3 Natural Results From Advances in Computer Techniques

CAAD Teaching in China Yesterday, Today and Tomorrow

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The computer science has been becoming one of the most rapidly developed science areas in the world since 1970s. Many new and powerful solutions to engineering and scientific problems are based on computers. Now the applications and teaching of computer techniques are quickly towards almost all of the fields including architecture and urban planning. Of course, the advances of application of computers in particular fields and teachings are very different for some reasons. CAAD is one of few fields in which the teaching states, teaching ways and level are obviously different from university to university and from one area or country to another. In this paper the history of CAD and CAAD applications in China is first briefly reviewed. Then the CAAD activities including teaching and research work at Tongji University are introduced, and the social, economical, functional, technical and physical factors that have effects on CAAD teaching are discussed. What is currently included in our CAAD program is also discussed. As the further advances in computer technology including both software and hardware, what CAAD will include and in what way CAAD will be taught and the CAAD collaborative research projects will be taken remotely are shown finally.

INTRODUCTION

The emergence of computer aided design(CAD) technology has made great effects on conventional engineering design methods. With the development of many special purpose CAD systems and spread of CAD applications in those newly emerging industries, including factories or firms of design and production of plane, automobile, ship, machinery and electronic products, etc., demands for application of CAD is also raised in such traditional design field as architectural design The CAD technology certainly, on one hand, make revolution and innovation to conventional design methods and modes(including the design procedures, tools, materials and medium). On the other hand, the professional fields oriented CAD technique will ask the professionals must learn and know the features of what kinds of design problems it can be used to deal with, how to use it to solve these design problems, and how to build or use the theoretic system or tools of CAD for the common design objects effectively. The CAD activities in universities should play an important role in providing the professionals with the knowledge of these features and cover three things, research, application and teaching. CAD technique has been one of the most concerned areas by most of engineers in the

world. It will need, however, not only the human, but also the certain physical and objective conditions and environments to engage such CAD activities practically. At the same time, CAD is one of the new and young disciplines and its theories and methods are still being completed, developed and grown up. Its acceptance by every one will take some time. These factors, in fact, result in an imbalance of CAD advancement among countries in the world and an imbalance of CAD research, teaching and applications among universities and even departments at one university. In this paper the activities of computer aided architectural design(CAAD) research and teachings at Tongji University(TJU) are introduced, the trends for the future are also briefly discussed.

1.0 HISTORIC REVIEW

CAD was born and grown up with the development of computer technology, especially that of computer graphics. The continued advance in computer graphics, particularly in interactive computer graphics, has greatly stimulated the sound applications of CAD in many fields. The research on theory and methods for computer graphics was undertaken early in 1950's and research on and applications of interactive CAD were taken in 1960's. CAD research and applications, however, were pursued only in few countries, large companies and universities, such as General Motor, MIT and Cambridge University, etc., for a longer time because of the notably expensive hardware, including graphics devices, and the shortage of CAD professionals. In China, both computer graphics and CAD research and applications were almost not carried at all before 1970. Until the middle of 1970's there was no research and applications of passive computer graphics at some key universities, institutes and ship industries, and the research emphasis then is put on basic graphics algorithms. At that time the available design methods to the engineers in architectural and civil engineering and construction were still the traditional ones except for structural calculations that could be taken by using computers. The coming out of raster graphic displays and maturing of raster-oriented interactive computer graphics in later 1970's and earlier 1980's, especially the marketing of workstations with high performance and micro-computers with raster displays in 1980's, have greatly excited the development of CAD technology in many fields, including architecture design. The research and instruction of computer aided architectural design(CAAD) at Tongji University(TJU) were initiated after 1980 and were mainly in

- methodology of CAAD,
- architecture related data collection and its quantitative analysis methods
- methods for evaluation and optimization of design index in housing architecture, including technical, economical, social and functional ones.

The course essentially belonged to design theory and analysis, and was scheduled as selected one by both under-graduate and graduate students before 1990. The teaching effect, however, was not ideal. The students did not learn much about and make many interests in CAAD, and they still could not use any CAAD in their designs to solve

even the analysis problems at hand. There were both subjective and objective reasons for this result, but the main ones were as follows:

- Poor condition and environment of computer operation. Even though a lot of cheaper personal computers(PCs) had been in use in the world during the 1980's, the cost of PC was expensive under the Chinese economic condition then. The university could not get enough funds or make budget to equip the computing center or laboratory with a number of PCs that was qualified for CAD and used exclusively in teaching. Till 1992, for example, there were altogether about thirty PC/XTs at TJU. It was impossible for the students to take much time to learn how to operate computers, even the fundamental operation for DOS, and get more training in experimental skill by using computers.

- Most of the teachers and students who were majors in architecture were not interested in this kind of design analysis even if they knew that it was some time important to the design. In contrast, they paid more attention to what was in design composing: how to assemble the architectural components into a building that was more attractive, artistic and interesting in shape. It was impractical in Chinese universities in that period due to the lack of powerful software for 3D modeling and rendering and the computers with high speed, performance and quality graphic functions.

