An Urbanistic Design Tool

Dr. D. Chitchian[1, 2], Prof. Dr. H. Bekkering[1]

[1]Delft University of Technology
[2]Iran University of Science and Technology

Abstract

The existing CAD and CAAD programs and design applications hardly support the urbanistic design activities. Although those applications are useful means to be utilized generally in design tasks, they are not suitable tools as urbanism community needs. Most existing CAD programs are based on the architectural design process and therefore not suitable for urbanistic design. The conceptual difference between architecture and urbanism necessitates developing new CAD software based on the urbanistic design process. We believe that our developed Urban-CAD system assists designers with urbanistic design activities and overcomes the limitations of the already existing CAD applications.

1 Introduction

Many CAD and CAAD programs and design applications exist to assist designers with architectural and urbanistic design activities. Most CAD programs are based on an architectural design process, so the masses or walls of a building are defined according to the heartlines of the construction. Therefore the space results from the design process. But in an urbanistic design process designers start defining the space according to the heartlines of the streets and the masses (building block) are created in the remaining defined space. With respect to the limitations of the existing CAD programs we have been working on a research project to develop a CAD program that will assist the urbanistic designers with their design process.

The chosen scaling method allows designers to work on their designs at various scales or abstraction levels. This permits the designer, when working at a specific scale, to manipulate only those design objects that are associated with that scale. The profile designer tool of the Urban-CAD allows designers to create sub-elements of a street, such as a green-part or a pedestrian-part, without drawing those parts in the design file. Manipulating and modifying those parts of a street will be achieved using the provided menus in this tool without changing the design file.

The current version of the Urban-CAD has been developed using an advanced CAD tool, MicroStation SE from Bentley Systems (Chitchian, Sauren and Heeling 2001). Our Urban-CAD design tool, sustaining the aforementioned capabilities, provides the designers with comprehensive information, and it fully supports the urbanistic design process.

2 The Urban-CAD System

The Urban-CAD system consists of several components, each of which carries a different aspect of the urban design process. This paper describes these components, their features, and the functions that they achieve.

2.1 The Architecture

The architecture of the Urban-CAD system is depicted in figure 1. The system, consisting of four

components, provides a complete and integrated environment for designing or re-structuring an urban space. The well-known and advanced CAD tool, MicroStation from Bentley Systems, has been used. Some utilities and functionalities have been added to it to support the urban design process.

