CAAD EDUCATION IN THE PANORAMA OF ARCHITECTURAL EDUCATION SYSTEM

A research on visualisation of the educational tools

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Abstract. The significance of CAAD begins with tools. However, the values of CAAD to architecture education are not only in increasing subjects associated with CAAD in the teaching but in improving comprehensive digitisation of architecture professional education. When CAAD develops into the level of BIM, the value of information emerges. And as the exchange mechanism of build information share data at the same time, BIM already has User-Facing Exchange Models and Vendor-Facing Model in NBIMS. Educators are more sensitive to the happening process of professional education and BIM should and can have Education-Facing Model and two inferences about the comprehensive digitisation of architectural education system including the visual organisation to architecture knowledge and the establishment of teaching process management digitisation system for whom a direct derived research is the application of AEIM (Architectural Education Information Model). This paper is a preliminary study of the possibility of such a model and its value as a tool of design education, and further research can be conducted to study the systematic structure of the information model and methods of its visualisation.

Keywords. Architectural education; education information; BIM; information exchange; visualisation.
1. Introduction

The study of CAAD education should include specific teaching methods and also the existence status and development of architecture education system. Architectural education has its own subject system including targets, contents and methods.

The architectural education with the cultivation of professional architects as its basic goal and “education based on problems” as basic education idea can include three main education contents, namely, “issues of architects, of building and of architecture”.

“Issues of architects” is actually issues of architectural design including the content of “design tools training” and CAAD is one of the tools of modern architectural design. CAAD develops as a design tool and gradually changes the paradigm and organisation method of design as well as the way how architects see architecture design as a subject. CAAD itself gradually develops into “digitisation design”. At the current stage of CAAD development, people finally become aware of the value of “information” and have BIM to describe buildings, eventually extending the meaning of CAAD itself.

Meanwhile, CAI has been widely used in education, too. With the comprehensive promotion of digitisation technology, CAI will combine with the modern educational technology and evolve into the application of CBE (Computer-based Education). At the same time, when CAD develops into digitisation design, it may also evolve into CBD (Computer-based Design), which may include BIM application, BIM data exchange standards, BIM education development and BIM & BLM (Building Lifecycle Management) integration etc., all being the informationisation of design.

Under such background, the digitisation development of architecture education has two main clues. One is study of teaching and learning methods of CAAD and the other is the visualisation information organisation of architecture education with modern education technology, and the comprehensive digitalisation of the management of education institutions.

2. CAAD Teaching in Architectural Education

The teaching and exercise of all sorts of design software are the most basic and intuitive composition of architecture digitisation teaching. However, the significance of digitisation to architecture professional education goes beyond that and the teaching methods of software tools are different from that of the traditional tools.

In the professional training tutorial, that “students learn tool use through the design training” is the general opinion. On the other hand, more positively,
CAAD can serve as teaching tools, where teachers or teaching system can “teach architecture, building and designing principles through the digitisation tools”.

Tools system integrates design knowledge, goals and methods and students’ understanding of buildings, experience of designing and use of tools are mutually influenced and happen at the same time. To master the using skill of design tools is only a branch goal of professional education and the fundamental purpose is to research architecture design through the design tools.

2.1. TOOLS OPERATION TRAINING OF VOCATIONAL EDUCATION

Among the series of courses relevant to CAAD education, professional tool training comes first in architecture professional education.

Any vocational education for the labour reproduction in the industry behaviour has “labour tools operation” training subject to educate. The training methods is practical and mature tools system also integrates major professional objectives and basic rules.

Generally, CAAD tool, in terms of design, can be briefly divided into “modelling” and “simulating”, two types of technical tools oriented to the comprehensive performance design of building. To extend, if the two components of modern architecture (academy and practice), namely, “environmental behaviour” and “environmental control”, are agreed on, modelling and simulating of digitisation tool are right corresponding to the basic goals of contemporary architecture.

Digitisation modelling tools, just like art methods, is a classical architecture design tool. Take parameterised shaping research for example. It does not just “create” or “produce” new shape aesthetics outside general life experience, but is to guide students, at the level of architecture education, to study the “possibility” of shaping including the linear and nonlinear. Parameterised shape design tool has a certain limitation, since it is a pure shaping study detached from human behaviour or humanity factors, so it still falls into classical architecture.

Digital simulation tools are related to technique-related subjects of architecture, and it is especially used for the teaching of green architecture design and building performance evaluation. Nevertheless, CAAD tool needs to integrate comprehensively with traditional subjects, such as the material and structure course based on BIM (such as Revit), graphics course based on modelling tools (descriptive geometry and shadow perspective), building physics, to name a few. These courses are easier to set up at a lower cost.

