A Model for the Study of Urban Transformation

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INTRODUCTION

More often than not, the same information may be evaluated differently by urban planners, designers, and researchers depending on their point of view. One of the main responsibilities of the urban planners is to provide the public with efficient, professional planning services in support of the short- and long-range development of the physical and spatial environment. Urban designers approach the urban environment from the architectural perspective and unlike planners they are more interested in designing and less concerned with policy making. Urban researchers study urban areas to trace certain architectural or related information either to support their hypotheses or to develop new arguments.

Each one of these groups, however, incorporates a wide diversity of information in their analyses results and solutions. Footprints of the buildings (in both digital and traditional form), maps, printed reports, aerial and eye-level photographs, images, and conversations remembered may all aid in envisioning and forming a sense of the urban area. However, all of this work cannot be done efficiently and timely by relying on traditional non-digital and non-visual information. Understanding complex information is greatly increased if the information is visual.

In urban analysis problems occur because the wide range of information available is disorganized and in dispersed locations. There are very few adequate tools to visualize the information at the researcher's disposal. A steady increase of computing power makes it possible to organize and visualize this dispersed information. Visualization aids conceptualization in improving, understanding and creative problem solving. Visualization is a method of computing which is not simply a matter of absorbing data in a more manageable or intelligible form. New patterns in the data can be identified spatially and hence new insights into real world processes generated. Moreover, the power to visualize also reinforces the increasingly popular notion that model outputs from computers must be evaluated visually, for many statistical techniques do not effectively communicate the quality of model prediction and estimation. In short, the notion that "seeing is believing" is slowly returning to modeling, but this time it is in terms of computer graphics.

The focus of this paper is the visualization of the historical development of an urban area. In so doing, we attempt to address the problems as briefly outlined above. In general, our research is aimed at developing a prototype urban database model and an emphasis is placed on identification, categorization and representation of information in a way that is useful for analysis by urban researchers. The concept of creating an urban scale database is not new. Several studies do exist with various different research agendas, such as fractal-based approaches (Batty and Longley 1986; Batty and Longley 1987), information representation (Giger-Hofmann 1991; Marble and Amundson 1988; Yapa 1989), interactive urban databases (Fox 1993; McCullough 1993), and historical urban analysis (Dave and Schmitt 1994; Seebohm 1992; Skauge 1993). Based on the existing studies and accumulated knowledge, we aim to build an urban database prototype model and to use a specific urban context to trace certain typological and morphological elements of an urban space.

Currently, the organization of information is problematic. Various forms of footprints of the buildings, free form of textual data (reports, articles, quotes, etc.), charts, drawings, still and moving pictures are typically stored in varied locations, and must generally be retrieved manually (see Figure 1). Most likely they are also difficult to access. As a consequence, this information is not fully utilized. One of the main reasons is that until recently computer hardware and software limitations severely restricted the ability of digital media to aid the urban researchers in using these type of organized information. Furthermore, traditional systems do not provide researchers with adequate access to data for unique analyses. Because of the inadequacy of these systems, selecting, organizing, and interpreting these data are difficult. Most importantly, since spatial information is not vertically coded, facilitating additional types of spatial analysis, and larger and more complex sets of data is not managed efficiently. Consequently, it may affect the productivity of the investigated study and/or misguide the researchers.

