Team Orientated Knowledge Construction for Architectural Education

Jin-Yeu Tsou and Benny Chow

Information Technology is always more accessible when we trying to imagine what the IT could be actually used. This situation is even more noticeable in the architecture field, and there are various technologies that have failed on delivering urgent needed education quality. Meanwhile, the tradition architecture education is evolving rapidly under the concepts of problem-based approach, knowledge reconstruction, and self-guided learning. "Education without institutional boundary" happens everyday in the classroom, and multi-direction learning modes have replaced the traditional single-direction teaching approach. The role of IT in the curriculum of architectural design education has become a subject of debate, scrutiny and experimentation in architectural schools. This paper will first outline the theory of applying team-oriented knowledge construction approach into studio teaching, the setup of our integrated digital design media environment is introduced; organization issue regarding the team formation and studio coordination is discussed; case studies are illustrated for demonstrating the methodology applied; and the student feedback is summarized to analysis the effectiveness of the approach.

Keywords*: multimedia, CD-ROM, problem-based learning, team-orientated learning, and constructivist learning*

Introduction

If providing the right information to the right people, in the right context, at the right time and in the right form is the essential part of every educator's job [Vest, 1996], then the application of Information Technology in architectural education must be one of the greatest challenges for our professionals. As educators of HK building professionals undergoing redefinition and situated in a region experiencing unprecedented economic development, there is an urgent need for teachers in Hong Kong to clearly identify the contours of change and patterns of shift.

Information Technology is always more accessible when we trying to imagine what the IT could be actually used. This situation is even more noticeable in the architecture field, and there are various technologies that have failed on delivering urgent needed education quality. Meanwhile, the tradition architecture education is evolving rapidly under the concepts of problem-based approach, knowledge reconstruction, and self-guided learning. "Education without institutional boundary" happens everyday in the classroom, and multi-direction learning modes have replaced the traditional single-direction teaching approach. The role of IT in the curriculum of architectural design education has become a subject of debate, scrutiny and experimentation in architectural schools. It is always under constant discussion regarding what should be taught to our

students in order to help them be successful in their future practice environment. There is need to re-examine the pedagogy applied on integrating IT with our traditional teaching techniques, and to imagine the new role of information technology in educating next generation architects.

IT-based instructional system has been developed in last decade for facilitating teaching and improve the quality. Various types of multimedia-based teaching materials have been developed for classroom or self-paced learning, and the physical boundary and time are no longer the limits for people to learn. However, the effectiveness of the learning process has been highly limited by the information structure, user interface, interactive mechanism, and context of multimedia applications. The important experience regarding judging and processing architecture information has been limited by the predefined "roadmap" or metaphor of these specific applications. In the learning environment, IT should provide students the opportunity to contextualize the architectural knowledge through their own observation and integration, and offer an unique opportunity to re-conceptualize architecture itself. Although this aspect has been noticed by educators, the research has been done on this issue for studio teaching is limited.

IT, however, is different from other developments that have impacted the architectural professional practice in the recent past. Although IT in its strictest definition is merely technology innovations, their impacts on architecture are profound as a profession. In the past four years, the research team in CUHK has accepted the challenge for integrating the multimedia technology into the architecture education. Apart of implementing a series of multimedia-based courseware demonstrating the IT for course teaching, we create a digital design media environment for the students to implement their own projects and construct their own knowledge. Social construction of knowledge has been adopted as the base for our students to contextualize studio design problems by conducting media integration exercise to explore the body of architectural knowledge. There are a number of key issues concerning the emerging information technology, which are uppermost in our mind. They are:

- Aspects of our current understands of human learning relevant to architectural education.
- The adequacy of prevailing educational infrastructure with its emphasis on classroom teaching and studio tutoring.
- The possibility of developing a more effective and responsive mechanism which can relate to the future environment for learning and
- Society and professional institution's expectations about what architectural students need to learn.

Attitudes towards a Constructivist Learning Environment

Experiential and Reflective Cognition

Studies on aspects of human learning in respect to the application of information technology have highlighted some human attributes which are significant to re-thinking architectural education. One of these is the recognition of the two differing but related modes of cognition: i.e. the experiential and the reflective [Norman, 1993]. Architectural educators who have championed the emphasis on experiential learning, often at the expense of reflective learning, should be well aware of the pitfalls of such a condition.

