An Electronic Tool for Urban Design Analysis

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Architects and urban designers are increasingly using computers in their attempt to improve decision making in urban design. Most existing systems emphasize hard data such as statistics, land use data, etc. In recent years with the use of more powerful computers we have seen a greater emphasis on managing visual data. Computer systems are being used to generate urban models and simulations of the various kinds of impact new developments have on the existing cityscape.

This project emphasizes the use of visual data. The purpose of the research has been to develop a computer system for urban designers to use in analyzing urban architectural qualities. Therefore this project focuses on applying traditional methods and theories of urban designers rather than developing new computer techniques.

The traditional methods and theories of urban designers fall within the category which the French theorist Francoise Choay calls Pre-urbanism and Urbanism-the Cultural Model.1 Theorists within this category include Camillo Sitte, Gordon Cullen, Kevin Lynch, Leon Krier, Aldo Rossi, Michael Trieb, Roger Tzanck and Thibe-Evensen.

This computer system has been developed as a prototype in order to gain experience and knowledge for future development of a large system. Later development will be based upon a vectorized three-dimensional model of a whole city using texture mapping and tracing techniques to annotate important architectural features.

The computer system consists of the basic analysis module supplied with a simulation unit and a theory unit. With this analytical tool, analysis is conducted on three different urban scales. The prototype has been developed on the Macintosh computer with SuperCard as the authoring tool.

The computer system was developed as a prototype for Danish Urban Designers and is currently being tested in conjunction with the city of Viborg, Denmark (population 55,000). Located in Jutland, Viborg was the capital of Denmark around the year 1000. It now functions as a center for regional government. Viborg was selected as the test site because of its historical core.

The Basic Idea Behind the Development

In order to understand the prototype as a design example it is relevant here to describe the basic idea of the future, larger system from which idea the prototype developed.

Architects traditionally make use of drawings and models when they analyze and illustrate points and present their ideas for new proposals. Similar to using models and drawings the idea of the future large system is to make use of a vectorized 3D model supplied with still photos, drawings, text information, animation techniques and film sequences.

The 3D model is to be developed from digital maps typical of a city in Denmark. The computer generates every house in the city from the map's z coordinate, the urban model will then consist of boxes with no roofs. Knowing that about 90% of all houses in Danish inner city environments has 40-45 degree raised roofs with their gutter lines parallel to the street facade the machine will also generate the roofs of the houses. Monumental buildings as well as other buildings with individual roof constructions are made manually. This gives a rough model of the city.

The local authorities will make orthogonal photos of a number of houses in the town and these photos will be pasted to their respective facades through texture mapping. The final result will be an urban three-dimensional model with photo realistic facades.
in which a high degree of interactivity is possible. The user can virtually move around everywhere and view the model town from chosen vantage points. The system will also generate annotations on the model and the photos.

However this prototype project has not yet been developed as described. The idea behind the prototype illustrates the design ideas. Further research based on the ideas of the prototype will be used in developing the final system.

Aims of System Development

One basic aim has been to base the system development on traditional methods and theories of urban designers. These theories and methods are well known ones used in traditional urban design analysis. A second aim of system development has been to design the interface and the system similarly to how an architect would approach an analysis of an urban problem. And finally the third aim of the system development has been to give the user a high degree of interaction.

Categories of Urban Design Theories

Theorists within the “Cultural Model” include people like Camillo Sitte, Gordon Cullen, Roy Worskett, Kevin Lynch, Jim McCluskey, Leon Krier, Aldo Rossi, Michael Trierb, Roger Trianick, Thiss-Evensen and many more. Common to these theorists is their approach to studying the city in terms of architectural quality and form. They emphasize urban architectural quality. One group puts their main emphasis on the visual qualities of the town e.g. Gordon Cullen, Roy Worskett. Another group emphasizes the mental knowledge of how the town is structured physically, such as Kevin Lynch does. Yet another group emphasizes on the city as art and architecture e.g. Leon Krier, Aldo Rossi, Michael Trierb and Thomas Thiss-Evensen.