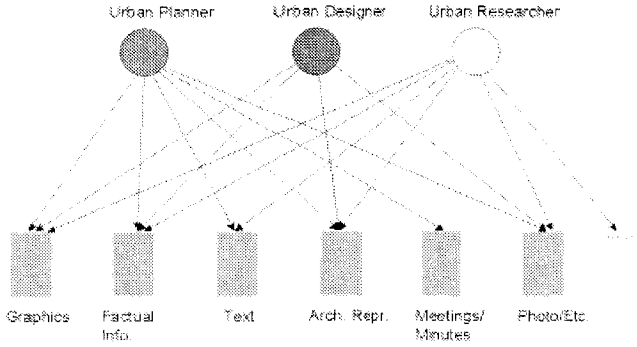


Fig. 1. The dispersion of urban information

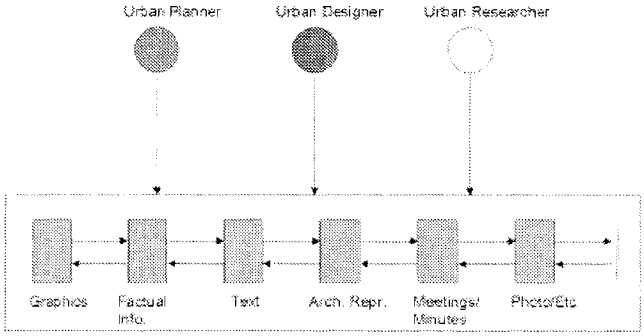


Fig. 2. The proposed re-organization of the existing knowledge base

Urban designers and researchers have usually used drawings to illustrate their design ideas. Even highly rendered images, which are professionally acclaimed for their artistry are, at times, inappropriate or poorly understood by the viewer. Misunderstanding is possible because single images can distort or hide critical architectural relationships. Furthermore, the ability to imagine the reality of a design concept depends on the viewer's experience (Arnheim 1974; Gibson 1950; Hilgard 1978; Kaplan 1978; Schiffman 1996). Therefore, it is important to recognize the limitations of existing media. This issue becomes more important if we consider the researchers' working relationship with other parties. The goals of the project, the complexity of the issues, the availability of resources and time, the size of the groups, and the acquaintance of the group with typological issues are all factors that impinge on the effectiveness of any research effort. This is particularly true for urban projects that change the form of the built environment (Beal 1991; Lang 1974; Lang 1994; Skauge 1993).

APPROACH

Our approach is to discuss the basic premises of a developing research project that aims to provide an opportunity to create a model that will aid urban researchers for archiving and visualizing information on an urban setting. Through the use of carefully structured 3D digital model and interactive database, we propose to create a tool for researchers, designers and planners that will surmount these problems (Figure 2). It is our hope that this model will re-organize the existing knowledge-base and improve the way information is stored, processed, analyzed and reported in urban scale projects.

There are several advantages of this approach. First, there is a real value in making three-dimensional ideas explicit and understandable. Second, it is extremely useful to be able to compose information from a diversity of sources in order to understand and to cope better with the existing increasingly complex position of urban design. Third, because of the scale and complexity of this information, computer-aided visualization can help in organizing, understanding, designing and communicating.

THE RECONSTRUCTION OF AN URBAN AREA

The analysis of an urban area requires a careful examination of the elements, which form that area, and the forces that work upon it (Alkhoven 1991). We propose that any urban study dependent upon images and architectural history is best when contextual and can be put in a formal framework only if organized temporally. The transformation of an urban area can only be studied in relation to its past for the future. In studying urban architecture from the current condition backwards in time, we often see that a site that has changed drastically in its urban relationships has held on to specific local site conditions. Relationships such as building to square or facade to street, for instance, might remain constant, thereby prioritizing and holding critical aspects of 'site' in spite of an area's growth and change.

In a like manner, a study of the architecture of the city is best accomplished in relation to its context, i.e. the city plan. Ideal vision versus applied planning has an impact on the architectural formation of the city. The strength of a plan's major components forms its network in spite of these two often conflicting goals. The characterization of the city as a network with individual works of architecture might therefore best be addressed by looking at the individual work in relation to its place in the city's overall plan. The comparison of the architecture/plan and history/context relationships through time would be best expressed by using a layered map showing the architecture and context, that gives a simultaneous view of the city's reconstruction through many periods of time. History and architecture in their respective contexts could, in a layered map, be carefully examined as changing elements.

