THE JUMP OF DIGITAL DESIGN THINKING

Overviews of Digital Architectural Design Education

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Abstract. Architecture design education is evolved in respond to the emergence of information technologies as well as globalization. In the new era, digital design education is becoming a design platform to integrate technology and design. This paper aims to provide overviews of digital architectural design education. Therefore, this paper proposes a framework to examine the focus of digital design education and the relationship among (1) design contents, (2) digital technologies and tools, and (3) design theory and methodologies in digital design studios. The attempts in National Cheng Kung University in the past 10 years provide the foundation for observation and discussion. The pedagogy and approaches are examined, and the trend and potential directions are reported.

1. Introduction

Architectural design education is evolved over the last decade due to environmental changes and technological advancement, and the evolving process is rapidly increased. As the result of adopting IT, digital architectures design can be largely seen in major media and exhibitions, and later on in real projects since late 20th century. Broadly speaking, the development is not a surprise to the design profession, but it creates profound impacts on architectural education. Therefore, this paper intends to examine the development of design education adopting digital design approaches since 1990s.

The “jump” of digital design thinking refers to the approach toward digital design education that are shifted from the practice of CAAD software and hardware into the theoretic, technological, and tectonic approach in digital design related courses and studios. Schmitt (2003) illustrated both the design...
content and the training programs are changing in the 21st century. More importantly, the attempts in design education have to address the needs for the education of the 21st century architects and designers that requires fully integration of the above. The difference of architectural education before and after adopting digital design is worthy for investigation.

This paper therefore proposes a framework to examine the focus of digital design education and the relationship among (1) design contents, (2) digital technologies and tools, and (3) design theory and methodologies in digital design studios. The experience at National Cheng Kung University (NCKU) are reported and discussed in the following sections.

2. The evolution of digital design education

Digital design education can be referred to the design education applied with various kinds of digital design knowledge and technologies ranging from geometric modeling, rendering, multimedia, web-based systems, virtual reality, CAD/CAM and rapid prototyping tools, to ubiquitous devices. The aim is to reflect the needs in the architectural practice. This section provides overall review of the development of digital design education.

2.1. OVERALL REVIEWS OF DIGITAL DESIGN EDUCATION

What should be taught in digital design education? The answer could be different due to the timing and focus. Nevertheless, the evolution of digital design education from conventional design education is evident in literatures (Chiu, 2003, 2001, 1998). The design is shifting from computer-aided, computer-supported, computer-generated, to computer-augmented in the last three decades, Figure 1.

The characteristic of studios is also changing from the Electronic Design Studio (McCullough et.al., 1990), Virtual Design Studio (Wojtowicz, 1995), Collaborative Design Studio (Chiu, 1998), to Digital Design Studio (Chiu, 2003). The domain is expanding, and pedagogy is from technology-driven, toward methodology-driven and context-driven. The digital design becomes an important integral part of the design. In the process, the application of design concept and methodologies are integrated appropriately with digital technologies and tools. Meanwhile, architecture is changed from static space into an informative and interactive space.
2.2. THE SHIFT OF DIGITAL DESIGN CONTENT

The shift of the focus mentioned above is to address the needs for educating future architects and designers. Pentilla (2003) provides a European overview of architectural education curriculums related to IT. The findings include IT-teaching environment and the reception of new media information has been very positive, although the use of hardware platform, software and the applications vary. In general the inadequacy of software-based CAAD education for tomorrow architects is well perceived. The search for design studio of the future is never ended (Achten, 2003; McCullough and Mitchell, 1990).

Today, the architectural practice is driven by environmental concerns (such as sustainable architecture), material and technological innovation (such as smart façade, ubiquitous computing, or wireless communication) and creative design. The design creativity or innovation is always a driving force for designers. Whether the design education can be enhanced by technological innovation become the challenges for educators. In order to get digital grounding or realization, Chiu (2003) indicates that digital design has to integrate with (1) designers, (2) design culture, (3) design theory and methods, and (4) design environment and tools. Therefore, a multiple-disciplinary approach can be applied to introduce students to understand the future needs.

