'ICT & REFLECTIVE EDUCATION IN AN ENVIRONMENTALLY RESPONSIVE ARCHITECTURE STUDIO'

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Abstract: The current debate of architecture education in UK Schools of Architecture is reviewed with special emphasis on environmental ingredients of the traditional and progressive curriculum. Environmental approach to design has far more benefits than just informing students of the basics of the ecological and urban settings. Traditionally, UK Schools of Architecture address these issues via required courses (RIBA, 2003) However, environmental forces, wide array of educational innovations and a number of conditions and performance criteria that are set by Royal Institute of British Architects RIBA, for architectural education curriculum are essential drivers that necessitated transforming architectural pedagogy. As a result, new themes are being woven across existing courses, and more attention is being accorded to pedagogical methods of delivery using Information and Communication Technology ICT.

1. Introduction:

Information Communication and Technology ICT represented in Computer Aided Architectural Design CAAD has dramatically changed the education and profession of architects. ICT has cleverly shifted beyond desktop applications into new physical and social perspectives. Computer architectural application emerged first as a means for digitizing blueprints.

However, with the development of technology, software packages were introduced to translate computer design into three dimensional forms, interoperable in rich ecologies, diverse perspectives and contexts and a tool to communicate designers with tools. Programmers have strived to develop ICT products in the form of software or systems that are functional, user-friendly and at the same time take into consideration social and physical environment. There are also indications that some schools of architecture are going 'paperless' in their design studio, by applying 'Design Computing Studio' (Reffat, 2002). Yet, there is still hesitation in accepting such transformation and what is more, is the debate on where this transformation stands in the architectural curriculum and its unalterable design studio pedagogy.

This paper is part of a PhD thesis aimed to investigate theoretical grounds towards an environmentally responsive architectural education using ICT. The paper is essential for suggesting innovative teaching techniques using ICT design tools to efficiently integrate environmental design into architectural design studios. The integration is based on investigation through most efficient areas of implementation within architectural design studio. The paper starts by introducing set of ICT trends and application in architectural design with the aim to reflect architecture practice in the context of architecture design studio education to deliver an environmentally responsive architectural education.

However, there are still limitations that require implementation directions. Thus, this research concludes by suggesting implementation technique for a successful integration.

2. ICT-Environmental Component in Architecture:

People have high expectations from a building they utilize these days, than they ever did in the past. Clients are not concerned only by the aesthetics of their buildings, but they want a building that at the same time can offer comfortable living environments for their occupants, and to minimize energy consumption. This has led to the need for new approaches in building design that has some claims: its complexity nowadays has the prospect of being only resolved by techniques based on ICT (Howard and Sun, 2004). What is more, architects cannot afford to correct any environmental related deficiency once a building has been completed; it is then when the need to simulate building's performance accurately at the design stage occurred, to identify and solve problems at an early stage.

The introduction of ICT in architecture also involved a diverse range of analytical and simulation tools, which are either applied onto, or directly synthesized into its digital virtual model. While those tools and techniques were mostly applied in architecture by specialist like service engineers, it was almost entirely done during the final design validation stage (Marsh, A.J., 1997). Yet, researchers in architecture have continuously strived to identify areas where there are opportunities to integrate advances in ICT by having in mind architecture, building, and society principles in the age of simulation. They stress on the fact that a building geometry undergoes constant changes in the conceptual stage and the use of sophisticated technical tools with extensive constant quantitative data may act to produce a psychological separation between the design and analysis.

2.1 THE TIMELINE OF ICT-ENVIRONMENTAL COMPONENT IN ARCHITECTURE:

Despite primitive computing techniques that emerged in the late 1960's, efforts were made to construct virtual modelling of buildings. Simon, H.A. (1969) from his first edition in late 1960's talks about what he called the "sciences of the artificial":

> "...a science of design, a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process" (Simon, H.A., 1969)

Furthermore, a common interest on the issue occurred in the late 1960's through the formation of the Design Research Society in the UK and the Design Methods Group in the USA, equally apprehensive to discover Herbert Simon's (1969) topic on the sciences of the artificial. The output for that common research effort was that, unlike product design, buildings require a virtual prototype. As a leading figure in the field of education and research in CAAD and building performance, Tom Maver (2004) in his latest personal retrospective on the subject states that, in the UK a year after he joined Building Performance Research Group in the Department of Architecture and Building Science at the University of Strathclyde in University of Strathclyde, in 1967, a new research group – the Architecture and Building Aids Computer Unit, Strathclyde (ABACUS) – was formed.

The evidence of further interest in building ICT tools beyond graphical representation, started with the publication of that described simple building assessment in terms of its cost (capital, recurring life-cycle) and its performance (daylight levels, energy consumption, plant size, etc). Therefore, and as a result of publication in the 1970's, the 1980's saw the evolution of highly sophisticated models of the energy behaviour of buildings, photorealistic colour imaging and animation. A decade later, other features has been added to climate responsive tools which are user-friendly or easy to use interface and representing numerical simulation output into highly representative graphics which was developed in the 1990's by the University of California UCLA (Milne, M et al, 1990). This was followed by the emergence of large scale urban models, multimedia, virtual reality, rapid manufacture and shape grabbing technologies in the 1990's.