CASE STUDY: PHILADELPHIA

The city of Philadelphia has been chosen as a case study because it is one of a handful of American cities with a long and consistent history of transformation. The current city form was begun as an ideal city in 1683 and has been mapped and envisioned from its inception. The original plan was based on a grid composition and five major squares. This plan, although not complete until the 1800s, is primary and present in the city's

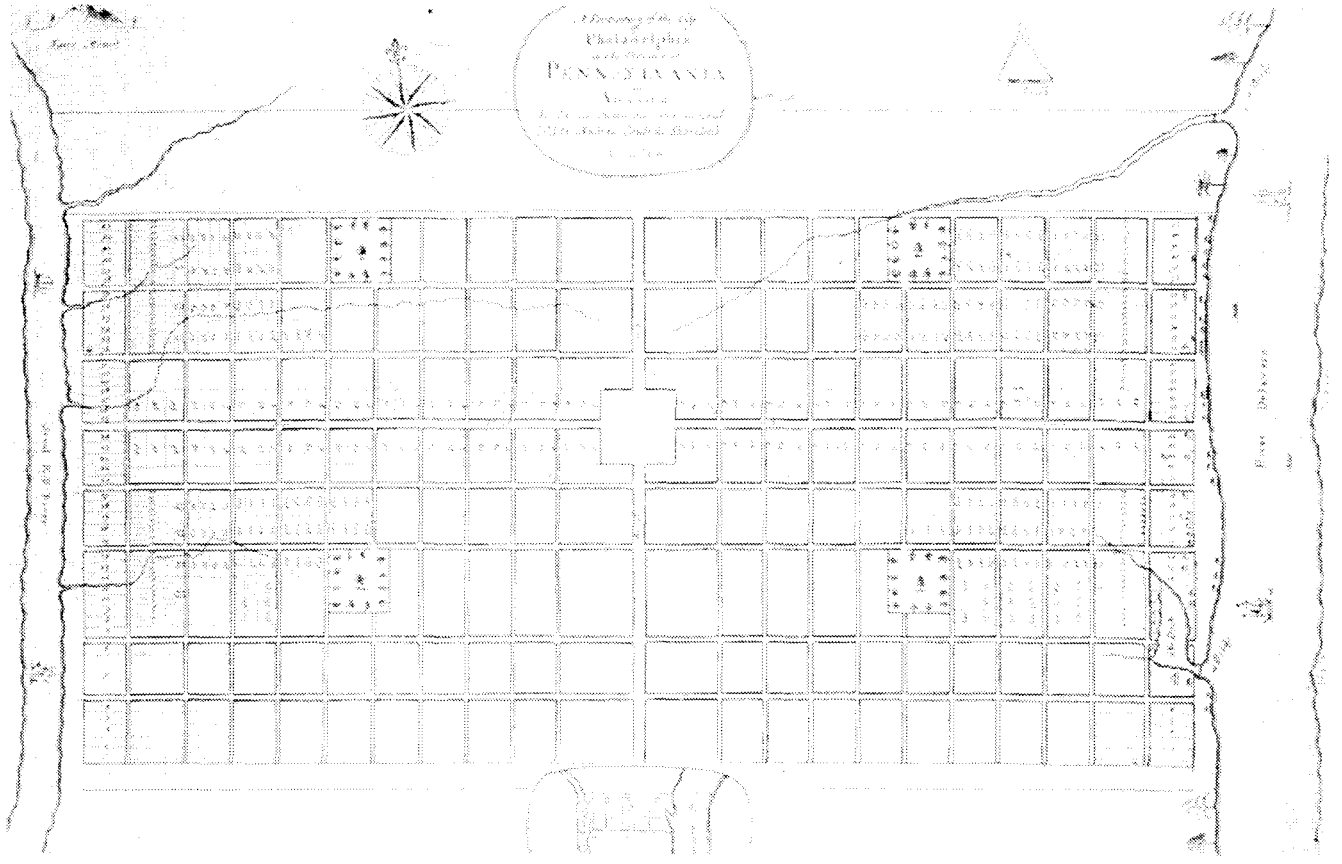


Fig.3. The Original Mapping of the City of Philadelphia

image. The overall configuration of this Penn/Holmes ideal plan has been protected and is still visible (see Figure 3).

