior de: escalera, peldaño y barandilla. Derivados del petróleo. Policarbonato, poliester. PVC Composites: alucobond. trespa. Resinas fenólicas: prodema. Naturvex cemento y fibra Corian
	29 martes	A	Taller: corrección de la 1ª entrega. Los elementos pétreos. Hormigón natural o artificial (Breinco, Escofet) El granito, los mármoles, el silestone
Abril	5 martes	XP+A	Los elementos textiles: propiedades y formas de trabajo. Sistemas de montaje." Nelson Rodríguez"consultar la página web sobre textiles de CA1, compuesta por Josep Ignasi Llorens y sus alumnos de doctorado.
		A+XP	Taller de diseño
	12 martes	A+XP	2ª entrega. Proyecto: plantas, alzados y secciones. Escala. 1:10 Tornillos, peldaños: huella y tabica a escala 1:2. especificaciones técnicas Crítica de los proyectos realizados por los alumnos.
	19 martes	A+XP	Normas y modelos de representación gráfica. DIN, UNE, ISO... Taller de diseño.
	26 martes	A+XP	Taller de diseño. Idea de ensamblaje y empaquetado de la escalera. Taller de diseño, apoyado por un professor de "graduado superior"
Mayo	3 martes	A+XP	3ª entrega corrección de la 2ª con despiece de elementos, Perspective axonométrica, 3D, o maqueta,. Discusión sobre los resultados de las propuestas
	10 martes	A+XP	Las instalaciones. Posibilidad de iluminación nocturna. Dispositivos de emergencia. Taller
	17 martes	A+XP	4ª entrega y última. Discusión abierta de los trabajos entregados.

Profesores: Alrun Jimeno Urban, Xavier Pouplana Febrero 2005

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How does the student evolve?

There are different ways of working: the student can begin about one model done & make it better or he can begin from zero and create a new form. That means that the industry can find new products if the student is sufficiently creative & receptive. We insist it must be eco.

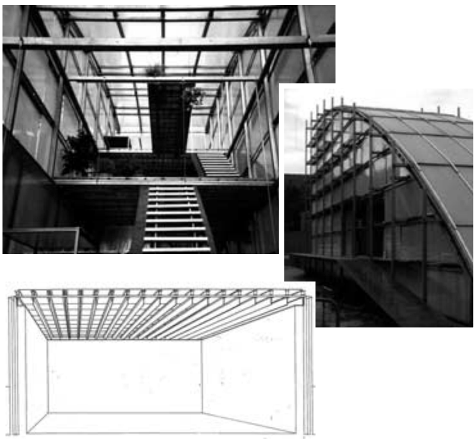
- The receptive and the creative, help to him to arrive at developing to an executive level.

The results come out with the support of many disciplines:

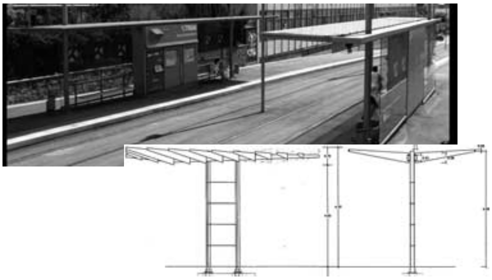
- Academic teaching at the classroom
- Visit to examples builder or analyse hypothetic cases resolved similarly
- Analysis of materials or systems that could be use for the project
- Making a pre-dimension with verification of the section
- Making a model
- Management of the elements & system characteristically
- Opinion on the fabricant, professional, internet, intranet, journal & catalogue
- An interaction inside, outside take out a very dynamic teaching.
- The presentation of the project will be complete with the assembly of the pieces, rendering & model
- Public discussions take place during the evolution of the project
- At the end there is the qualification and the recompilation of the works to show at the new year to the new people of the course.

The sequence of the theme has very often contact with the reality

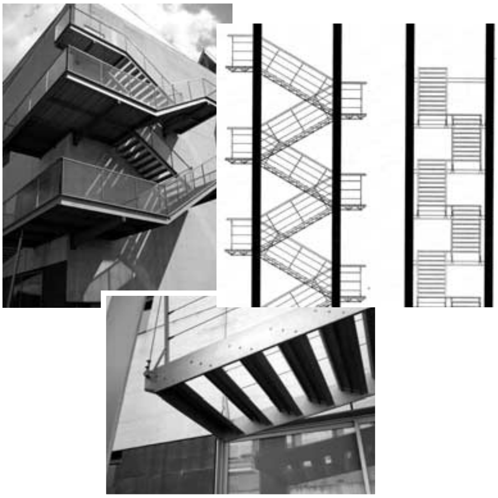
1. *Plan deck transparent with domestic large.* There is a moment that the society & architect will use the glass for beam and column. Structural glass is very useful in our building. The professional Jose Pablo Calvo of CITAV, (technology centre of glass technical applications) visit us to explain how to use and make the calculus of this material. He sends us the catalogue with plenty of information one year after another.



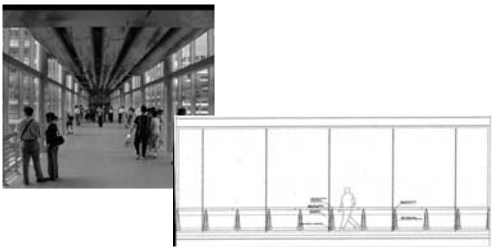
2. *Tram station*. The project was develop before the existing the "tram-baix". The designer of the Metropolitan area transports came and exposed to us, all the possibility of station cases. We get the basis about the itinerary of the rail tram and models of different tramways.



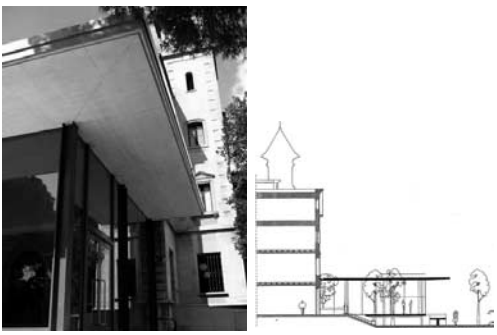
3. *Fire stair* is a candent theme after there was an edition the CPI-96 norm's in Barcelona, about the fire. Francisco Labastida invited teachers of condition and bumpier to interprete the text. With the introduction we visit the stairs add to the buildings of our university and after the students make the definition of their work. It must be a series industry element. After 1996 many hospitals, schools and public building have adapted the construction to their fire norms.



4. *Bridge between two hypothetic buildings*. After the Olympic Games many bridges were built so we intent to suggest the analysis of the problems that have ancient and new materials when put together, different levels to connect, covered or uncovered.

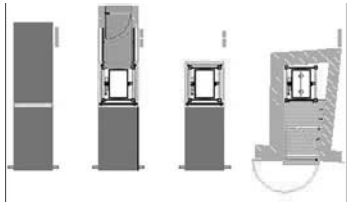


5. *Hall-porch the UPC-chapel "Torre Girona"*. It was a chapel at a girl's school and now it will be one multifunction space that needs a hall for teachers & people of the upc. It is a real necessity to approach to the ETSAB. The UPC will give an actual image of the corporation. We could hear the necessity explained through the Dean and many solutions

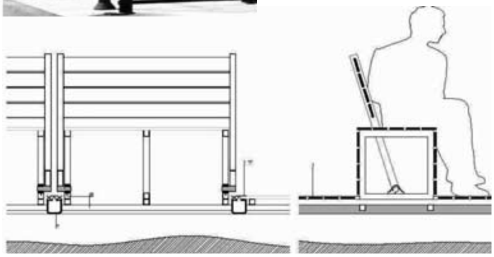


came up. The problem of the accessibility was a new parameter resolved. The architectonic barriers need to disappear.

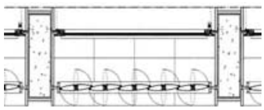
5. *Exterior box* lift going up to the top of a gothic church. The remediation of Sant Marti's Church needs to use the space under the deck. The stairs to climb up are very uncomfortable and one must be able to visit at the incapacity people. We give the plans of the place and the building to make the project. Professional of lift Kone and Ersce make us a presentation of the different product of the market. Other professionals make a speech of lightness façade for to close the lift.



7. *Rural bus station*. With the big movement from the city to the country, the state makes the strengthening of the public communication. The time of wait is longer than in the city & the construction presents several difficulties. May be there is a small road unable to be used by the truck. So different problems appear than the tram-station. It was a year that we had many Socrates students and the solution had great variety.

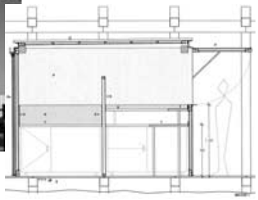


8. *Window* for the ETSAB was one not so interesting project for the students. Anyway it is a real problem for the teacher's offices of Segarra building.

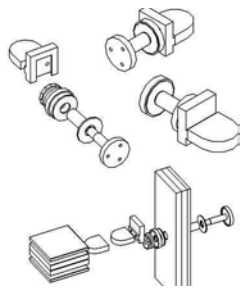


9. *Beach kiosk* coincides with the arrangement of one beach in "Bagur" village by the collaboration with another OP in combination with Teresa Rovira and

Bosch. We use the landscape of Costa Brava beach to begin to work. At the time, in Barcelona there were constructions for the forum cultures, so we visited the different constructions in situ guided by the director architect.



10. Industrial public interior stair. That is the last project done by our students. They could propose the emplacement. The places are changeable: a department store with a very extended stair, a big store with a transparent stair, little elements that you can make in a unit with different inclinations, or others that want to offer a good, beautiful & cheap solution.



Every year the theme is new, and enables us to deepen more and more, year to year. The renovation every year supposes an attraction for the student and also for the teachers. The teacher brings from the industry news to the classroom. There is a continues knowledge at the lecture room. The student learns to find information in the front of every challenge. They learn to critic and choose the best solution that the industry offers. The teachers offer their opinion about the esthetical aspects and respect student opinions. The constructive critic is drive to the possible pathology. What will be with time and how the sustainable concepts so necessary in our world are resolved.

Note
The technical industries that visit us are: glass (CITAV, Pedragosa, Cricursa), aluminium (Technal), stainless (Acerinox), polycarbonate (General Electric, Poliglas), composites (Alussuise, Trespa), photovoltaic (doctor in the theme Rogelio Leal, Dr. Lloret), textile (Nelson Rodríguez, J.Ignasi Llorens), silicon (Collack) zinc (Guild Cooperative), lift (Kone, Ersce) ...

Mesut B. Ozdeniz
Halil Z. Alibaba

The New Ways of Construction Teaching

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A construction tutor in a school of architecture faces a number of problems. The first problem is about how much to teach. There are vast number of construction methods and components in our days. How much of this vast knowledge should be taught? The mostly used construction methods and components should be taught in detail. However, some of the other methods which look promising should also be mentioned to cause attention of the students and to develop their creativity.

In addition to these, students should be guided on how and where to find additional knowledge. There are many sources of construction knowledge in our days. These can be listed as:

- Construction Textbooks,
- Construction Journals (Scientific and Professional),
- Construction Catalogues,
- Company advertisements and technical notes,
- Internet Sources,
- Building Research Establishments and their publications,
- Building Documentation Agencies (like CIB) and their publications.

Another problem faced by construction tutors is how to teach construction. Normally construction courses are given on the first two or three years of curriculum. Most of the construction textbooks are too dull. They contain information in a serious manner. A text book written by (REID, 1988) explain how structures stand up in a splendid way to freshman students. Construction textbooks should be written in the same manner. Another tool which can be used in teaching construction to the freshman students is the magic of color. It may be a good idea to have large, colored explanatory drawings on sheets, kept continuously in the drawing studios or classrooms. It is always possible to show the students pictures of these constructions by slide or LCD projections.

An alternative way of teaching students construction is allowing them to construct a building. This is what we call learning by doing. These exercises are very valuable. They give students insight to understand many construction problems. However, it is a costly teaching method and it is not possible to realize this for all types of structures.

We should also consider the difference between students of architecture and the students of architecture or building construction technicians. Architects are more interested in the best final solutions so that they can design them. Technicians are more interested in the way a building element is constructed. This is what they will manage in their occupation. Certainly, if in a country there is no difference between architect and the construction technician both should be taught.

Construction by computers is another possibility which we should start thinking today. However, there is still much research to be done in this field and possibly construction people should work together with the computer scientists.

At Eastern Mediterranean University, Dept of Architecture we have developed the expert system BES, for the selection of building elements in architectural design which can also be used in teaching construction (ALIBABA and OZDENIZ, 2004). Expert systems are computer programs which are composed of knowledge about a special field and are used for solving the problems as human experts can solve. In the design of this expert system, we have considered on how architects select a building element. Firstly architect may have some preferences on the alternatives. Secondly, an architect may have some expectations from a building element. For example, the building element should be this much fire proof, or it should have this much sound insulation etc. Thirdly, some expectations may be more important than the others or some alternatives may be totally eliminated due to the conditions. For example, timber staircases may not be required. The outlined flowchart of BES is given in Fig 1.

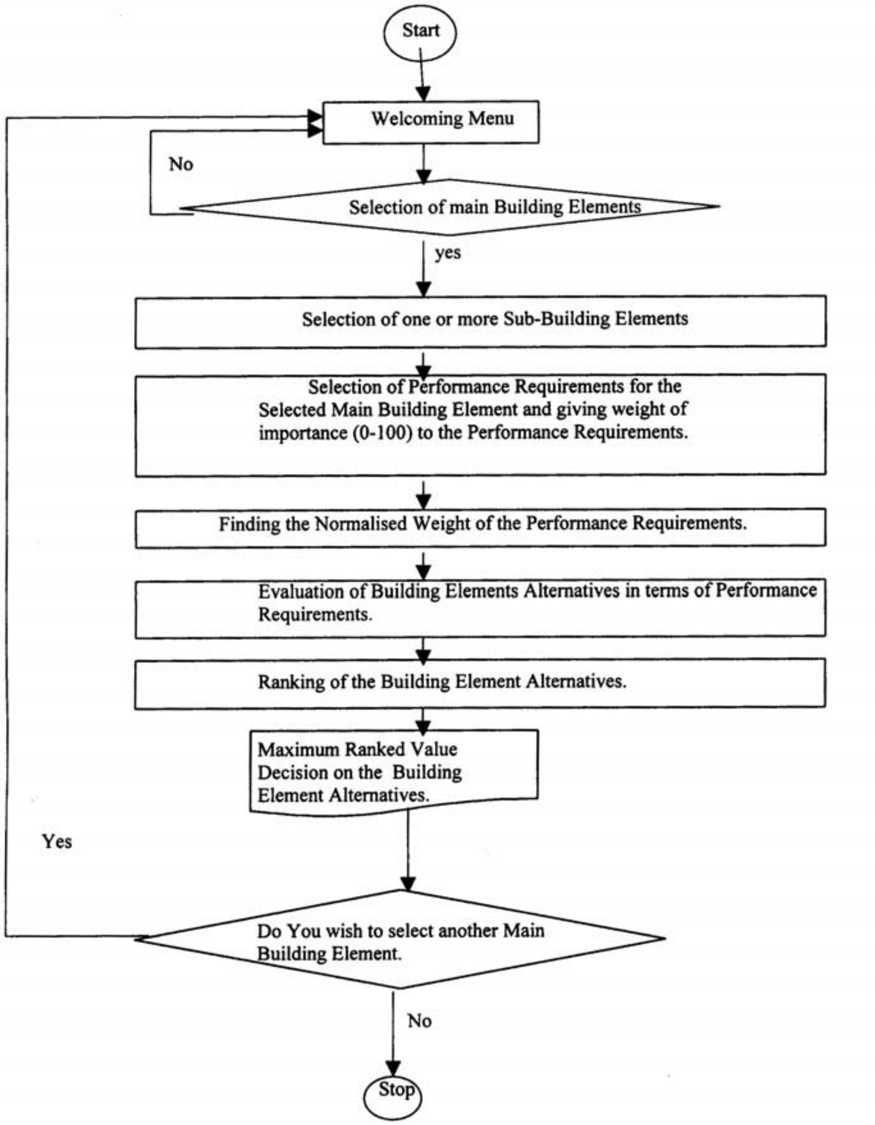

Figure 1.
Outline flowchart of BES.

All the construction knowledge available at the moment were included in BES. Behavior of the building elements is an expert knowledge this is also included in BES. It is also possible to add new knowledge to the model. When the designer inputs his/her preferences about the building elements and the performance requirements BES will rank the best possible building elements. It will also provide the technical information and cost data. This feature of the expert system and the possibility of using it through internet, makes it an international tool for construction education. User dialog boxes of BES are given in figures 2A-F and the data examples in figures 3 and 4.

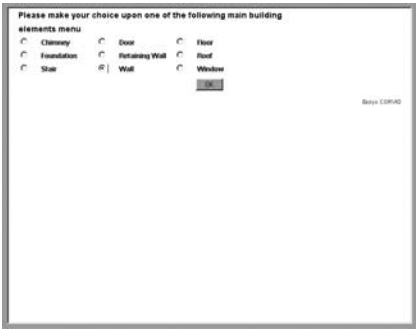

Figure 2A.
User dialog boxes in BES. (Selection of wall from main building element list.)

Figure 2B.
User dialog boxes in BES. (Selection of wall function from building element type list.)

Figure 2C.
User dialog boxes in BES. (Selection of external walls from sub-building elements list.)

Figure 2D.
User dialog boxes in BES. (The list for the performance requirements of external walls with editable default values.)

Figure 2E.
User dialog boxes in BES. (The list for the expected performance grading of "stone solid wall" with editable default values.)

Figure 2F.
User dialog boxes in BES. (The final grading of the sub building elements in ranking order.)

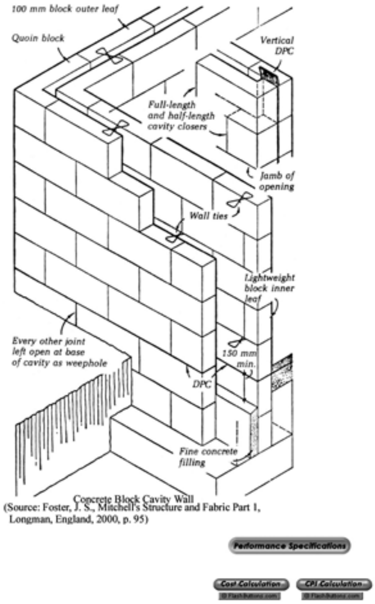

Figure 3.
An example of construction drawing BES gives for concrete block cavity wall.


Please write the amount of the items required at the intersection points shown as "0" of items and building elements.

Item	Description	Unit	Mobilization etc	Ret.Wall	Found.	Walls & Partitions	Floor	Ceiling	Stair	Roof	Chimney	Window	Door	Sewage	El.,Mech.,Sanitary	TOTAL	U.Rate $	Total $	OH&P % (Overhead&Profit)	Total $
			Quantity																	
1	Mobilization	LPS	1													1		0.00 $	0	0.00 $
2	General site clearance	LPS	1													1	0.00 $	0.00 $	0	0.00 $
3	Excavation to reduce levels	m3	0													0	2.50 $	0.00 $	0	0.00 $
4	Excavation for foundations	m3		0	0				0							0	6.00 $	0.00 $	0	0.00 $
5	Excavation by hand	m3		0	0				0							0	10.00 $	0.00 $	0	0.00 $
6	Backfilling in layers and compaction	m3		0	0		0		0							0	4.00 $	0.00 $	0	0.00 $
7	Layer of sand 10 cm	m2		0	0		0		0							0	1.20 $	0.00 $	0	0.00 $
8	Hardcore 15 cm	m2		0	0	0	0		0							0	1.50 $	0.00 $	0	0.00 $
9	Lean Concrete - 200 dosage	m3		0	0	0	0		0							0	52.00 $	0.00 $	0	0.00 $

Figure 4.
A sample for cost calculation.

The model is in the process of development and we also have some criticism on it. Firstly, the construction data on it are in the raw form. In other words we put all the data into BES as we found them. We are in the process of organizing them. Secondly, we are considering what else we should add to it, so that it can be used more practically as an educational tool. One possible thought is to make the drawings appear on the computer screen as though they are being constructed. Thirdly, how can we make it work for building elements with dual functions? For example a building element which is both external wall and roof. Fourthly, how can we make it work for the structural building elements? Lastly, how can we increase the creativity in selecting the building elements?