Each of these people has presented theories on Urban Design and has also applied these theories in case studies and thus describes methods and techniques used. It is these methods and techniques which have been used in the computer system presented.

Introduction to Visual Analysis of Form

The following is a brief introduction to what is meant by analysis of urban visual form in order to explain the urban design content of the system.

The basic assumption is that form and form quality appear with the same visual characteristics at any scale whether it is city scale, building scale or brick scale. These visual characteristics can be contour, mass, surface, construction etc. Therefore, it is possible to analyze form aspects the same way at any “zoom level” such as city level, urban area level, building level etc.

The visual characteristics of form are: 1) the way form is structured; 2) the way form is related to other form; and 3) the way form is organized. Form expresses itself visually in a dynamic sense or a static sense. Our visual experience of a form may tell us that this particular form looks heavy because the dynamic movement in that form is downward. We experience form as being in movement downwards.

As for the structure of form; this can be geometrical or amorphous, heavy or light, downward or upward in movement, open or closed. Examples of a geometrical structure are a plowed field and the amorphous structure of a forest floor. An urban square, streets and urban areas may be geometrical in form whereas light is amorphous/diffuse. A classical building expresses itself as heavy in contrast to a gothic building. The first is "resting" in character; the second is "rising" in character. A very narrow street with tall walls is visually closed; the square of Place Concorde in Paris is very open in form.

The relationships between forms can be additive, subtractive or overlapping; contrasting or continuous; aggregated or dispersed. An example of addition is the relation between a sharp mountain met by the water level, while the form relation between the water and a slow rising beach is an example of integration of form. A single tower block in an urban area with with low rise housing is an example of dominance and contrast. A Dutch street facade which is held together because of the gables, each of which is architecturally individual, shows an example of continuity of form. Form that is aggregated describes a static situation opposed to a dynamic situation generated by dispersed forms.

Organized form may be aggregated along lines, gathered around a point, evenly dispersed in a
pattern or symmetrically or asymmetrically dispersed. The basic principle of form organization takes place in relation to line, point or raster. Raster is a combination of the two. Examples are terraced houses follows the line, cluster housing is gathered around a center a point, the street pattern in many Hellenistic towns shows an even distributed pattern in all directions.

As an example, McCluskey shows the difference between dynamic space and static space. Dynamic space exists where a sense of movement is visually experienced. Static space is where the sense of movement is visually stopped. An enclosed space may have certain architectural qualities whereas a more open space has other architectural qualities. At an urban space level such qualities are analysed by the computer system.

Another example of analysis of form is analysis of elevations. Such analysis has been carried out very systematically by Michael Trieb in particular. Elevations may for example be dominated by either horizontal or vertical form or a combination of the two. Zucker suggests that the visual field expands not only to the horizontal dimension but also the vertical. He says that an architectural setting induces a definite ceiling to the sky above. Analysis of a city's skyline is an example of using this knowledge. Skyline analysis is a commonly used type of analysis in particular when new dominant buildings are placed in front of the view of a important city profile.

The Computer Interface

An analytical tool like this is useless to individuals who do not understand how to use it properly. The difficulties encountered in mastering these tools often cause less technically oriented people to be excluded from utilizing the system. Thus it has been important to make the tool visually appealing. Instead of using a command driven interface, this interface is based on a so called human interface. Graphical interfaces overcome the need to memorize commands by translating the users actions into commands that can be understood by the machine. This is accomplished by providing a human-computer interface displayed in a form that matches the way humans think about a problem. Any action the user may need is immediately visible to him. This means applying such principles as the use of metaphors, direct manipulation, see and point, and aesthetic integrity. The graphical interface uses metaphors, direct manipulation, see and point and icons for possible actions on the screen. The user can point and click on maps and photographs, use slide bars, and push on screen buttons to elicit a response from the computer.