Its early history as a center of revolution and then the nation's capital deemed it a city to 'render' and convey in the European context. As such, the city has not only many accurate maps through time, it also has been the subject of great delineators from the 18th century on. Because the current Center City Philadelphia is embedded in an ideal plan with European 'roots', it is easy to measure growth and change against any number of attributes. The logic of the original plan is well recorded for both its practical and symbolic reasoning. The plan's precedents and innovations are readily comparable. The layout was carried out accurately, and the early ownership and real estate transactions are recorded. These are all factors that impact the strength of the Philadelphia plan's network and its readability. Any re-working of or addition to the city's infrastructure can therefore be measured accurately.

The 1683 Penn/Holmes plan is essential to any research on the buildings and context of Philadelphia, as it is the major contributor to the infrastructure of the city. The next period — the 1770s through the early 1800s—is a period in which Philadelphia's economic base is trade and politics plays a role. Maps include relationships to the river/port and military maps. There are maps and images that depict political events because of the city's importance to the American Revolution and as the first capital of the nation. The latter part of the 1800s reveals the city as a place of industrial growth. Included in this are the physical growth and the coming of age of the city, mostly seen through changing transportation needs and other infrastructure and the need for cultural institutions. In the twentieth century, there is a new modern city that emerges and a parallel reflective component that focuses on the city's history. The importance of the role of planning in America is well illustrated in the Philadelphia plan. Changes that occur in the modern city reflect the city as place for planning experimentation and as a leader in the inception of new planning theories. The most recent period in Philadelphia shows the city as place of re-building, demolition, and new building and re-working of the city based on optimistic economic projection along with the problems of urban blight.

The availability of maps and images of the early city makes it possible to speculate about its built form. There is a consistent amount of information to accurately recall the place, image, and form of early public buildings and open spaces, and there is enough information through maps about the massing of the city to understand the background buildings, i.e., housing, commercial, etc. Many early maps accurately depict topographical features, major institutional buildings, and public spaces. There are an equal number of accurate views of the city, showing public buildings and spaces. The first time period where a consistent public record about the physical aspects of the city occurs through insurance maps in the latter part of the 19th