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*Figure 1.* The evolution of digital design education.
3. The Approaches of Digital Design Education

What can we learn about the digital design? Some well-known schools are investigated for getting in-depth understandings.

3.1. SOME OBSERVATIONS IN CURRENT ARCHITECTURAL COLLICULUM

The study surveyed at least 15 architectural schools with digital design programs for defining the digital program content and rationales. In many cases, digital design programs including courses, studios and workshops are lead by innovative programs by key educators. Therefore, analyzing the pedagogy and persons who teach might provide clues for current conditions. The authors had interviewed instructors (G. Schmidt, G. Lynn, H. Rashid, D. Donath, T. Kvan, B. Dave, S.R. Liu, and C.C. Chen) and studied several programs including Columbia U., Harvard, Carnegie Mellon U., ETH, Universtat Für Angewandte Kunst (UAK), Bauhaus-Universitaet Weimar, HKU, CHKU, U. of Melbourne, NUS, NCTU, THU, TKU, and NCKU.

In the mid 1990s at Columbia University, former dean Bernard Tschumi envisioned the power of digital tools and the design potentials in the digital era. Therefore, the program is largely reformed. Importantly, the courses are always tightened back to the design studios. Many digital design theories are referenced back to his understanding of technology and culture. Digital design studios at Columbia University are organized on a smooth operation between technology and theory (Tseng, 2003).

As Kvan (2003) depicts the reasons to carry on teaching, what we need to do is to recognize the range of opportunities that digital tools present to both the practice of architecture and processes of construction. Students need to be introduced to the new potentials of creating a built environment with ubiquitous digital tools.

Effective design teaching and learning needs an extreme streamlining of the subjects taught. In the past, it was believed that only one particular curriculum with carefully worked out vertical streams could lead to good education results. Yet a comparison of excellent architecture schools demonstrates that the quality of the design teachers and the context might be more important than a particular curriculum structure (Schmitt, 2003).

3.2. SEARCH FOR NEW ARCHITECTURAL COLLICULUM

Apparently, the increasing adoption of digital media in design education also leads to subtle changes in design objectives, means and outcomes in that process (Dave, 2003). As new novel concepts demonstrated in major international competitions such as World Trade Center in NYC or Beijing Olympic Stadium, it is clear that digital design education will play a crucial
role in tomorrow architectural education. The digital content could be developed into a platform or language in the new architectural colloquium. On one hand, digital design education enables external communication between methods, knowledge, and architecture, and internal communication between technology, history, design and professional areas on the other hand.

4. Experiences at National Cheng Kung University

The attempts in Department of architecture at National Cheng Kung University in the past 10 years provide the foundation for observation and discussion. These attempts can be divided into three approaches, i.e. (1) technology-driven or content-driven, (2) theory-driven, and (3) methodology-driven, Figure 2. Each approach is exemplified by a student project to elaborate the focus and experience.

4.1. TECHNOLOGY-DRIVEN AND CONTENT-DRIVEN

Digital tools are central to the digital design, and the use of CAAD in design is generally to represent the concept and product. In the example of a house project driven by the concept “the light as a form sculptor,” the design is developed by applying software (3DMAX, CATIA, Lightscape) and RP (3D Printer) to visualize and examine the concept, Figure 3. On one hand, the designer can manipulate the form with the assistance of computer modeling and establish a process model for design development. On the other hand, he
can still feel the scale and form by rapid prototyping. In this manner, the education is to realize the concept with all possible technologies.

Figure 3. Computer modeling and rapid prototyping tools applied in a house project.