Experiential mode of cognition involves data-driven processing, essentially reactive to sense inputs and analogous to the knee-jerk reflex, and there are strict limits to how far such a chain of reasoning can proceed. The design studio where most architecture students spend by far the largest proportion of their time in architecture schools preparing and defending their designs tend to favor such mode of cognition. It has been said that the latest photographs from fashionable architectural magazines have the greater influence on the trends of architectural design in some schools.

On the other hand the reflective mode of cognition involves the assimilation of concepts and the creation of schemata in order to interpret data, explain sets of related events and solve problems. Deep learning relates to the progressive development and refinement of concepts and schema which, with the acquisition of skill, can be put to effective use. We believe the mark of a successful education in architecture is in the balanced opportunities given to both modes of cognition.

Given this background in architectural education due recognition must be given to the limits and characteristics of each learning mode in the development of learning support system using computers, multimedia, and other new forms of IT.

The Generic Shift

While the provision of an efficient and cost effective learning support system has always been the avowed goals of infrastructure development for higher education; in light of the development of new IT there is a need to re-examine the purpose and technique in conventional classroom teaching with its assumed spatial requirements. As changes emerge in the methodology of developing learning support system using advanced information technology, conventional assumptions are in danger of being made obsolete.

The features of IT relevant to teaching and learning are its speed, versatility, popularity and interactively such as multimedia, WWW technology and Virtual Reality. Some of the generic shifts for higher education at institutional level anticipated by researches [MacFarlane, 1995; Mitchell, 1991; Sanders, 1996] are worth noting.

- Institutions need to generate a greater degree of flexibility in their teaching arrangement to accommodate very high degree of self-paced exploratory learning. From synchronous single-location learning support the shift is to asynchronous networked learning support.
- A shift from passive learning, as in most classroom lecture format, to active learning using networked information sources.
- A shift from static presentation to dynamic presentation involving the production, transmission and storing digital design media in multiple forms.
- A shift from the use of real objects to the use of virtual objects whose behavior is simulated by computer and which are interactively accessible.

From the perspective of architectural education involving the development of design knowledge and skills, the implications of such shifts are obvious and of great significance. It is clear that dynamic representation helps designers conceptualize and learn architecture knowledge, but will the ability to experience virtual reality further alienate the designer from the actual building process?

Constructivist Learning by Engagement

In the past decade, architecture, engineering, and civil engineering disciplines have integrated various IT technologies into their operation to increase efficiency in the areas of design, performance evaluation, analysis and documentation. However, these approaches have failed to assist the architect and engineer in solving problems comprehensively because of the lack of a team oriented IT environment to coordinate different design decisions during the design process. This failure becomes even more obvious when conflicts occur between the many disciplines involved in the process. Misinterpretation and miscommunication of information between different disciplines inevitably lead to inefficiencies and inconsistencies in the problem solving process.

There is a need to provide a learning environment that allows participants to engage other participants to explore the content of problem domain and to complete a project by themselves. Several features which are lacking in the traditional classroom setting are embedded in this type of learning modes such as self-initiation, self-guidance, team building, group-based learning/thinking, project management skills,

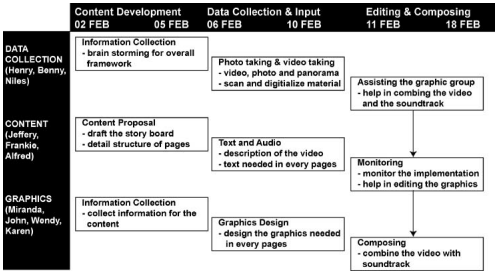

Figure 1 (right). Overall time schedule & individual task force organization chart

global vision, and exploration through engaging the real world scenario. The experience received from the learning process could provide students important framework to conduct multi-disciplinary collaboration and self-guided learning in the future.

Project Organisation and Team Building

Design Studio

In the current practice of architecture education, no one could deny the importance and the supreme position of studio teaching for an architecture student. Studio is everything. It allows students acquired the necessary knowledge and skills in different design stages. They spent nearly all of their time for studio project. Since the problem-based approach and self exploration have been well adapted to the studio teaching, students are used to learn in a multi-direction and task orientated pattern.