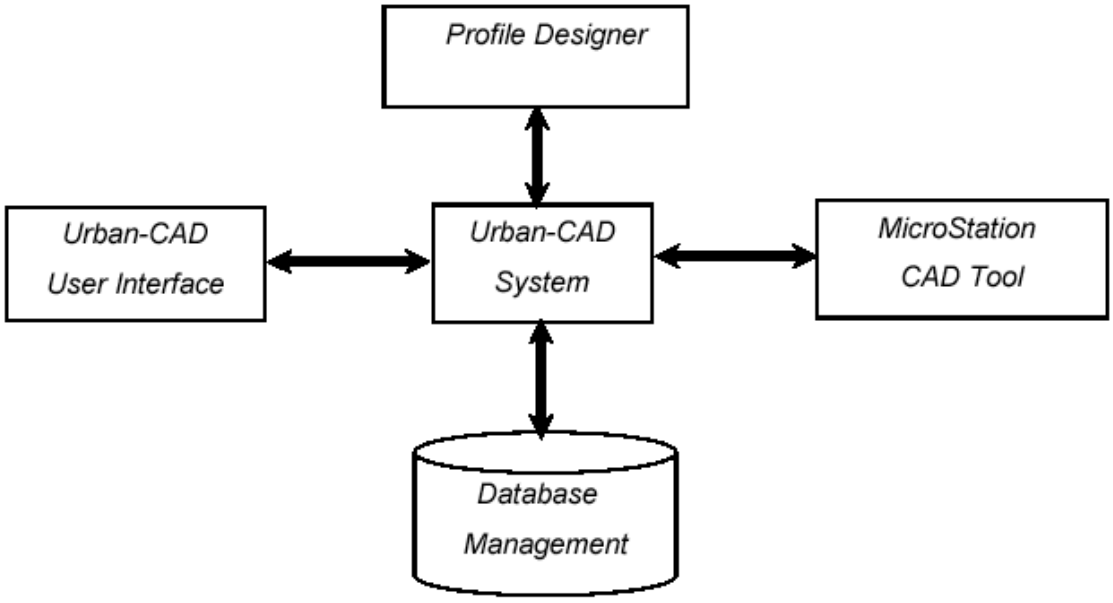

Figure 1. The structure of the Urban-CAD System

2.2 The Profile Designer

Designing the streets and their profiles in an urban space is one of the main tasks of an urban designer. Usually a street consists of some parts or sections with different functions. For instance, a part that is used by vehicles also in some countries includes a separate part that is used only by cyclists. Pedestrians also use a specific part of a street. Green parts, tram/train or bus lines, and canals or rivers may be other parts of a street. In the existing CAD programs, designers must draw or design these parts separately.

The Urban-CAD system has a specific component called the profile designer that eases designing streets' profiles. In fact, designers don't design or draw parts of a street at all while they work on an urban space. Instead, they perform this task using a graphical environment in a drag and drop manner. The graphical profile designer environment is shown in figure 2.

The Urban-CAD profile designer interface consists of four sections. The right section shows a tree view of the existing profiles in the system. A plus sign beside the profile name shows that profile has some parts. Clicking on the profile name will display those parts. (see parts of profile3 shown in the figure). There is a panel at the top of the interface containing six icons; each icon stands for a certain part. These six parts are: car, green, pedestrian, water/canal, cyclist, and tram/train/bus line. At the middle of the interface the chosen profile is displayed.

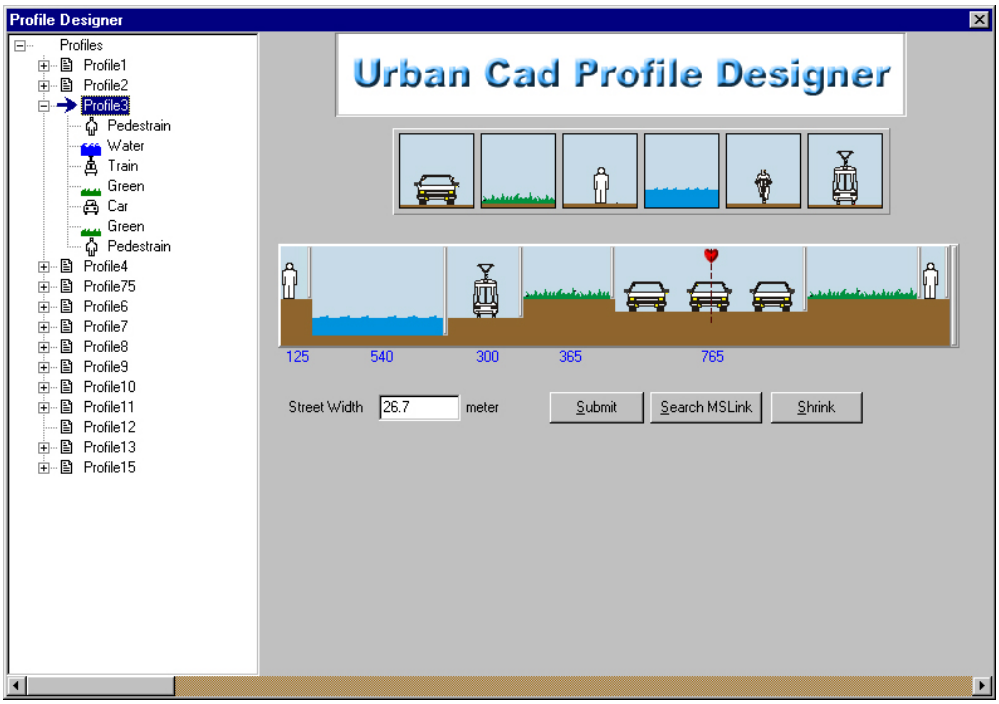

Figure 2. The Urban-CAD Profile Designer.