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Josep Llorens

Computer Assisted Presentations, on-line Exercises and Internet Databases for Construction Teaching

School of Architecture of Barcelona
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Present day difficulties in construction teaching at the university may be faced combining old and new techniques such as conventional lectures, exercises on-line and Internet oriented databases. Some experiences developed in Barcelona for students and architects suggest a method based on the three aforementioned techniques:

1. *Conventional lectures* devoted mainly to theory, principles, ideas, fundamentals and all concepts that can only be taught at the university and professionals will never learn. They refer to the knowledge needed to formulate the problems, look for solutions and verify them. Lectures are nowadays supported on Microsoft PowerPoint presentations or the like. Several warnings have to be kept in mind:
   - Do not project and read the same text.
   - The background may interfere with the text. Be careful using photographs as background.
   - Refrain from using dynamic features. Words flying from outside and letters built from points annoy the audience.
   - Stand up and move around. Seating in front of the computer and monotonous speaking promotes sleeping classrooms.

2. *Exercises on-line.* More detailed transmission of knowledge is now possible through the Internet. Two courses on-line were designed and tested to teach design of structural reinforced concrete members to professionals. The following conclusions can be deduced from the results:
   - On-line education is based on the individual relations between the professor and the student through the net.
   - The time-table can be adapted to the possibilities of the student.
   - The teacher follows directly each student.
   - Much more dedication is needed. Cost of production is very high.
   - The participation of the student who does not abandon the course is practically total.
   - The communication increases substantially. Feeling that others are not listening inhibits timidity and shame.
   - Everything is recorded. Comprehensive evaluations are possible.
   - The transmission of practical knowledge and exercises is much more effective than the transmission of theory and ideas. That's why on-line for practical purposes is recommended here.
   - Repeated questions are stored in the FAQs section.
   - Dialogue is possible through the Forum section.

   (Courses on-line of the "Escola Sert" where these experiences were done may be visited at: http://www.coac.net/escolasert).

3. *Internet databases*. It is necessary to filter and orient the huge amount of information available in the Internet concerning to every topic. For that purpose, recommended links and specialised databases can be provided:

   - «Textile Construction & Tensile Structures. Joints, connections, fittings and anchors database ». To teach textile roofs and tensile structures a database has been provided at: http://www.upc.edu/ca1/cat/recerca/tensilestruc/portada.html. It includes typology, details, references and links. Started by the teaching staff, it is now fed by the students as a part of their contribution to the course.

- http://www.e-coac.org/sai/inter/ is a searcher based on Internet web sites that provide useful information to architectural design. Visiting them technical data and explanations are found because the addresses are filtered by the Architects' Association.

Conclusions

A practical way to deal with increasing university constraints, complexity of knowledge and new techniques consists on mixing computer assisted presentations, on-line exercises and education oriented databases. The presentations assume the role of conventional lectures aimed to theory, principles, fundamentals, ideas and concepts, while teaching on-line is more effective for practical issues and updated information can be provided through the Internet. All of them need important alterations of previous texts and material. Consequently, the answers to the questions of the call for the Fourth EAAE-ENHSA Construction Teachers Sub-network Workshop are:

What tools and vehicles will be employed in the new construction teaching?
Computer assisted conventional presentations, on line exercises and education oriented databases.

How will new information on innovation, new materials and construction methods become known to construction teachers?
Teachers are professionals involved in building construction.

How could this information be taught and disseminated to students?
Through conventional lectures, on-line exercises, websites and databases.

What are the necessary initiatives our Network should take towards strengthening this new form of information exchange and towards enriching and improving the process of teaching?
"THE EUROPEAN BASED NETWORK FOR TEACHING CONSTRUCTION IN ARCHITECTURAL EDUCATION": www.teachingconstruction.com
(Database of documentation, images, links, on-line exercises, computer assisted presentations, news and events)

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Oliver Fritz

Mass Customized Constructions and Architecture

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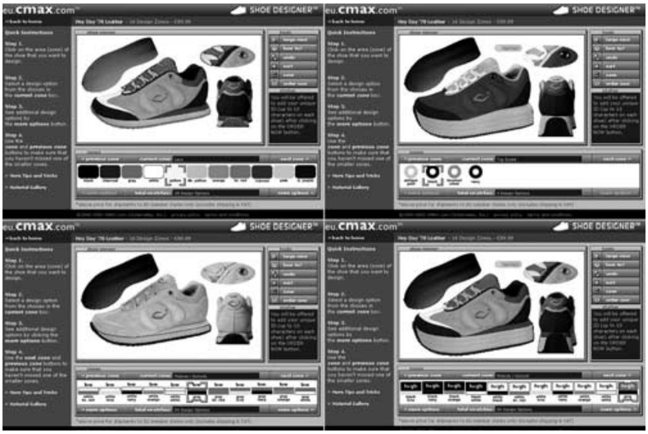
Since the beginning of the 20th century, architects have been experimenting with industrial methods of construction to build residential housing. Experimental projects like Gropius' Dessau-Törten as well as constructive experiments by Wachsmann and Prouvé provided the basic insights that led to prefabrication as practiced in the construction industry today. The various design and production methods that have resulted from this effort encompass a broad spectrum ranging from prefab homes-uniform and ready for occupancy-to highly developed modular construction systems, all the way to façade elements that are prefabricated in the workshop and installed in a large-scale application process on site. These systems assume fundamentally different forms but display a number of shared characteristics and objectives: shorter time spent on the building site, higher degree of precision, increased security, and reduced costs of planning and construction. Conventional prefabricated housing construction is extremely limited and practically no customizing by either the client or the architect is possible, while modular construction systems are distinguished by their regularities and uniform patterns. Building elements individually prefabricated in the workshop are generally not restricted to a predetermined form or mode of installation.

On the other hand, construction costs are usually proportional to the flexibility of the construction method. As a rule, traditional and less flexible planning and construction methods are more economical. A real challenge for the future of industrial construction is to enable builders to react to clients' individual wishes and needs. In the industry, there is an increasingly widespread orientation on individually customized mass-produced structures. In the past, this was practiced only in cases of cost-intensive products (like those of the auto industry) available with limited configuration options; now, there are firms that are customizing small, lower-priced products. This tendency is being made possible, above all, by new types of information technology, new forms of communication (like the Internet), as well as modern, individualized fabrication techniques.

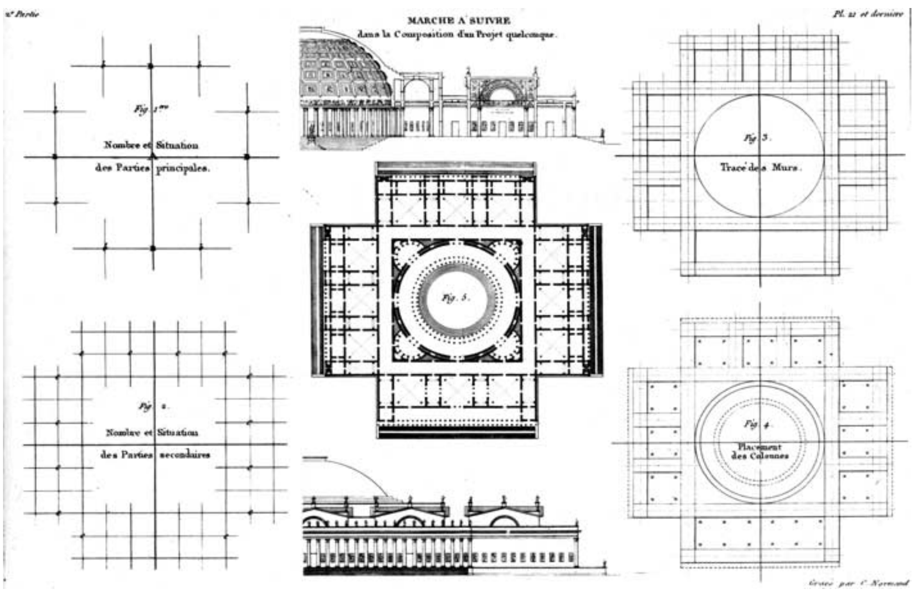


Customized Footwear,
http://eu.cmax.com/

For the last years, the Department of Computer Aided Architectural Design (CAAD) at the Swiss Federal Institute of Technology in Zurich (ETHZ) under the direction of Prof. Ludger Hovestadt has been conducting research on the integration of state-of-the-art information technologies into architectural production and design processes. The aim of this research is neither the formal development of a new type of architecture nor the definition of stylistic or formal characteristics; rather, the point here is the structural development of buildings in a way that proceeds from their essential "core" and the formulation of this process in a unified code that no longer provides an exact rendering describing a piece of architecture but rather fixes it as a program in a set of data- as what might be termed a "genetic code" that contains all relevant information about a building but no prescribed form of representation. This set of data can be configured, displayed or produced by any output device: in the Internet, via plotter, or directly as a structural component. Since 2004 I'm also work in this direction at the Liechtenstein University of Applied Sciences – on the one hand to refine and complete the technical Ideas- on the other hand to find a pragmatic approach to reality.

Programmed Architecture

Previous attempts to program software to generate architecture to some extent independently have run up against a very generalized problem in the field of architectural design: objectifiability. To what extent can the solutions generated in this way be objectively assessed? Issues of a functional nature - such as keeping distances that users have to walk within the building as short as possible - can indeed be analyzed adequately, but not the question of whether the windows on a particular façade ought to be rectangular or square. The problem that usually arises in evaluating architecture is that there frequently is no clearly "right" or "wrong" solu-



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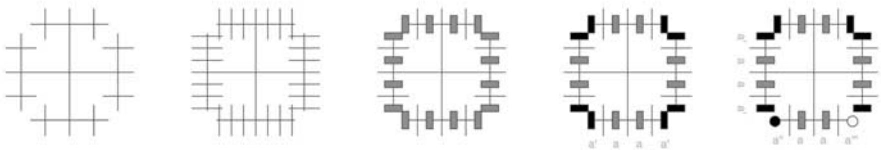
tion, but rather only one that someone likes or not. The assessment cannot always be supported with objective criteria; subjective taste is often the determining factor. Efforts to equip programs with learning algorithms-akin to genetic algorithms or neuronal networks- have not been an unqualified success thus far. Obviously, the interrelationships among aspects like physical setting, analysis, idea; style, space utilization program and choice of materials are too complicated to be succinctly summarized. And every designer has a different conception of the hierarchy and the importance of the individual aspects. Similar problems arise in the field of computer-generated music with the attempt to simulate classical composers, whereas new compositions not subject to these restrictions can be programmed very easily. Accordingly, there can be no generally applicable software or universal machine to design architecture.

How, then, could the computer-as a tool with great promise for the future, and beckoning areas of deployment that go beyond the electronic drawing machine, communications manager and archiving system-serve as a means to support the design process, and what consequences would such use have for architecture?

One of the first "programs to generate architecture" was described by Jean Nicholas Louis Durand in his 1819 book Marche à suivre. Précis des Leçons d'Architecture données à l'Ecole Royale Polytechnique.

In it, Durand derived the construction of a detailed building from a few simple, multi-step rules. He formulated the axes of reflection and the minutest commonalities in his program and, in this way, unmistakably described the architecture. The result with which we are confronted is a plan in which, for one thing, elements are arranged in a way that is by no means haphazard and, for another; it is very easy to discover errors. This is not a program that generates architecture; rather, this is a case of programmed design - a description of a building that could not be more compact and one that avoids redundancies.



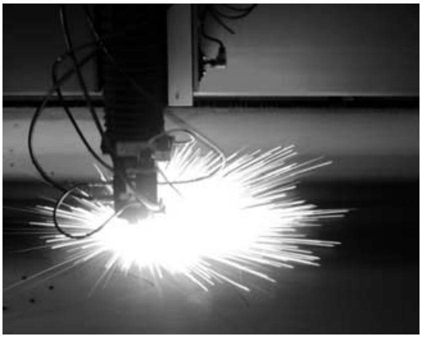
the Program of Durand – object-orientated

As far as the description of objects is concerned, modern object-oriented programming languages have a crucial advantage over Durand's linear (procedural) descriptions. With them, exceptions as well as rules are described in such a way that characteristics of a precursory object can be overwritten. In this way, it is relatively easy to build up very compact and yet highly adaptable structures that can be used both descriptively and operationally. This mode of programming is most convenient for the task of architectural design since structures can be described in detail without a definite solution to a super ordinate problem having to be found.

Laser Printers and CNC Machines, Programmed Objects and Postprocessors

Only a few years ago, producing a single copy of a book, for instance, or a limited number of color postcards was a rather highly involved undertaking, since such jobs only made economic sense with print runs over 1,000 copies. Approximately 10 years ago, the first color laser and inkjet printers came onto the market. A laser printer was a considerable advance over its forerunners such as offset printing machinery. With this new technology, it makes no difference whether one prints out a single copy or multiple copies of a page. A new typeface or a completely different layout can be selected for every page. The laser printer is a flexible output device for any content whatsoever, whereas offset printing machinery is set up to turn out a single page at a time. These functions can also be usefully applied in architectural production processes, assuming compatibility between the descriptive format and the output device is achieved.

As previously mentioned, architecture can now also be designed as a program instead of, as is usually the case, as a blueprint. The essential innovation here as far as architecture is concerned is the ability to take the code that describes a building and, through the use of so-called postprocessors, to generate a variety of different forms of representation: a CAD rendering, a print file, a data sheet featuring a list of components, or an invitation for tender offers. In most cases, postprocessors are small translation programs that produce the necessary data from the code.



a concrete-"printer", a CNC – Mill for wood, a lasercutter for steel...

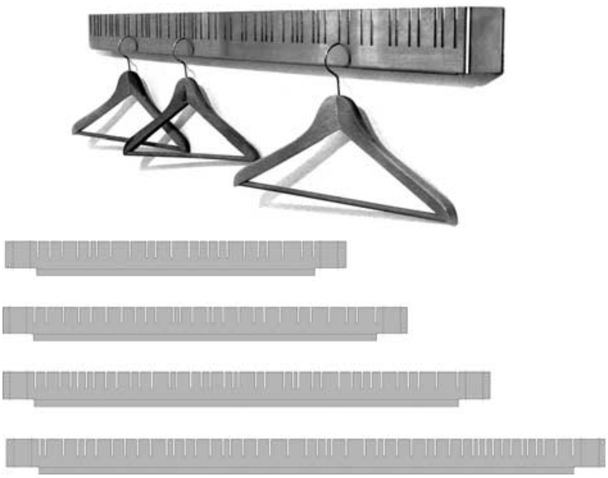
If the programmed architectural object offers a "print" option and if the program can execute it, a CAD rendering is generated from the code and sent to a laser printer. The printer, in turn, carries out this program in step-by-step fashion and produces a drawing of the programmed object on paper. In doing so, it makes no difference to the laser printer which printing instructions have been sent by which object, just as long as it is able to execute the program. Furthermore, the above-mentioned program can also feature a production option, whereby the necessary production data are calculated from the code and sent to the corresponding production machinery.

Thus, if the laser printer as a machine is capable of printing onto paper, it follows that there must also be computer-controlled machinery capable of directly "printing" a construction.

With respect to technique and content, the problem of "printing out buildings" seems to have been solved. Just as a programmed object can be printed to paper with a laser printer, the same object can now be printed out" in concrete with a concrete plotter. Metals and plastics can be cut with laser cutting machines; any imaginable form can be produced from glass or stone with water-jet cutting machines; plastics and wood can be worked with computerized numerical control (CNC) molding machines. In accordance with this line of thinking, a current challenge for the field of architecture is to develop and implement structures that are compatible with these principles and can be produced on such machinery.

Parametrized Objects

Here is a brief but easily understood example meant to clarify the idea of a parametrized object and the series of steps involved in producing one. A rack for hanging up clothing is described in a program; entering the corresponding parameters-e.g. its length or the minimum distance between the individual notches that anchor the hooks of what- ever sort of clothes hangers are used with it-makes it possible to generate a specific object that can be produced directly by means of a laser cutting device. Whether three of the same objects or three different ones are to be produced does not have a material effect upon their price: a rack costs about 100 Swiss Francs per linear meter. This is a programmed design from which, in a matter of seconds, an unlimited number of different objects can be produced. From this, it follows that the economic viability of a piece of architecture is no longer proportional to its uniformity. If a design consists of many different objects of the same type and it can be described and designed in this way, then this has far-reaching consequences for the organization, construction and design of architecture.



Design: Christoph Schindler CAAD ETH Zürich

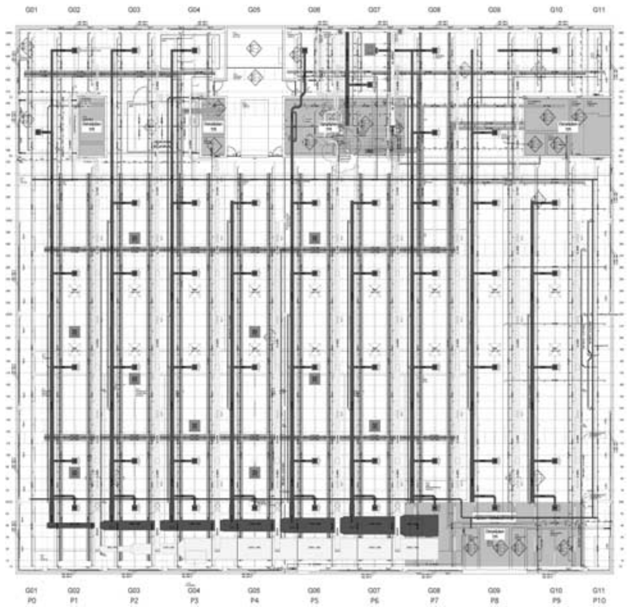
Prototype = Series

When CNC machinery is used, the production costs of a prototype differ only slightly from the costs of producing a component in serial production (assuming that the concept of serial fabrication still even plays a role in this type of development and production process). With these design and production principles in force, very small production runs can be economically set up, produced and marketed with the use of very limited personnel resources. From the architect's point of view, the blending of a form of organization derived from the crafts and trades with industrial production methods could open up attractive new possibilities. After all, why shouldn't he go ahead and create a prototype of the façade component he developed himself, and, ultimately, produce it himself too?

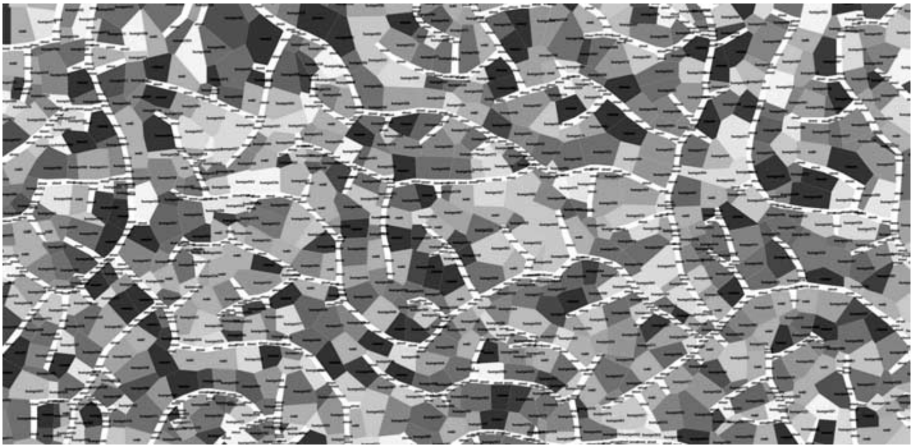
According to the principles of conventional industrial construction, the development of a building component means a high initial investment which can only be amortized through big production runs, an elaborate marketing campaign and a large working group; here, however, it is conceivable to generate constructions and details that are highly individually adapted to a particular piece of architecture.

Summary /Work in Progress

Works of architecture can be programmed generatively as well as descriptively and in a way that is economically viable. By way of illustration, I present several projects with which I have been associated-one involving the firm digitales bauen and the collaborative project entitled "KaisersRot" (http://www.kaisersrot.com) carried out by the ETHZ, my own office and the Netherlands architectural firm KCAP Rotterdam.

