DISCOVERY OF HISTORICAL TAINAN: A DIGITAL APPROACH

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Abstract. This paper depicts the use of computers in the urban studies, and provides a digital way of understanding historical buildings. "Discovery of Historical Tainan" is a joint project among historians and CAD researchers to use a digital approach to preserve historical evidences of the central city of Tainan. The importance of historical scenes is revealed by the efforts of integration with digital information and models. Furthermore, the level of abstraction and accuracy in the large-scale urban models are examined. The result demonstrates that the ability of foreseeing the future changes can be enhanced by the digital approach.

1. Introduction

Visual simulation is used for architectural design and urban planning for a long period of time. Recently, the use of computers in visual simulation for experiencing spaces or evaluating the quality of spaces becomes easier. It is more economic to use computers than the physical model for simulation, and it is helpful to understand the interactions among environmental experience, attributes and characters. Meanwhile, urban models provide planners and people a visual communication tool, which can help better understanding of the characters of urban landscape and urban design procedures, and also the future development. Furthermore, ancient cities or ruins are also explored through computer simulation for examining historical evidences [Bourdakis 1997, Chiu 1995, Heng 1995]

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Tainan" is a joint project among historians and CAD researchers which uses a digital approach to preserve historical evidences of the central city of Tainan. Therefore, the goal is to build a digital urban model and scenes, which can be used for historical and urban studies.

The city of Tainan is a historical city in Taiwan. Its unique urban spaces are closely related with it cultural and geographic characters. During the last three hundred years, the city is slowly transformed, and Tainan is quickly losing its urban contexts because of man-made changes such as demolish of landmarks, new infrastructures, and the relocation of local government offices to newly developed areas. From the urban development and historical point of views, records of the change of urban spaces will help better understanding the past and predicting the future development. Meanwhile, how to represent a city of collective artifacts, memory, and experience by computer simulation is not just a technological problem, is also an urban study problem.

K. Lynch (1959) indicates that three factors contribute to the image of the city: the identity, the structure, and the meaning. We are also imposing similar questions for ourselves in terms of the subjects of modeling, the process of modeling, and the rationale of modeling. Therefore, the discussion of the rationale, the process of modeling, issues in modeling, and the demonstration will be addressed in the following sections.

2. The Rationale of Modeling

While a major part of this study is accomplished by computer modeling and simulation to reveal the importance of historical scenes, we spent more time to convince ourselves and historians to make the shift from traditional approach of urban studies to a digital approach. A dialogue between the architectural historian and CAD researchers was raised with a series of questions such as:

What can we do about computer for studying historical buildings?
Why do we need to visualize the precedent or artifacts?
What can we know about the precedent from computer simulation?
Is that worth to study architectural history by the computational tools?

The above questions provide the impetus for our thinking about the rationale of modeling. Historians search for the evidence as well as the facts and new views. Therefore, historians as well as designers handle a large volume of information for their daily work. CAD can be used as a tool in discovering as well as recording the facts and views. Ancient people carved the artifacts in stone, now we are shaping the artifacts by bits with the help of computers.

Indeed, an image is worth more than a thousand words. People receive a strong perception from computer images, such as these generated from full-color rendered images. The lesson learning from architectural history is to validate the possibility of new views or theories. Computers provide a reconfigured eye for historians to examine the created digital world (Mitchell 1992). So far,

computer simulation is more efficient than any other means for collecting and representing digital information.

In the past five years, we continuously inquired the above questions and had used computers for the following reasons:

a. A recorder - We start to build a collection of text, graphs, images, and maps regarding the historical buildings and related literature, which can be useful for architectural historical studies.
b. An organizer - We intend to classify the collected materials as mentioned by chronological or locational orders for historical study, preservation, and computer simulation purposes.
c. An analytic tool - We study the urban patterns with digital maps and models, and evaluate the feasibility of proposed new projects.
d. A teaching tutor - We have built a multimedia database for teaching historical buildings varied from traditional Chinese architecture to colonial buildings.
e. A virtual preservation method - We start to use the collected digital architecture for preserving and renovating historical treasures. Meanwhile, the virtual reality technology is used to experience the virtual space.
f. A metaphor - We compare the perception of virtual spaces vs. physical space, and study the meaning of digital architecture.

This study is undertaken to pursue the following issues: (1) to establish a 3D model of the central city of Tainan, (2) to study the issues in modeling, and (3) to study the effectiveness of observation from the model.