If we perceive the value of traditional tools in the sense of “modelling” and “simulating”, we can see that traditional design tools appear to be some
skills about architecture art, but in fact, architecture art techniques are modelling and simulating too in shaping study of physical building and its space design. We may even find that the traditional “tools training” approach, originally a “visualised” means, is running by integrating special subject training with subsequent circular practice (in design course). Early use and teaching of CAAD also followed the work mode of art tools, such as AutoCAD and SketchUp, which, like paper, compasses, pens and rules, shared the common property of “general-utility tools”. They can be mastered by the educational level coequal with high school and are kind of “body memory” skill.

Compared with the traditional “general-utility tools”, current digitisation tools for design are professional “customised tools”, which integrate more professional goals, rules and methods. Digitisation tools have higher level of integration of the professional behaviour and the establishment of “tool-use skills” needs to be based on more comprehensive specialised knowledge.

Therefore, professional architecture education needs to help students to gain comprehensive and systematic knowledge of the specialty via the use of tools. In this sense, the essence of “pedagogic rule” of digital tools does not lie in “learning to use the software tools by designing practice (design assignment)”, but in “learning architecture and design via the designing tools”. And this is what digitalisation technology really means to the architecture education.

2.2. THE SIGNIFICANCE OF DIMENSIONS OF DIGITISATION TOOLS

Design associates with goals via tools, and goals and tools are mutually influenced and restrained. Meanwhile, goals and tools also develop synchronously, and the number of dimensions of digital tools is close to the comprehensive information description of the goals. Form-oriented “geometry modelling” software differs from design-oriented “information modelling” system, in that they concerns different level of dimensions.

Digitisation tools are generally considered to be a system concerning three dimensions. But if 3dMAX and other big and perfect modelling tools are used only to render graphs in practice, the final number of dimensions would be less. On the other hand, although the use of 3D tools will alter some terms in the traditional design concept, such as plane changed to function, section to space, elevation to form, sit plan to environment, which even implies that drawing as “design achievements” may be surpassed, 2D graphics operation method, however, is still effective.

For example, the Revit system based on the idea of BIM is not meant for 2D graphics but it does not reject to work in 2D space and each operation of “back to 2D” is to make necessary dissembling of three dimensional
space in order to isolate the irrelevant data or information. The 3D Shaping and Viewing management ability of Revit is almost the same with SketchUp, but its operation process is accompanied by more follow-up work information, which shows the significance of BIM in perfecting the dimensions of construction information. The design by using BIM and extended tools will no longer be stuck with the issues of production drawing, but will focus on “design for construction”.

In this sense, the development of digitisation tools is not a simple leap from 2D to 3D, but is three-dimension beyond simple geometrics, having significance in managing the whole “design-construction” process in time dimension.

When CAAD develops into digitisation tools, it is more than just a CAAD software product, but an integration of a series of related tools corresponding to each gradual goal in design process and a series of related subjects in the professional education. Just as each design or each house includes all the issues in architecture, the teaching and learning of digitisation tools need to be comprehensive, systematic and penetrate into each subject, and need to help students to form the concept of BLM in architectural education.

3. CAAD promotes the digitisation of the information resource of architectural education

In the concept of information, information quantity varies at three different levels, namely, “informationisation, digitalisation, and quantification”, with that in informationisation being greater than in digitalisation, that in digitalisation greater than in quantification and quantification is the most stringent informationisation. There are still elements in architecture that can’t be quantified, but can still be digitised and informationised. CAAD gets into development as a quantifiable design tool and its training is added to professional education. But tool training solely does not make the whole of professional education.

When CAAD develops to the stage of the introduction of BIM, the concept of information is highlighted. The value of information regarding architecture research and its education research brings bright prospects.

3.1. THE VALUE OF THE CONCEPT OF INFORMATION IN ARCHITECTURAL EDUCATION

Digitisation is the study of information in essence. When “information” works as a basic “observation method” to architecture, it will help to get a completely new understanding of the traditional concept of architecture and to make clear the logic order of prevalent concepts.
In fact, the wide existence of digital information changes traditional idea and behavioural habits of architecture design. As a result, architecture design has already been a process of information processing.

Part of the basis of architecture design and architectural education defies digitalisation, but it is still effective work information. Quantification is the strictest at the informationisation level, just like various data in professional regulation. Various information systems are also management systems and the management operation object is all kinds of information or, information is the intermediary to manage things and processes. At the level of digitised information, design may as well be perceived as the study of construction, and the excavation, managing and processing of construction information.