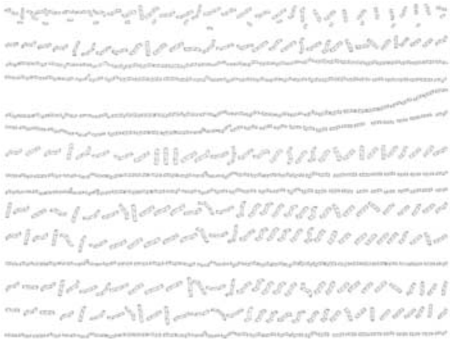


Digitales bauen, a programmed layout, Roche Diagnostics, Mannheim, Architekten: Schmidt& Schmidt Architekten, Karlsruhe



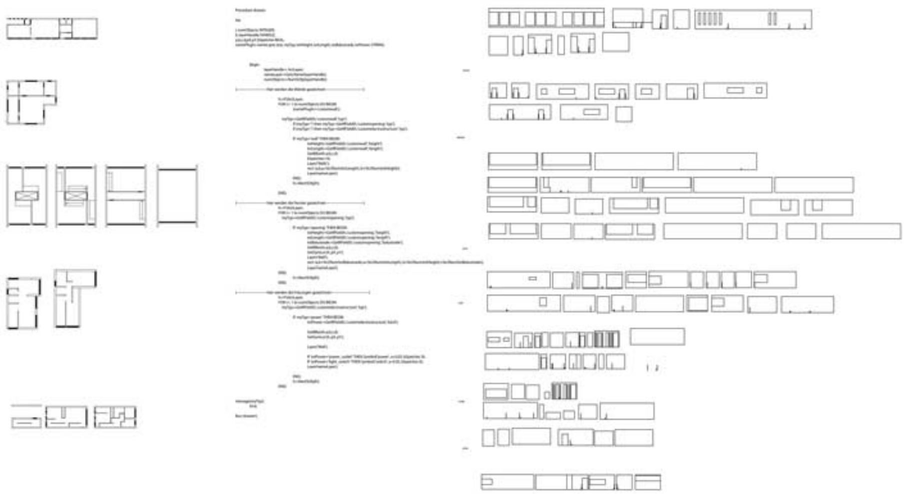
KaisersRot Collaboration KCAP Rotterdam NL und ETH Zürich, a generated plotplan – software: Markus Braach, ETHZ

Structures are generated and described in both examples, and this is done more economically and more efficiently than with conventional methods. Projects like the clothes rack or the NDS Pavilion, in which the generated code-uniform for the design itself and the drawings of it-is also carried over into the CAM process, show how the future of an integrated design, description and production process for architecture might look. Accomplishing this, however, will necessitate gaining additional experience with a wide range of "printing technologies".



NDS Pavilion 2001 / 2002 CAAD ETH Zürich

For example, a new printer driver for the concrete plotter will be written in the coming months, which will make it possible to produce walls directly from CAD programs or from the code. Aside from the technical issues involved, these production processes also exert a not inconsiderable influence upon the design of architecture. For example, what might the details and exterior surfaces of computer-programmed and computer-produced architectural works look like? Could this possibly give rise to a new type of ornamentation? The range of possibilities discussed above opens up



Parametric Design 2004/2005, digital Tools, Liechtenstein University of Applied Sciences

a great deal of room for new experiments of a technical and formal nature. The decisive aspect of this effort will be to pragmatically pursue the objective of "printing out buildings" and its consequences for architecture in a manner that is free from ulterior motives of an esoteric nature.

After all, in the past, changes in construction technology usually manifested themselves very directly in the design of architecture.

Note

Oliver Fritz is architect, worked three years at the University of Kaiserslautern at the research project "media-experimental design", five years at the Chair of CAAD at the ETH Zürich and since 2004 as assistant professor at the Liechtenstein University of Applied Sciences.

Koen van de Vreken

Searching for a White Blackbird
Teaching AEC in the New Digital Era

Henry van de Velde Institute for Architecture
Antwerp
Belgium

Overviewing the history of Architecture, Engineering and Construction (AEC) in Europe one can, briefly conclude that till World War II most buildings were elevated with a small differentiation of materials. Most commonly used were: bricks for walls, wood for floors, roofs, stairs, doors and windows, plaster in the exterior as well as in the interior, and natural stone (floors and facades).

Besides this, structures were often based on massive load-bearing systems with direct descent of loads. Post-beam was rather an exception because it could ask for the (expensive) use of concrete which wasn't readily available as it is nowadays.

Regarding post-war, architects had to face a huge increase of new construction parameters all developing for common use such as:

- curtain wall for skeleton structures, initially to erect on site but more and more prefabricated to join using a new logic of connectivity
- building physics control
- increasing needs for technical equipment
- fire safety concepts
- considerations of sustainable exploitation and materials of buildings
- safety of on-site-execution as well as of exploitation.

At the same time and speed a multiplicity in the supply of materials involved designers in such complexity that, according to Christian Schittich (publisher of the famous magazine 'Detail'), after execution more and more architects cannot explain any details of their own conceived buildings. They do not even possess drawings because they were actually elaborated by engineers and contractors.

Obviously teaching construction and tectonics becomes a heavy part in educating architects, for teachers as well as for students. More specialists (in building-physics, ecology, acoustics, ...) are in attracted to fill in appropriated study curricula while a larger amount of know-how seems to emerge from contractors and producers of building materials instead of educational centres.

Since the seventies the digits enter the world of architectural design too. First as a drawing tool but faster than expected as a real instrument of design. They certainly produce many opportunities for project presentation and execution plans as well as for parametric design. The University of Bath in the UK even set up a new conference, the so called Digital Tectonics.

The never-ending commercially driven race between software and hardware developers also generates an endless quantity of interfaces, operating procedures, commands and drawing techniques that can only be mastered by specialists working day-by-day on these programs.

Exploration of and application in both domains of knowledge i.e. construction and digital methods seems more and more impossible to get managed by one person. Perhaps this is the reason why at many schools an autonomous CAD-cell is often established. In this way lack of collaboration and synergy between educators involved in designing, construction and computing is a dangerous trap easily to walk into due to overemphasizing the means to and end which, at least, should be architecture at first sight and finally people living site-bounded together.

So far so good a new approach in appointing teachers in construction and CAD urges. The creation of duo-jobs in which specialists of both disciplines work effectively together can be useful as far as mutual influence is guaranteed and, above all, made visible for students. Assimilation of the complexity of the architect's world and learning methods to master it, can give them the self-confidence they will undeniably need.

Debate on the Presentations
Second Theme, Part II

Chair:

Nadia Hoyet
Versailles, FRANCE

Nadia Hoyet
I want to add as an aside that the famous French writer, Flaubert in his 'dictionnaire des idées reçues', once said that architects are silly because they always forget the staircase; so I think that we can feel smart because, as I noted, staircases were very much present in all the presentations we have seen.

By the way, databanks put always the question of standards' harmonisation, as we do not have the same standards from one country to the other. But if we define data in terms of performance, and not of the characteristics, we could perhaps acquire the best tools for discussion.

In front of these obvious differences how can digital tools be diffused in our teaching. I wonder if the students we educate are, therefore, more efficient than before. What will this new know-how represent given that they will be professionals, amongst all those participating in the construction and face all their responsibilities?

Then there is the question of the database: for example, Herman, where does the information come from when you 'build' your database, and how do you control the validity of all the information?

Herman Neuckermans
The information comes mainly from our staff, from pictures taken and drawings done by our staff; otherwise it is taken from publications. And that is the reason why in this kind of database you need to set up an association, and why if you do not they take you to court. We have been very careful to be legal. The validation is done by a member of our staff, a Doctor of Engineering. Maybe it is not the ultimate verification, but the information is certainly checked. It is a little like what TIME magazine presents: cases without judgement. The only thing we added was a structure for accessing the database. For example – because I see different proposals here – the first thing I would like to do in terms of structures is that when you choose 'structures' in our database there will be a link to your textile structures. This could easily be done; we do not have to rebuild the whole thing. In my opinion it is would just be a more universal access, that is all.

Dimitris Papalexopoulos
I think that we have arrived at a point where we can broadly discuss databases and gather different approaches and examples. Adding to that 'building memory' is a software programme that creates, in data version, historical construction systems of building. It is open to the Internet, so you can visit it if you like at the National Technical University of Athens website. Another problem is that historical buildings have no clear classification of the elements, so I accept your classification of historical buildings. It is a bit difficult, because you have to use a more open system that will accept new classifications for when you have a find – a cistern, for instance, that you have found in a village in Greece – that does not quite fit into any category, but you have to classify it. So there is a huge discussion about that; but I think that the whole database question could be structured as follows: there are two kinds of databases, the personal database, that Herman described very well, and what we might call an institutional database, that is, a database that a university creates and that is validated by its name and its experts. So we are faced with the following very com-

plex problem: that at a certain moment we may think that the personal database could be used as a help for the structuring or input of material for an institutional database that can carry out research on meta-data, that is, on describing the data. I think that this is a very crucial problem. And then, at an academic level we have to have fine-tuning for the different descriptions between the architectural schools, for instance.

The second trend that I cannot explain is that it appears that, in the schools of architecture, construction courses are a very hot point concerning continuous education and cutting-edge formation within the European Community. **The old idea was, and we see it now with your databases and our database, that a student on the edge of the profession constructs a database of details, of buildings, etc., inside the university, and then when he leaves the university he takes with him not only his diploma but the database that the university has helped him review. I mention this very hot point because the role of the public university, the economic role of the public university in the European Community, and the school of architecture, now passes through construction, not design, not urban planning. Construction teaching is very close to professional life and to continuous education.**

But so as not to abuse any more of your time, I will very briefly explain that 'Building Memory' was a research project carried out with the Computer Technology Institute of Patras for making software for the creation of a multimedia database of construction systems. At a certain point in time the product was finished; we had the software and we had entered twenty historical buildings into it; and the question was whether or not to sell it. There is a street in Athens called Stournara St. which sells almost only computers, so we were asking whether we should put it on sale in Stournara St. and then everyone could create their own database. The answer from the university, and in my opinion it was the right answer, was no, because the university and the school of architecture have somehow to continuously validate the building description and the fragmentation in order to input things into it. I will stop here, after I say once again that I believe that the database issue is a crucial one, and that we should perhaps have a larger session in the next years dedicated to it.

Herman Neuckermans

You make a clear distinction in your reasoning between the individual database and the institutional one. I do not know whether they have to be separated that strictly, because, and I forgot to say this before, a lot of the projects that are in our database are the result of student assignments and analyses of buildings, which are revised or checked by the teachers before they are entered. They contribute to it, and they can use it, and when they graduate they can still use it. You can use it too, even though you were not a student at our school. So it is not only, or necessarily, a matter of property.

Dimitris Papalexopoulos

Yes, I agree with you on that. I am talking about a database from the point of view of how, if I am in your office and I have plenty of information, I can classify it, hold it together. That is a different thing from using your database, and I think that it is a very real problem. That could be a matter of teaching, inside architecture. In the lesson I told you about previously, we started in the ninth semester, and for the last two years the assignment given to the students was to make the first page of their personal database; that is, to make a schematic building that you can click on to, etc. And when I asked them if they understood what they had to do, they answered sort of, which was the normal response. And then one of them asked me if I meant that they could do what the design studios do not let them do. And I agreed that that was right: they were to do an imaginary building, do the fragmentation of the image of an imaginary building. That is how you classify information. I do not say that it is a resolved problem – it is an open question.

Herman Neuckermans

There is still one thing I want to say. The reason I presented this is because I think that one of the legitimations of this kind of meeting is the exchange not only of ideas but also of things that we have built. It is less interesting to hear that, for instance, you have a treasure in your school that you are sitting on, and we have another one, and so on. I think that one of the purposes or aims of the European Association for Architectural Education, which initiated this thing, is that we should do things that none of us can do alone. And you can never 'build', on your own, a database that your students can really consult while designing. I agree with you, of course, when you say that we should have further debate on this, because you can discuss what is in the database, how it is input into the database and, in terms of information technology, what made the data – these are all important issues. I am always a little bit sad when people just give their presentation and go home and sit on their own thing – what have we accomplished then? We know that they have something, that I have something, that you have something. We all have something to give, and my ambition is to put these things together. In my understanding, from what I have seen of the textiles, I would say that in our database on structures I would like to have a link to your base – I am not going to copy it, but I would like to have a link to it. It widens the access, that is all. If you go, for example, to the museums in our database and select Guggenheim, you enter the Guggenheim site, which is four sites and full documentation, much more than you can find in the books or anything you can have in your office.

Dimitris Papalexopoulos

I am sorry to interrupt, but I do not understand your comment. My database and a database built by an institution are two different things. Institutional databases have to be interconnected, but this a huge problem that was tackled ten years ago – on this I think we can agree. It is not just a question of making a link – that is very easy; the question is whether we can make a way to communicate between different databases. Do you have to build a huge European database, or can you standardise the link between databases? This is a European Community research problem that has been going on for the last fifteen years and has not been solved yet. This is something that we have to work on together. You could do a database for textiles, perhaps; I could do antiseismic construction types, you buildings, and so on. So it is a clear theme for cooperation, and we can remain there; but there is also, in parallel, not mutually exclusive, the right – because Internet is also freedom – to fabricate a personal database on something; and the school of architecture must at some point give guidelines as to how to structure this database.

Donal Hickey
I just have a couple of quick questions. Who edits the databases? Who evaluates the information that goes into it, to say that it is viable or useful? For instance, if I have done a nice factory and I have a lot of images and I send them to you, who says what is viable? And the second part of the question is, if everything is viable then what is the point?

Herman Neuckermans
Is that a question for me?

Donal Hickey
For both you and Dimitri.

Herman Neuckermans
As far as we are concerned, if it is the description of a project that exists and is documented by photographs, then we can check the internal elements; but the check is more for when students start to do analyses which are interpretations of things, and then somebody has to say whether we can show this or not.

Donal Hickey
When you set something like this up, does everything that has ever been built end up on it? I mean, at the moment you have a database that is quite small, you have eighty museums at the moment; but if every museum that was ever built was put on it, some of which are not very good or not particularly interesting, how would you evaluate them?

Herman Neuckermans
There is no evaluation, no.

Antonino Saggio
I think it is not so difficult: you choose examples that are of interest to the department that is going to manage the database. Objectively, your knowledge may be very interesting, but if for the purpose of the database it is not, then you do not allow this or that museum to be in your database. The database is not objective, and it is not only information; it is also a tool for you to teach what you are teaching.

Donal Hickey
I understand that, but if there is to be a Europe-wide database that has lots of things in it, then who decides what goes in? You have your criteria in terms of learning outcomes or whatever you decide is suitable and appropriate, and Herman has his particular criteria that include some things but not others; **but the big question is, who edits the information? And why? What is the reasoning behind your decision to include something?**

Herman Neuckermans

I have the same answer as my colleague. So far what we have entered is for the most part examples and precedents that we thought were relevant to the assignments we give to the students. For example, in the third year they have to design a museum, and a lot of our staff have visited museums that are interesting and up contemporary standards. But as long as the information is correct I do not exclude museums that are not modern, because someone may be interested in them. In the previous session, too, there was some confusion about information and knowledge; these are different things, you understand. The database has information, that is all; and the person using it has to build their knowledge and, as I said, be critical of the information they have.

Ola Wedebrunn

In this network database, are you actually screening something, or are you just taking in a lot of information in one realm without evaluating it? This is, of course, a standard way of exploring new territory. I mean, if you go somewhere you have never been before, or to some new land that has never been explored, then you have to find out what all the spaces in the area are, and you have to bring them all together before you can really find out what it is about. Is this how the databases will work? Or is the idea that this database will be for buildings that have this or that character, or construction, or aesthetics, or some other core idea; and if so is there somebody managing this database? **Or is it the other way round, that everything goes in and then we weed out afterwards anything that should not be there?** These are the two possibilities, as I see them, and I would like to ask if perhaps they are both viable.

Herman Neuckermans

My answer is that it is a self-regulating system. I am not asking the layman, the man in the street, to input things into the database. I am asking people like you, who I presume are aware of what is happening in architecture and aware of what Information Technology allows one to do. For example, if I had to prepare a lecture, and we have seen several lectures here, maybe I could take images from the database. The use of the database is open, and the structure is the one we have given it, with categories of formal articulation, of composition, of things, etc. If you are looking for examples of houses on a slope with a skylight, for instance, you will find them there – if there are any. Whether there are any or not depends on who enters information, and I agree with you that it is the weak point of the system. Maybe it is the strong point of your system; I have the impression that textiles were well documented, so it has a theme. Ours has many themes, and that is its weak point; but I can imagine, and that is why I suggested we open a window on re-use, so that you can input examples of re-use and copying old and connecting the old and the new. This could be done; and if many schools came to view it, then it would ultimately become the place to go when you have a question about re-use. That is my aim, my ultimate goal. When I talked about structures, I thought that from the point of view of construction in general there could be an interest for a specific community – maybe builders or those that teach construction would go there.

Ola Wedebrunn
I have another question, which follows on from what you have been saying: **Do we know what it is that we are growing in these databases?** Whether it tomatoes or cucumbers? We cannot decide from the beginning what the database will grow into. We go into a field where we have planted a lot of different things and we will nourish these databases and we will find out what is good in them with regard to both the examples that we put in and how we structure them within it. Perhaps it is very difficult if we describe what we put in there too rigidly from the beginning. I can agree with you, but I am asking because this is a way of education. I would think that we have to navigate into this kind of way of gathering information, and then, from this navigation, eventually we will find out if it is cucumbers or tomatoes.

Koen Van de Vreken
It is not a question; rather, it is an answer. Would it not be possible to add a tab, a page, to the site for criticism, where anyone could record an opinion? The only thing is, as Herman suggested, that you would need a filter for rubbish. That is the only thing. So we would have the objective characteristics of a building, and in that way we could build such a site as a dynamo. But you can very easily add a tab for criticism.

Herman Neuckermans
I did not show it, but briefly, when you surf to one of the projects you have different keys: you have pictures, if there are pictures; you have drawings, if there are drawing; and you have texts. The texts can be either criticism or references, publications about the particular theme. And if you want to add a criticism of your own, you can. If somebody enters rubbish, then we will eliminate it. And of course it is very important that everybody can give criticism.

Nikolaos Panagiotopoulos
Commercial databases know what they are doing and what they are for; non-profit organisations create databases because they want to give you information about whatever their purpose is. So far, so good. Now, university databases follow practically the same path that university teachers follow: namely, they try to prove to the world how good they are. So there are millions of databases coming from universities, apart from the commercial ones, that add practically nothing to the situation so far. **What I would appreciate from a university would be useful information from a database to be input into some software so that I can explore, investigate further, a specific situation – for example, if I am going to be building in Africa or Indonesia or the Middle East. That is what I would appreciate. To that end we need collaboration among universities, and we need to filter out useful information and see that it is operable, that I can use it in my software, or that it has a format, a protocol that can be used universally.**

Zoltan Hunyadi
In my school, we have the same kind of experiment as you. My students and I have made a database of about 120 buildings. As in your case a group of students did the research, they made the accommodation, and I think, the information is absolutely

neutral. It should be neutral and it should be accurate, because it is a document. And I think that even an ugly block of flats from the communist era must be documented, because it is good for educational reasons. Everything else – the sort of knowledge, the information, the attitude, the ethics, how you teach – is personal. This is up to you: you will make your selection, and I will add my things to your database.

Sabine Chardonnet
I have two remarks. One is about the issue of the information that students can find by themselves when they surf through the database and all the links; and they can surf far away. So I think that this creates a problem of validation that we have to try to deal with. This is an issue that I feel we should be thinking about. The other thing is a question of growth. When an airport is growing rapidly, it reaches a certain point where you cannot let it grow any larger, you have to build a new one; and I think this is also true for information. If you want to hide precious information, just put it in the middle of a lot of information. This is the way strategic developments are now going about hiding information. So I wonder if teachers are going to become a sort of navigators in wide and expanding circles of information stored in an enormous databank. This is another issue that I think we have to think about. But the question of validation is certainly very important, because if you are sitting in, for example, a seminar, where your students have to write an essay, and they have to build their references and they have to define a corpus, there will always be one who comes and tells you that there is a new database that you do not know about, for thirty people in a room will always know a lot more than one person, even if he or she is the teacher and twenty years older than the rest. I think that there is a moment when the question of the evaluation and assessment of the quality of information found in databases will start to be a problem; and if links are going here and there, it can turn into a very odd and curious thing.

Just to finish, one of the teachers in my school is a very well-known engineer in France, who is commonly called in when people have difficulties in solving a problem; and he says that the young engineers that he meets in industry or in different firms are making more and more errors, simply because of the way in which they work. They search the Web and they import a process or a piece or a product and patch it into something else, and in the end it does not fit; and he says that he has to correct more and more information that comes from different departments and that is supposed to be validated. And this is starting to become a real problem.