Problem-based Learning

Based on the traditional teaching techniques, the advanced computer-aided architecture design (CAAD) course is organized in a lecture-based and classroom setting that covers students overall advanced concepts. Although the teaching model could provide a general knowledge regarding the subject, the CAAD teaching group re-examined the pedagogy and identified that there is an urgent need to migrate the traditional approach into studio learning environment. The third year studio project is reconstructed to cope with new paradigm, and the goal of the project is redeveloping a market office complex in Wanchai area. The area is one of the oldest districts in Hong Kong, highly populated and full of local context. During the early design phase, students are required to document the local context, cultural events and local activities for site analysis. For the conventional approach, this kind of dynamic and multi-dimensional information is not easy to be captured and presented. The research team collaborated with studio teachers to investigate the new role of multimedia technologies in design education.

Team Formation

As the studio design project is organized into different sections, team-orientated approach is adapted to group students into four teams with specific sub-group on different tasks. The methodology is developed from the technology transfer workshop for training electrical engineers for substation operation for a research project. Based on the findings of the workshop, the number of team member in a group is one of the critical factors we have to consider from the very beginning. Too many members in a team will increase the administration overhead and the coordinator may not maintain the team in a coherent mode. Insufficient human resources in a small team will cause individual member over-loaded, hardware resources allocation problem and limited technical staffs support. After we consider these factors, we decided that each team should consist of ten students. For each team, there is a project coordinator and four sub-groups.

The project coordinator will be responsible on maintaining the overall time schedule and coordinate the works done by individual task force. Three sub-groups have been formed in each team. 1) The Data Collection task force is responsible on photo taking, Quicktime VR panorama, video taking and document human activities. 2) The Content Development task force to collect and interpret the data for site analysis. 3) The Computer Graphics task force will integrate and pack all the materials into presentable format, and program a graphic interface for the ease on

navigation in the digital design media. By the process of problem-based knowledge reconstruction, information technology provided an opportunity for students to contextualize the missing knowledge via their own observation and integration. Students take advantage of their strengths, as well as nurture their weakness.

Project organization & Studio Integration

In order to help students understand the team formation and organization, the functionality and scope of each sub-group is introduced the first briefing and the tutorial session. Based on the interest and background of students, they selected their own task force to join. For example, they select the content group because they are more familiar with the context and technology associated with it. Detail time schedule of projection implementation is revised from time to time, in order to reflect the teaching goal of the studio project, and it is important to make time schedule in various courses coherent. Project requirement and intention of the individual student decide the direction of information collection and the information structure for grouping. Apart from using the result of the multimedia project for studio review. Design studio instructors are invited to participate the progress check for comments and suggestions.

For helping the students to have better understanding on how to select the specific task force, a briefing session and demonstration are held to introduce in the functionality and scope of each sub-group in the first tutorial. Based on the interest and challenge of individual student, they selected their own task force to join. Some of them selected the group because they are more familiar with the context and technology associated with it. Some of them selected another group because they take the challenge to learn something new and cover their weakness. Detail time schedule is revised from time to time as the response to the changing of the studio project. Keeping the same time schedule is very important in this exercise. The teaching group needs to consider

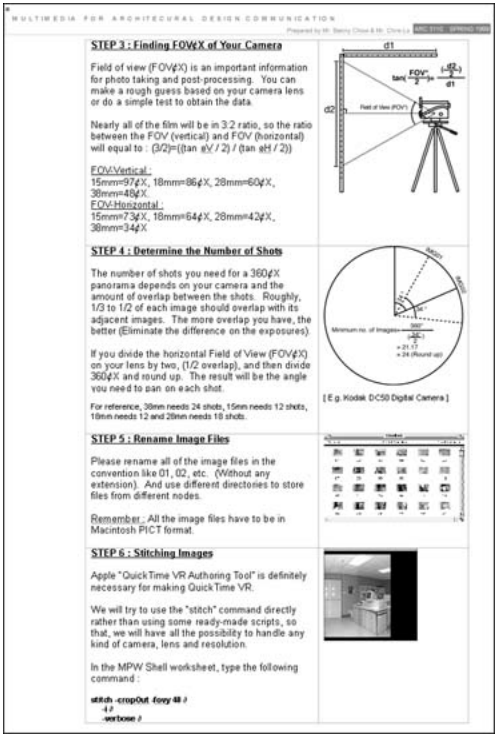

Figure 2 (top left). Item Checklist for project development.