The desktop is the primary metaphor for the interface. The scale palette as well as the navigator palette is the metaphor of a map. The menu at these palettes is extensions of the metaphor. The user can connect the idea of making choice from a computer menu with making choice from a restaurant menu. Direct manipulation allows the user to think that he is directly controlling the objects represented by the computer. When the user performs operations on the object the impact of those operations is immediately visible. Users perform actions by choosing from alternatives presented on the screen. Users interact directly with the screen selecting objects and performing activities by using the pointing device, typically a mouse, to point to elements on the screen. See and point is most commonly used in this project. This has been achieved by the use of arrows on maps to show specific views, check boxes and radio buttons to adjust for annotations.

Aesthetic integrity means that the information is well organized and consistent with principles of visual design. This means that things look good on the screen. This has meant that considerations about the design of the appearance of the screen must be considered in terms of icons, windows, dialog boxes, and so on.

The Building of the System

The System Structure

The analysis of urban architectural form takes place on three 'zoom levels' (see Figure 1). One level is the town in its landscape setting called landscape level, the second level is the built up area which is divided into various urban areas each of which share specific homogenic form characteristics. This level is called urban area level. Each area will consist of a number of urban spaces such as streets and squares. This level is called urban space level. This way of structuring the navigation is very similar to the way urban designers and architects think and operate when analyzing and making proposals for a town.
The System

1. Analysis at landscape level

At landscape level the user may select among the following themes; 1) historical analysis, 2) description of the area, 3) landscape analysis. Or the user may choose to 4) visualize certain important architectural features from various standpoints, or move about in the three dimensional model and view that from various sides. Finally a theme named 5) evaluation consists of planning information and a simulation module.

2. Analysis at urban area level

At urban area level the user may select among the following themes; 1) historical analysis, 2) landscape analysis and description of the area, 3) form analysis which consists of an analysis of the urban area, an analysis of the urban structure and an analysis of the urban silhouette. Or the user may choose to 4) visualize certain important architectural features from various standpoints, or move about in the three dimensional model and view that from various sides. Finally a theme named 5) evaluation which consists of planning information and a simulation module.

The theme analysis of the urban area consists of a number of topics like edges, intersections, landmarks, of crossings all of which are important physical features in the cityscape.

The theme analysis of the urban structure is based on the idea that any space between buildings should be a defined space. Undefined space is called antispase. The theme urban structure is analysed in order to identify space and antispase.

Within the theme urban silhouette the object of analysis is the city profile seen from outside the city and seen from the inside of the city.
The theme visualizing includes three dimensional sequences in the particular urban area. This has been achieved by the use of Picos movies.

3. Analysis at the urban space level

At the urban space level the user may select among the following themes; 1) historical analysis, 2) description of the area in which the urban space is located, 3) form analysis which consists of an analysis of space composition, an analysis of the surfaces of urban space, views form various places in the chosen urban space or the user may choose to 4) visualize certain important architectural features from various viewpoints in the particular urban space. Yet another theme is 5) evaluation which consists of planning information and a simulation module.

The theme analysis of space composition includes analysis of urban typology, urban form and proportions of urban space. The theme urban surface analysis includes analysis of elevations of roof forms, of the urban floor form and patterns and the way urban space is constrained and terminated/enclosed.

The theme views includes important views of the encasing planes of the particular urban space chosen. The theme visualizing includes three dimensional sequences in the particular urban space. This has been achieved by the use of Picos and QuickTime movies.

How to Move About Within the System

The Scale Palette

The user moves up or down in scale by using the scale palette (see Figure 2). This scale palette appears on the screen as a map the user can then point and click on in order to move his way down to a lower level of analysis. The user can make his way either...
down or up to a different level by using a pull down menu.

The Navigation Palette

At each of these three levels there will be a number of selections. To the left of the screen the navigation palette is shown (see Figure 3). From the navigation palette the user can choose among a number of themes of analysis and within each theme the user may choose among a number of topics. These topics can be inserted or removed by the user’s own actions. Each level includes a theme of historical analysis, and a theme of information about the chosen area or urban space including any relevant planning information.

The navigation palette also has a mode control which will give the user a choice of view between three dimensional view, plan view or elevation. These three modes of view are normally used by architects to present proposals.