However, although the first potential of ICT application in architectural discipline involved developing tools to assess building performance, the development continued in a track that produced complex simulation and realistic visualization which did not find its place easily in architectural curriculum and in particular design studios.

3. The Integration of Environmental Design ICT Tools in Architecture:

ICT applications and in particular CAAD developers are becoming increasingly aware of the need for tools that enable architects to predict, identify and possibly resolve problems in an early design stage of a building's project that may have an effect on the environment.

Also, previously, ICT tools were developed using a distinct format for processing data, which made it difficult to collaborate and exchange data between different tools in the design process of a single building project. However, just around a decade ago, a number of research projects occurred in different locations around the world, investigating issues related to the topic of integration, one in Finland (Björk, 1987), another in the United States (Brambley, 1988), European Community (Augenbroe *et al*, 1989), and on a national level in the UK represented by (Construct IT initiative).

Those research projects focused on finding tools that allow designers in architecture to act intuitively which is one of the main features of design rather than restrict them to think mathematically which is more engineering and technical (Marsh, A., 2004). They concluded that at the intuitive stage of a design lies a potential for designing an environmentally responsive architecture.

Arriving to the right orientation may reduce the need for large number of air-conditioning; where passive solar elements and solutions for natural ventilation may eliminate the need for air-conditioning on the whole. The role of the design tool is to serve the design process, where for example; the form of a building could be designed using its own fabric to provide shading without the need for extra material waste by adding extra materials (AAEE, 2002). Therefore, if students that is 'future architecture designers' were better able to use and apply tools at the 'intuitive' design stage, understanding and communicating with the consequences of their decisions while designing, the chances would be enhanced in arriving to an environmentally responsive architecture.

3.1 CONCEPTUAL ENVIRONMENTAL ICT-DESIGN TOOLS:

For the purpose of this research, the term EIDT is used for describing computer software developed to be applied at an early design stage is also known as 'conceptual design tool' replacing technical manual ,lengthy manual calculations used for informing the design in architecture and in particular design studio for future architects.

According to Reffat, R., (2005), the conceptual stage of a design occurs at an early stage of designing, where it fits with proposed architectural design paradigm reflection-in-action as opposed to the technical rational paradigm (Akin, Omer 1986; Schön, 1995; Kvan, 2000). One must take into account that reflection-in-action at the conceptual stage lacks the clarity and rigor of the other rational problem solving paradigm (Schön, D.A. and Wiggins, G. 1992; Dorst and Dijkhuis, 1995; Hargrove, R., 2005; Gero, J., *et al,* 2005). Thus, a successful ICT-Environmental design tools should serve the conceptual stage paradigm yet at the same time taken into account elements that determine building performance and its effect on the environment.

Traditional methods used in a conceptual design stage involved quick perspective sketches, simple geometric analysis on a drawing board, or even small manual calculations. However, at this stage speed is a key measure, by being able to rapidly replace an idea with another satisfactory and traditional ICT tools which prove to be inadequate in speed that gives full understanding both spatially and operationally of the full needs that shape up the final form (Coutts, 1998; Akin, 1979). Willey, D. (2005) adds that, ICT tools in general lack the capability to operate using incomplete information. On the other hand he argues that humans can assume the incomplete, where ICT even with its advanced techniques holds back.

Figure 1 Use of EIDT and CAAD (AutoCAD; Ecotect, Radiance, Lightscape, 3D Autodesk VIZ)

3.2.1 APPLICATION IN DESIGN STUDIOS:

Schools of architecture in the UK have for the last number of years placed an emphasis on the appropriate consideration of environmental design within curriculum, persuaded by many forces and on top of those forces is architectural practice and professional bodies represented in the RIBA and Architects Registration Board ARB as accreditation and validation bodies in the UK. However, the emphasis on a full integration within design studio projects is still in its infancy and facing many challenges. In a typical school of architecture that seeks validation from the RIBA and ARB, students are asked to evaluate their designs in terms of environment performance by submitting a technical report as part of a stand-alone technical module.

In a study conducted by Roberts, A. *et al* (2001), the authors investigated the use of an environmental prediction tool among second year students at the Welsh School of Architecture during 'environmental prediction week' arranged by the school. The tool which was investigated was the ECOTECT software (www.squ1.com, 2006), designed to evaluate daylight penetration and quality at different times of the year and to calculate acoustic incidents. The main 'shortcoming' found in this study of the tool is its lack of accuracy due to the limitations of the rendering algorithm when conducting a simple ray-traced light and rendering shadow analysis using an imported CAAD model to ECOTECT; however, at the same time for the purpose of comparison they were also asked to assess the environmental performance using conventional manual techniques with the aid of a physical model (Hanna, R., 1996). Since then, not many efforts has been taken to use advances of ICT in resolving that shortcoming and addressing the issue of fining a simple ICT tools that is user-friendly, quick to learn and at the same time produce reasonably accurate results that informs the conceptual stage of design with environmental conditions elements, targeting student of architecture. Yet development continues to take place in producing complex ICT simulation tools that can generate significant spatial and temporal data describing 3D environments (Dorsey, J. *et al*, 2002).

