PLANNING FOR EFFECTIVE UTILIZATION OF INFORMATION TECHNOLOGY IN ARCHITECTURAL DESIGN EDUCATION

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ABSTRACT. Architectural design education has witnessed important transformations with the introduction of information technology (IT). Developments in information technology have been providing opportunities to create new specialties and extending the realm of architectural design education. Architectural design educators along with University administrators are urged to prepare future architects for this new realm. This paper presents a planning framework for effective utilization of information technology in architectural design education. The proposed framework has four primary components that are articulated in this paper: advancing IT education in architecture; strong infrastructure; IT-based pedagogical focus; and cognition-based IT tools.

Keywords:

Digital Architectural Design; Design education; Information Technology; Impact of IT.

Relevant Conference Topic:
Utilization of Modern Technology in Education

1. INTRODUCTION

The application of information technology (IT) in the delivery of architectural design education continues to grow at an incredible pace [1]. Boyer et al [2] assert that architectural design education is primarily about fostering the learning habits needed for the discovery, integration, application, and sharing knowledge over a lifetime. Since the late 1980s architectural design education has witnessed an important transformation with the introduction of IT in which computers has become pervasive in all aspects of architectural practice and education. The pervasiveness of IT in architectural design education and practice has been manifested in the growing proportion of IT related courses in the curricula of architectural schools. Many schools have increased IT content in their curricula and are investing to acquire computing resources to ensure that they provide their students with the necessary skills and competitive advantage.

Modern IT and digital tools have been utilized in architectural education since the 1990's. For instance, Computer Aided Architectural Design (CAAD) or Computer Aided Design (CAD) has been adopted by many architectural schools around the world and became the major working environment. CAD is either taught as separate courses or within a larger CAD-curriculum. The role of the IT and digital media has not been fully exploited to reshape architectural design education as it did in other design fields such as industrial design [3]. This might have been due to the way in which IT was utilized wherein the content of CAD-

education given in architectural schools tended to be quite technology-oriented. Course objectives quite often seem to be rather CAD-system specific and the education given does not necessarily respect architectural objectives or the needs of architectural design education. Nevertheless, the motivation to learn CAD and IT seems to have been always high among the architectural schools. In order to appropriately plan for effective utilization of IT in architectural design education, this paper proposes a framework that aims to assist in delivering effective computationally-based architectural design education.

2. DEVELOPMENTS OF IT IN ARCHITECTURAL DESIGN EDUCATION

This section presents some of the most influential developments of IT in architectural design education. These developments as illustrated in Figure 1 include computational design methods, CAD visualization, paperless design studios, virtual design studios, and IT-based architectural design curricula. The sequence and impact of such developments on each others are graphically represented in Figure 1 through the direction of arrows connecting these developments. Furthermore, these set of developments are articulated in the following sub-sections.

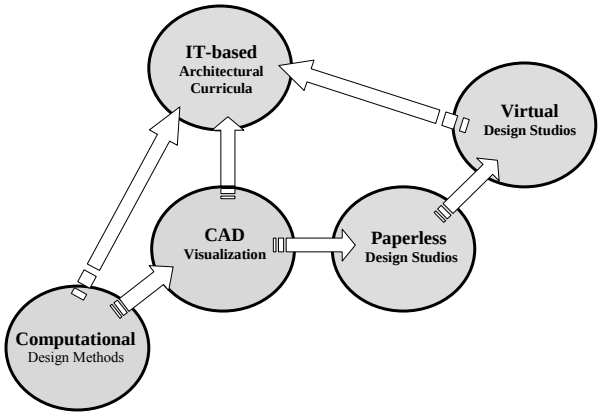

Figure 1. Some of the most influential developments of IT in architectural design education.

2.1 Computational Design Methods

The first attempts to build a relationship between the disciplines of architecture and computer science dated back to the late-1950s, when most of these pioneering attempts were born inside academia and were direct descendants of the problem-solving or systematic methods that dominated the computer science community during the 1960s. Researchers ended up with a large number of models and theories about the rationale of designers, of which they intended to automate. A complete set of research, regarding the computability of architectural design can be found in the architectural academic community during the 1960s and the early 1970s. Among the most celebrated were Christopher Alexander's "misfit variables", Nicolas Negroponte's "architectural machine", Asimow's "design elements", Christopher Jones's "factors", Bruce Archer's "sub-problems", Nigel Cross's "automated architect", and Horst Rittel's "issue-based information systems". These academic endeavours generated not only the theory but, in fact, created the basis for many of the first architectural computing software [4].