3. The Process of Modeling

A top-down process is used for modeling from the district level, buildings, to details. We start to collect related references such as maps, literatures, and photos to build a visual platform for urban design and historical study. The integration with digital maps of the city provides the foundation of modeling. However, the process of modeling is more than just creating a digital model. Meanwhile, data management is also important to a collaborative project. The provision of information up-to-date in the net becomes an unavoidable step.

3.1. A DIGITAL APPROACH

Figure 1 demonstrates various approaches and tools for transforming the verbal or visual description of artifacts to digital data representation. From an observer point of view, the major concern is whether the data representation can clearly deliver the actual meaning of artifacts. It is critical to choose an appropriate way to represent the characters and attributes of artifacts. While various tools are reported in use, tools like photogrammetry, 3D digitizer, or virtual reality has its

limitations (Chiu 1997). Particularly, the high-end equipment is more expensive to operate and maintain. The justification lies in the quality and the economics for modeling and simulation.

We then decide to adopt various tools at the same time based on the flexibility of data transfers and the availability of data. We clearly see the advantages of using the digital approach to simulate artifacts. Therefore, all materials have to be converted into digital formats. Raster-based and vector-based files are compliment to each other. 2D data, which are essential to presentation, are still largely used and can be converted into 3D data for further studies.

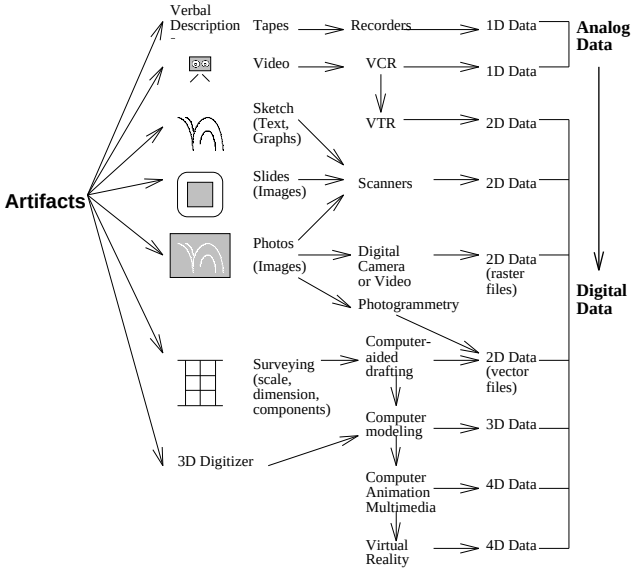

Figure 1. The approaches for representing artifacts

3.2. THE SITE

The realm of the Confucius culture district is shown in Figure 2. The Confucius temple and the old city hall are the core of the district. The boundary of the site is defined by applying the concept of layering in CAD drafting, and is subject to many aspects of layers such as nodes, path, districts, landmarks, and open spaces. Figure 3 also demonstrates the site simulated in 3D. The distribution of historical buildings is the primary factor defining the boundary of the district. Within a three-kilometer diameter range, thirty historical buildings are studied in-depth and indexed. The planned historical route for travelers will become the path that links the traffic nodes and future renovation projects.

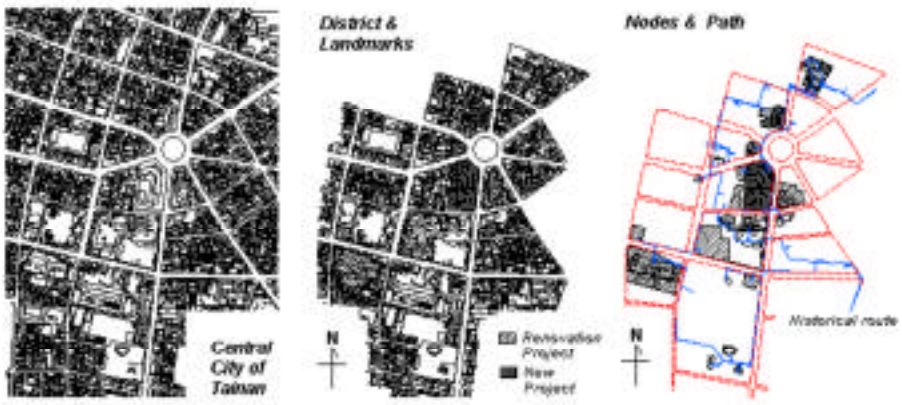

Figure 2. The site simulated

Figure 3. The 3D model of the Confucius cultural district

3.3. DATA MANAGEMENT

In this project, the working group consists of experts from multi-disciplines such as historical preservation, urban design, landscape architecture, traffic management, and CAD. Data management is critical for a collaborative project which all participants need to access the basic information. A visual database is created in the World Wide Web at http://www.arch.ncku.edu.tw/project/confu/ for demonstrating the current status of project work. The web becomes a repository of this project. Data organization is determined in according with the working status and the purpose of uses.