Figure 3 (bottom left). Sample page from training package.

Figure 4 (top right). Chronological sequence on local history

Figure 5 (middle right). QuickTime VR panorama for context study

Figure 6 (bottom right). Social & cultrual events highlights

what the studio project needs, and what we could help the students to provide the information for it. Apart from using the result of the multimedia project for studio review, we also invited the Design Studio colleagues to participate the multimedia project progress check for comments and suggestions.

Training package

In order to facilitate the application implementation and reduce the workload required for individual student, a training package is developed in last one year. One of the objectives of the training package is to provide limited technical detail for project implementation only, and to group the details into modules, which consists of examples for future reuse. The package is composed with six major sessions: overview of CD-ROM production; digitizing video and video editing; Panorama with QuickTime VR technology; Computer graphics in CDROM authoring; Programming your own CD-ROM application. Since individual student has different background, interest, and design intention, the package is revised frequently in order to accommodate the scope of the design project. Although each student is expected to complete the whole training cycle, individual student might focus on specific skill and master the operation in certain aspect. During the project duration, students do learn from each other for solving their problems.

The tutorials do not cover all of the area in the individual application. Instead, it focuses on the specific usage in terms of functionality in the development cycle. Students found the right piece of function module on the time they needed during the course of the multimedia project. They are not required to go through all the unnecessary details on each application. The problem-based approach on delivery the information technology not only streamline the project implementation, it also helps students to focus the project itself and applied the just-in-time knowledge.

In order to help students work smoothly, technical support staffs with field experience is provided. With their expertise received from previous research projects, the sequence and pitfalls identified by the supporting team provide roadmap to students to prioritize their major tasks which have to be

accomplished first from the works which have very limited impact on the final product. They also demonstrate to students the path to combine separated information components into an integrated and comprehensive multimedia application for communicating their design ideas. The following are the screen shots from one of the project team on Wanchai context study application CD-ROM.

Feedback

The class has produced four CD-ROMs, and the content of the CD-ROM demonstrates the paradigm and design approach adopted by each individual team explicitly. A project evaluation is conducted to understand students' attitude towards for using multimedia technologies as the design media for design problem forming and exploration. Based on the feedbacks received from students, students got a mixed feeling regarding to this exercise. On one hand, the project itself is attractive and enjoyable that made them keeping on doing it for few over-nights. On the other hand, the project itself required a high demanding on both computer hardware and end user knowledge that made them frustrated from time to time. Even two full-time researchers were allocated to provide technical helps, just-in-time knowledge still pay a dominant role on the project development such as online help.

Students also felt that the CD-ROM project were harsh, exciting and interesting to work on. Ten students formed a group project. They have to prepare everything bottom-up. From field trips data collection, site analysis and all the ways to computer programming for a CDROM. At the same time, as the multi-disciplines and multi-dimension nature of CDROM project, students did learn a large variety of computer applications in multiple aspects. Lot of the members said that they got a chance to experience and acquiring some very important and practical skills on individuals applications.

Students got a chance to construct and communicate knowledge in a heterogeneous environment. Each one contributed their multiple intelligence on the project. They worked as a group and full of social interaction. The multimedia project not only capture the diversity of individual intellectual profile, also help students to improve their learning motivation, communication skills and the capitalise on their strengths.

