Architectural Education: Students Creating a City Model

Wolfgang Dokonal, Graz University of Technology, Austria

Bob Martens, Vienna University of Technology, Austria

Reinhard Plösch, Graz University of Technology, Austria

Abstract

This paper describes experiences with the creation of a 3-D City Model at our University of Technology. It presents an innovative approach in establishing a city model with the support of the students in the study fields of Architecture and Surveying. The main goal of this work is directed at the implementation within the framework of architectural education. This contribution presents the concept in detail. It also discusses matters concerning the level of detail for different uses of such a 3-D model.

Keywords: Urban Modeling, 3-D Modeling, Architectural Education, Collaboration

1 Introduction

The idea for the creation of a 3-D city model resulted from the situation that innumerable design and urban projects were modeled individually at the Faculty of Architecture in the past, focusing on various parts of the City. All these computer-based models were created for several purposes and accidentally in different ways. Unfortunately, re-using these models for other projects was not possible and in the course of the time several parts of the city were modeled again and again. However, this work improved the skills of the students basically in computer modeling, but did not deliver any further benefits or any added values for the faculty or the city.

2 Objectives

The starting point of the procedure for the creation of a 3-D city model is the potential contribution by a large number of students. By means of bundling and coordinating all efforts in city modeling a perspective for collecting and assembling all the entire parts of the city modeled in the framework of different study courses is developed. Moreover, a sharing and re-using within the framework of the curriculum is intended. The main data source for this model is the photogrammetrical evaluation of aerial pictures supplied by the Department of Survey. This is a reliable source for larger areas in the city, as the digital cadastral map proved to be not sufficiently accurate. For small parts of the city also data from the terrestrial survey are available. The efforts behind this project are generally coordinated with the Faculty of Geometry. The photogrammetrical evaluation of aerial pictures provides data about the configuration of building roofs (eaves and ridges), but not about the exterior walls. For this reason a site analysis is necessary to check e.g. the distance between eaves and the exterior walls and also important detailing elements concerning the façade. However, there remains a certain difference towards the accuracy of the terrestrial survey and estimation. The 3-D city model is based on models of individual buildings within the city. For every building an AutoCAD-drawing is produced by using 3-D polylines. After conversion into 3-D faces, there is still a possibility of changing the model of every individual building.

3 Working Principles and Ideas regarding Realization

Comprehensive data on the existing buildings are to be compiled, to be processed for further analyses and to be made available for simulations of constructional approaches and planning by digital

systems. The required data are recorded gradually and furnished to the data base management system. The governing data principles are to be defined unambiguously and are to allow for tracing back in order to grant usefulness. The data once recorded thus can be supplemented and analyzed and lend themselves to numerous uses. As data gathering is patchwork delivered by different individuals, the pertaining defined guidelines are to be carefully observed. Therefore, any information to be added to the 3-D city model is for this reason recorded on a data sheet. This makes for tracing back and controlling the input of the data afterwards; concerning more accuracy this information can be reviewed. Building data are entered into the database at varying "LoDs" (level of detail), depending on availability of basic data. The first LoD contains photogrammetrically evaluated aerial views as AutoCAD file *.dwg- and/or *.dxf-format. Thus the roofscape is determined to a large degree by the horizontal projection and the altitude development. An in-situ picture, however, will prove indispensable in order to correct any possible mistakes of aerial evaluations and moreover, to determine the location of facade surfaces with respect to the roof outline (estimation). Based on these data the girding surfaces for every individual building are constructed in AutoCAD and stored as *.dwg- and/or as *.dxf file.

The second LoD deals with the additional information derived from evaluation of aerial pictures (e.g. dormers of roofs, chimneys, etc.) in an individual file. So required it is linked to the basic model. Links to the next, the third LoD make for information on space-defining elements recorded in in-situ pictures of the facades (e.g. balconies, bays, etc.). Insofar as detailed models are available due to terrestrial surveying and detail planning, resp., these are added to the database as the fourth LoD. If required these are used instead of the basic model and the other LoDs.

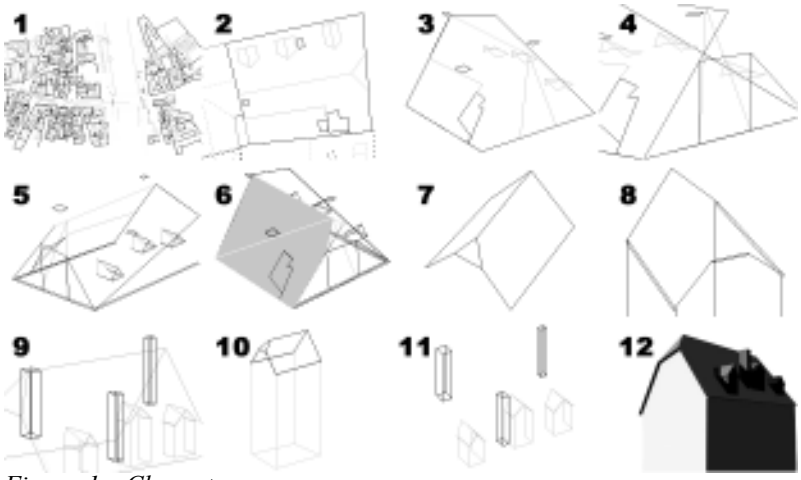

Figure 1. Characteristic steps within the working procedure [1) Basic data of the area evaluated; 2) Basic data of the building to be covered; 3) 3D-view of the basic data - shows obvious mistakes at the gable end and dormers of roof; 4) 5) subsidiary line constructions; 6) construction of a roof area; 7) main roof areas; 8) facade areas; 9) main roof and detail elements; 10) exported basic model; 11) exported detail level-1 model; 12) shadowed 3D-model.