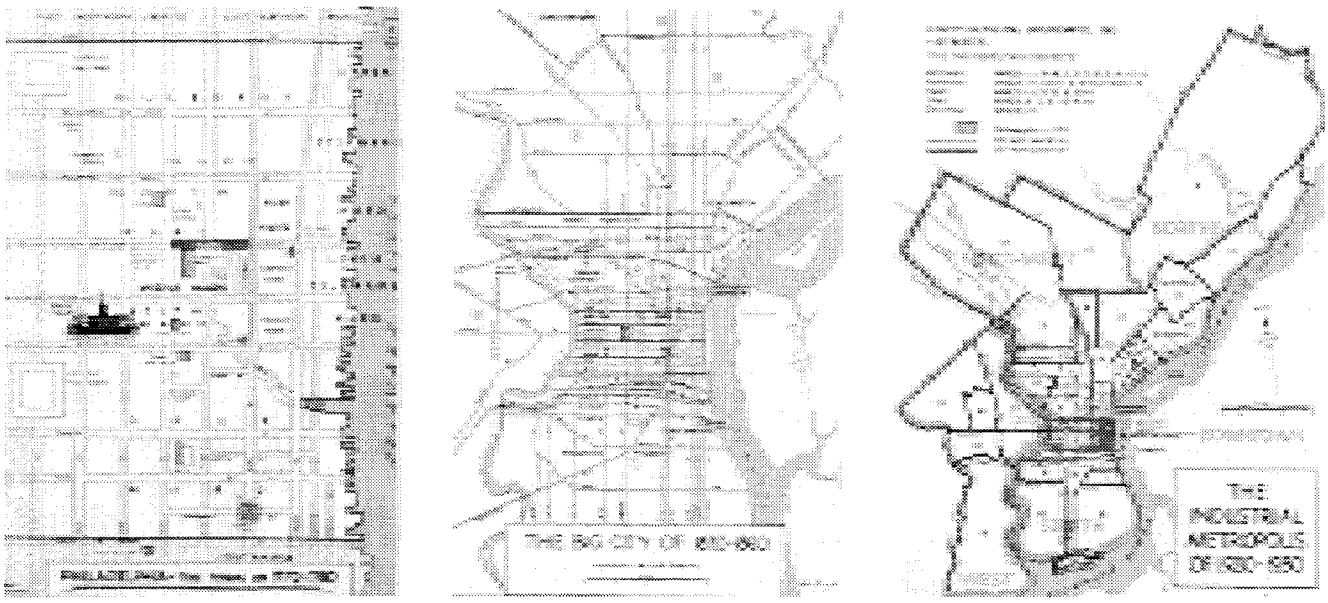


Fig.4. Philadelphia in different time periods of its growth

century. At this time period it is possible to distinguish the footprint of housing, the specific nature of manufacturing facilities, public/institutional buildings, and major open spaces. Coinciding with this, data about building heights can be determined through photographs, illustrations, and maps.

As a precursor to this project, some preliminary tests of a Philadelphia historical model have been carried out. These include a two mile study of Market Street drawn from the first post-war mapping period (1950), a two mile study of North Broad Street in two time periods—1875 and 1998, and a study of a ten block area of the city, searching for the origins of its name 'Chinatown'.

With maps, archival material, and images as the primary source material, each one of these studies was accomplished because there is enough historical information to visualize the city in different time periods (Warner 1968). Through these studies, we have developed the following knowledge-base:

> In the Market Street mapping project, major works of architecture were addressed in relationship to the city plan. Because architectural icons are distinguishable in maps throughout the history of the city, they trace the city's planning and development. Because of their long lasting life, major architectural works often act as the

