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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 with-

in 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 teach-

ing 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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