Herman Neuckermans
If I may, I would like to make one last comment. There is, of course, plenty of readable material in the world; but I hope that if you visit our database you will see that it is conceived for architectural education, and the questions and the indexes derive from what we taught, and there could be interesting approaches to what is there. It is not like a firm, selling all kinds of wood products. It is a perception, a view of architecture from the point of view of education and design. We asked ourselves what kind of questions a student would face with, for instance, the design of clustered housing. Do we have examples of clustered housing somewhere? Yes? Then put them in, so they can find them. Maybe you underestimate us, but when I speak of

seven years I mean not only for entering data, but also for the structure and the software that were part of the effort. Anyone can build a database, but it costs a lot of effort. We had four or five projects going for financing this thing. Thank you.

Donal Hickey

I just wanted to make one last remark. It sort of responds to what was said about things that can go wrong, giving an example of what might happen. Take Gehry's project in Bilbao, which is included on your website. I go to the building, I take photographs that show all the defects in the building, all the things that have gone wrong, which are very interesting technically, aesthetically, and in terms of learning outcomes. **I think that these are good ideas, and I will say that I am the author, I have taken these photographs, and I have looked at what exists, and I give them to you for your website; but there may be an issue, if you put them on your website, with the negativity or the potential negativity that may be construed from having information that is not positive about something. This might create a problem. How would you feel about that sort of scenario?**

Herman Neuckermans

Maybe I have to clarify. We are already collaborating with schools that want to contribute, and others, but this does not mean that you can log on and do what you like. I think that if schools in Europe would like to contribute to something, that is fine. I am not a seller here; I am just showing things that we have. There should be some kind of concentration, of course.

Maybe you know, and someone did touch on the issue of e-learning, that there is a whole system in Europe that is called Ariadne. It is an empty system interconnecting eighteen or so universities, and you, as a teacher, can input your course and it is circulated to everyone in the system. It has a structure, and a board that rules on things and looks at the things to be put in. In legal terms, if you show the failures of a building, it belongs to the association, so I do not think that there is a problem there. I think it needs concentration. My presentation was more to see if people were interested in working with us; and when you say 'your' database, yes, of course, we built it, but in fact, when you use it, it is as much yours as ours.

Donal Hickey

So there is a collective responsibility there.

Herman Neuckermans

Yes, of course. I think the responsibility is collective, and maybe we have to ask for a European project.

Third Theme

Research in Contemporary Construction and in Contemporary Construction Education

What types of research will emerge from the (re)search and redefinition of the content of contemporary construction teaching?

What can be researched, experimented and tested in the context of construction today?

Where can research on construction be published and disseminated?

What research results will be useful to advance construction and construction teaching?

What types of interdisciplinary collaborations and effective research outputs might emerge?

Are our institutions prepared, equipped and supported adequately enough to allow research to be included in the new content of construction teaching? Who would be interested in funding research in construction nowadays?

What are the necessary initiatives our Network should take towards strengthening the research activities and collaborations among its members?

N. Hoyet, *Versailles School of Architecture, France*
R. Sastre, *ETS Arquitectura del Vallès, Spain*
R. Crisan, *Ion Mincu Bucharest University of Architectrue, Romania*
A. Snyers, *Grands Ateliers de l'Isle d'Abeau, France*

Nadia Hoyet

Architectural Research Applied to Experimentation on Innovative Uses of Materials or Technical Systems

School of Architecture
Versailles
France

The question of research in our architecture schools is acquiring a new importance (in France), with the introduction of the doctorate in architecture. Until now, architectural research came under other fields of knowledge such as mathematics, physics or history, for example. From now on we will be able to offer students research paths that have their starting point within the architecture schools themselves. However, since there is no strong tradition of academic research and such approaches are often alien to the ways of thinking of architect teachers, whose roots tend to be in the profession itself, it would seem that there are some exciting avenues to be explored, notably in the field of construction.

Scientific research, as a means of producing knowledge validated by demonstrations based on previous knowledge or on experiment, needs to adopt particular forms for the technical study of architecture, which is a hybrid field of knowledge.

In his most recent work on "Method", Edgar Morin emphasises the close interaction between science and technology, dependent as they both now are on economics and politics. Scientific research today takes varied forms and is equally present in academic research laboratories and in big industrial research facilities. This change in the way knowledge develops, which affects all disciplines, is particularly significant in our own, with its close ties to professional applications.

Research on what ?

If we consider that the primary purpose of the architectural act is human, it is important that research should address the big issues that face contemporary society.

Indeed, is it no longer possible to design using our traditional methods that date back to the arrival of the industrial era? We live in a time when the energy and raw materials which were the basis of wealth production are set to disappear in the not too distant future, a process now accelerating with the emergence of the Asian economies. Is it possible to devise the same forms of building as 50 years ago, when the population of the planet has doubled? Our social, economic and political organisations are becoming ever more complex and the information processing capacity of our computer systems is growing day by day. What place do architects occupy amidst this growing complexity? I think that we possess a specific know-how – an understanding of the project – which represents a genuine asset in dealing with complexity. We work in a discipline that simultaneously embraces several fields of knowledge, relating to the physical, economic and social contexts of the project, fields that by a creative process are integrated into a single synthetic object. And of course, this creative process is one that operates in space. We are therefore accustomed to working in four dimensions: is that not a major advantage in dealing with complexity? However, one of the objectives of research is to fit the intuitive process of creation into an evidence-based and scientific framework.

In the field that concerns us, i.e. the materialisation of architectural design, it is clear that we need to look for radically new solutions to meet the great challenges of the future: building more with less energy and fewer resources. Obviously, research into lightweight structures or ambience management is part of this. However, I also think that architects can do innovative work on the use of materials. I demonstrated certain aspects of this last year at our Athens workshop. Here, architectural research operates on the scale of technical detail.

Why not devise research based on experimentation, as they do in physics or biology, for example, incorporating our complex criteria of architectural design? We are in a position to provide new technical solutions because we have a different perspective and we use different tools. However, students in architecture schools still receive little preparation for the special and rigorous methods of research. We should help them get there by inventing forms of research in which knowledge production exploits all the resources of the project approach.

As part of my doctoral thesis, I am working on defining experimental protocols which could be used in the design of new technical components as a means of demonstrating their validity. The aim is to combine a form of architectural creation with a rigorous scientific approach commensurate with the complexity of the design. Although the work is only in its early stages, I will try to describe it in concrete terms.

Research through experimentation

The first step is to make the experimental object, be it a technical system or a component. This proceeds from a standard architectural process with the production of a prototype situated and used within an architectural space. The second step is to conduct a process of demonstration involving different scientific fields.

This form of research is only possible if a certain minimum level of technical resources are available. You have to be able to build portions of full-scale experimental architecture situated within an architectural space. The Great Workshops (Grands Ateliers de l' Isle d' Abeau) in Lyon where an earlier workshop was held, are particularly suitable for this type of experiment. This is because assessing architectural qualities is a perceptual process involving the presence of all the constituent elements and combining the dimensions of space and time. A satisfactory level of complexity can only be achieved by integrating as many dimensions as possible. In addition, in this type of experiment, the perceptual process operates in direct relation with the body and its sensory complexity.

In describing these experimental protocols, it is important to specify the corpus on which we are working, because only elements that are dissociated and easily describable can be studied. In my thesis, I have chosen to work on envelope components, because they require knowledge about the environment and energy, and involve a wide variety of materials.

Let us take a concrete example, based on a student project. They designed a sunshade device as a base for photovoltaic cells. Both pieces of equipment are designed to be positioned on the sides of a building with maximum solar exposure. The innovation here is to make a device that both produces energy and provides protection when placed in front of a glass façade. The problem was to make blades that could be controlled and directed both to provide shade and to ensure maximum sunlight on the cells (radius at 90Æ from the surface of the cell). They designed a dual mechanism that could fulfil both functions, resulting in an innovation to the structure of south-facing walls. However, their study stopped at the design phase, with a wooden model. To transform it into scientific research, the following process might be undertaken.

A prototype would need to be built on part of a wall, with all the technical components and perhaps several types of material. The prototype would have to be manoeuvrable and the space behind the wall would have to be habitable, say a room in an apartment.

Next comes the trial phase. The construction of the protocol would depend on the performance objectives chosen for the structure.

From the point of view of the physical sciences, one can imagine that it would be interesting:
- to measure the energy supplied by the photovoltaic cells over a significant period
- to measure the mechanical performance of the materials
- to assess the level of light protection provided by the blades.

From the point of view of the human sciences, there might be sensory and physical assessments such as:
- the object's capacity to fit in with different architectures
- the structure's aesthetic qualities
- the feel and comfort of the light levels
- ease of use
- cleaning and maintenance...

These evaluations would need to be carried out with a significant sample of people.

In the next phase, one might envisage adjusting and modelling parameters on the basis of the importance assigned to one criterion or another. The research might continue with improvements to the structure and changes in the use of materials.

This type of experimentation calls for significant financial resources, which are beyond the reach of a single architecture school. Such research therefore requires the right kind of partnership and pooling of resources. It would probably involve joint ventures with industry, but it is also important for schools and universities to be able to work together.

In conclusion, I think that our network could play a useful role in pooling this type of research. We would acquire legitimacy and representativeness by combining our respective skills and partnerships. This would enhanced our resources. We should also think about publishing this type of work, so as to establish solid bases that will give legitimacy to our research results. Perhaps our network could create a scientific journal capable of doing justice to the different forms of research that lie on the cusp between technology and architecture?

Ramon Sastre

Personal Experiences in Teaching Construction in the New Digital Era

Vallès School of Architecture
University Polytechnic of Catalunya
Spain

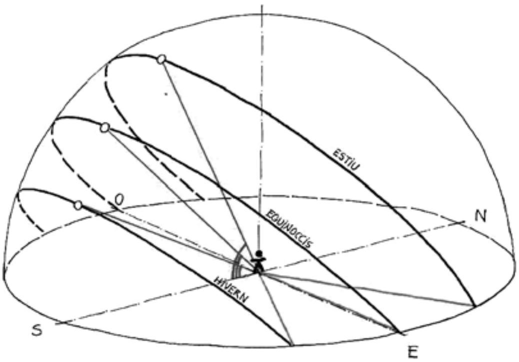
Introduction

The paper will focus and describe the author's experience in everyday teaching and how it had changed along the previous years.

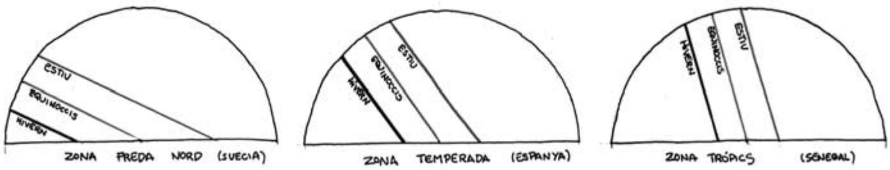
I took two of the subjects I teach. The first one is "Construction1", a compulsory matter in the first year where we introduce the architectural technology to the students. Then, a free elective subject, "Tensile Constructions", a specialized type of Architecture which has been developed during the last fifty years and, consequently, has suffered the influence of the digital transformation in all its strength.

First case: Construction 1

I observed the contents of the subject and I tried to find parts where the influence of the digitalization has been clear and effective. And without having noticed it before I came across to a very recent implementation in one of the themes that constitude the programme of this subject. It was theme 3: "The Architecture as Shelter and Filter". In this theme I've been using for several years some drawings to show the solar path in order to understand the strict relation of the sun in architecture and human life: radiation, heat, shadows, etc. At the same time, to show how latitude influence in the everyday relation sun-earth.

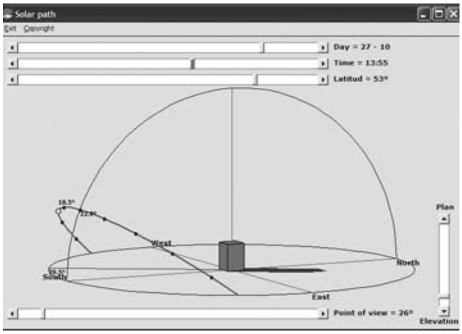


We used an axonometric projection to understand the solar paths along the year, by drawing the equinoxes and solstices. But this drawing serves only for a precise latitude and we should have a different drawing for any other latitude.



These three elevations help to understand what happens in different situations on the globe, but probably we'd like to have more: the poles, the equator, etc.

And here is when the paradox appears. Although I use to write software by myself in a professional way, I hadn't realise I could apply this knowledge to the way I used to teach Construction. So I decided to write a piece of software to explain the same in an interactive way.



The result was the program called Solar Path. It is a fairly simple work, done in a week end (which really questions me why I didn't it before), that shows not only one but several data in just an image:

- solar path along the day in a fixed date and latitude, with the maximum solar height.
- position of the sun in this path in a fixed time (you get the solar height and the azimuth angles).
- the shadow of a prismatic volume, the idea is to show in a graphical way how shadows move in angle and length along the day.

The program is used interactively through a series of scroll bars. First of all there is a group of three bars:

- Day: shows the actual day in a format "day – month". You can move it along for all the days of the year.
- Time: you can change it with steps of 5 minutes.
- Latitude: from -90° (South Pole) to 90° (North Pole), steps of 1°.

The other two scroll bars just change the point of view, so that you can see better the shadow or the sun position at precise times, or the elevation from vertical elevation to a plan.

Obviously the understanding of the whole phenomenon is much better now, not only because you can see many more situations but because you see what happens in motion. The students can just "touch and wait" which is a good way to analyse the behaviour of any event.

The conclusion, however, is that there are, probably, many other subjects we teach in an old fashion way just because we are not aware we can use digital means. And sometimes (not always) these new ways are more efficients in the transmission of knowledge, which is, in the end, what we intend to do.

Second case: Tensile Constructions

This is a completely different case. It is about a free elective subject which deals with a type of construction quite different of the standard ones. Although tensile constructions (ropes and skins) are almost as old as compression (stones) or bending (wood), the truth is that they have not been developed in a technical way until the second half of the twentieth century.

From the first edition of this course (six or seven years ago) I've put the attention in the fact that shapes (forms) are not as free as they are in the other constructions. Tensile structures require shapes that adapt themselves to the tensile forces producing results as catenaries (hanging), spheres or cylinders (pressured), or double curvature (anticlastic).

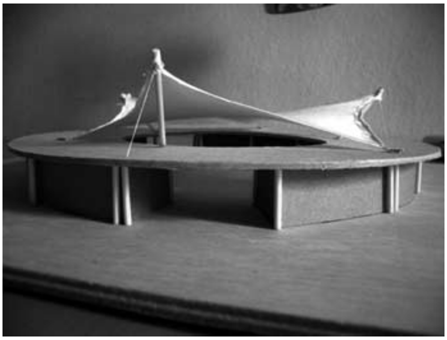
So, one of the major points to be studied in this subject is how to find these shapes. That's call form-finding. We propose 5 ways to do it.

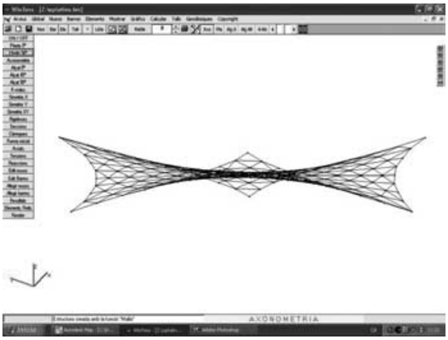
1) Mathematical method: Using equations representing surfaces: spheres, cylinders, hyperbolic paraboloid, etc.
2) Constructive method. Ruled surfaces, the way that concrete shells are built, although they are *compression shapes*: hyperbolic paraboloid, etc.
3) Model method. Using very deformable and elastic material (latex, Lycra, etc.) we can achieve complex irregular shapes.
4) Simulation method. Using computers we can simulate the processes done in the three former methods, particularly in the method 3. Of course we need specialized software and this is a serious inconvenient in a school, since this type of software is not common (therefore expensive)
5) Soap bubbles. This method is only suitable for pneumatic structures. Although the shapes are not permanent and sometimes very ephemeral, it is an easy and funny way to create and analyse different possibilities.

During the recent years I always recommended the third method to the students. There were several reasons to do it. The main one is that they recognise the suitability of the shape at the same moment they create it. They notice if the surface is stressed or not. They see how small changes in the geometry cause wrinkles. They have a 3D model to work on it, to photograph it and use it for photo-composition, etc. In fact, drawing plans and elevations of these shapes is quite difficult without specialised software.

But I must admit, and I explain this fact to the students, that most of the real work done in this field, all over the world, has been done using the fourth method. Thus, it is not strange that they insist in asking me to use some software to make their proposals. At first, I was reluctant to let them use computers instead of making models. But when I began to change my mind and facilitate them specialized software, to work with their designs, I had a surprise when I saw how they used both methods.

They always begin working on models and drawing sketches, and when they have achieved a certain level of decision they move to the software. And not all of them, there is always a group of students (those who are not so friendly with computers)





who never use the software. Of course they know they should use it if the project must be real, but the exercise is focused on the design of the whole and construction details, not in calculating and manufacturing the membrane.

During the last twenty years I've heard so many times complains from my colleagues about the use of computers in teaching and learning architecture. About the possible loss of the students capability of drawing by hand, about the loss of the students capability of calculating simple structures, and so on. I agree with them sometimes, but from time to time I realise that students chose the use of computers just when they need it and keep on using manual skills. Our fears are unfounded somehow.

Our effort, as teachers in this New Digital Era, must be focused on discerning how the new tools that are there (and there is no sense in neglecting them) can be used to complete, enhance and sometimes *substitute* the tools that we have been using for years. Our task as professional teachers in a University can not be a task that encourage to avoid the use of the new means but a task to show how to use old and new tools together. I'm sure students expect *that* from us.

Rodica Crisan

Teaching Construction in the New Digital Era
"The reverse of the medal"

"Ion Mincu" University of Architecture and Urban Planning
Bucharest
Romania

It is evident that teaching methods, as well as design process itself, cannot remain unreceptive to the opportunities brought by the 'new digital era'. The IT has changed, and will continue to change, the way we think and represent architecture.

The computer is nowadays a legitimate design tool and an integral part of our endeavor to educate future architects. But it can also become a major distraction, with long term effects concerning essential competences of the future graduates.

Several aspects of digital design have been easily adopted in professional practice and in architectural education, such as geometric modeling and rendering, but not all the implications of it are fully considered in School.

Teaching of architecture is fundamentally related to theories and media of *representation*. Design has come to be seen synonymous with drawing; through drawing and redrawing, the architect explores possibilities and gives shape to ideas. "*The sketch is a window into the architect's min*"[1], it reflects architect's thinking and intentions, expressing different individual personalities in approaching architecture.

The 'new digital era' brought important mutations in architectural representation. The new technologies have given new possibilities of visualization that make the conception, understanding and communication of architectural ideas much easier, but also richer in spectacular effects and *more powerful in impact*.

The obsession of architecture as graphic image has currently reduced CAAD to image processing. Digital drawing, modeling and rendering have been quickly assimilated in professional practice and in architectural education. Schools and students dedicate a large amount of time to improve their skills in *image processing*.

In our School, the 'representation' area is the main field of computer use. It gets an increasing importance within curricula; IT and CAAD are practically synonymous with 'representation' and the design studio is the main field of application. For the new generations of students the computer is the common drawing instrument. Usually their projects are demonstrations of high ability in digital graphics.

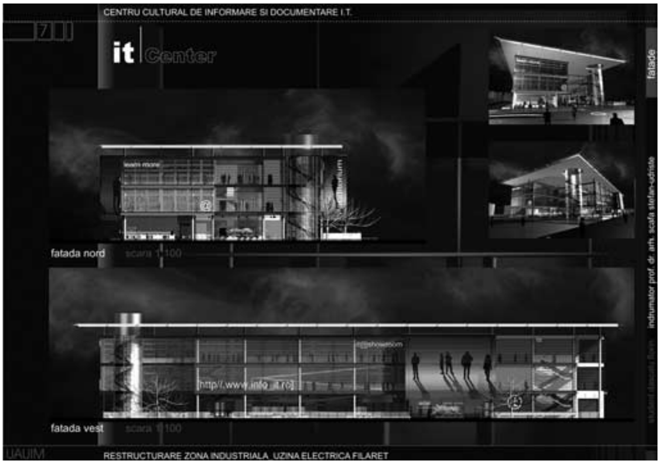
Obviously, it is a useful skill, highly requested by the present professional market. But, from educational point of view, some 'secondary effects' are also to be considered.

The act of drawing digitally is different to that of drawing by hand: different mental mechanisms are involved in. By repetitive exercise, these mechanisms create in time *different ways to understand architecture*.

The data usually embedded in manual drawings are now replaced with data automatically generated. The engagement of drawing by hand is not replicated in the digital world; when 'zoom', 'copy' and 'paste' are available, the process of redrawing - exploring alternatives - disappears.