- Without the strong background of computer technology, most teachers and students in architecture departments thought the computer as mysterious and with suspicion and rejection deliberately or inadvertently. They did not believe that the computer would be able to play an effective role in the architectural design involving the high degree of creative work in shape. The above design analysis was not welcome to the students, because it often required the students to write a special program according to the particular case.

Since 1990 the price of PCs has dropped and the graphic function on the PCs improved and enhanced rapidly. It results in the fast spread of CAD applications in many Chinese industries and design departments. In order to improve the productivity, some local architectural design institutes begin to make use of PC-based interactive computer graphics software in the construction and engineering drawing (architecture and structure) and are well succeeded in such applications. The rate of the number of drawings produced by computer to all the drawings to be produced has then become one of the important criteria for evaluating the level of an architectural design institute by the Ministry of Chinese Construction. At the same time 3D models and images of the building built and rendered with software are also produced by some engineers and excite the architects' interests in CAAD applications. Clearly it is a good time to teach the students, future's architects, the CAAD. The College of Architecture and Urban Planning, TJU, bought forty 386/486 PCs in 1994. The CAAD teaching at TJU is carried well since then.

2.0 CURRENT STATUS

As we stated above, until 1994 the teaching mode of CAAD at TJU was not experimental. Now each student takes the CAAD program at two levels or stages: fundamental in third academic year and applied in fourth or fifth year.

2.1 CAAD Fundamental Course

This course will take one semester and is scheduled to be introduced in the computer room. It is designed to aim at three purposes:

- To make the students understand the basic concepts and features of interactive computer graphics and know the primary procedure of CAD application by introducing the modes of human-machine graphic interactions and information feedback in one of the typical interactive CAD software, AutoCAD.

- By transforming and composing some simple objects into complex ones with such operations as copy, array and mirror, etc., the students will know the advantages of computer aided design and drafting.

- The students will learn how to use 2D and 3D drawing and editing functions in CAD software and how to use CAD to create a building model after they are asked to complete two exercises by using computer graphics. One is to draw a floor plan and another is to build a model of single building, such as a house, multi-story or high-story building, etc.

In the class we ask the students to keep the followings instructions in their mind when they use CAD in architectural modeling:

- The way or mode of organizing the related entities has effects on the modeling, object management and rendering;

- The different strategy for simplifying and constructing a model by using line, facet and solid entities has effects on modeling efficiency and performance in hidden-line or surface removal and rendering;

- Data formats of the model and convertibility of data in one CAD system have effects on the design process in a team or design communications;

- The complex objects, such as vehicle, person, tree and light, etc., have effects on CAAD and urban design.

The students do probably not well understand the exact meanings of the above points only through this course and they are not forced to follow these rules in their exercises. They will know that in the applied CAAD course.

2.2 Applied CAAD Course

The Applied CAAD Course is implemented in the course, "Course Design," or during the period, "Graduate Design." So it is in fact a part of Course Design or Graduate Design.

At the stage of course design or graduate design, usually, every 3 to 5 students is grouped into one group. Each group is asked to complete a design schema based on a real project that is either architecture or urban design. The schema is first completed manually and the model is then required to be built and rendered with CAAD. In this case the model is first divided into several parts upon the number of students in a group. Each student is responsible for build a part of model for himself, the parts are combined into the model after they are finished. The perspective view or rendering image is finally obtained.

At this stage we ask the students must take the factors stated in CAAD Fundamental Course into account so that they can match and behave well each other, improve the quality of the model they built and make the processing more effective. This is a course of comprehensive and practical application of CAAD in drawing, design, modeling and rendering. The students' ability to use CAAD and knowledge about the features and characteristics of CAD after the fundamental course is tested and further improved through this course.

FUTURE TRENDS

The computer technology today is one of the most rapidly developed science areas in the world. The time for upgrade of computers is even measured by month. The performance of computer is enhancing and its price is decreasing remarkably. It can be expected that the line of distinction or difference between the PC and computer workstation will disappear or be blurred in the new future. What previously can only work on workstation will be able to do on PC now or soon. Furthermore, the advance in and applications of multi-media and networking, particularly the spread of Internet in China will certainly influence, even though not yet at TJU, the contents and modes of CAAD teaching and research. At least the followings should be included additionally:

- The concept of 4D (3D object space plus the 4th dimension-time) and its functions in CAD, and realistic rendering, computer animation and walk-through view in CAAD can be introduced in detail because of the available of powerful graphic functions on PC.
- Digital design media, including graphics, image, video and sound.
- Design considerations on network, remote design communication and collaborative design.

Finally, if a group of available tools and CAAD resource, lessons or libraries can be carefully designed, organized and built separately by computer and architecture professionals over the world, who are interested in collaborative teaching and research

work on CAAD and on Internet. The new mode of CAAD teaching, "computer aided instruction (CAI) for CAAD" or "computer aided CAAD instruction", is also feasible via Internet. This is the most desirable and exciting image for our future CAAD teaching.

CONCLUSION

In this paper the past review, existing status and future image of CAAD research and teaching at TJU are discussed. It can be seen from the discussion that any notable changes and advances in CAAD activities are actually natural results from the advance in computer technology.