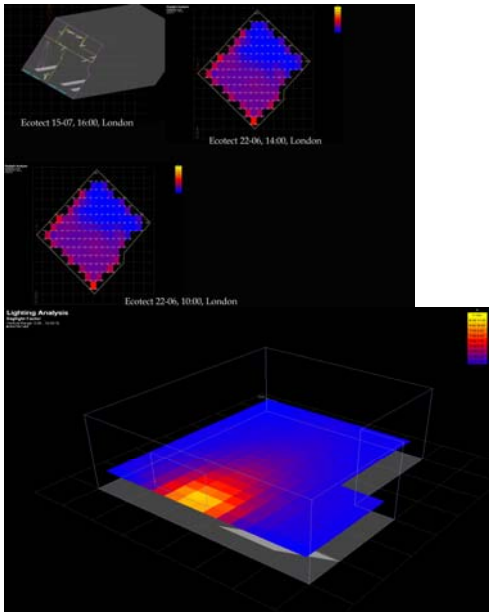

Figure 4.5 Ecotect Simple Daylight Factor Analysis

3.2.2 Features of ICT-Environmental Conceptual Design Tool EIDT:

> "Given the increased concerns in energy consumption, the environment, building sustainability, and the development in computer technology, I will continue to enrich the subjects I teach at MIT in the next five to ten years to meet the real world challenges" (Qingyan Chen, 2000).

The above quotation reflects ongoing efforts on a global level to meet new challenges and in particular developing perceivable and easy to learn software to assess environmental performance of a building. However, again software developed are targeted towards architecture and engineering students equally, in addition to its failure to be applied at the conceptual design stage.

The main feature that discerns an ICT-Environmental conceptual design tool EIDT is its capability to overcome the psychological gap between design and analysis caused by having to enter a great amount of data at this early stage interrupting the process of being decisive and ending up with a design acceptable to the tool and not necessarily to our environment.

One of the major challenges in developing such tools is the production of a responsive interface that keeps the standards of a traditional sketch used during the reactive design process, enabling students to draw simple and loose geometric model, yet at the same time applied during the accurate reflective design process in which environmental components are considered.

When designing in the reflective stage, students need to pass information to their created model; however, each design has a certain amount and level of data and information of environmental components according to its level of complexity. Thus, a feature that is required in this sense is that the tool has the ability to receive data gradually, allowing basic analysis at the beginning of the project right through a later stage where accuracy is

required. Finally, the last feature is the visual representation of the designed model. Students of architecture need to view the impact of their solar and lighting design, both visually with photorealistic output and/or graphically displaying lighting levels in numbers. However, there are attempts now to overcome some recorded shortcoming by having graphs of lighting levels responsive to the photorealistic output. Yet, for the time being this is done through having the software compatible with more advance stand-alone software, where students can export their finished model in the conceptual software to complicated analysis software, yet this may add some complexity and cut the flow of a simple conceptual paradigm in a design studio.

4.5 Summary and Reflection:

The impact of Information and Communication Technology ICT on our culture, including the built environment, is reflective. Schools of architecture must be influential, not only with consumers in developing design studio with ICT and foresee, and not just adopt it. Like architects, architecture schools must work with ICT and realize its great potential turning it into practice. In the 1970's students and tutors of architecture were doubtful of the role ICT plays in design studios, however, today, students insist that they gain ICT skills and in particular CAAD as their ticket to future professional careers as architectural designers.

This paper introduced the development of ICT and its applications in architecture profession and academia in assessing building performance. A particular emphasis was on exploring features of ICT tools that aid students of architecture conceptual design stage in their design studios. The research revealed that there is a growing recognition of ICT as a key facilitator to improve our environment and well being through architecture. However, not much in the right direction to facilitate the education of future architects.

Elements discussed in this paper were explored in the context of both architecture practice and academia, to investigate calls that indicate a need to educate future architects, with long-term professional skills and assist them in their future professional career, in designing environmentally responsive architecture. Yet, existing assessment ICT tools does not attract young architecture students due to their technical nature and complexity, widening the gap between rapidly growing ICT applied in architectural profession and architecture graduates lack those tools. Furthermore, ICT in architecture is a particularly dynamic field that is developing through the work of architecture schools, architects, software developers, researchers, technology, users, and society alike. In this paper this was investigated and a particular emphasis was made on software that has been developed by an architecture tutor and researcher at the Welsh School of Architecture (www.squ1.com, 2006). The developer's aim was to use ICT to develop a conceptualised tool to facilitate and early design stage in design studios. Thus, for this research this conceptual tool was taken as a starting point for further investigation through different methodologies adopted in the main thesis.

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