Re-examining the IT-based Learning Environment

If the development of "Virtual Corporation", described by William H. Davidow [Davidow 93], gives us the direction of future business organization, then the findings of this experiment provide a new direction for the architecture school to re-engineer its design education based on IT. Findings and discussions are summarized below:

Opportunity to re-structure design information for education and practice

Based on the research done in the design computing field and the information processing model, information structure adopted by the designers deeply influence their problem solving activities in the problem domain. In the past, the traditional design media has limited the design representation and the mechanism to structure the information, but these limits have been challenged by new IT tools. IT has not only changed the way educators and students organize, retrieve, and share valuable design or construction information, but has also altered professional practice in the building industry. The implications include: firstly, information and data can be exchanged more rapidly; secondly, it assists designers to convey complex ideas more effectively; thirdly, it has an impact on traditional text-based and classroom-based architectural education. Meanwhile, Prototyping process of multimedia authorizing environment facilitates the publishing of building design and construction information. The team members can develop and implement the contents simultaneously and incrementally, and then adjust the overall framework. Through the IT infrastructure installed in this region,

on-line information system and multimedia technology has provided an important platform for education institutions and building professionals to exchange and re-structure design information.

Developing a user-centred learning environment

The interactive IT technologies for building design and construction can facilitate the multidisciplinary student collaboration, and fulfill different level of learning interests. For example, CUHK research team had developed a CD-ROM for documenting construction process of the Harmony Block of the Hong Kong Housing Authority. Students in architectural school emphasize the design aspect with the learning goal – "to understand"; students from building construction engineering focus on the construction process with the goal – "of being able to"; and building professionals from other disciplines will be interested only in the general concepts – "be aware of" the purpose. In order to assist a student to learn systematically and explore building knowledge from an interactive information system, a roadmap is required to organize the design information and develop the navigation method. The "information landscapes" concept proposed by Fabrice Florin [Ambron 90] provides an interesting framework for our research team to explore the self-paced, self-guided, and distance learning environment with appropriate levels of detail.

Issues of content development

Since the usefulness of the information provided by a multimedia application or a information system is the key to ensure the success of the approach, a methodology which can support a systematic approach to the content development is required. The experience received from this project and other CUHK works suggests following considerations:

- In order to establish an effective learning environment using IT technologies, teaching paradigm, student background and education environments have to be considered simultaneously.
- To verify the effectiveness of an interactive information system is to see how readily it can be adopted by its intended users and applied repeatedly by its users to different occasions.
- In the traditional design education environment, it is not an easy task to make the paradigm shift and find new ways of thinking about how multimedia or IT technologies can facilitate learning and empower the learner to become a more creative participant in the design process.
- If we limit our understanding by assuming that multimedia and on-line information system is just a kind of electronic page tuner, we will not be able to use these new tools to our advantages. With the emergence of the multimedia approach, architectural learning could become "interactive" and "fun" in a high-fidelity sense.
- Multimedia and other IT technologies do contextulize the information presented by students and educators, it is not an easy task to develop a clear guideline for facilitating the free expression of a student's view and maintaining an un-bias view for the whole group.
- "Deep knowledge vs. shallow knowledge" needs to be considered when we evaluate a student's development in a group-based IT learning environment. Although teachers could be highly impressed by multimedia applications developed by a multidisciplinary student team, cross-examination is frequently required to ensure the achievement of the learning goal.
- Since the design information presented in a multimedia application is constrained by the physical limit of the computer, 3D design information has been translated as 2D or 2.5D media for representation purpose. However, a design problem typically requires true 3D

spatial thinking, the abstraction in the application might not be sufficient to support the design decision making.

- Organizing a good team with diversified interests to carry out different tasks is always a challenge to any project leader. The result of a project is deeply affected by the performance of individual team member and the management skill of the project coordinator.

Multimedia as a cultural act and social act

The creation process of a multimedia application, as well as the application itself, embody both the cultural practices of a designer and the social response of that practice. Through compiling multimedia application, design ideas get contextulized and represented, different aspects of the problem domain get examined, various types of information get re-interpreted and re-structured, and design related decisions get finalized and documented. This incremental and recursive approach replacing the traditional waterfall process serves as a platform for testing a designer or student's idea, and the creation and realization of architecture have been built through this kind of social and cultural interaction. All forms of digital design media offered by the multimedia technologies define their own forms of communication fluency, and their own choices about what is important to communicate. The use of these communication mediums is a clam about who is the master of that communication, what is the need for communication, and how this is best accomplished. The use of multimedia in design communication and design education is a claim about what is crucial in the realization of architecture and what best describes architecture, a design, and its social culture settings. Considering above rationale, issues other than IT technologies have to be further explored, and the new paradigm for incorporating IT technologies into design education is needed urgently.

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