Each button at the bottom of the profile designer interface performs a certain task, for instance, when a profile has been changed, clicking the submit button saves the changes. Also the shrink button fits the profile to the total size of its parts. The street width text box shows the total with of the corresponding profile.

A small horizontal handler is attached to the right side of any part in the profile. You can hold down the left mouse button on any handler and slide to the right or left to increase or decrease the size of that part. Also you can use the handler displayed at the end of the profile to resize the whole profile. You may do this by entering a certain value in the street width text box and then press the enter button on the keyboard.

2.3 The User Interface

An interface exists in most computer programs or applications for usres to interact with the programs. The user interface of the Urban-CAD, the main interface of the system is shown in figure 3. This user interface is much similar to that of the MicroStation CAD tool. However, we have added extra functionality to it to support the urbanistic design activities. Facilities like *Topography, Lines, Areas, Junctions* and *DBTools* are added to the menu items of the user interface.

Each added item to the menu bar includes specific functions and utilities associated with that item. Clicking on those items causes a window containing some options to pop up. Each option performs a certain task. For instance, the *Lines* menu item includes: *split line, merge line, reverse line, attach line* and *identify line* functions.

2.4 Database Repository

In any CAD program, each graphical element on a design file has a lot of information. Such information has been stored in a certain structure and attached to that element. This way of storing information within the graphical elements make the design's file size very large. To retrieve information from an element, the structure associated with that element must be used to extract the required information.