The digital representation leads to an understanding of architecture not as construction of bricks, timber and glass, but as data sum, a digital description which builds upon and extends other digital pre-existing descriptions.

'Prefabricated' details can be easily downloaded from data bases or simply reproduced with digital instruments, even without understanding their logic. The IT and the digital devices are part of our daily (professional) life and it is normal, even necessary, to consider them in education. What new competences are necessary to the architect in the 'new digital era', how to form them, when and by what means - this is another argument. What I am trying to point out is that the more and more extended use of digital representations is accompanied by a more and more accentuated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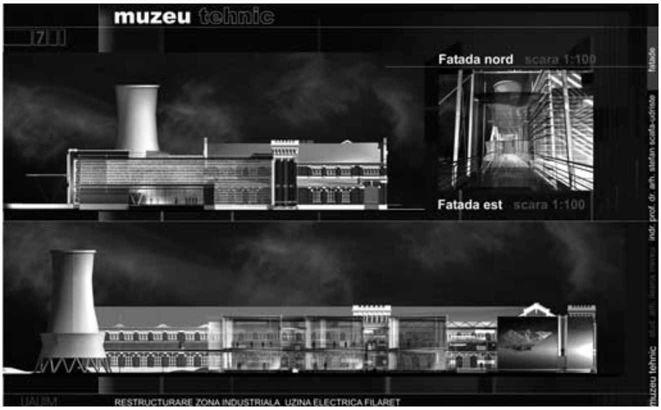
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perspective

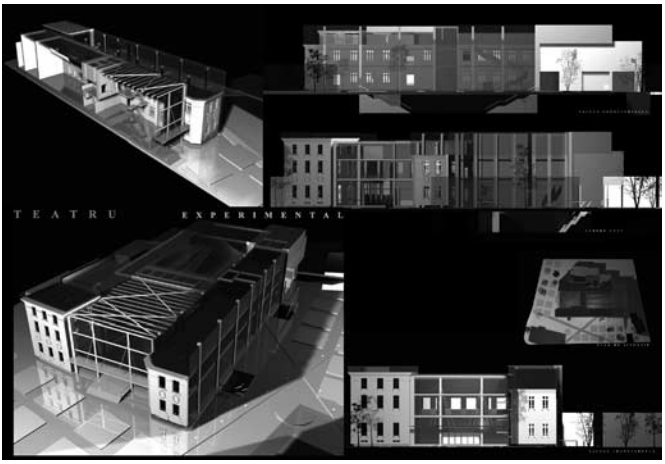
loss in the exercise of constructive logic and finally by an increasing ignorance of the constructive processes.

The manual drawing always follows the constructive logic of architecture: so, it is (was) implicitly an instrument of learning construction.

'Draw as it is built' says a basic rule of detailing. Drawing by hand, the designer needs to keep in mind the *materialization of architecture*. In the digital design this is not a necessary condition!

The current digital design distracts attention from the materiality of architecture; it focuses on IMAGES, not on substance. This is often so evident in students' projects!

The obsession of ARCHITECTURE AS IMAGE, fed by fascinating digital tools, is a fact. It is more and more visible at the students (maybe also at some teachers?), accompanied by a *decreasing interest for building processes*, especially observable in diploma projects. Even executive designs and details become often 'graphic compo-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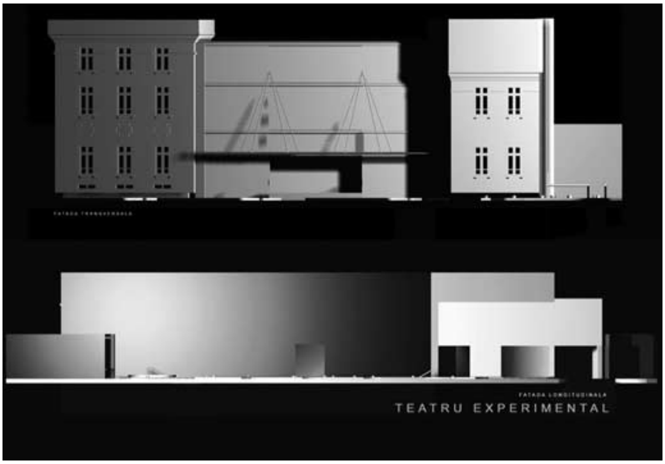
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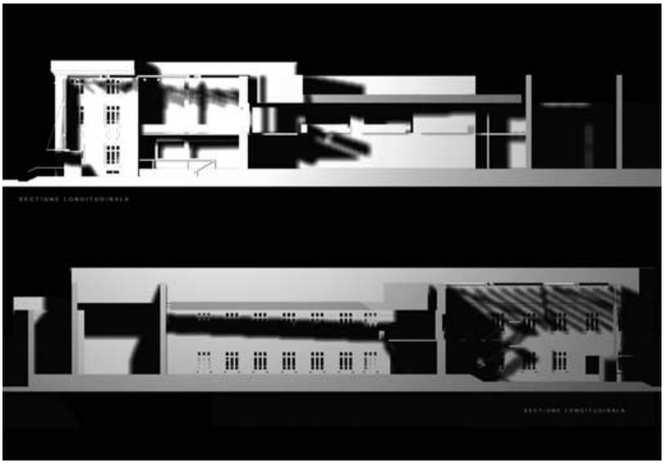

sitions' of digital lines, patterns and colors, loosing, more or less, their communicative function.

Not only the School, but also the contemporary architectural creation seems to concentrate on IMAGE. The last Venice Biennale offered an overview of the international architecture dominated by the *aesthetic of the closures*; it pointed out how the superficial IMAGE of the architecture becomes dominant in respect to its spatial and structural content.

In a recent interview, Jean Pierre Buffi expressed an interesting point of view on this argument: "*It is important to understand that the new methods of producing projects, like informatics, have introduced a lot of force in producing seducing images (…). The architecture is loosing its essence: in order to re-find it we have to transcend this image facility and its mediatisation. The Biennales mythicize the consumable image; quickly devoured, it doesn't have a profound existence anymore, it looses its own materiality and inexorably the architecture is reduced to pure spectacle.*"[2]

The fascination of spectacular digital representation, this 'obsession of image', is accompanied by *the loss of the constructive sense of architecture*. It can lead to a deeper fracture between 'architecture' and 'construction' – already considered as a major dysfunction of the present teaching and professional practice – minimizing the role of the second one in 'architectural creation'. If for older professionals it can be only a problem of option for new specializations, in education it could be dangerous to ignore this fact.

Don't misunderstand me: it is not about 'condemning' computers or ignoring their importance in present professional practice and education. But we have to be aware that there is also an 'other side of the medal' easily screened by so many 'special effects'.

In education the 'digital era' hasn't brought only advantages, but also some possible loss in fundamental competences of the future architects. Contents and methods in teaching constructions have to be reformulated in order to compensate this loss.

I think it is a problem which deserves attention. It might be the 'seed' for a research in construction education investigating and comparing the psychological mechanisms involved in analogical and digital drawing, their relation with the learning process, the present and future mutations within these processes, with pluses and minuses, in order to have a scientific base for formulating effective corrections in teaching construction.

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1 Kendra Schank Smith, *'Architect's Drawings: A Selection of Sketches by World Famous Architects Through History'*, Elsevier, 2005.

2 Jean Pierre Buffi, Interview by Elisabetta Pieri, in *Costruire in laterizio* n.104, March/April 2005.

Alain Snyers

Les Grands Ateliers au Temps du Post-digital

Grands Ateliers de l' Isle d' Abeau
France

Les Grands Ateliers, structure unique en France comme en Europe présentent plusieurs aspects qui interrogent les enseignements et les pratiques dans différents domaines dont notamment celui de cultures constructives.

L'atelier de pratique du réel

Le projet génératrice des Grands Ateliers repose sur l'idée d'offrir aux pédagogies comme aux étudiants des écoles un espace de travail conséquent approprié à l'expérimentation physique comme intellectuelle associée à la pratique manuelle.

Le principe d'apprendre en pratiquant trouve pleinement son expression aux Grands Ateliers qui revendique ce postulat.

Il apparaît à l'usage que leur espace physique est plus qu'une « extension territoriale » des écoles, et que ce prolongement s'inscrit dans une réflexion plus large et plus sous-jacente.

L'espace proposé, tout en permettant une focalisation sur la démonstration ou les travaux pratiques, est polysémique et connaît plusieurs niveaux de lecture générés par l'expérimentation qui peut s'y déployer.

L'expérimentation de l'espace

Les Grands Ateliers, de par leur forme de plate-forme de travail, place d'emblée l'étudiant lors d'un workshop dans la 3e dimension. La perception proposée, indépendamment du sujet de l'exercice est de facto tridimensionnelle.

L'expérience de la matière

L'usage des matériaux, principalement les plus courants pour la construction (terre, bois, acier, béton…), procure un réel contact avec la matière. Cette expérience, parfois anecdotique, est pour l'étudiant source de connaissance. Cette connaissance qui est concrète est souvent pour lui une rencontre avec l'une des composantes de base de la construction.

L'expérience sensorielle

La rencontre avec l'espace physique à l'occasion de différentes manipulations induit une expérience sensorielle. Cette perception prolonge la connaissance théorique et l'acquis de la vision plane. L'étudiant est ainsi situé en « sujet » réceptif aux sensations produites par les matériaux, les structurations expérimentales de l'espace et l'échelle Un qui est un des aspects singuliers de la pratique aux Grands Ateliers.

L'expérience de la rencontre

Le fait de partager un lieu lors d'un exercice, d'une expérimentation ou d'une réalisation de prototypes, induit la prise en compte du groupe et implique un positionnement de chacun dans celui-ci. L'expérience de la collectivité au travail, même si cet aspect humain n'est pas formulé dans l'énoncé pédagogique, il est fortement présent dans le vécu des étudiants aux Grands Ateliers.

Les Grands Ateliers, parmi la diversité des propositions et actions qui s'y développent permettent ainsi de nombreuses sont à travers l'expérience du réel un territoire d'innovations dont les termes reposent sur de fondements simples, intangibles voire universels. L'innovation n'y est toujours synonyme de progrès technologiques mais est pleinement liée à l'expérience humaine.

Les Grands Ateliers face aux nouvelles technologies
Si l'usage des outils numériques est dans le corps même de la construction et de son corollaire, l'enseignement, les Grands Ateliers, est d'abord un espace réel et se situe sur un autre terrain. Le débat sur une position face aux nouvelles technologies n'est plus d'actualité aux Grands Ateliers qui se situent dans une logique « post numérique ». L'expérience humaine de l'espace, de la matière et des ambiances se présentent et se vit comme une expression complémentaire aux attitudes liées et issues des pratiques du numérique. Le territoire spatial des Grands Ateliers prolonge l'espace de la réalité virtuelle par l'introduction en son centre de l'individu sensoriel qu'est l'étudiant, futurs concepteurs d'espaces à vivre.

La dématérialisation des espaces projetés, de la matière à l'écran comme dans la pensée, trouve à travers la proposition des Grands ateliers l'occasion de la rencontre avec le réel, celui du touché et du senti.

Le positionnement de l'offre que représente pour les enseignements les Grands Ateliers, provoque un dialogue entre différents types de réalités dont la connaissance des paradigmes est nécessaire à la formation de l'étudiant.

Dans le débat ouvert par la pensée informatique et ses outils, les Grands Ateliers, avec des données simples et immédiates trouvent un nouvel argument dans sa réponse complémentaire et vécu au champ des nouvelles technologies pour qui le vécu et le sensible demeurent des outils nécessaires.

Debate on the Presentations
Third Theme

Chair:
Jeremy Gould
School of Architecture
University of Plymouth
United Kingdom

Jeremy Gould

Thank you, Nadia. I will say a few words on your presentation. I think there is clearly an issue about what architectural research is. This has been debated long and hard in the United Kingdom for some years now, because as you probably know the funding of university courses depends upon the research output of the university. What has tended to happen in those universities that have elected to do research is that there has been a division between researchers, who bring in the money, and undergraduate teachers, who merely do courses; and the two do not quite meet. This is a problem that many universities in the United Kingdom are facing at the moment, and therefore there is a huge debate about what architectural research is. Nadia has tackled the idea of the energy issue, which is clearly one major strand of architectural research and I would suggest that that implies that the divisions between construction as a subject and energy as a subject and built environment as a subject, and so on, are actually very artificial; and those divisions that we have seen in various diagrams in this conference probably should not exist, because actually they are all the same subject. I think that Ramon is ready to begin, so please welcome Ramon Sastre. On Ramon's presentation, I think that what he said about not losing touch with reality is quite important for students. I find that particularly with giving them a computer programme that always works. They get a sort of satisfaction in making it work, but they actually have no understanding of what they are doing; and I think that giving them bits of cloth and wire and other things is rather important, because they do at least have some simulation of what the problems of the real thing might be. There is an instant gratification to computer drawing that sometimes worries me. Let us now welcome Francesca Muzzillo from the Second University of Naples in Italy. On Francesca's presentation, I very much liked the idea that all our students should spend the morning building and the afternoon in the studio or in school. I am reminded of Le Corbusier, who spent the morning painting and the afternoon doing architecture. Although one would hope that our students build rather better than Le Corbusier painted. But that is just prejudice, of course. Alain Snyers from Les Grands Ateliers de l'Isle d'Abeau, I know the reputation of Les Grands Ateliers that is indeed large. In Britain we are very jealous of this institution. Visiting the website one sees these really extraordinary things that undergraduate students have experimented with and built, and the whole thing is really the most extraordinary experiment. I would just like to add one little thing to that: research is only research when it gets published. That is, research has to be shared; you must not be jealous of research, you must not keep it hidden. Sometimes, of course, when you reveal things to people they think that you are just being silly, they think it is light-weight, they are rude about it, and so on; but I think that is a risk you have to take. You have to be upfront with research. The website is obviously the easy, low-cost, easily edited, easily censored way of doing it. Maybe that publication edited by Maria is actually a thing of the past, very nice though it is – maybe that does not have to happen anymore. We will leave the subject of research for the moment, although I am sure we will come back to it during the discussion, because we have three other things to fit in. Thank you, Fraser Hay for your presentation. Those of you who have not seen the Parliament Building in Edinburgh should really go there and see it. It is the most extraordinary amalgam of detail that you will ever see in your life, and one that will keep Fraser and his students happy for the next twenty or thirty years, I would think. I am sorry I have got the running orders slightly wrong, and I apologize for that, but we are going to continue even though we started late and will finish late. On Rodica Crisan's presentation, I do know what I think and I may say that images of that sort, which I would call pornography, as a much easier way of describing it, are much supported by the architectural profession. The architectural profession love all that stuff, because it is a good way of selling the product. That is the world that we are part of, whether we like it or not, and we have to sort that one out for ourselves. The last presentation for this session is from Oliver Fritz, who is Assistant Professor for Digital Media and Architecture at the Liechtenstein University of Applied Sciences.

We can begin the debate on the presentations we just heard. The last two presentations talked about computers again and, adding that to the lecture we had late last night about the Sagrada Familia and other things, it seems to me that there is a clear direction emerging about computers. Computers can, of course, do whatever the operator wishes them to do, and certainly producing those pornographic images of buildings, as I called them earlier, is **one thing that computers do very well, and I think that our students learn how to do that sort of thing very quickly. But it does not really prove anything; those images can be of anything, they do not really matter. The other use of computers that Oliver showed us seems to me to be far more interesting, both in terms of our architectural output and in terms of this word construction, as well as in terms of what future architecture might be, how it might be conceived, how it might be drawn and how it might be made.** So I suggest that the beginning at least of our discussion should be about these things. I would like to ask Oliver to explain, simply, how all that work was produced: that is, was it done by undergraduate students, was it nineteen-year-olds, or was it post-graduate students who had been through a more conventional – dare I say old-fashioned? – architectural education?

Oliver Fritz

Most of the work I showed was from the ETH, where I was teaching for the last five years, and all but one of the pavilions were done by post-graduate students, who worked very hard on computers for a full year to understand all the aspects. They learned programming, they learned scripting, they learned parametric design, they learned production in CNC; and it is not possible to learn all this in a short course. One of the examples, the second one, is not complete as a structure. It was made in one week – a seven-day pavilion. We prepared the parameters, we prepared the construction, and we made some experiments before we took it to the students. Then there was a week when we had the students for the whole day, like a workshop; and after seven days this pavilion was done. It was worked on by first-year to fifth-year students; it was not a special course. I think that the students need to learn the tools by themselves in the first two years. It is really not possible to give a lecture about AutoCAD, or any kind of CAD field, really. Each student must decide for himself what software he wants to use. All you can do is give them something fun to work with, things like this; and if they are really interested or if they need a programme or software for a new project I am sure that they will learn about it, they will buy a book and learn about it. **You have to open their eyes. Students have to understand what different formats are for. I think that it is very important for students to learn to write a small programme, a very small programme, just so they understand**

what a loop is, or an 'if then'. That is my opinion. Now I work only in Liechtenstein, where I am teaching students in the Master's class. We bought a CNC mill, a big one, that can produce six metre pieces – personally, I would like to build houses with it. This is my first semester, and I am surprised at what they learn. I do not have any experience in this, but I think it will work. I just have to prepare more than for post-graduate students, but I think that the results will be similar.

Herman Neuckermans
I would like to comment on your point, but first I would like to make some remarks about two or three of the presentations. In my opinion, the interesting developments that we have been seeing were done by people like Ramon Sastre, or our other speakers, who called themselves masters of the technique of programming. If Ramon has a problem – well, I do not know if it is really a problem, but if he wants to do something different – he goes ahead and does it. He does not have to go to somebody and beg them to make this or that, and waste his time explaining what it will do once it has been done. This brings me to a point that I have been arguing about for many years now, because I have been in computer-aided design since 1971. **Of course we cannot avoid IT. It is an illusion to be against it, and I think that that has been explained, so it is not an issue.** In my school, where I am the programme director, all first-year students have to take a programming course whether they like it or not. The reason for that is that it represents a very important recent development in human thinking, which is algorithmic thinking. Algorithmic thinking did not exist before IT; and society today, the many developments in society, and even all these things that have been built here, are based on algorithmic thinking. In my view it is something fundamental, which should be part of architectural education. I think that if we really want digital tools to be our tools, this has to come also, and maybe even primarily, from architecture. So that means that the bulk of architects have to be confronted with this during their education, and then some will grow and develop. But it should not be done only by very specialised people: I think we should all do it. If I may say one last thing, in regard now to the first presentation: research is endless in its subjects, and by definition it is innovative. So I will not attempt to answer the question of what should be researched. However, if I had to suggest something in relation to what has been said here, I would say research in representation, as at least one thing that should be researched.

Jeremy Gould
Rodica, may I be slightly unfair and ask you what your answer was to your final question?

Rodica Crisan
Well, this will be an instantly formulated answer, but it will have to do. I was thinking that what is lost could be compensated by exercises of learning by doing. Normally, I do not like this kind of exercise very much, but I think that we could partly compensate by using them. Computers are obviously a part of our life, and even more a part of our students' lives. I agree with what Maria said yesterday, that they are living in another world – I see this in my seventeen-year old son, who is already living in a different world from mine. We have to accept this as a fact; but I think we

can improve, we can develop this kind of exercise of learning by doing, for the moment anyway. Although I think that it is a very delicate problem, because the situation of a practising architect using a computer but who is educated in a traditional school and can use a computer without any problem as a tool, is totally different from the situation of young students, nineteen-year-olds, that enter a school and are fascinated, drugged by computers, by the force of the image. So, I repeat, it is a very delicate problem that should be deeply studied.

Jeremy Gould
Yes, thank you.

Henk de Weijer
I would like to tell you one example of an exercise we give to students in our academy. For me, and I think for all of us, **it is very essential to see the relation between the technical foundation of the design,** the structures and the form; so one exercise we do is to give a very rough sketch of a part of a building, and tell them what materials they are going to be using in this or that situation, and then ask them to find out for each different situation which is the mother, the leader. So there is one mother and there is another mother and there is a father, and then I ask them to try to find out the relationship between the mother and the father. Or if there is a grandmother also, I may ask them to discover the grandmother. And then after all this I ask them which is the first detail they need to take care of. Many details are solid and many are taxical. And then I ask them to try to discover the technical prerequisites of the different situations. So there is one detail here, one detail there, one detail around the corner, at the bottom, at the foundations, and so on, and they all have some influence on each other. I do not let them go very deep into the detailing, because it does not matter if you do not go very deep into detail on 1:1, or 1:20, or 1:10 at the maximum, as long as the essential items are dealt with. And you may find out that a detail that is at the far back corner of something proves essential in finding the solution for a detail somewhere else entirely. So these relationships between details are very helpful and very creative in finding the relation between the needs of form and function, and this is very illustrative for students.