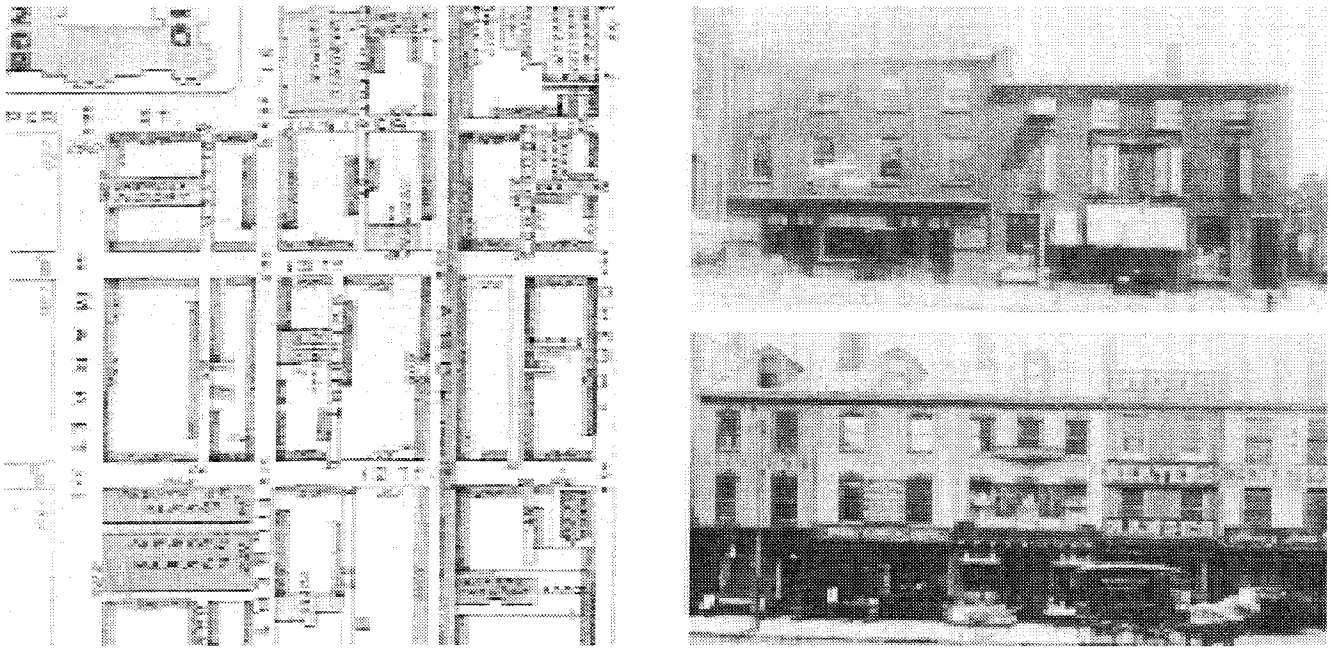


Fig.5. Market Street study

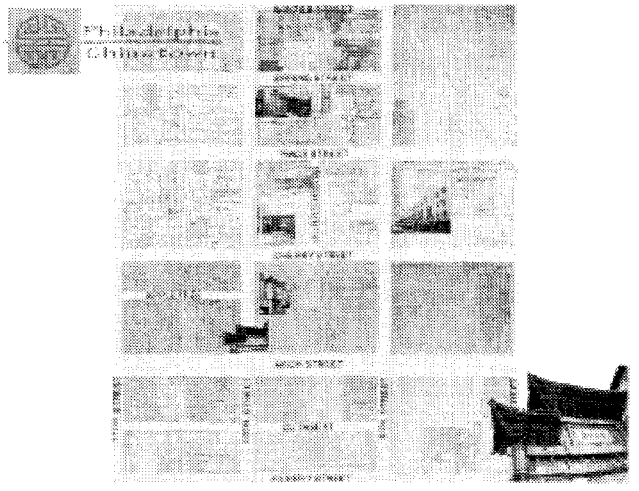


Fig.6. Chinatown study.

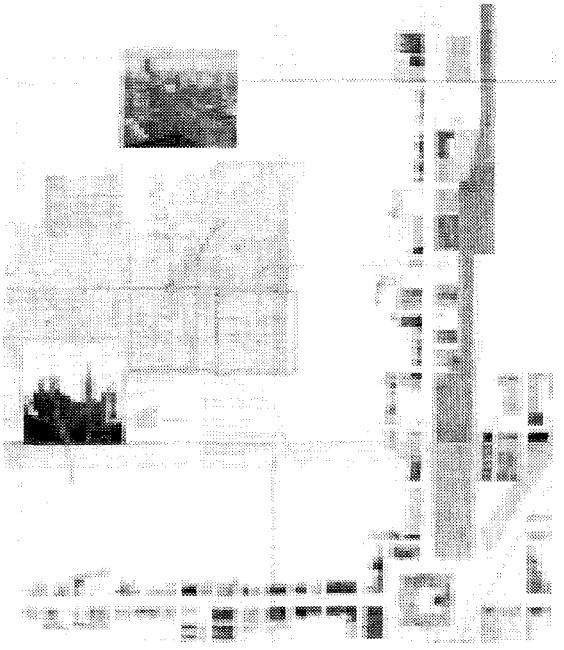


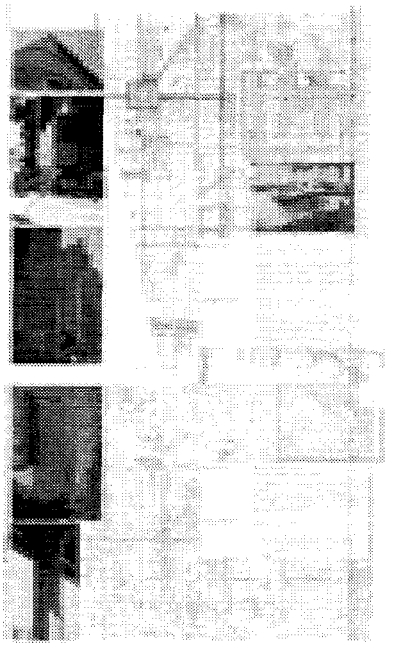
Fig.7. Broad Street study

anchors in the city and are therefore important to call out separately in a digital model or map.