The concept of information is of great significance in the study of various issues in architecture education. The goal of architecture professional education is to cultivate the ability and ultimately form the working style of architects. “Issues of architects” are to help students eventually learn the “professional working mode of architects”, including the architects’ way of dealing with comprehensive construction information in various media.

“Issues of building” are expressed by BIM system now. As a digitising, visualising and structure-systemising information model, it includes the quantifiable part of construction information such as material, structure, spatial scale and codes of practice. Beyond BIM, we have put forward the possibility of SIM (Space Information Model) existence as a kind of coupling type gestalt work (Zhang and Wang 2010) to promote the study of perception behaviour in space. As to “issues of architecture”, its digitisation calls for continuous exploration due to the existence condition and complexity of the general knowledge hierarchy in architecture. The digitisation of existing concept in the subject is relatively easier, such as the completed work on IFD.

For architecture education, however, the multiple relations and logical sequence of various concepts (including technical and humane, spatial and behavioural) are more important. Researches find that the link between concepts is neither linear nor 2d, but some kind of “N-dimension space system with many subsets”. An effective software tool is required to deal with this “system of architectural concepts”, and this is, to some extent, the requirement of architectural education on CAAD system development.

3.2. BIM LINKED WITH BLM UNDER THE CONCEPT OF INFORMATION

With regard to the management value of digital tools to design-construction process, needless to say more, the study of BLM has already been conducted. This is a concept with ecological significance, which can give a more profound insight into building and the professional behaviour of architectural design. It
should become one of the basic professional concepts of the contemporary architecture graduates. When BLM is connected with BIM, as is easy to see, the Ms in “Model” and “Management” can help to understood each other, that is, besides the original meaning of BIM (Building Information Model) and BLM (Building Lifecycle Management), “the process of design” is “the Management of construction information (BI-Management)”, and “the result of design” is to get some “predictive Model of building lifecycle (BL-Model)”. The academic research and teaching application of the related issues of architecture digitisation should also be based on such basic understanding.

In fact, the types of special tools of architecture digitisation correspond to all phases of the lifecycle of building (or the lifecycle of design). The discussion of relevant teaching methods can take “the time sequence of digitisation tools entering the design process” as one of the research topic and provide reference for the organisation and management of the production and practice of the architectural engineering design, by researching the organisation methods of architectural design courses. In fact, the organisation methods of the two processes can be cross reference.

4. Visualisation of architectural education information in the concept of BIM

Even if based on the same architecture discipline knowledge, principles, methods and tools, professional education and vocational practice differ in goals and processes. BIM system is mainly researched and developed for professional practice and takes building information description, information exchange and production organisation as the core. On the one hand, although BIM is not intended to be a specific design tool, but the tool system based on the BIM idea (such as Revit) provides a kind of data structure to describe building system, known as the organisation structure design of the software menu, gradually familiar to software users. On the other hand, studies are being conducted about BIM as a share data exchange mechanism of construction information, including organisation methods of data structure, such as the ongoing work of The National Architecture Information Modeling Standard (National Institute of Building Sciences 2007). A direct derived research of this study is the presentation AEIM (Architectural Education Information Model).

BIM already has User-Facing Exchange Models and Vendor-Facing Model in NBIMS, and educators must be more sensitive to the happening process of professional education. Therefore, BIM should and can have Education-Facing Model and two relevant corollaries of “Comprehensive Digitisation of Architectural Education System” including the visualisation organisation.
of architecture knowledge and the establishment of the digitisation system of teaching process management.

4.1. SYSTEMIC ORGANISATION OF THE EDUCATION CONTENT

Enlightened by BIM and as a speculation and extension of BIM, AEIM (Architectural Education Information Model) is the study and expression of the architectural knowledge system. The system of AEIM (Architectural Education Information Model) is set up according to the special requirements of professional education, which may include logical organisation of professional knowledge and the establishment of the intrinsic connections between concepts. The R&D thought of this system takes basic cognitive process and education goals as the core. In fact, the R&D technology of BIM and the hyperlink technology between web pages have been the technical template of AEIM system.

The textual information of architectural education, in a narrow sense, refers to the “thought, history, theory, knowledge, principle, method” of architecture issues, which are present in theory courses and are knowledge components of architecture to some extent. It’s textual and relatively static. The textual set of concepts can at least be digitalised and informationised, if not quantified. In fact, the appearance of BIM is right beyond the restrictions of early CAAD tools on quantification. In generally, there are two main aspects in architectural education, namely, architectural design courses and architectural theory courses. Theory courses are not the specific design ability itself, but are needed in the design process as basic subject cultivation and serve as the knowledge basis of design innovation. The aim of the establishment of AEIM is to promote the integration of design courses and theory courses.