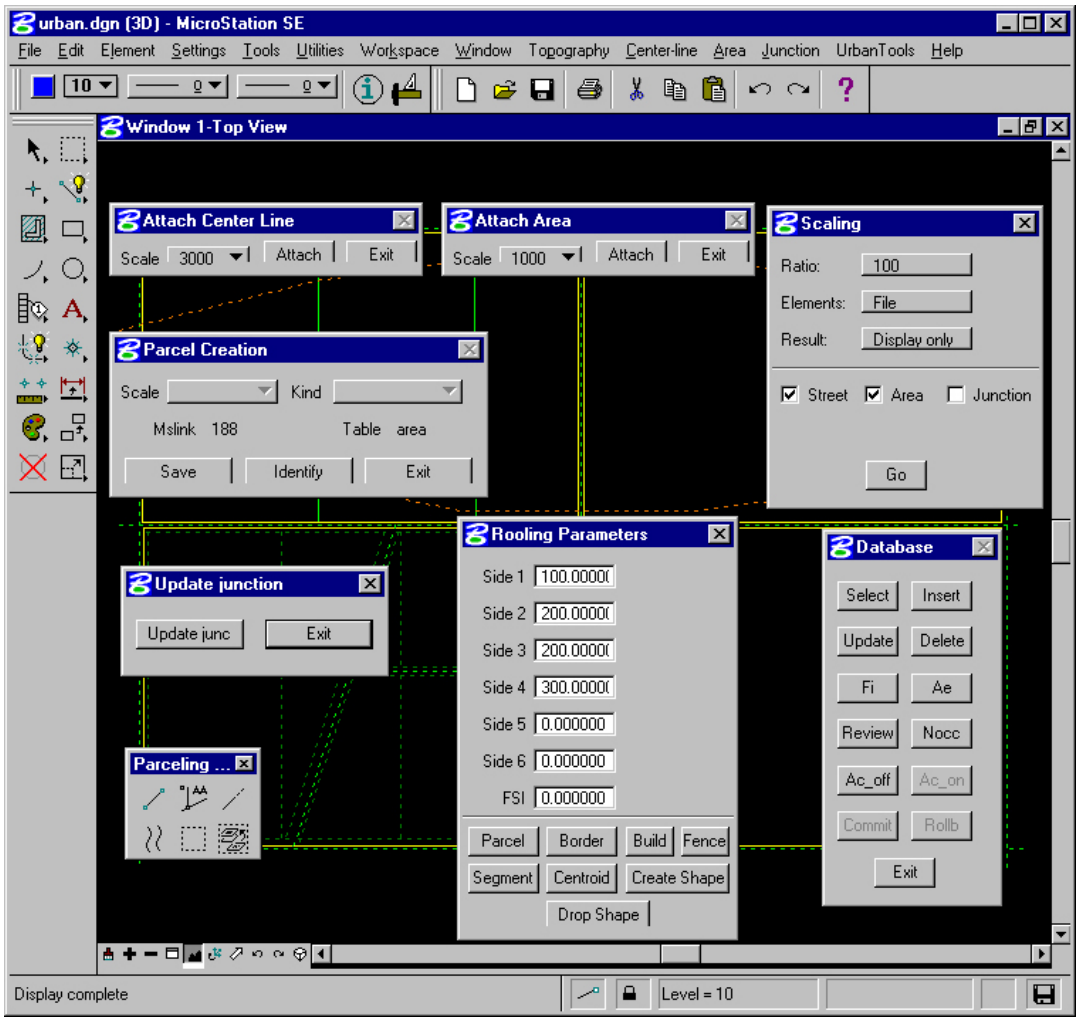

Figure 3. The user interface of the Urban-CAD system

To keep the design file small and to retrieve the graphical element's information easily, a database repository has been included in the Urban-CAD system. In this repository we store the information associated with the elements or objects of an urban space. Using a database as an information repository not only has the aforementioned advantages, but it also helps to keep all information in the system in one place. Also, other programs such as GIS systems can use this database system.

3 The Features of the Urban-CAD System

The Urban-CAD system has been developed as an extension of the MicroStation CAD tool. Therefore, the user can access all utilities and functions that the MicroStation CAD offers. Besides this, our Urban-CAD system offers some new and interesting features to the users. The most important and useful features are: the storing and retrieving information mechanism, the scaling methods, and displaying and viewing of the urban space objects. Supporting the Urban-CAD system with such features provides an integrated environment to help urban designers in their design tasks. These features are explained in this section.

3.1 Manipulating the objects

An urban space consists of many related objects. These objects may contain particular elements which can be seen differently at a detailed or an abstracted viewing level. Three different objects exist in the Urban-CAD system. They are: *streets, areas* and *junctions* (or intersections). The first two objects consist of several other elements or parts. These elements are not drawn or designed in the Urban-CAD system as stand-alone objects. Rather, the system stores descriptive information in the database that represents the object's elements. Therefore, designers only draw the main objects, and their composing elements or sub-objects are defined as information the associated with those objects in another environment.

Street objects might have other elements such as a *green-part, a pedestrian-part,* and *a bus-part*. These parts might contain sub-elements such as *trees, lighting, bus stops*. Although a street is not a single object, in the Urban-CAD system it is drawn as a simple line (representing the heartline of the street) in the design file, and its elements will be defined using the profile designer of the system and stored in the system as the associated information with that street. When the users view that street on the screen, the system automatically displays its elements on the fly using the stored information in the database.

An area can have some elements such as a *green area, public* or *private areas, and a residential* or *industrial area*. An area in our system is drawn as a simple shape, but its associated information such as its type and height are defined and stored in the database. It is the responsibility of the system to find the associated information with an area while it displays that area. The system can display the sub-objects of an area as well.

Junctions also considered as individual objects in the Urban-CAD system. So the information associated with a junction is kept separately. Designers do not draw or design any junction directly in the Urban-CAD system. The system finds the junctions and their associated information and stores them in the database. When there are some changes in the existing streets in the design file, such as deleting a street or shifting some streets, the system updates the junction information automatically.

3.2 Scaling mechanism

Almost any CAD application provides a certain mechanism to manipulate graphic objects differently with respect to the viewing points. Designers use some means such as *levels* or *layers* to reduce (generalize) the amount of information or refine (specialize) it in a design file. A design file containing graphic objects can be as detailed or abstracted as the designers want. Therefore, designers have to turn on or off some 'layers' to focus or work only on the right information. This takes a lot of time and slows the design process.

Usually an urban designer focuses on many different scales, from defining the pedestrian pavement to making plans on a national and even international level; he/she often works on different scales at the same time. One of the main features of the Urban-CAD is to show the designers the right information at the right moment in the design process. Whether an object of the design file is displayed on the computer screen depends on the scale the designer is working at. For instance, a street at the scale of the whole city can be shown as a single line. But at the scale of a neighborhood, that street will be shown as a strip with a certain width containing different parts such as car, bike, and pedestrian.