4. Issues in Modeling

Radford et.al. (1997) indicate that issues of abstraction, accuracy, and realism in large-scale computer urban models are critical to its performance. During the modeling process, these issues are also raised in our study. From the historical point of view, it is also critical to know how to represent urban contexts and building details in the past, current, or the future. Time span is added to the fourth dimension of modeling.

4.1. THE LEVEL OF ABSTRACTION

The determination of the level of abstraction is generally based upon the scale and volume of artifacts, and consequently it will affect the computational performance and visual quality. Tables 1 demonstrates that five modes of modeling are used in the study, and the result is shown in Figure 4. The conceptual mode is the simplest mode that the prototype of artifacts is used to represent the reality. It is often used in large-scale models as shown in Figure 3, and the openings such as doors and windows are typically ignored in modeling. On the contrary, the real mode is to model the reality as close as possible, and it has greater level of details and larger number of polygons. In the study, the level of abstraction or details is determined and assigned to each artifact according to the importance of buildings and the complexity of geometry.

TABLE 1. Five modes of modeling

Mode	Level of abstraction
1. Conceptual mode	Prototype (without openings) + (color)
2. Articulated mode	Articulated massing (without openings) +(color)
3. Imagery mode	Articulated massing + texture mapping (openings)
4. Photo reality mode	Articulated massing + details + texture (openings)
5. Real mode	Massing + openings + details + full texture mapping

Figure 4. Comparison of the result of five modes of modeling

A preliminary test is performed to examine the difference of visual quality and computational performance. The last four modes are tested on the basis of using computer hardware with a Pentium 166MHz CPU, and 128MB RAM installed, and the software 3DS MAX. The models are tested with the same light source (one spotlight + two omni-light). To achieve the similar visual perception as the other modes, the articulated mode is enhanced by adding textual mapping

generated from the real mode. Table 2 compares the visual perception of these four modes and found that are all acceptable while the shading effects in four modes are different and can only be distinguished at the close distance.

TABLE 2. Comparison of the results of rendering

1. Articulated mode 	2. Imagery mode 
3. Photo reality mode 	4. Real mode 

However, the computational performance of four modes is different due to the geometry. The rendering time is changed from 20 seconds to 3 hours because the number of faces or polygons is dramatically increased. Figure 5 demonstrates the computation time is increasing slower than the growth of the number of faces. Nevertheless, the articulated mode (1) or the imagery mode (2) is still suitable in large-scale urban models or the VR environment, and the photo reality mode (3) or the real mode (4) is suitable for small-scale buildings.

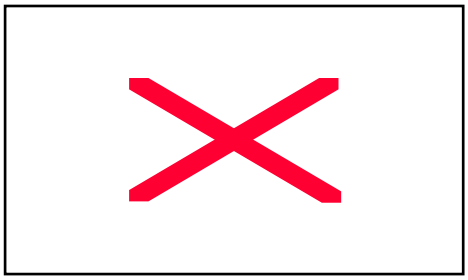

Figure 5. Comparison of the performance

4.2. ACCURACY

Buildings are the major artifacts of the model. In order to simulate the impression of a view, accuracy of the location, geometry, color, and textures of buildings are important for our understanding of the past, existing and future environments. Besides buildings, their surroundings such as road, plants, and street furniture can enhance the realism of visual perception. However, some

artifacts are necessary to maintain the abstraction of geometry or form. For example, a fifty-year-old banyan tree may have one million leaves, and it is necessary to reduce the number of polygons to a managed level.

4.3. ARTIFACTS CHANGED OVER TIME

The timing of the artifacts is critical to historical study. Because buildings are changed during the time, it is also important to know the status of modeling. Figure 6 illustrates that several changes of the city occurred from 1874 to 1997. For example, Figure 7 illustrates that three phases (year 1916, 1996, 2000) of the old city hall are slightly different in roof structure due to renovation. Then we have to maintain a profile of each major artifact with several models. Similarly, infrastructures such as roads may be changed, then the model need to maintain the flexibility of modification.