Donal Hickey
Over the past number of years I have noticed that the image is presenting a serious problem in terms of how students understand work. **They believe that the image is total, and their understanding of projects is solely based on the image. And in some respects this is separating them from the idea that they need to physically experience architecture, and that is directly translated into how they conceive their own work, both in terms of materiality and how it is expressed, that it is not fixed.**

Jeremy Gould
I agree with you, and I am assuming that you are disapproving of this notion of the image. What do you do about it? I apologise for intervening, but I agree with you, and I am interested to see how you and others propose to deal with this.

Donal Hickey

We must stress the critical importance of the physical experience of architecture, because it is so fundamental. One problem that we have in our school in Dublin is that insurance conditions rule out school trips to other countries; and we are fighting a continual battle to retain our right to make trips to visit, to physically see buildings, as part of the curriculum. I am sure it is the same in most universities, because we believe that the physical world is fundamentally important as a teaching tool, that in some respects can balance the issues that are now being confronted by the accessibility that multimedia platforms give for expressing architecture.

I have just one more point to make; I have a very good friend whose father is a joiner, and for the first time I brought to the studio maybe forty or fifty little cubes of timber of different types and handed them out to the students, so they could smell what timber smells like, so that they understood that when you paste a piece of timber on a surface, a 3-D face, it has a quality greater than colour, and that when you photoshop timber and change the scale it is not representative of the reality of texture, surface, absorption in terms of light, and so on, and that the materiality of the world we exist in is fundamental in terms of our understanding of how we make architecture.

Jeremy Gould

I should just say we made a building out of cedar some years ago, and it was the best-smelling building site I have ever been on – a wonderful experience.

Dimitris Papalexopoulos

My question to the panel has to do with parametric design and algorithmic thinking. I think that one of the main design problems is **how we define in an object what is stable and what is parametric or changeable.** This is a capital design decision. What is you opinion on that? Do you have a theory, do you have paradigms? Do you have something, or are we still at the research stage in this domain? We do not define a form once and for all; we define a kind of form that has stable and changeable parts.

Jeremy Gould

I certainly do not have an opinion, because I have no knowledge with which to form an opinion, but Herman might, and Oliver might as well.

Herman Neuckermans

I think that the only real example so far of parametric design, as it is known in the area of computer design, has been given by Mark Burry. It means that when the shape is defined by mathematical equations, we have the parameters; that is where it comes from. You may be able to extend it to other concepts, but then you will come to something that will be very vague, and that, I think, is the reason for your question. Basically parametric design is when, instead of saying that this is an idiosyncratic object that measures 9x6x19 and is called a brick, you say that it is an A,B,C parallelepiped and has a certain matter. And then you instantiate the values, as was said earlier. Whether this methodology can be applied to any shape you like, I do not know.

Dimitris Papalexopoulos
To make my question clear: my point was, of course, that we have very good work; but to be clearer, and I want an answer from mass customisation people, do we have a new problem in the definition of habitat, for instance, because you presented some objects there, or do we have a new design research area? My personal opinion is that we are in the open, redefining old subjects of architecture, or new subjects, in a double way. **There is a *homeopoetic* dimension and a heteropoetic dimension: that is, the part that is their core of identity and the part that can be changed by others. This, I think, is a new design problem,** and I would like an answer also from the people who spoke about mass customisation. Thank you.

Nadia Hoyet
The last thing I showed was a diagram giving the idea of how you can enter the prototype information. In the tests for different origins, scientific, parametrable, measurable, they introduced human parameters and tests in all their great variety. To deal with all this information you need to be able to parameter human factors, so that you can find the interface between all these pieces of information. It ends with works that are close to what Fritz showed, and the question is the iteration of the work.

Jeremy Gould
I will go back to your question of whether things are new. As a historian I always think, and I actually know, that there are no new things. There are different ways of doing things, there are slightly different ways of approaching things; but it is interesting that both the lecture last night and Oliver's introduction today were both showing ways in which historically the same process had happened. It had happened differently, the technology was different, and so on; but historically the same process was always there. We started with Gaudi's geometry in the early part of last century; now there is another way of looking at it and another way of making it, and so on, but the idea was always there. And I like the idea that we are part of a progression; it makes things much easier to understand, I think. One of the problems with today's students, it seems to me, is that they have no sense of history; and I find that a very curious thing. They do not understand what is old and what is new – everything is new, because they press a button and it comes up on their screen. Think for a minute about the two details that Christian Schittich showed us – a very cold house designed by Tadao Ando and a very warm German building designed by someone else. I think that it is very difficult to explain to the students the difference between these things, because they see them both as current modern architecture; but actually, the one by Tadao Ando I call heroic architecture, it technically belongs to the heroic period of modern architecture, and the German example belongs to maybe the 1990s or something. If you have a historical perspective on these things it is much easier to understand the form, the materials, the technology, and so on. So, I am afraid to say, the top of my list for first year students is to teach them architectural history, because then you can start to put things in a very wide perspective. And then the connections between Gaudi and parametrics and the modern computer are much easier to explain and to understand. It is just an idea.

Dimitris Papalexopoulos
I partly agree and I partly disagree with you. Durant in the 19th century was a catalogue under a total concept. Now maybe this is an overture to the unforeseen. The lesson of interaction today is a kind of liberation, a freedom, that surely must know Durant and all the things and the variations very well, but here with Durant we have a catalogue "Les plus beaux bâtiments et la construction et details qu'il faut faire" and here we have an opening to the **virtual ethic.**

Sabine Chardonnet
I just have one thing to say, and one question. The thing is that of course we have problems in our schools, because we have so many issues and so many disciplines that we will never have the staff required to handle that. So you have to select. And in our school we selected two fundamentals, one of which is history, including history of building and construction, and the other is geometry, which had disappeared but which we re-introduced into the curriculum, because I think that in the digital era we need to give our students a geometric culture that is fundamental to the discipline, not just a mater of forming images. These are two things that are complementary. Then, regarding the question I had in mind: this summer I was in Iceland, and in Iceland they have no more wood, they have destroyed all the forests, and they have brilliant architects, who build public buildings; but when they want somewhere to live they just go to the Net and buy a house from Sweden, which is delivered by boat. They have to give dimensions and say what kind of thing they want. I was at a farm where the farmer wanted to build a house, and when he discovered that I was an architect he asked if I could help him, because he did not know how to deal with the catalogue. And suddenly it occurred to me that in these kinds of situations we need a mediator. A mediator between a new way of access to everyday products, which is what a house in Iceland seems to be, and these people who do not know exactly what is going to happen to them with their houses being delivered and built in front of their noses, and there is something new happening with that. This is something that we should perhaps think about, and maybe develop a new profession somewhere between architecture and building and management and merchandising and customising.

Jeremy Gould
Yes, I see what you mean. You can buy your house from IKEA, and it can come with all its furniture, I assume; and just as you hire someone to build the IKEA furniture, you can hire someone to build the IKEA house as well. IKEA could maybe even make it the same person.

We have a comment from the back.

Joan Luis Zamora Mestre
For many years I longed to see a meeting of the EAAE in my school, the school of Sant Cugat des Vallès, and now it has happened. So first of all I would like to thank all the organisers, and especially Ramon Sastre. Now, I would like to make some remarks on the three speakers that I have been listening too. I must say that although this is not my field – I am a professor of architectural representation – I found the concepts you have been addressing interesting, and I liked the questions that were

put forward by our colleague from Ion Mincu University, the school of architecture in Bucharest. But what is representation? There are three issues (these are not my concepts): mental set, meeting and the notion of equivalence. For me, the concept of equivalence is the most vital: whether what we are representing can be equivalent to what is going to be built or whether it is biased. So I think we can link this aspect with what has been put forward, that the way of thinking that is relevant today is that of computers, and computers are here and they are here to stay. So we are probably in a moment of transition. I say that we are hybrids, and I see that Ramon is not a pure and devoted computer designer of programmes ...

Jeremy Gould
Yes, none of us are pure.

Joan Luis Zamora Mestre
Ah, but there is more to that. It is quite interesting to see the issues explained, but they have got be linked to other information. I have information from students who have come here from Bucharest, who are quite serious and hard workers, which is of one kind; and I have information from the building in Edinburgh, which is of another kind. Having had an opportunity to work with Van Eyck, de Carlo, and so on, I know that the leaves come from Van Eyck, out of Van Eyck, with a special meaning, and that was the way to start a process. But what concerns me most is that it would be a pity to lose the seriousness of building. Our colleague from Liechtenstein made two points in that respect. The example put by D'Arcy Thompson On Growth and Form is formalistic, and in fact Thompson was trying to offer an example of the relation between function and the environment. He was attempting an organic way of explaining forms, so I cannot accept this as a good example – in fact it is completely biased. And I prefer not to give any opinion about the little houses in the plot. The future is fascinating but, as has been said, the drawing of architecture is the first construction of architecture.

One final point and I will finish. Candella was a very strong critic of the Sydney Opera House; and when they defended it, it was in terms of the fact that the work of an architect is a service, not like the service performed by a rubbish-collector, but in terms of creating new types, new modes of seeing the future of architecture, and that is a challenge.

Jeremy Gould
We have had presentations from the people from Warsaw, and I talked to the representative from Wroclaw about how teaching was done in Poland. I am conscious that the eastern end of Europe has a particular tradition, and that it is a much more methodical, systematised, separated, perhaps, tradition than is the tradition now in western Europe. And I am wondering if they have thoughts about these things. You are in a state of revolution in the nicest possible way, and I wonder if you have thoughts about the use of these strange machines and how your course and what you teach might be altered by them.

Rodica Crisan
I was thinking that there is also another important difference, not only between east

and west but also between big schools and small schools. It is very easy to make experiments when you have 80 students; but we have 300 students in each year of study, and that causes a lot of problems. For instance, I teach constructions of wood and steel: what kind of experiments can I make when I have 28 hours and 300 students?

Jeremy Gould
Do not think this is a problem unique to Eastern Europe. In fact, your numbers may even be a little modest. I know what you mean, and you have to work out ingenious ways of breaking that number down into smaller and smaller groups. I have a theory that it is very difficult to teach a class that has more than fifteen students. I am sure that we are all teaching classes of 150 or 300 students and so on; but if we really want a discussion amongst a group of students, to really talk about what they are doing, then I think fifteen is a good number. Anyway, I just wanted to say that we all face such problems, and therefore problems with money and so on. But then, of course, we have to find solutions – our job is not only as teachers of facts and theories, it is also about practicalities like these.

Donal Hickey
There is something I find interesting about the new programming languages, how students hyper-text in terms of how they read images, that sometimes we look at our students and believe that there is an irrationality in terms of how they play. **What I would suggest is that we have to allow for unstructured things to happen. So playing and dreaming are really important. It is not just empirical facts that allow us to understand the world; to dream is important too, and to play with programmes is very important as well. And to look at play as being critical to how we learn is also very important. And maybe it is not about looking at the world in an absolutely structured way.**

Joan Luis Zamora Mestre
Federico Fellini said: *Nulla si sa, tutto s'immagina:* Nothing is known, everything is imagined. Something that is quite interesting is the representation of biologists when they are researching viruses. The way they explain them has nothing to do with the advances that are made. As the research is going on; new ways of describing it are put forward, and they vary enormously. So, for us, what is an image? Is it what we have, or what we know? A means of putting forward our knowledge? But this is not complete. It has always got to be revised and it has always got to be complemented.

Jeremy Gould
Should we maybe just change, move the subject slightly towards research in architecture? We touched upon various issues in the presentations just now, but there are many issues that we have not discussed. For example, I am interested in research into actual materials, which I guess never comes into schools of architecture. Is that right? Does anyone have any experience of actually dealing with the things in the building industry? As far as I can see, the products in the industry are becoming more and more globalised. You can buy the same roofing tiles in China as you can in Eng-

land, which I think is appalling, actually, but the point is that it is possible. They are made from the same moulds, they have the same licence and so on. So increasingly these products, owned by a corporation, are the common currency of the world. And these products often do not come near the schools of architecture, but as architects we are asked to use them all the time, and that seems to me to be an extraordinary gap. We saw a diagram yesterday that had the three circles of academia, research and practice. I would add another one for industry. We have no connection with that, am I right? Does anyone have any experience in researching a building material? You see? It is interesting, is it not? It is interesting because we put ourselves forward as thinkers – that is what we say we are – and actually all the pieces that go into a building are rarely designed by us. Most buildings are an assembly of standard products.

Ferenc Makovenyi

My opinion is that it is unfortunate that the construction industry is not part of the military industry: if it were, we would have much more money and many more opportunities. From what I know research in construction means, for example, how it is possible for someone to start from a basis and in twelve hours to build a landing platform and have the concrete stable and even. That is interesting, and that is research. **We, on the other hand, use the products, but we have lost the game. The game is that normally, traditionally, universities and schools were bases of research; and we gave this away. We outsourced this, unfortunately.**

One more point, connected with something Nadia Hoyet said about a Doctorate in Architecture. I think that there is quite an important connection between research and doctoral studies. Because if we want to reproduce our profession of, let us say, construction, building construction, we need educated people, and we need doctorates. That means, especially in my region, that you have to be a DLA, Doctor of Liberal Arts, or a PhD; and then you can have doctoral schools. I know that the ACE, for example, is fighting to get a special Doctorate for architecture, so that we are not PhDs, because we are neither like chemical engineers nor artists. Our knowledge is a little bit different, and that is why the ACE is fighting in the Chamber of Architects to remove PhDs and DLAs from our profession and to form our own doctoral courses. I think that this is very important for research; so we can say that this is a special task.

Nadia Hoyet

It is a problem, and we have to build it. It is researching itself. We have to build this kind of knowledge, what we could call hybrid knowledge.

Maria Voyatzaki

I want to go back a step as we talk about research, because there are questions that are emerging, firstly relating to the generalist nature we want our diplomas and effectively our graduates, the architects, to have, which means that automatically we are not specialists in any area. When we talk about researching materials, there are other disciplines out there that are specialists in the matter who will do it better than we can – materials scientists. You talk about acoustics, and you get mechanical engineers or acousticians that have a physics degree, and then they specialise with doctorates, and so on and so forth. That is one problem that we have been discussing for years: what are the specific fields in which we can, and have the authority, to do research? The other thing, is what is the milieu, what is the platform, what is the physical sphere in which we do research? For even assuming that we overcome the first part of the problem and we have specialisation and higher degrees, with doctorates in special areas, and even though research has traditionally been a sphere or an asset of the universities, the contemporary reality is that research is funded by industry. We all know who or what drives the RAE exercises in British universities – the needs of the industries to produce and to be productive. Which leads to another point: where do we do this research? Because if research is funded by industry, then we have to find the links and the ethics to create the framework to allow research to flourish. And finally, research has to become a common ground for all of us; and this is also something that we have been discussing for quite a few years. The more specific so-called serious journals, the scientific journals, with their scientific committees, and so on, could theoretically host the research that we as construction or other teachers undertake. People mentioned last year publications like the Architectural Education Journal, which is produced in the US; but if you flick through it, it is exclusively American universities that publish in it – and what they publish is always, in my opinion, more or less irrelevant to the title of the journal each time, but that is a different story. At least they have played it clever; they have invented a journal and they publish in it. We Europeans, and we, as a network of teachers of construction, have no niche in which to publish, not only for our CVs and our promotions, but to promote research as a whole. We have nowhere to publish.

Francesca Muzzillo
I would like to say something regarding the field of our research. Because of my architecture history, I have always had to deal with engineers; and I remember that when I was younger I decided at one time to become an engineer, not because I did not like being an architect but only to explain to them that there is no difference between us. In that sense I think that every field is my field as an architect, if there is, as someone said before, a passage from a dream to a construction. Obviously I am not able to do all these things alone; I have to do them with other people. Generally I begin my courses with twenty centimetres, because I think that the first thing the students should know is how big their hand is. Then they will not say that something is twenty centimetres when it is five or fifty. I think that the first important thing is for them to be able to calculate length, how big something is, and physical space. So you see everything is my field, and in everything I could work with others; but there is a dream in between. Yesterday I was in Barcelona, and while I had seen the new architecture, Gaudi architecture, before, I had never seen the Barrio Gothico. For the first time in my life I saw ceramic tiles from the outside, steel and ceramic. You get the feeling that they endure for years and years; they are not eaten away. That is an obsessive way of thinking. I calculate like an architect, and that is my field: to imagine, to dream and to try to arrange. That, I think, is our field.

Maria Voyatzaki
In response to this I would very quickly like to put on the table two realities, unfortunately very cynical, as all realities are. **The one is that industry funds people and**

ideas with prestige, status, acquired through past experience, specialisation, studies and work. They do not fund dreamers. The second reality, which is even stronger and is based on fact, is European Commission General Directive 13, which does not include architecture as one of the research areas that is funded by the EU.

Ole Vanggaard
You postulated that there was no research at architectural schools. Seen from the Scandinavian point of view, we started off with the Aarhus style, and I know that in Bergen they are doing a large scale research operation at the design school, 1:1 building in timber – there is an architect working up there – and very closely related to where the Norwegian timber industry is, that is doing full scale structures every year. Well, one year a structure fell down – it is, of course, very dangerous to work with full-scale structures. Then in Copenhagen we had a PhD student in architecture, who was working closely with Wiennerberger, which was financing half of the project. This meant that our research in brick was not limited to the architectural site, but it also meant that we were working on the structural part; and our exploration of reinforced brickwork and reinforced brickwork industrial components can be included in architecture. I think that going into the materials is a possibility, and it is strengthened when we work together with the industry. There are examples, and they are important. It can have an impact on the whole situation in the school when someone brings you input and others react to it and include it in their research.

Jeremy Gould
I would add that that is also true in England. Research into materials is done via the routes of low energy materials, or the so-called green materials – glued brickwork is one example I can think of – and so on, particularly in the use of so-called green insulation materials. I think that there are examples; and for those who wish to get into that sort of research, what they should do is to find out how those existing researchers manage to work the system. I think you will find that it is done through collaborations with other university departments, and gradually you build up a simple network which allows you to be both an architect and a researcher into materials and to get the necessary money from industry. This is forthcoming, but it requires a lot of effort and persuasion to make it happen; and, again historically, I would say that architects have been very bad at that over the last century. If you look at the 19th century, architects were very much involved in the production of materials of all sorts. In the twentieth century, generally speaking, they were not; and there were very good historical reasons for that. Partly because architects wanted to be famous, and were spending too much time being famous and had not enough time to do other things. However, I am digressing, so I will stop.

Herman Neuckermans
I wanted to answer your question of whether we know a school that is working on materials. Of course we have schools that are working on materials, and I think that our friends from Denmark have proven it. Our school also, does so, in an engineering context. So I will not go further into that. Instead, I will take the question further and ask you not to forget that education in architecture has a full scale of diver-

sity, which I hope and I am convinced will subsist in Europe. In your school you start with history, my school starts with theory, another school starts with construction, another with raw materials, and so on; and this diversity will persist. In the new structure of the Bachelor's and Master's degrees, the Bachelor's will probably be more uniform, since the European Union will impose similar elements; but in the Master's you will be free to specialise: some people will do materials, others can do history, others computers – and I hope that this will happen. The second remark is that maybe, and I hope that you know, the EAAE, which I think is the model of this network, also has a network on research.

My last remark is in answer to you, Ferenc Makovenyi. The EAAE has established a joint working party with the Architects Council of Europe, which I think will meet again next month, and I will bring that matter to the fore, because it is new and very strange for me. The joint working party is now working on the critical issue of how we access the profession after the abolition of the Architects Directive that has been in operation since 1985, and which has been replaced by a Qualifications Directive that I presume does not concern you much, but that is very fundamental, very important for us. And there we tackled the problem of the PhD, because I fully agree with you that research is primarily fed by PhDs. What I do not agree with, although people have said it three times here, is that research is funded by industry. That is not entirely correct. It is also funded by industry, but there is a lot of research, for example, into energy, where many industries may be involved but that is funded by the European Union.

Per Ola Wedebrunn
One of the biggest resources that we have for research at schools of architecture is rooted in the diversity of culture that we have in Europe, and that is the students. This is one of the greatest resources that we have: not the economy, but the students. And the students will experience things and will help us to develop things because they come to us with new ideas, and we will pass on ideas to them.