4 Preparation of Data Records and Management System Thereof

A detailed documentation sheet on every individual building, as pointed out above, is kept up-to-date stating clearly data source, any mistakes regarding basic data, data corrections, etc. This documentation represents an essential component of the data records, as any missing description would make the data obtained useless for the database, as the data source (and thus its correctness) could not be definitely traced back at a later stage. Thus the word-document template "digcity.dot" was developed, making for storage of each individual building according to name of street house number. The geometry data are stored in the various file formats (*.obj., *dxf and *.3ds). Presently, data management puts a file-system with hierarchic directory-structure to use, access via various levels: street name, house number and type of file. A Perl-script is used to this end. In future a GIS-system is to be implemented for this purpose.

5 Findings and Outlook

Most of the existing city models are built as a 3-D city information system for public consultation or planners. The main goal of the creation of this 3-D model is to establish improved resources for architectural education - both on level of urban design as well as (architectural) project design - by using the potential of a "mass university" on a low budget. Other schools of architecture might benefit from this experience. As an educational approach, the experience can be the starting point for future studies.

The actual state is as follows: approx. 300 buildings have been covered according to above guidelines. Time consumption per premise amounts to approx. 10 buildings per student within roughly 2 days. Due to his experience the same person would cover further 10 buildings within only one working day. Subsequent treatment follows thereafter, mainly consisting of checking for completeness and correctness of the data records furnished. Based on the total building stock in the city area approx. 26.000 will have to be covered. Determining preferential treatment will prove wise, particularly concentrating on the downtown area. Quadruplicating the existing building inventory, a representative basic stock of approx. 1.000 buildings could be registered. Intended building activities would require innumerous documents by the authorities, thus submitting a specific (corresponding) 3-D data model would also be handy.

Though commissioning an outside provider with the production thereof would seem meaningful, this paper focuses on production delivered by students. The expansion of the city model presently is linked to several study courses thus granting different degrees of motivation on behalf of the students due to the different "usefulness" of the model products within the framework of the specific study course.

Motivation of the students proves sometimes difficult and "drop-outs" leave us with "white spots" (unfinished geometries) in our city model. In order to minimize this rate the study course for this project is be turned into a studio workshop making for more efficient continuous control of the process and immediate troubleshooting. The creation of the required basic geometry (sometimes a bit tedious for the students) is to result quicker by supplying a basic 3D Geometry for the buildings they are working on. The aim is to produce a "rough" model automatically by the photogrammetrical evaluation of aerial pictures. This project is being performed by one of our students - who is also a professional programmer - as a joint project with the Department of Survey of the Graz municipality and first results should be available by the beginning of the next semester. All these adjustments to our project will positively increase the speed of the "growth" and the quality of the city model by allowing the students to concentrate on the main aspects. The main goal of this project remains the process of creation of the model itself, as utilization of the city model can be a very helpful and important tool in architectural education.

Figure 2. The "rough" model and an example of the application in the framework of a project (a) sectional inventory photograph/ (b.-c) 3D-model with facade mapping / (d) computer-assisted simulation of renovation.

References

http://www.digcity.tu-graz.ac.at contains a more detailed description concerning the guidelines resp. working procedure. A careful explanation of techniques is furthermore presented there.

http://xarch.tu-graz.ac.at, is the experimental web server of our students which contains a big autocad supply page by Reinhard Urban

http://vrglasgow.co.uk, which contains a City model of Glasgow, which was modeled by a group of students at the University of Strathclyde under the direction of Tom Maver.

Dokonal, W., Martens, B. and Plösch, R. Graz: The creation of a 3D City Model for Architectural Education. In: ECAADE 18 [Proceedings of The 18th Conference on Education in Computer Aided Architectural Design Research in Europe], Weimar (Germany) 22.-24. June 2000, pp.171-175.

Day, Alan K. and Radford, Anthony D. Imaging Change: The Computer City Model as a Laboratory for Urban Design Research. In: Sixth International Conference on Computer-Aided Architectural Design Futures, Singapore, 24-26 September 1995, pp. 495-506.

Kaga, A., Shimazu, Y., Yamauchi, T., Ishihara, H. and Sasada, T. City Information Visualizer Using 3-D Model and Computer Graphics. In: CAADRIA '98 [Proceedings of The Third Conference on Computer Aided Architectural Design Research in Asia], Osaka (Japan) 22-24 April 1998, pp. 193-202.

Radford, A., Woodbury, R., Braithwaite, G., Kirkby, S., Sweeting, R. and Huang, E. Issues of Abstraction, Accuracy and Realism in Large Scale Computer Urban Models. In: CAAD Futures 1997 [Conference Proceedings], München (Germany), 4.-6. August 1997, pp. 671-690.