2.2 CAD Visualisation and Change Resistance

During the late 1980s computers were still very much resisted by large proportions of traditional design studio professors. Studio professors' fears were based in many fronts. Anecdotal accounts report that one of the strongest arguments formulated by these studio professors' was that computer drawings were taking away the suggestive nature of hand drafting and hand modelling which were very important elements in developing rationalization in the design process. It was not until the early 1990s that CAD literacy courses became widely recognised as necessary and were included in the core of architectural design education. Since then, CAD proficiency has become an important requirement for the employment of graduate architects. As for the integration of computers in studio classes the story again follows a similar trend to what occurs in professional practice. Unlike the previous decade, most design studio professors are currently encouraging students to engage digital tools into their design process. However, more than a century old, studio methods of developing design rationalization through plans, sections, elevations, and models have been hardly touched by the new tools. Usually, the initial drafting and modelling is done manually when most of design rationalization occurs and computer drawing and rendering are mostly used for final presentations and project documentation [5].

2.3 Paperless Design Studios

The paperless design studios emerged initially in the early 1990s and were characterized by eliminating hand drawn designs, and developing strong dependencies upon the usage of high-end CAD software such as Alias/Wavefront, Softimage, and Maya. Software ability to create fluid diagrams, character animations, and other special effects has proved to be extraordinary tools to test unproved architectural speculations. Circulation and mobility studies, building programme variations, quick diagrammatic ideas allowed paperless studio students to explain and experience their design formulations in a totally new way. The high-end CAD software has proved to be more useful than offering a mere rendering tool, and started to inform and transform the design process [4, 5]. Designing with computers is based on establishing a fruitful dialogue between the designer and the tool. The "digital imperative" to switch from analogue to digital mode has already begun to manifest itself at the schools of design and architecture in the form of the paperless Design Computing Studio (DCS) [6].

2.4 Virtual Design Studios

The Virtual Design Studio (VDS) explores the asynchronous and synchronous techniques in remote design collaboration. By using technologies, such as video conferencing, Internet publishing, e-mail, Web3D, and digital modelling, students gain an increasing understanding of the new modes of collaboration and media integration in design practices. The experience also enriches the architectural experience since the VDS exposes students to different design cultures and to a larger context of design feedback.

The first VDS were attempted at the University of British Columbia, during the early 1990s, in collaboration with other schools of architecture such as Harvard, MIT, Washington University, Cornell University, and Hong Kong University [7]. This early experience relied heavily on asynchronous communication technologies that supported e-mail, bulletin boards, FTP, and Internet publishing. As collaboration technologies evolved and became available to the masses, virtual studios began to foster more international experiences that lasted a complete semester. Most of the studies report that the cross-cultural and global nature of the VDS experience usually motivates students [8]. Also several interdisciplinary experiences emerged in the mid-1990 as students, from architecture, engineering, and building construction, from institutions such as U.C. Berkeley and CIFE at Stanford University, collaborated in virtual studio experiments.

2.5 The Impact of IT on Architectural Design Curriculum

It is not clear if the basic structure of an architectural design education programme needs to fundamentally change in order to fully realise the new opportunities and changing perspectives offered by information technology. Mark et al [9] proposed a broad outline of computer related subjects that could be included in an architectural curriculum, and examined two alternative curriculum models, one model that sets within the framework of a typical curriculum structure of today, and a second model that displaces a greater number of traditional courses. It was argued that a re-integration of information technology into an architectural design curriculum is possible without necessarily displacing traditional subjects or time-honoured notions of building and place. An ideal curriculum might be one that merges information technologies into existing courses more progressively than is typical today and at the same time looks to the studio teaching method as a catalyst for shifting perspectives on the relevant areas of design theory and methods.

3. THE NEED FOR EFFECTIVE UTILIZATION OF IT

When computers were introduced in architectural design education, the reflection on building practice was seen very clearly. When one looks back at the historical development of computer use in the education of architects, it can be realized that computers were used as a tool mainly for such purposes as: information processing tool, communication tool, and visualization tool during the design process. They were mainly used for animation, simulation and the whole spectrum of visualization. All these three categories of computer use have a primary aim of improving quality and efficiency of building design processes. By the developments of advanced 3D visualization tools including Virtual Reality (VR) techniques, one may expect enormous improvements.