Fourth Theme

Dynamics and Tendencies

Discussion

Chair:

Emmanuel Tzekakis
School of Architecture
Aristotle University of Thessaloniki, GREECE

Emmanuel Tzekakis

I would like to welcome you all to the last session of this workshop, which hopefully will be a fruitful one. We have a panel here made up of all the chair-persons of the previous sessions, and our objective is to try to reach some conclusions and to try and see dynamics and tendencies. This means that we will attempt to draw conclusions from the other sessions, and with this the chair-persons are going to help us try to see what comes next. Before asking the members of the panel to make their comments on the sessions they presided over, I would like to say two things: first that what the chair-persons should do is not, of course, to summarise or repeat what everyone has said, but to try to draw conclusions from the sessions in order to help the proceedings move forward. The second point is that everybody should help to draw conclusions on what to do next, which is the basic question we have to answer. What to do next about this network, what to do next about issues that have been raised these past few days, what future activities will be organised, how good the work we have done is, what we see as questions or items that should be addressed in the future, and how we can organise this work next year.

Maria Voyatzaki

You never tell your students that you are stressed when you deliver a lecture; but since you are not my students, I can tell you that I feel very nervous to be the first one to sum up. I am very pleased that I do not have to sum up from the people on my panel, because it is better to hear things from the horse's mouth rather than have them paraphrased and perhaps distorted. So I will paraphrase only myself. I will be very critical of myself on this, because I bear a huge responsibility in setting up this workshop. People have been very politely saying that they are happy with both the organisation and the content of the discussions, but I can also sense that there must be some disappointment in some people's hearts; and since it is not in my nature to be complacent, I will not stick to what is successful in this workshop, but will stick to the theme. I tried to listen last year to what you wanted us to set up for the next workshop, and we came up with this title: *(Re)-searching and Redefining the Content and Methods of Teaching Construction*. We could have stopped there, but we added the words *'in the New Digital Era'.* Language is a very tricky tool, and we could just as well have chosen 'in contemporary architectural education', 'nowadays', or 'in the future'; but I think that perhaps in that case we would not have had all this debate. This wording was something that I have worried about all along. The trouble may be that we have to question our existence as a network all together, because this artificial separation of what exists and what will exist is similar to us as distinguished construction teachers: we are educators, under a general umbrella, but we are also designers, theorists, and so on. Perhaps we can claim, as the Aarhus School of Architecture claimed, that we are getting too academic; but that, if I may say so, is a narrow viewpoint, because all of this heated discussion would not have occurred if we saw as the one unifying word the word 'context'. History, theory, design, research and construction are one thing; it is the context that changes, and with it all the other things change, including, of course, perceptions of architecture, construction, and the ways in which they are taught.

As I said, language is a very tricky tool, because while it provides us with nice words to allow us to express ourselves, when we put them together we run the risk of creating artificial polarities and separations. These past few days I have been writing down words that came up, like 'physical' versus 'digital' or 'virtual'. If you go back to word context you will realise that there is no such separation or that if we would separate them we would add other things such as 'fusion' and 'continuity' to overcome and dissolve these polarities. There is a danger that we see things as either/or situations, as Dimitris Papalexopoulos stressed; and this is simply because if we stick exclusively to the fundamentals we run the danger of being naïve, while in the other case, if we see everything as virtual, we run the danger of being utopian and extraordinary just for the sake of it. So no one around here is claiming an either/or situation, but there is a plea for a both/and situation.

Another thing I want to stress is the aphorisms that have been around in the doctrines on which some people have based their track of thought. I think that there is a danger here, because, to quote Dimitris Papalexopoulos again, resistance should be there to make people more creative, because they have something against which to fight; but if you just take the aphoristic position of simply abolishing, deleting, wiping something off a screen, then all you do is strengthen it and give it power to exist and become stronger. So, as far as I am concerned, it is very important to have creative exchanges of ideas, to be able to sustain our views or refute them, but based on in-depth theories, ideas and philosophies, rather than just ruling things out without discussing them. The other thing that I feel is important is this tendency that I think we have of attaching derogatory or negative connotations to words. This, I think, is a conservative view for everyone, but even more so for teachers who are trying to feel the pulse of the young people around them. We had this discussion a little while ago, where someone was saying that something was not rational, and I asked him what was wrong with that. Statistics say that most car accidents happen within three kilometres of the driver's home; this shows that what is predictable is not necessarily safe, because it is when you are relaxed and not expecting trouble that things can go wrong. So the word 'unforeseen' should not necessarily be seen as something wrong, derogatory, negative, because it is something that allows you to create – and after all we are architects and we are here to create, either as architects or as educators or both.

One of the themes that was raised was ethics. I think that it is very important in our discussion, whether it concerns the digital, the virtual, research, teaching, industry, students, or all of the above, for us, as educators, to define the ethical framework that would allow us and free us to do things.

Last but not least, I want just to return and justify the title of the workshop. It is like the woods and the trees, and I will just give you a personal story because people like this, but I promise that it is relevant to what we are discussing. Eight months ago Dinos and I became the parents of a baby boy. When you ask him "where is your mother?" or "where is your father?', he does not know to look at us, but he can spot an aeroplane. Every time we say "where is the plane?" he turns and looks into the sky, and I find this particularly interesting, as well as funny. The thing is that when he is actually in a plane he does not realise it, and when we try to get him used to the idea that he is on a plane and we say to him "here is the plane, you are in the plane", all he does is look up, trying to find the sky to spot it. And I think that this is the case with the digital era – we are in it. Let's not pretend that we do not see it and that we do not feel it. Thank you.

Emmanuel Tzekakis
I do not know if it will be fortunate for this session that we made Maria speak first; we will have to wait and see how it goes. In the meantime, Ramon, could you please add your remarks?

Ramon Sastre
When we chose the wording of the title of the workshop, I was pleased with the phrase 'the New Digital Era' because you can read it in two senses: simply as the time we are in or in relation to computers. So we can talk about teaching in a digital era, or about music, or anything, because it is a time, an era. In the history of the centuries the 20th and the 21st century will be the digital era. I had the chairmanship of the panel that addressed the new in relation to the other. This is a theme that I suppose you in your universities have every day. We have relations with the other subjects in architecture. Sometimes we talk about design in construction, which covers many things: for example, in our schools we have construction, conditioning, insulation and structures – separated, not together. Construction is just a part of technology. Maybe the use of computers, if we talk about this sense of the digital era, can help us to be closer together, or maybe not. It depends. Someone said earlier that he could programme, and that is real; sometimes with friends at my school I say that programming is like speaking English, so it is not so bad. All the students learn to speak English, and in the same way they can all learn to programme. So you learn programming – there are many languages in programming as well – but that is nothing if you do not have something to programme. What I find particularly interesting is that if you programme you understand programmes, and you can understand what is behind any programme. Programmes are like books without their authors. You have a book, but you do not know who the author is. It is the same with programmes. It is not necessary to be an expert in programming to create something. Maybe you will never use it, just as people sometimes learn a foreign language but never use it; but you will understand it, and that is important. You can read, you can surf the Net and read things. So when you learn to programme you learn what is behind it, what is important and what is not. In the same way you look at the computer and think how beautiful it is, the images, the colours. Colour, though, is just a number in programming. You have red, green and blue, you can mix them together and get new ones, but it is still just three numbers. When you reconnect to the others – I mention this because we also have this problem of connecting with other fields in the school, like design, construction, history – maybe there is a possibility of working together through the new digital era of computers. We can share things. The obvious example is databases, of course, but this is only one thing: there are many other things, just by way of the means that we have. And it is important that we have lived this transition. Our children will have lived only with computers. They will not have lived the transition; there will be no before and after computers for them. So we have this obligation not to be archaic with regard to computers. We have to be with them, otherwise we are dinosaurs. This connection with the other subjects in the schools may help us to be obdurate, because when everyone is making something of these new rules, of this new era, you have to be a saint to connect them. Otherwise, when we find ourselves in the studio, or when we speak with professors of history or design or urban planning, if they speak a different language – and maybe this

era has another language – we will not understand one another and will be unable to make a team. That is the theory I have seen emerge these days. And sometimes we see presentations that are very good in themselves, but somehow do not connect with the others. This is just a means, of course; but, as Maria said, we are within these means and we have to use them. So that is all I have to say for the time being. Thank you.

Emmanuel Tzekakis
Thank you very much, Ramon. Can we have Donal's comments, please?

Donal Hickey
I always wonder at the end of a conference how useful it is to come up with a final solution, to put an underscore beneath what has happened; so I do not think that I am going to do that myself. The questions that were highlighted in the session I presided over related to creative tools – which is strange, really, because tools are not creative – and means of transferring knowledge. Certainly there seem to be two camps: the camp that was about navigating and the camp that was about tools or expert tools. And I think that for me the important thing that came out of that session was that as teachers we have to take responsibility for both the knowledge that we are trying to communicate and the way we communicate.

The last thing I wanted to say was that an issue about lighthouses was mentioned in an earlier session. And I would like to leave you with the notion of lighthouses and ways that help us to navigate. Maybe navigating will be more interesting if we help students to navigate a certain number of things and ways of working and thinking, if they were able to determine where they are going to go without lighthouses. So maybe we are lighthouses only in the beginning. Recently I watched a programme about mapping in Scotland, 250 years ago. Lighthouses are a means of fixing points, so if we fix a number of points in space then we can use those points to move on to other places. I think our responsibility is to place lighthouses so that our students can find new places to go. Thank you.

Emmanuel Tzekakis
Thank you very much, Donal. I find what you just said a very nice thought. Can we proceed with Nadia, please?

Nadia Hoyet
All presentations by the participants in the session I chaired confirm that digital tools are well present in our Schools. Students, their best consumers, are evidently familiar with them. Digital tools are used accordingly by teachers, modifying the ways they teach thanks to the new possibilities offered in managing information through data banks, the Internet and software of all sorts.

More globally, the different interventions showed clearly the advancement of our teaching and research practices. But this mutation also poses certain important questions to which we have to respond. I could distinguish three main questions that correspond to three types of using digital tools. Concerning the access to information, we could realise that complete data banks are now available. The example shown by Herman Neuckermans is remarkable from that point of view. Hence, databanks, irrespective of their origin, provide a great deal of knowledge with the aid of search machines. However, this instantaneous access to information poses the question on the validity of the information offered. In effect, we have to recognise from the sources what is serious and valid. We must rapidly possess this type f recognition in order to exploit data from the data banks we find on the Net. Another important question that appeared in relation to the use of the available information through the Net: a number of construction teachers are confronted nowadays by the use of their students of prefabricated construction details which they 'paste' on their projects without really comprehending what they represent. This type of import, with the method of pasting parts of information produced in another context of conception, becomes another interesting question which risks leading us to the opposite results. The databanks we possess today pose the question of good use.

Concerning the representation of information and the great facility with which students manipulate software to treat an image, certain teachers submitted their difficulty. Some believe that the seduction driven by the image is a masque which hinds away the real architectural thinking. We are confronted here with the terrible power of the image, which we have to debrief with difficulty. The image possesses a specific language, which we do not entirely grasp. We must our best to understand, by giving it sense, in order to have a better discussion with our students who leave in the world of image.

Finally, concerning the use of a number of applications for our profession, beyond the traditional CAD software, such as AutoCad for example, we note the appearance of small software designated for teachers; what we would call in France 'didacticiels'. What was shown by Ramon Sastre and Oliver Fritz is representative of this new trend. We possess here a way to amplify our capacity to demonstration and we imagine that those of our students mostly interested in IT will find here a real means of expression. This last point represents mostly an opening rather that a problem to solve. But that supposes that students must be educated in programming. We are facing new ways of thinking of a project and probably of new ways of producing architectural and urban space; it is still hard to appreciate the implications for our teaching as we miss the hindsight to known the effects; but this encourages exchange with the other disciplines, which are probably confronted with the same questions.

One of the results of the diffusion of new technologies is found in the interrelation of the complexity of our entire environment which lies in the social, financial and physical domains. The complexity represents the state of contemporary society. This implies new attitudes, where we are capable of managing the data of our practices and professions.

It would be interesting to ask ourselves on the way in which our teaching deals with the question of the management of complexity. How to teach the management of different domains where the data are numerous and often confused? The architect is one of the actors of this process; what is the management of the participants of the deign process? The information produced on the occasion of a project is getting increasingly wide; how will our students be prepared to manage this?

Our young engineers (who graduate from schools of engineering) are educated to this type of management; will the architects remain absent in this? It seems to me that questions on management and methodology belong to our discipline (in the area of technology) and they are subscribed within our education. How will we take them on board?

Donal Hickey
If I may, I would like to suggest as a future topic of discussion the materiality of how we make architecture.

Emmanuel Tzekakis
We will come to that. Let us finish with the summations of the panel and then we will discuss such and other issues.

Jeremy Gould
This is probably easy, because it is the freshest one in your minds. We, of course, also talked about computers and computing, and we looked at the dangers of computing, the competition by posters as Rodica said, and marvelled – I hope – at the work that Oliver Fritz showed us from ETH and from Liechtenstein, which I think is a real pointer, perhaps together with the lecture last night, about the way that computers will seriously change the way we look at form and materials and so on. Another thing we touched upon were the practicalities of how we demonstrate construction on a scale of one to one or two students. Or rather how the students demonstrated it to us, as at the Grands Ateliers, which, incidentally, I think is a really great experiment. What I liked about this wonderful work is that it is truly experimental: it might easily fail, and by failing one would learn a lot about it. I think that that is a truly useful exercise for students, but, of course, one that for individual schools is very difficult because it costs money, takes a lot of time to set up, and so on.

We also talked about the nature of research, and what research is in architecture as a whole, and what research is that might label itself research in construction. Lightweight structures, structures in general, the use of materials, technical detail, and so on, were mentioned; but I had a slight frustration that I again wanted concrete examples – that is not a good expression: let me say definite examples -- of how that research was being done, by whom it was being done, and what effect if any it was having upon the world of architecture; and I would certainly suggest that this is an area that we ought to have demonstrated to us here. I think that it would be extremely useful to look at that. On a personal note, I want to add that I am completely ignorant about computers and computing, and that is something that does not worry me at all. I do not lose any sleep whatsoever over computers, because I think that within the world of architecture there are greater issues that we have to deal with. Computers will help us solve some of those issues, and we should not be afraid of them – the younger generation, as has been pointed out many times during this conference, has no fear of them whatsoever. The only problem with computers, I think, is one of too much, too soon, too quickly. Our generation just has not had enough time to get used to them. Also, they are not censored and, like the Internet, are uncensorable. The Internet is full of uncensored information, and the only thing we have to teach our students, as we have always been teaching students, is how to filter information, how to analyse and question information that is given to them, and how they can then use small pieces of information to inform their world. And I do not have any difficulties with that at all. Thank you.

Emmanuel Tzekakis
Thank you very much. Before opening the discussion let me add a few words of my own on one or two points that I noted during the other sessions. I observed that there is a tendency to see today's student work, which has to do with computers and mainly with producing images, as something that is perhaps not so positive, because it focuses them on virtual things and not on real things. This is, of course, a very valid position. I would like to point out here that design, as a concept, has always been a good selling point. Design always sells; so in our days, when image is so dominant in everything, because we live in an era when the virtual is there all around us, I do not find it negative that our students use these opportunities to express themselves. Personally, I feel that we also have to keep them connected to reality, to material things as well as to virtual things. Nevertheless it is not a bad habit that they have. Also I am not so negative towards the marketing that hides behind this love of images; this is the world that we are living in now, so we cannot fight it directly. We have to understand it, and perhaps somehow introduce changes into it, but we cannot fight it head on. Computers in themselves are nothing; they are just tools. You can all see the difference since the time when the way to represent reality was to commission a painter to make a painting. After that we developed photography, then the cinema, and now we have an infinitely better tool for recording or representing reality as we like it. So we have to see computers as tools and nothing more. The real work we do is always there; the question is how to use this tool to make our work better.

I put these thoughts down in order to stimulate the discussion and to urge you to connect, if possible, what has been said about images and their role in today's architectural work and the tool that the computer represents. Finally, we must keep in mind that the ultimate aim of this discussion is to find out what we are going to make or not make in the future as a group of people and as a group of teachers. So let me now open the discussion.

Nikolaos Panagiotopoulos
Maybe we would not have such a long debate and discussion about this if we could arrange two things: thinking and designing. If we could teach people how to think before they grab the keyboard, this would not be an issue.

Jeremy Gould
I would like to make a comment on that, if I may. I speak only for England, as opposed to the United Kingdom. We are finding that the children that go through the school system, and have what are called A-levels, which are the exams they finish with in the school system, are becoming progressively worse educated. We are now running courses in the university for basic mathematics for engineering students, and we are running English language courses not for foreign students, but for English students. And this, as you can imagine, is a real problem for us. So, yes, I agree with the comment Nikos just made; but unfortunately the education that we are inheriting, the educational system that we have, does not appear to be giving us students that are good enough to do what he proposes. The idea of a foundation year, a year after school before university of doing general courses at what we would call a liberal arts school or a polytechnic (not quite the same word as in mainland Europe) is a good

one, but very few students these days can afford to do that. They go straight to university in their semi-educated state. Thank you.

Per Ola Wedebrunn
I have a question about what we would address as problematic. We have been talking about navigating in the network. We are gathered here, people from European schools, who have 'tasted' a new system in all our schools. We have three years of Bachelor's and then we have two years of Diploma and we all work to have some kind of Master's, and we are trying to get these kinds of things, research and specialising, and research into the realm of what architecture is. So, since we are teaching in schools of architecture, we are also occupied with the question of what architecture is. We are talking about constructions, we are trying to map what architecture is, and we are trying to do this in the light of the new digital media that we will be working with. We also talk about the problems we face; we are very worried about the environment and what environmental issues there might be. Environmental issues might be about natural sciences, but they may also be about cultural sciences, of course; the environment is both cultural and natural. This is not just a romantic view of the world; it is, I think, a real thing that we have to face. We have to look at problems from these kinds of aspects, and the digital media provide us with possibilities for trying out how things work before we put them into the real world. This could be an idea, thinking in terms of two kinds of worlds, or parallel worlds, or parallel technologies existing from different times. We, at this meeting here, have been talking about digital media and the digital world and virtual realities and how these could be brought into practice in the real and material world. Perhaps we should also talk about the relation between teachers, students and the material world. That could be an issue for discussion and further development, because our relationship with the environment is a reciprocal one: if you treat the environment well, it will treat you well too – or at least so we hope. So perhaps this will bring us from the virtual, the digital media, into the real media, into reality. It might offer a possibility for going a step beyond this year. Thank you.

Donal Hickey
There is an old saying, a carpenters' saying, which I think might sort of tie the real and the measuring together, it is: measure twice, cut once. I think it is very interesting, and maybe it will help us in terms of how to think about things.

Constantin Spiridonidis
Since there is no one ready to intervene at the moment, I would like to make some remarks concerning the last three days, when I had the opportunity to follow your discussions. To the question of teaching construction in the digital era, the participants in this room, it seems to me, reacted primarily in three different ways, with three different understandings, three different strategies, three different ways of answering the question raised by the title of this workshop.

The first approach was that the digital era is a totally new paradigm, a different way of understanding our world and our place in the world, of understanding architecture and thus of doing architecture. From this point of view the new digital era is a new thing, a totally new thing, which obliges us to rethink

and to redefine the whole discipline, the whole doctrine of our teaching. That is one approach.

The second approach that I noted saw things in terms of an evolution: we are living in a digital era; it is therefore natural that new things are appearing, and so we have to include them in everything that already exists and thus to enrich our knowledge, techniques and approaches. Computers have indeed entered our world, but they just do things faster, they facilitate our representation needs, they help us. We have the same logics, understandings and considerations as before, and we simply have to incorporate computers into our understanding and everyday work. That is the second approach.

The third approach accepts that we are in a digital era, that things are happening around us, but sees this as something bad, or dangerous, or as a threat that we have to do something about it, that we have to protect ourselves from, and to which we have to react through our teaching, or through our actions, or through our behaviour.

I think that these three approaches coexist in this room, and the question we are faced with is whether these three different views are mutually intelligible. Do the members of these three camps, as we might call them, have things they can discuss with one another? I am sure that within each of these camps there will be interesting things to be discussed, internally, but I doubt whether there is any real possibility of communication between the three camps. So I am wondering if a future event, like the one we have had the opportunity to experience these past few days, has any meaning, and if so what that meaning could be. Will it be just to reproduce the same discussions or the same arguments or to redefine more clearly the differences that exist? I think that if we are considering another event of this type, we have to take into account the difficulties of communication associated with these, to my understanding, radically different ways of approaching and feeling the issues raised by the workshop.