At the level of keywords, the system of AEIM meaning will establish the (visual) connections between key words and overtake the established structures of traditional courses and subjects, and may well change the forms of traditional teaching material. In this sense, the study of architectural education is also the study of architecture itself, in which there may appear advancing research propositions, such as the study of “knowledge discovery” in architecture. AEIM will be conservative as well as open, and a continuous maintenance of AEIM will accumulate the value of conservable part in architectural education. AEIM faced with students can provide a panoramic cognitive map of the subjects, which can be seen in AEIM software menu interface.

4.2. THE SIGNIFICANCE OF VISUALISATION TO THE THEORETICAL TEACHING OF ARCHITECTURE

The reason why AEIM is put forward as a hypothesis or inference is owing to the awareness of the concept of computer visualisation and the development of its technology.
In fact, architectural design has all along been done with the visualisation method. The art method is the most primitive and most direct visualisation. It can even be realised that the development of the architectural design tool system is right attributed to the continuous advance of “visualising ability of tools”. It’s not because the design object is substantial and with concrete shape, but because visualisation can aid thinking intuitively in the design process. And this is the key to the question.

The “implicit” thinking activity in the design process, either analytical or synthetic, needs materials to analyse or synthesise; design innovation is firstly thought innovation, stemming from the processing or disposing of the existing concepts.

Architectural knowledge, principles and theories are the basic material for the design conception, converting to the designers’ professional background. The education information composed of knowledge, principles and theories contains graphs, text and data, etc., and can be further divided into graphics primitive, terms, principles, formula, etc. among them, the conservative, stable and static part is the basic components of the discipline, which takes the form of a series of “subjects” and is stored in the principles or theories in the textbooks. However, the storage of text information is one dimensional, and the connections between concepts and the production of meaning have to be achieved via reading. This is the drawback of text in terms of dimensions when used as a tool of thinking. For example, in A Pattern Language (Alexander et al. 1977), in order to overcome the barrier of linear text, the book offers the context of every pattern in the whole pattern system of the book, so as to establish connections between different modes. This is the most primary mode of mind mapping. It can be imagined that today’s version of A Pattern Language will take more direct and exquisite visualising expressions. In fact, that is the method we adopt when guiding students to study this book.

Concepts are meaningful only in the connection system. Visualisation method, as is assumed in AEIM, expresses concepts as a direct, connected and panoramic mind mapping, making theory learning and design conception an “explicit” activity in a degree. This is the meaning of design tools in aiding thinking activities. The thought processing of concepts is an operation to the non-quantifiable information in architectural design, which is beyond the traditional CAAD tool. Digital information is information instilled with energy. The visualisation of such power-driven information is real-time and dynamic, aiming at establishing multi-connections between concepts, while the thought activity itself is dynamic, active and sometimes unpredictable.

The awareness and using of AEIM have actually existed subconsciously and occasionally in the practice of design education. Converting the sub-
consciousness into conscious and explicit research subject is right the life prototype of “knowledge discovery”, where the “hypothesis & verification” process is the basic way of academic research. The conjecture of AEIM is, apart from scientific study, the product order made by architectural educators to the software providers.

5. Conclusion

This paper is not intended for specific teaching method of CAAD. It advocates the education aim of protecting and cultivating students’ innovation. However, if the emphasis on innovation was confined to “moral preachment”, it would be the “educators’ bluff”. Practicable innovation requires innovators possess basic specialised knowledge and master the operating skills of professional tools. Besides, all vocational education has the duty to train practitioners to use professional tools and advanced tool system needs more specialised knowledge as a basis. In the basic education of architecture, the dissemination of knowledge, even if it’s only for the use of design tools, is important; while the efficiency and effect of the dissemination is restrained by teaching methods and tools. AEIM is put forward for the development of the tools and methods of architectural education.

A definite research goal will help the allocation of academic intelligence, so as to boost the academic development. The teaching research of the architectural digitalisation, not confined to the use and teaching methods of CAAD, is a comprehensive digital upgrade in contents, organisation and institutional management of architectural education. In the background of the Information Age, the teaching research of CAAD coincides with the study of architectural education, while the latter is a systematic study of architecture, with digital methods and technology as the most effective tools, among which “information model” and “visualisation” are the most typical methods.

References