Figure 4. Animating form and digital fabrication in a digital design project.
4.2. THEORY-DRIVEN

The design principle can be classified into the cause (rationale) and the result (goal). Theoretical background for form-making such as folding and in-between are introduced into digital design education. Figure 4 demonstrates that the flows of people and activities can be generated by parametrical design and simulated by light tracing algorithm. It includes 2 processes: (1) recording the behaviors and simulating the movements by Rhino and MAYA software, and (2) designing the components of an adjustable wall and building a façade by digital fabrication. In this manner, the education is to realize the concept with necessary design knowledge and technologies.

4.3. METHODOLOGY-DRIVEN

Prototype development generally requires methodological analysis and synthesis. Figure 5 demonstrates a house project by generative design, four steps are undertaken: (1) select the initiate form, define the function and coordinate as the basis of generation; (2) spatial layout in according with spatial unit, activities, user, and environmental factors to define the growth direction; (3) form generation by manipulating the axis, dimension and combination; (4) refine forms and select the final alternative for prototype development. In this manner, the education is to formulize the concept with necessary design knowledge and technologies.

![Image of a house project](image.png)

**Figure 5.** The generative design of house prototypes.

In a preliminary survey of digital design education in NCKU, we found that the relationship between design studio and digital design education are
essential important to the successful program from the practical point of views. In many cases, the introduction of digital education into design studio relies on the instructor and resources in the institution. Various approaches in some institutions focusing digitally enhanced curriculum that may promote the practices of software and hardware, but not necessary lead to the innovative design. Furthermore, the learning processes still rely on the aims and constraints of courses. The worst scenario is that digital design education and design studios are separately instructed.

5. Discussion

The above case studies of each approach in student projects and their findings are important for the next step. More important questions such as the incentives for learning and the relationship between education and practice are raised.

5.1. EDUCATION AND PRACTICE

Can digital design education serve the need of current and future architectural practice? As new novel concepts demonstrated in new generations of digital architecture, it is clear that digital design education will play a crucial role in tomorrow architectural education. The digital content could be developed into a platform or language in the new architectural curriculum. 3D printers, CNC laser cutters as well as parametrical and generative design will become the common language in the field. On one hand, digital design education enables external communication between methods, knowledge, and architecture, and internal communication between technology, history, design and professional areas on the other hand.

5.2. EDUCATION AND RESEARCH

It is undisputed that excellent education depends on excellent research, most effective if carried out by the same instructor (Schmitt, 2003). Digital design research will therefore more significant than ever before. Thus the demand for fundamental research in architecture from smart materials to ubiquitous computing will increase massively in the coming years. From architecture capabilities to absorb and use findings from other disciplines, it will finally depend to which degree the individual architect or designer can maintain professional independence one the education is completed. As a result, future architects or designers will become a creator of digital design culture in education and research, and participate the creation of digital architecture.
5.3. NEW ARCHITECTURAL CURRICULUM

After analyzing various schools, it is found that most excellent digital design programs including courses, studios and workshops are lead by innovative designers in well-known institutions with novel concepts. Effective design teaching and learning needs an extreme streamlining of the subjects taught. In the past, it was believed that only one particular curriculum with carefully worked out vertical streams could lead to good education results. Yet a comparison of excellent architecture schools demonstrates that the quality of the design teachers and the context might be more important than a particular curriculum structure (Schmitt, 2003).

In conclusion, digital design education will play a crucial role in tomorrow’s architectural education. The needs for responding to the future environmental concerns and inquires about future design studios are never ended. How digital design can be organized and integrated naturally with the architectural design education to pursue creativity will be important. With the evidence of digital design projects, both the professions and the academics can foresee the continuous development and challenges in this domain. The future emphasis in digital design education should be in the digital ground rather just the outcomes, i.e., the integration and implementation of the design process digitally, including design information and knowledge management, collaborative design, CAD/CAM, and resource management. The findings from this paper provide the possible direction and challenges for the field. Toward theoretic, technological, and tectonic approach in digital design related courses and studios are needed.

References

Wojtowicz, J., (ed.), 1995, Virtual Design Studio, Hong Kong University Press, Hong Kong