The predefined scales in our system are based on the research done by Prof.dr.ir. T.M. De Jong of the faculty of the Architecture department at Delft University of Technology. In his work (De Jong 1995) he explains the relation between the scale and the perception of information. The mathematical relation between a certain scale and the objects seen at any scale has been discussed too. So we considered six different scales of observation: 1:10000, 1:3000, 1:1000, 1:300, 1:100 and 1:30.

Main objects, *streets* or *areas*, in the Urban-CAD must belong to one of the six predefined scales. To manipulate objects, designers use the scaling dialog window depicted in figure 3. Using this window, a designer selects a certain scale and then chooses viewing options. When the system displays, for instance, at the scale 1:1000, all street objects belonging to this scale and the higher scales (in this case the scales 1:3000 and 1:10000) will be displayed.

3.3 Separation of Information

In most CAD applications, information associated with graphic elements has been stored within those elements in the design file. In doing so, the design file containing a few hundreds of graphic objects becomes huge. Therefore, manipulating such a design file or retrieving attributes of objects from that file takes a long time. In the Urban-CAD system, we separated the graphic element from the information associated with it. The system has its own database to store the related information to any urban object. Having a separate database management system provides flexibility.

As explained before, a street or an area object in an urban space is represented simply in the design file as a line or a polygon element, respectively. The information associated with that street or the area object is stored as descriptive information in the database. Let us say a street has other parts, pedestrian and bike, parallel to the main part. To draw or design these parts using any CAD application, a designer must draw those parts again as lines with certain width and color in the design file, perhaps in other layers or levels. But in the Urban-CAD, the designer doesn't draw those extra parts in the design file at all. Instead, he defines such parts using the profile designer of the system just by filling in some text fields in certain dialog boxes.

Keeping the information associated with an urban space object in a database has a number of advantages. First, in existing CAD applications designers must modify that graphic element in the design file either by deleting or changing it, but in our system they change only the descriptive information stored in the database. Second, because in the Urban-CAD system the graphic objects are simple elements, such as lines and polygons, the resulting design file of an urban space in this system becomes small. Third, the chosen scaling mechanism explained before becomes a feasible task. Therefore, hiding or detailing the information in our system can be done easily. Finally, because we kept some information separately in a database, integrating this database with other applications such as GIS tools, the designers will be able to take the advantages of those tools as well.

4 Conclusion

The inadequacy and limitations of the existing CAD software for urbanistic design process and needs of the urban designers for new software led us to work on a research project to develop a CAD program to overcome the aforementioned drawbacks. To avoid rediscovering the wheel, we started with existing tools. The well known and advanced CAD tool, MicroStation from Bentley Systems, has been used as the main graphical environmentand the Urban-CAD system has been developed on top of it. The profile designer of the system is one of the outstanding modules that helps the designers to design the profiles of the street objects of an urban space in a user friendly and graphical manner. The scaling mechanism of the system is another outstanding feature that is missing in almost all the existing similar applications.

Professor J. Heeling was the initiator of this research work in the faculty of Architecture (Heeling, Meyer and Westrik 1997). The basic goal was the development of a computer application to make the urbanistic design process by computer easier, quicker and more effective. We expect that the students will work with the Urban-CAD software in their education program starting September 2002.

References

Chitchian D., E.G.M. Sauren, and J. Heeling. (2001). Urban-CAD, A Design Application for Urbanism. *Proceedings of the CAAD Futures, the ninth international conference*: 387-399. Eindhoven: Eindhoven University of Technology, Endhoven, the Netherlands.

De Jong, T. M. (1995). *Culturele Variatie.* In technical report, Ecology Technology and Environmental Planning, Delft University of Technology, Architecture Faculty.

Heeling, J., V. Meyer, and J. Westrik. (1997). *The basics of Urbanism in the 21st Century*. In technical report, Blauwe Kamer, Delft University of Technology, Architecture Faculty.