In the Chinatown mapping project it was possible to pinpoint the origin of the name 'Chinatown' through a combination of historical maps and newspaper articles about the lore of the city. It was important to first record the location of current functions throughout the area to determine its character. The ability to 'test' hearsay information through map documentation could then be accomplished. The information recorded on the map would have been overlooked without the written information.

In the Broad Street mapping project, two historical periods were recorded—1875 and the current day. Because of rapid growth in the city in the early twentieth century and changes in the late twentieth century, a third period would have been more accurate in depicting the city as a changing entity. We concluded that in any portion of the city it is important to represent at least three periods of growth.

In all studies the central square of the city was included. Information about Center Square, a prominent node in the original plan of the city is available through anecdotal accounts of its use from the city's inception and from visual records. This and other prominent sites in the city change face through the development of the city plan, sometimes acting as figural elements and sometimes as background. The history of the square includes uses such as meeting house, tavern, gallows, race course, bowling green, pump house, public open space, and city hall. These socially significant uses (located architecturally) depict a changing character of the urban landscape through time. These kinds of changes can be modeled and can add value to this study.



With each project there was an attempt to address architecture and historical information alongside contextual information. The consistent use of an accurate plan and map as a grounding device and historical maps as documents to trace back through time proved in each of these test projects to be important parameters. With the contextual mapping, some conclusions became obvious and clear through visualization.

METHODOLOGY

Our ongoing research examines the city in different time periods by working in small areas of the city and posing questions particular to these places, then collages these together to provide a multiple viewpoint. Time periods for architectural development (depending on the portion of the city to be

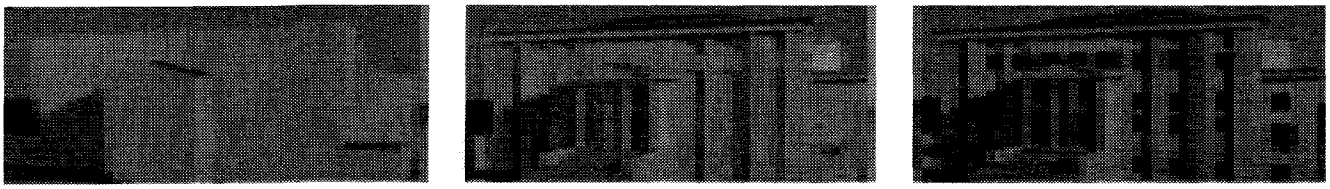


Figure 8: Digital model representations

mapped) include 1680/1700, 1770s, 1850/60s, 1870/90s, 1920s, 1950s, 1980s, current and future conditions. These correspond to periods of growth in the city and mark times when maps or atlases are available. In each instance, the Center City (ideal plan) acts as a reference base.

The time periods reflect some events and insights that are unique to the city and some that are indicative and typical of what has occurred throughout the country. This combination at one time shows the uniqueness of the city and at another, some universal trends. The combination, shown through the layers of history, gives us a comprehensive condition and supports the notion that a method can be achieved.

The model operates in several levels based on a two-fold system structure: 1) 3-D Digital Model; and 2) Interactive Database. Fundamentally, it contains a "shell" that allows urban researchers to contribute to the database simultaneously. A 3D-computer model of a selected urban area in Philadelphia is the core of this shell. This method is used to represent current and past typological elements, such as spatial types and morphological series and to explore and analyze historical transformations.

This computer model is the point of departure in this investigation. It is created by using a digital modeling program Building models are created using architectural plans, 2D digital files, elevations as well as site measurements and photographs. The digital models of the investigated elements, such as buildings, zones, etc. are not single representations but rather three separate representation models: 1) Mass models; 2) Flatshaded models; and 3) Texture-mapped models.

The organization of urban information, including digital models is established by using a layering system based on architecture and time. The starting point of the layering system is the representation of different timeframes and each timeframe includes a subdivision of architectural information. At this stage, architectural information includes building types (residential, commercial and public), zones, recreation areas and transportation (see Figure 9).