Computers are not any more used only as a tool for architects but are becoming a new medium besides the other existing ones within the architectural design process [10]. Computers are becoming a valuable media for designers and architects in relation to the use of conventional medium. The widening of Internet opened the horizon for computers to become more and more an open medium and speed up ongoing processes. It is difficult today to imagine an architectural practice that is not making use of this new medium. Computers have become essential and crucial for success in architectural practice. Hence, there is a growing need for advanced tools that enables architects to cope with the increasing complexity in design and with the increasing need of efficient communication with many partners in the building process. Computers are expected in the near future to play a more important role than being a medium; they will become a reliable partner [11, 12]. How can they become a partner and what will be the role of this partner in the design process? Computers will be used as partner when they are put as: Knowledge Integration tool, Decision Support tool, and Design tool [13]. Therefore, viewing IT as a partner in architectural design education requires developing new methodologies and techniques to realize the goal that computers can be put into the architectural design educational processes [14]. Hence, this paper provides an attempt to this cause by developing a framework for effective utilization of IT in architectural design education through which the partnership of IT can be anticipated.

4. A PROPOSED FRAMEWORK FOR EFFECTIVE UTILIZATION OF IT

The proposed framework aims at introducing the important components that should potentially facilitate an effective utilization of information technology in architectural design education. Such effective utilization includes facilitating: better management and delivery of curriculum resources; communication between stakeholders of the architectural design process including students, teachers, university administration, and architectural profession; and supportive platform for designing, presenting, and reviewing the products of architectural design education. There are four primary components for the proposed framework depicted in Figure 2: (a) advancing IT education in architectural design; (b) strong infrastructure; (c) IT-based pedagogical focus; and (d) cognition-based IT tools. The components are articulated in the following subsections.

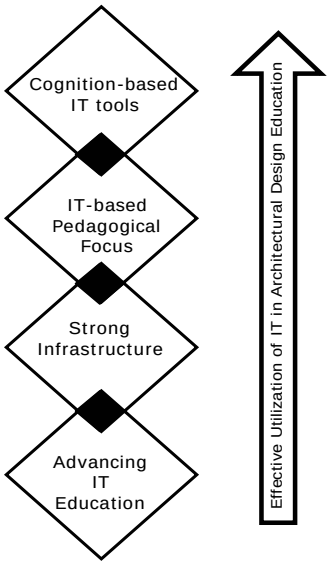

Figure 2. The proposed framework for effective utilization of information technology in architectural design education.

4.1 Advancing IT Education in Architectural Design

Currently, computers are mostly used as a tool for visualization, communication and information processing purposes in the architectural design process. The architectural practice has reached a stage where computers should be used as a design support tool, a knowledge integration tool and a decision support tool that supports architects during the entire design process. This requires architectural design education to effectively take this move into consideration. Hence, there is a crucial need today to upgrade the IT knowledge of future architects. This goal can be achieved firstly by training educators from architecture and its related disciplines. They must be aware of the possibilities and limitations of current IT concepts and applications to be able to guide the students in the right direction and stimulate students to come further on the field of IT in the process of building design and its related disciplines. On the other hand, some architectural educators are so enthusiastic to see the results of computing in architecture and overlook the real design quality of students and judge it objectively. Architectural educators must reach a balance between design quality and fully integrating the IT in architectural design education. Secondly, architecture students should be

capable of developing the criteria for required computational support in design, decision support and knowledge integration and communicate them to software engineers to develop the required computational systems. However, it is not meant that architecture students will become software engineers, but they must have the capacity and understating of IT to be able to define their own needs and requirements of IT tools and applications. The necessary knowledge should come from the architect to build up computer systems to be useful for both architectural design education and practice. Therefore, architecture students should reach a certain level of IT knowledge in their education to convey and formulate such requirements as they graduate and join architectural practice.

4.2 Strong infrastructure for IT in

Many architecture schools have adopted an approach within which architecture students should have their own notebook computers. This direction is primarily selected due high enrolments, shortage of physical space and cost of technical computing support and maintenance services. This approach has become more feasible with the advances and speed of wireless networking technology that facilitates mobility and dynamics of accessing the internet and network resources with institutions and organizations. Adopting this system requires architecture schools to build a strong infrastructure of wireless networking and provide an interactive platform that facilitates resources and communications between architectural educators and their students. On the other hand, the University at large is required to efficiently digitize its communications and transactions with both students and faculty members to enforce the culture of full integration of IT not only in education but also in the academic life. Within this framework, architecture students are expecting from their school to make educational licenses of IT applications available to be used for educational purposes.