The navigator palette consists of a scale map at which the user will have opportunities to select a view of photographic pictures.

The Annotation Palette

When choosing a photographic view the annotate palette shows up. This palette is used to make annotations of the photo chosen (see Figure 4). The annotation means pointing out important architectural characteristics, e.g., the urban profile, by indicating the perimeter of the buildings or drawing the perimeter of volumes or the edge of a road surface. This method of analysis is used by many urban theoreticists such as Trieb, Bacon, and Holmgren.

The Theory Palette

The system has an on-line theory palette which the user can “call” at any time needed (see Figure 5). The theory palette supplies the user with any relevant urban design theory.
The Simulation Module

The system also has a simulation module in which the user can actually model a proposed building and view the impact of the proposed building on the existing buildings in the cityscape. This is particularly useful in preservation and conservation situations.

The Software Authoring Tool

The tool has been programmed in an object-oriented programming environment. For the prototype SuperCard has been used on the Macintosh computer. Object-oriented programming differs from traditional programming in that rather than writing out a long list of programming code to construct one computer application or program one simply writes a series of scripts that are tied to particular objects. These objects can be buttons, fields, cards, windows and menus. These scripts can be considered subroutines that have the ability to pass messages along to other subroutines in a set hierarchy. One of the greatest benefits of the object-oriented approach is its ability to construct a system using a modular approach. Objects can be copied and pasted among windows and their associated scripts are duplicated and carried along with them.

The main reason for selecting SuperCard as the development environment is its ability to incorporate maps made up of either objects or bit mapped images, the ability to link information to irregularly shaped objects within these maps, the ability to display these maps within large sized windows, and the ability to display color, video and animation.
Conclusions

As it has been mentioned this research gives expression to the type of research that is of a very practical type opposed to theoretical. Research has been based on trial and error in order to gain further knowledge of its practical use. The Department of Technical Services at the City Authority of Viborg has been involved in discussions regarding the design and use of the system.

The prototype has only dealt with very limited aspects of a total urban design analysis for a whole city. Further research has to be done regarding other aspects. Research also has to be done on the technical problems of developing the final 3D urban model for the whole city generated on the basis of digital maps. In addition research will have to look into technical problems of texture mapping in terms of the formats in which photos of buildings are being made.

This project has been developed with the aims of developing a system based on traditional methods and theories of urban designers, to design the interface to appear very similar to how an architect would approach an analysis of an urban problem and to give the user a high degree of interaction with the tool.

The application of traditional methods and theories of urban designers using a computer system is new. Much computer research has focussed on how to technically present and show images of urban spaces rather than on how to build a real analysis system. To my experience this concept opens for new ways of designing real electronic analysis tools for urban design.

The interface has been designed to fulfill an architect's expectations by simulating traditional methods of urban design analysis. The navigator palette and scale palette provides constant reference to the user location within the system.
There is only a moderate degree of interactivity in the prototype. It is preprogrammed to perform certain actions to illustrate the idea of interactivity. In the later final system interactivity has to be developed to a much higher level in which the user will be able to move around the three dimensional model freely.

Since the system is only a prototype it is not in a form capable of being fully tested by the local authority of the city of Viborg. However it is useful for further development as an illustration of how an electronic tool for urban design analysis can be designed. Moreover it will be presented to the local authority for their remarks and advice in relation to routines in urban design.

Very few new systems like this one peak in usefulness immediately after the initial development. A process of "aging" or "maturing" occurs as many users interact with the system over time, adding ingredients of knowledge by building links and relationship among the data. In order to assess the relative impact the system has on the urban design process, it will be necessary to study human interaction with these systems more closely. Increased access to computing systems that focus on analysis of urban architectural quality may ultimately increase the quality of urban design and preservation. Visual analysis tools also have the potential of being easily understood by non-professionals which suggest that the such systems may be useful in public participation processes and thus improve the quality of the group decisions that are being made.

Notes

7 Tranck, Roger, Restructuring Anti Space, Chalmers tekniske høyskola, 1981.