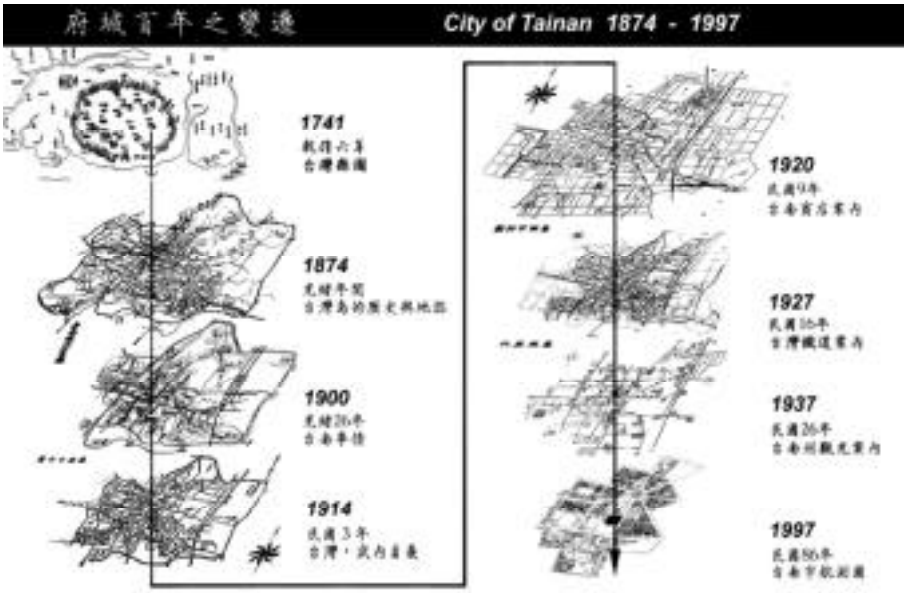

Figure 6. The appearance of old city hall in different period

Figure 7. The appearance of old city hall in different phases

5. Simulation

5.1. PURPOSES OF SIMULATION

Chiu (1997) indicates the influence of computer simulation technologies on the built environment, and why designers want to transform the reality into virtual reality. This study proposes several projects of reusing historical buildings in order to revitalize the area. Therefore, the purpose of simulation is to study the prospective projects. As shown in Figure 8, the urban model is used as the foundation to study the past and future changes. For example, the old city hall will become the national heritage conservation center, and the old courthouse is planned to be an art museum.

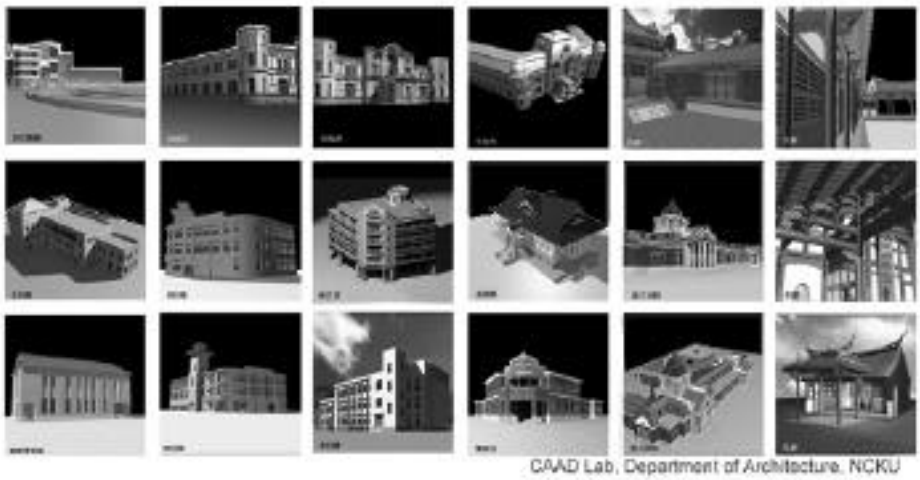

Figure 8. The projects simulated

5.2. OBSERVATION

It is also important to understand how to observe the characters of urban space from the digital model, and how to access the model by people to understand the urban issues and problems. We first examine the model based on K. Lynch's notions on the elements of urban image such as paths, edges, districts, nodes, and landmarks (Lynch 1959). Planners and people are invited for evaluating the digital model from the street level and the air. A multimedia-based presentation creates better visual perception then the physical model. However, the freedom of observation is critical to viewers. A simplified virtual reality model is planned to implement on the web in the future.

6. Conclusion

The lesson learning from the above exploration and implementation of using

CAD proofs to be a feasible way for historical and urban studies. Computer provides a vivid crystal ball for historians to examine the created digital world. Indeed, computer simulation becomes affordable and an efficient approach for architectural studies. In conclusion, this paper provides a digital way to understand the historical buildings, and various examples are demonstrated for highlight the above points. From the research aspects, the level of abstraction and accuracy in the large-scale urban models are examined. This study demonstrates that to extend the usefulness of CAD beyond the computational theories is critical for future CAD research. CAD users also play an important role in CAD research by providing directions and reflections.

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