4.3 IT-based Pedagogical Focus

Pedagogy is any conscious activity by one person designed to enhance the learning of another [15]. While pedagogy can be a personal matter it is more often conceived of as the art or science of teaching; a set of principles and practices to improve learning. Educational technology, as a subset of pedagogy, is the sound use of any technology to support and improve learning. IT, on the other hand, focuses more on the digital delivery of information. Technical issues tend to take precedence. Christie et al [16] argued that educational and information technologies cannot be separated. For better or for worse they impact upon one another. When one seeks to improve learning using digital media pedagogical considerations are always an issue. The same fundamental questions that are asked of traditional university pedagogy need to be asked of IT-based curriculum but, in addition, the potential for a radically different, more innovative pedagogy has to be explored. Good pedagogy can inform and be supported by good IT. Poor pedagogy can subvert the very point of using good IT. A combination of bad pedagogy and bad IT is a disaster for the future of students' learning in general and architecture in particular.

Ever since computers were deployed in earnest in the 1960s, researchers have been trying to use IT to improve learning. And yet, except for a few cases, there is little proof that such exercises actually improve learning [17]. A major problem many researchers face in this area is the difficulty in isolating and quantifying learning improvements resulting from the use of IT among a myriad of other factors. Thus, one has to evaluate possible benefits that IT can provide for delivery of education at a conceptual level and rely on the qualitative feedback that s/he gets from users. At a conceptual level, to measure the impact of new information technologies on delivery of education, one can look at how advances in information technology can enrich or facilitate various facets associated with delivery of education. Some

of the major areas are providing access to information, improving communication means with a human tutor, customizing information provided to a student based on student's past performance and using specific information presentation schemes to enhance understanding [18].

For the relation between medium and approach, observation of students using an interactive video showed that it was the interactive tasks with immediate feedback that enabled the medium to engage their attention for longer than usual, and the open-ended tasks that invited discussion, and promoted a questioning approach to the material. A comparison between using a computer simulation of a problem, with those using an off-line pencil-and-paper method showed that the computer invited trial and error problem-solving rather than the more analytical hypothesis-testing of the off-line group, but it did offer a better test-bed once the hypothesis was developed [19]. Irvine et al [20] conducted an experiment to measure the impact of technology-based instructional environment on student learning. Their findings indicated that computer mediated discussions can be a valuable component to any traditional course. Students were able to actively participate in an activity that allowed them to extend the ideas of the course outside the traditional confines of the classroom, and in particular they were able to think more deeply about the information presented in class in a different format. Therefore, the IT-based pedagogical focus has to be manifested in architectural design education wherein IT should be exploited based on its impact on learning architectural design rather than being used as a mere tool or medium to partially design or entirely present the products of architectural design education.

4.4 Cognition-based IT Tools

In order to realize the nature of architectural design protocol analysis is utilized to examine the design process in order to provide information for a cognition-based CAAD system. Retrospective protocols have been used to explore human design activities since they are less instructive. In retrospective protocols participating designers are first design for the designated brief. An expert and a novice are videotaped then retrospectively they report the design process with the aid of the videotapes of their designing in the first phase. In a retrospective protocol study conducted by Tang et al [21] the expert's encoded protocol consists of 338 segments with an average time span of each segment of 8 seconds, whereas the novice's encoded protocol consists of 145 segments with an average time span of 20 seconds. The experimental duration was 45 and 48 minutes respectively. This result indicates that the shift of focus from one topic to another was on average every 8 seconds for the expert and 20 seconds for the novice. The speed of shifts is much faster than what was expected. In terms of using a CAAD system, the time this expert took to shift his focus was of the order of that for a user to pull down a menu, select the function, and input parameters. The surprisingly fast speed of change of topic during conceptual designing provides a basis for why designers during conceptual designing still prefer using pen and paper even when expensive, powerful, and cutting-edge CAAD systems are available for their use. It is simply because sketching skills using pen and paper allow them to come up to the speed of thought, follow their ideas, and be creative. The speed here is not relevant to computational power nowadays because even the latest CAAD system cannot efficiently support this design phase. The interaction between designers and machines is not sufficiently intuitive and simple enough to follow the train of thought so that the use of a CAAD system does not match the development speed of thought and ideas. Results of recent studies [22] reaffirm earlier result of retrospective protocol studies whereby young generation of design students who are more linked to computers appreciate the potential of computers in terms of precision, ease and time saving, yet believe that current CAAD systems are neither providing designerly feeling while drawing nor offering great possibility for reflecting one's ability and creativity. Therefore,

there is an essential need to develop cognitive-based CAAD systems that assist in fostering better utilization of IT in architectural design education. In order to achieve a successful partnership approach of information technology in architectural design education there is a need for design support systems that can act as interactive counterparts and provide appropriate design assistance to designers in relation to design actions.