Dimitris Papalexopoulos

I have a small comment to make on the digital era. The digital era is a moving reality. It is already here, and we cannot describe it. Derrida said 'give a name to our monsters to make them our pets'. We could say that we are in this situation in the digital era, and that we have practically moved on from digital reality, which is the computer: are we with the computer or not? The IT engineers have passed on to the network society: are we with the networks or not? And now, during the last year, there has been a shift towards ambient intelligence, as we call it here in Europe, and what the Americans call the disappearing computer. There is a cultural difference in this approach. So the digital era is a moving reality, with two shifts during the last ten years: **from the virtual reality of computers to network society, and from that to the ambient intelligence society. What we can say with assurance is that the shift from network society to ambient intelligence society is accompanied by a very strong return to materiality, and that does concern us. So there is a digital return to materiality, which I think changes the whole way of thinking in construction, architecture and design.**

Spyros Raftopoulos

I have been thinking about whether to react or not to what has been said over the past few days; but, taking a lead from what Dinos and Dimitris said, I would like to make a few comments. Being from the older generation, myself, I am not, as Jeremy mentioned, a computer addict; but I use a computer, I live with computers and I think that we can no longer live without computers. These are facts. I think that as teachers our problem is how we react in relation to our students. What do we do? Our students are there, they have their computers, they too live with the computer. So, do we encourage them to use computers or do we restrain them? How do we react, how do we ask them to use this tool? I think we should try to let the students know that this tool has to be directly related to the skills an "ordinary" architect should have, which include using their minds, using their imagination, using their five senses, using their hands to sketch, and the ability to have a perception of space. Personally, as I said, being of the older generation, I would react negatively if they use computers in a mechanical way. I think it was Maria who spoke on the first day about the young generation that from the age of four play with computer games, later with cell-phones, and so on; but they use these things in a mechanical way. The problem is that when they start designing architecture they will do that in a mechanical way as well; and that is what I am afraid of. **When we design buildings, when we design for human beings, when we formulate human habitat, we have to use certain qualities that cannot be found in a machine.** It is something beyond that. There are a lot of things that are beyond the actual use of computers. What I am afraid of, and I think it was evident in some of the presentations, is that a lot of the younger generation use the computer and create images without any depth, whatever you may understand by the word depth in terms of architecture. I think also that Jeremy mentioned the lack of history. We do teach history, especially in Greece, where we have a very long history and our students spend a lot of time learning it, but it is not related to what is happening now. They learn history as if they were reading a novel, and once they put it aside they continue with something that is completely different and, as they see it, unrelated. When I said I was wondering whether I should react or not to what has been said here, it was because I do not have a definite or concrete opinion on these things. I am wondering, I have many questions, as we all have, and I do not have the answers right now. These are just the worries that we all have about what and how our students are producing in their architectural work, and that is one of the basic problems we are faced with. Thank you.

Emmanuel Tzekakis

Thank you very much, Spyro. We have already had four reactions, so I think it is time I gave one of my own. Let me begin by saying that I have done a lot of work with computers. I have worked for many years in designing tools to design acoustics, so I know things from the inside. I do not think that we should make a division between those who are fond of computers and those who are afraid of computers. I think this is a wrong categorisation. We now have in our hands a new, invented tool, and that is all there is to it. The question is, what is this tool? My response to that is that we should start by helping each other understand. Those who are for the computer should understand the questions raised by the others, and those who do not want to work with computers should understand what it is that they are afraid of. So I think that this is what we should be focusing on, rather than making theories about what is happening around us.

Project designing has always been about putting on paper a representation of what we imagine the future work to be. The computer is all about representation; it is a new tool for representation, and as such it can be used for many things. For instance, when I look into the future of designing by computer I see something like this: how do we build a building? We take certain materials and we put them together in a certain way by programming what is going to happen next. So the future of designing by computer is going to come about when all these elements are already programmed entities in computer software that has all the parameters they really must possess – weight, colour, temperature, and their reaction to other things around them; so that in the same way that we build a real building we can build a virtual one, not only as an image but as a real model. For instance, let us imagine we have designed the structure of the building, and then we go on to put in certain material features like walls, ceilings, and so on, all of which add weight to the structure. The software should be able to continuously calculate whether the structure we initially designed is now adequate for these weights. The same is true for many parameters that affect the design of a building. Nowadays we use very simple models of this. For instance, we make drawings more or less by using AutoCAD or something similar – the best way is to make 3-D models there – and we export them to software tools and these tools give us back answers about acoustics, thermal insulation, and so on. This is a very primitive way of using computers as a design tool. We still have a long way to go before we reach this end. Thus, we do not have to be so emotional about computers, either being afraid of them or loving them. The only thing we have to do is to try to understand their possibilities, and also try to understand the questions those who do not work with computers have with regard to what is happening with what we are doing as a profession. So if this can add to the life of the discussion, I will be very happy.

Maria Voyatzaki

In response to Spyro's comments, and I suppose it is a general viewpoint that many of you share, I will go back to what I said in the beginning about the tricky tool which is language. The word 'mechanical' and the word 'thoughtful' are polar opposites, but when we drive a car, for example, although we drive it mechanically we do use our brain to distinguish it from just a mechanical thing. Similarly, when we use computers, or when young people send SMSs to their friends, you cannot say that they use them mechanically, because the mechanical part is only the typing: they use their brains to produce the message, and they express themselves, and they have even invented a substitute for facial expressions, using symbols made of colons and brackets. So they are inventive, and they use their brains to communicate and express themselves, but they use a different tool to send a message, rather than their tongues and mouths.

Now the other thing I want to touch on is this issue of the self-evident skills of our students to sketch and draw. Have you seen the sketches and drawings of first-year students? They are terrible in most cases. What is this myth, and where does it come from, that our students can sketch, can make models, can communicate architecture with physical means? It is not true, and you all know it very well. **If you take someone as ignorant as a first-year student, they know nothing about comput-**

ers, they know nothing about physical modelling and they know nothing about communicating architecture, either physically or digitally. They are tabulae rasae. So we cannot really say that when people design with digital tools they produce something that has no depth, because I can assure you I have a whole archive of hand-made drawings that have no depth at all.

Now, about humanity and architecture. Architecture has to be felt. Architecture is for humans, and therefore it has to be produced by humans in the most tactile, physical way possible. That is one position, but I can give you an extreme example of using computers to free human beings from complex difficulties integrated into the social context. I was reading in the plane on the way here an article on bioethics and face transplants. There are computers that can simulate what the face of someone who has lost their face after a serious injury looks like, and they want to reintegrate such persons by giving them a facial transplant using the skin of a dead person, to let them live on this planet that has no shame. So really, **I think that computers have great potential to do microsurgery, and so to tackle even much more important issues than architecture, when they are used properly and carefully.**

Nadia Hoyet

Thank you. This is not linked to the previous speakers, because I think we have said enough about this. I would like to suggest another idea for our next meeting, and that is the question of complexity, which is a reality of the digital era. And we have not mentioned project management, which is something our young engineers are working with. They are involved in the management of their projects, and this represents a field of knowledge that we scarcely touch on in our schools, although it is growing. We must ask ourselves how to manage projects, how to manage data, how to manage the various players in building, and how architects are situated in relation to that.

Ola Wedebrunn

I want to return to the relation again, but I want to focus on paper, white paper, blank paper, because with white paper we can establish signs, we can establish relations, and we can also establish these within the computer. We can, in other words, use paper in the same way as we use the computer. I think that they are very similar: just as you can make signs and images on the computer, you can also do them on paper. We could also make signs, or talk with our hands, and we could make sounds, and we could then start to make a language. We have to make a language. We want to develop a language of architecture, and we want to develop it as it has been developed on paper, as visionary projects of architectural schools and of architects who have sometimes brought it into reality. We also want to do this through the computer. So it is about making a possibility to speak through the computer as you have been speaking through paper; using the paper for images, using the paper to establish relations, to establish all kinds of words, drawings and whatever else could be filled in. As you can mechanically press down a button to make a letter, you can write the same letter with one finger in the sand, for instance. So I mean the relational thing is very important, and I also think that it is not about one person interacting with one computer, but we are many people interacting with the computer as a scene, as a network, as a place where we can meet and discuss things and this is what we want to bring out from this meeting.

Boel Hellman

I would like to comment on some things that I have experienced these past few days. First of all, I want to tell you where I am coming from, because in terms of using computers I am halfway between the older and the younger generation. I used computers when I was in school, and the whole idea for me behind using computers was not because I thought they were so sexy, or something, but because of geometry. I did a very difficult thesis about the space of some intricate geometrics, and it was the only way for me to be able to express it in an image, which was what I was supposed to do. I mean, we were producing images all the time, and representations of our thoughts. And I thought it should be possible to do it with the computer, but although I had five or six computers to work with it took three months to do something that now I could do in one day, because the power and the interface and everything else about the computer have reached a totally different level today. That was the first thing I wanted to say, that the whole question of using the computer has to start with the fact that you know what you want to do with it. If you have a task or an interest in something and you try to solve it or learn more about it, then you also have to be smart enough to know what the computer is or could be good at. And I think the teacher's role in this is, of course, to navigate; and in order to do this we have to know a little bit about computers, because otherwise it would be impossible for us to teach anyone to navigate and to do the right thing with the computer. For me, geometry is the basis of using computers, and it is much, much smarter in a computer. The second thing is that you can also learn things the other way around: playing with things is another way to learn. Because today the computer is so advanced that everyone can use them just by association; with the tools and symbols you can navigate through the computer in a totally different way than the linear way of thinking that used to be taught in our schools. So I think that this way of association and links between things is much more important for educators today to understand, and it is also a way to give things a depth and be able to link them to history. Students do not have to learn the whole history in a linear way anymore: you can focus on one word, like stacking, and learn in depth all there is to know about stacking throughout history. You can go via words. You do not need chronological linear thinking anymore to get what you want, and in any case there is too much of that all around us: we could be seventy before we get to know all the things that exist in the Internet; but **the capability of navigation through links, through words, through associations, is for me the most helpful thing about computers.**

So those were the two things I wanted to mention: **navigation through the Net, through other words, being able to make associations and pair things together; and geometry,** which is also very easy for testing a person, if for example you get problems with pasting, as some people said. When I was a student we used to take cut-outs from books to paste into our assignments, if there was some detail we liked and needed to use; so I do not understand what the problem with the computer is. Perhaps the problem is with the assignments, which ought to require you to transform it into something else – a perspective, an axonometry – that proves that you are in the realm of geometry. So, finally, I think that everything begins from understanding the logic of the computer.

Alain Sabbe

You said that computers and paper are tools, and I agree with this; my only objection is with the building. **There is a big difference between paper and the computer. With paper you stop time, and you have the chronology of your meaning; but with computers the student never stops time: they just go on and on, and they never conserve the history of the meaning for the project.** And I think that it is very important to go back and think of the whole meaning of the concept.

Jean-Marie Bleus

We were just talking about the same thing. Perhaps the main thing in all these different visions is this relation with time. I would not say that we have to return; rather, we have to go in the future with a little more time on the project, in any way or with any tools that we use to make enough time to think, to make and to enjoy.

Antonino Saggio

I think the issue is to make a contribution to the future years of your organisation. This is important, so I would like to put something on the table too, if I may; but before going to that I want to make my position a little clearer. So this is a kind of a footnote to the lecture, but I think in the end it is important to make things as direct and straightforward as possible. It is clear that there are many important differences here. I agree with you, Constantin, about the way you divided us into three camps of thought, and I very much liked your metaphor, Maria, of the baby being in the plane and looking at the world in which he is. I always remember the citation of a famous philosopher who asked "who talks?", and the answer to this question is "it is the word itself that talks". I think this is very important in introducing what I wanted to say, which is this: there are people around the world – not too many, but definitely some – who think that **Information Technology is more than a neutral tool or is not a neutral tool at all; but the whole challenge is to understand how the world is in some way changing because of its impact. There is a transformation of knowledge, a transformation in the way we approach the world, in our understanding of time, space, and how we do things; and thus it is a completely different world. And because of that architecture is passing through an age of transformation, a very important historical transformation; and the only way to understand that is through the word revolution.** That is why – since words are important – my book series is called "IT Revolution into Architecture". We really believe that there is a total paradigm shift within that. So does this necessarily mean that I cannot relate to other persons? I love other people, I love other points of view; and I understand that in teaching this particular strategy is a little bit dangerous. Not everyone can do it, not always, not on all levels. Culturally, my position is that I really believe that this is the real problem – the problem of finding a new generation of architecture that is able to incorporate some features of Information Technology. That is why one of the key images that I presented is the one of Steve Jobs looking inside the chip, because through that process a revolutionary architecture is in a way actually happening. So of course I agree very much with what Boel Hellman just said. For example, **the whole idea of jumping, of moving non-linearly, the**

whole idea of interconnectivity is something that comes from Information Technology. And the important thing is that it is not just there, outside us: it becomes a feature that is incorporated in a new generation of architecture; and that is the real problem. **The computer is not only a tool for representation; it is not only a way to express knowledge: it is a new characteristic of a new generation of architecture.** That is the problem. Just like the problem of how to enter a kind of standardised way of thinking, a linear analytical way of thinking, which was incorporated into the architecture of the Bauhaus generation. This is absolutely crucial in order to make our different positions clearer. This is my position, and these are the lines along which my work runs.

Now, coming to the possible agenda for next year, which I think is an important issue, of course, I would like to offer some proposals. Continuing on with this idea, what I will say is that now we have new things, and these new things are happening because of this process. When we talk about a keyword like mass customisation, **we must remember that the whole concept of mass customisation could not exist without computers. Certain aspects of production exist because we have Information Technology. The idea that it would be exactly the same thing to make each shoe different as to make all identical is a consequence of information technology. It is not as simple as that, of course, and then there are other things as well. But there are aspects of construction that are completely new because of this, and I think that this is very important. Mass customisation is one, of course; the use of movable sensors and intelligent buildings is another. More and more we are making structures that are really site-sensitive in many ways. So there are topics that are new, conceptually new, and they are strictly related to this. Complexity is another one. This is a key word, and it is important that we understand what we mean by it, for it is one thing to deal with complexity within a traditional set of issues, and quite another to address new issues. Complexity could be another of those key words that can bridge different meanings.** In brief, then, I think that there are new issues which are related to the last part of that, and it is very important that they are dealt with in the real world. How much of that we teach and which techniques we should use is another story.

Henk de Weijer

We have been talking about programming and about the potential of computers, and yesterday I also heard someone mention the word nature; so we are interested not only in the technical side of living, but in the environment we live in as well. We are learning that we are part of an environment; so what interests me is less what the programme is than who or what programmes the programme. And if the nature of nature is not inside our own nature, then what is the use of what we are doing? In the 13th and 14th centuries, when the Renaissance was beginning to develop, the essential human values were heavily discussed; and if we are not learning to apply these human values, then what are we doing at all? This morning we heard some discussion about the superficial application of technology in some universities, and the sensorial perception of what we are dealing with is just the start. What we need to think about, whether we do it explicitly or implicitly, is the search for meaning and what we do with it. And we can have full confidence that, **if the students learn how to shape their sensorial perception, the very first approach, and if in the long**

run we are able to continue to look for meaning, then they will also look for meaning; and computers can be a tremendous aid in contributing to the expression of what we are looking for.

Donal Hickey
I think there is something interesting in what you said about "in our nature". There is an expectation that our buildings and the environments around us will be able to sense us, and I see this as kind of inanimate. I think that there is an area of technology that we always miss. We see technology as being about inanimate things; but there is a technology that is inherent in us, which is how we experience what is around us, that I think will become more interesting as time goes on, whereby things like the human genome project will help us begin to understand more about how the computer that is in us functions and how it understands what is around us. And I wonder, is there a technology that is beyond how computers see things or how we react to what is around us?

Herman Neuckermans
I would like to say something, because I thought, when we started the idea of the thematic networks in 2000, and later, when the Council decided on the title of this workshop and the focus on the digital era, and now, having heard all the presentations, that we would have focused more on those issues in which there is a strong connection between Information Technology and construction. A lot of interventions had to do with what I would rather call architecture and IT. Construction is, of course, part of architecture, but it is only one part of it, and I think that there has been a lot of general discussion that transcends the issue of construction. That is one point. The other is that there is an on-going in-depth debate on computers – there is ECAADE, there is KEDRIA, there ARCADIA, there is CIGURADI: there are plenty of associations that discuss the issues in a very specialised manner – and we are not on that level. I thought, when we decided on the title "...Teaching Construction in the New Digital Era", that we would be more focused on that aspect. I am not trying to be narrow-minded, but many things have been said that pertain to a much more general level. So, since this is the concluding session, if I had to say something about the future, it would be that perhaps we ought to decide on which level of discourse we want to discuss this topic: a general, cultural, philosophical level – What is IT? What is IT in relation to architecture? What is the new position of architecture? – or a more specific and practical level? Perhaps a better articulation of this broad area could help.

Ole Vaangaard
I think that it was nice to hear the suggestion that this could be a revolution in architecture and in architectural thinking; but on the other hand, a revolution never starts with a committee, and this is not the place to develop a revolution. If there is going to be a revolution it will come, and I for one believe it will. I know that there are a lot of people in this room who think otherwise; but to me it is very important that we are listening to each other. In all the subjects that we have touched on in the last four years, there have been considerable differences of opinion; but I think that it is very important that we get the European landscape of what is going on in

different places, so you can put yourself in another's place and rethink your position. And on this matter too, although we have all these very different views and expectations, I think the fact that we are bringing them out and listening to them all is important.

This brings me to my next point. I think that it is important that these sessions continue in some way. I am less interested in what the specific subject is, because whatever the subject the fact remains that we are different and that we do things in different ways; and whether it is materials or theory or computers that we are talking about, we see the same pattern. The point is that we develop each other, we work with each other into getting a kind of understanding of each other – as I said, we are not making revolutions here.

Ola Wedebrunn

I am always very happy to hear what Ole has to say, and I agree that we need to know what each of us is doing so that we can really exchange what we need to exchange, because we all have a lot of problems to deal with. I would like to refer to Bruce Bowen and the issue of making this relation between what we are and what the environment is and how these issues could be addressed in the context of construction for designing the world – not design for the world, but designing the world. He raises this issue, that perhaps we will not be not doing constructions in the traditional architectural way, but in a totally different way. In any case, as long as we share our views and experiences we will have a much better idea than if we just discuss in philosophical or theoretical terms.

Dimitris Papalexopoulos

The question of whether the computer is a tool, although perhaps a bit vague or philosophical, is nonetheless a worthwhile and critical one. But if we think that the computer is a tool external to us, we cannot advance very much. A little mapping is not bad. **I think that there are new subjects related to Information Technology, which I could divide in the following way: new subjects in the building and new subjects for the building. This categorisation is not mine – I think I got it from one of the books of theories** (perhaps De Luca's), but I like it. So there is Information Technology for the building, which includes 3-D models, production and databases, and then there is Information Technology in the building, which is interaction devices and – something that we have not referred to – the monitoring of new and old buildings. In relation to other specialisations we have to manage our cost relation to civil engineers that are called upon to deal with the informal, the mechanical engineers that are called upon to deal with building management systems and ambient intelligence company integration, and of course we have to manage our relations with IT engineers, that is, with the people that develop software, which is something we cannot do. We can perhaps learn how to programme and collaborate with them, but – and this is a totally new situation – **we must recognise that there is now another and extremely critical partner to architecture, and this is the IT engineer.** Not a mechanical engineer, not a civil engineer, an IT engineer. **How do we develop a language to speak with them? These are the people who can create intelligent environments, who develop software for 3-D productions for mass customisation. This is not a job for architecture. Architecture's job in mass cus-**

tomisation is to define, for an object, what is stable and what is parametric; and this is a very big job, which can revolutionise the whole of architectural thinking at the moment, because architecture is not a stable form, it is a form that changes. That is easy to say, but very difficult to design, believe me. So this is an open question. I think that there are three crucial areas here: the area of production, or construction, the area of sustainability and the area of monitoring buildings and environments, which could also be prevision of reactions to catastrophes, earthquakes, and also building sustainability. And all this, I believe, always comes as an intervention to what exists. Do not forget that Information Technology never pretended to have made a revolution; that is the interpretation of those who have tried to understand IT. IT is parasitic by nature: it works its way into what exists and, slowly, transforms it radically. IT is not a collage, it is morphing. I think that is all.

Maria Voyatzaki
I am not going to speak about forthcoming events, but thanks to computers it is possible for us to stay in touch until the next one. Once more, thank you very much, and I hope you have had a fruitful and enjoyable time.

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