5. DISCUSSION

IT is filtering into many aspects of daily life and also impacting on architectural design education, profession and the built environment. Developments in IT provide opportunities to create new specialties and extend the realm of architectural design education. Architectural educators along with University administrators need to prepare future architects for this new realm. For instance, with the expansion of distance learning through global networks, students have the freedom to learn wherever and however they wish. Therefore, Universities must identify and capitalise on unique resources to find a specialized niche [23]. As in the architectural practice, the design education at the universities has been changed by the influence of IT. Architecture schools should appropriately adapt with developments in IT in delivering architectural design education and be aware of the danger of not or miss-advocating this necessity. Therefore, the level of education must be on a higher level in the field of IT. Architectural design education needs be directed more to allow students to use IT tools and applications for knowledge integration, decision and support and utilize the computer as a reliable partner. Architecture students should be able to develop criteria of required IT tools besides getting insight and knowledge about the existing IT tools. With the advancement of information and communication technology, the global world is becoming a small village. This has started to impact on the architecture practice and will be more evident in the future. Therefore, future architects (today's students) can not be educated as national architects but must be prepared as global architects with focus on their national context. The partnership approach proposed in this paper can be used as a catalyst for fostering better utilisation of IT in architectural design education for the future.

Reduction of repetitive delivery of concepts or skills can leave more opportunity for individual or small group design crits in which teachers combine Socratic questioning with demonstrations of tacit knowledge through sketching [24]. The IT can help in the delivery of architectural design education through the enhancement of presenting content materials. Architecture schools can draw on a shared body of self-access materials, preparing students with learning strategies and attitudes to take advantage of their enriched environment. In parallel to setting up an efficient culture of self-learning, schools can emphasise face-to-face mutual learning and cultivate human interaction skills which are critical to the design profession.

The discourse on future and forecasting remains a rarity in architectural design education. There is a need for more consideration on the future of architecture in architectural design education and the inclusion of future thinking within the architectural curriculum. A good portion of teaching time is spent of the history of architecture and dealing with present conditions but seldom bring the future as a subject of inquiry. However, thinking and being prepared for the future is essential to architecture students who will carry on their professions to that future [25]. To succeed in the future, one needs to know more about how the world is likely to change [26]. We live in a universe of continuous change. At today's world most of the unchanging things in the past keeps on changing based on discoveries and interpretations; IT and digital media are some real indicators of that changing world. Such a world requires responsive professions and professionals. Perhaps one of the most important gains in an architectural curriculum that considers this notion of change is the possibility to make

students and educators alike change their mind about the present. The perception of today can be significantly altered if we look at it with the eyes of tomorrow; what seems to be a problem today might turn out to be tomorrow's opportunity and vice versa today's asset might be tomorrow's burden. Every architecture school probably has a few faculty members that probe into this territory within their teaching. They provide valuable work, although their actions may not result in widespread curricular changes. Administrators need to tap into this territory to adopt a more proactive approach to addressing the future of the field of architectural design educational that is fully integrated with information technology and its developments.

6. CONCLUSION

The application of information technology in the delivery of architectural design education continues to grow at an incredible pace. This paper presented some of the most influential developments of IT in architectural design education. These developments include computational design methods, CAD visualization, paperless design studio, virtual design studios, and IT-based architectural design curricula. Since computers are becoming essential and crucial for success in architectural practice, there is a growing need for advanced tools that enables architects to cope with the increasing complexity in design and with the increasing need of efficient communication with many partners in the building process. Therefore, viewing IT as a partner in architectural design education requires developing new methodologies and techniques to realise the goal that computers can be put into the architectural design educational processes. Hence, this paper has presented an attempt to this cause by developing a framework for effective utilization of IT in architectural design education through which the partnership of IT can be anticipated. This framework is for planning effective utilization of information technology in architectural design education. The framework has four primary components that are articulated in this paper: advancing IT education in architecture; strong infrastructure; IT-based pedagogical focus; and cognition-based IT tools.

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