For many studies of spatial distributions, such as land use, ownership, zoning, etc., there is little need for any such three-dimensional representation, and much more need for plan topology. In contrast, for others where volumetric factors such as building heights, building types, shadows, or view sheds are concerned there is stronger motive to use geometric models in combination with maps. The choice of the use as a base depends on intent. In this study, we use GIS. GIS is the preferable base where different coverages are to be studied and analysis is critical. In this case, crude building forms can be extruded from

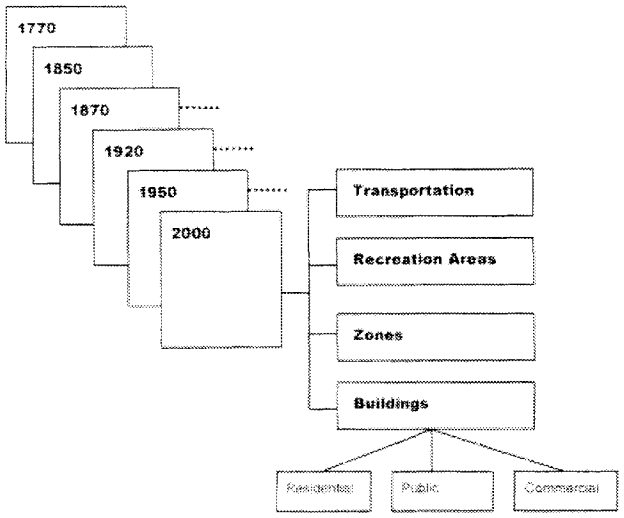


Fig.9. The organization of the studied transformations in different time periods

polygon features and their height attributes. Where more complex visual elements such as rooflines or façade modulations are needed, or where macro programs need to interpret both forms and attributes, geometric modeling is the preferable base. In this case, attributes are exported to tabulation programs as necessary. In terms of geometric organizations, polygons have many possible uses. If a complex form can be linked to the same polygon used for spatial data access and area topologies, then the issue is not which kind of program to use but how much can be represented without information overload.

The interactive navigation system is based on several components. One component is dynamic query and display of information from the database in both two- and three-dimensional formats. Another component is partially based on a theory and methodology called "Case-Based Reasoning." Case-Based Reasoning (CBR) is memory-centered cognitive paradigm within Artificial Intelligence based on the idea that people are good at figuring out what to do in new situations and adapt those cases to the current problem (Kolodner 1993; Schank 1982). CBR is being developed into technology for building systems that assist human users by presenting them with useful information chosen from organized memories of past experiences (Domeshek 1993; Domeshek and Kolodner 1992; Goel et al. 1991a; Goel et al. 1991b; Kolodner and Wills 1993; Maher, Balachandran, and Zhang 1995). In this study, CBR is integrated for interactivity to collect and utilize the case studies.

This component allows urban researchers to make inferences and to see how certain transformations have occurred by comparing the cases.

DISCUSSION

The application of knowledge organization and new visualization techniques provides a method for analyzing the transformations of an urban development and for posing questions about the history of architecture. The organization, visualization and interpretation of the non-visual material are major problems in architectural history research, especially in urban design. Our goal is to develop a prototype of an interactive digital urban model. Although this study uses Philadelphia as a case, the underlying framework of this model is generic and applicable to any urban area. We believe it will provide a model for archiving and visualizing information on a city and for analyzing urban transformations.

A number of considerations underlie this study. The first and most important is the need of digitizing the data and visualizing the urban information. Second, organizing that information in a digital form. Finally, building an interface to navigate and guide the researchers on this organized information. The objectives of this study have arisen from these considerations and questions. The main objectives of this study are: 1) to conduct a research about the urban scale models and databases; 2) to develop a comprehensive computerized 3-D model of Philadelphia; 3) to store and link all forms of information in a single work area; and 4) to create a flexible interface tool to interactively assemble and edit information.

We argue that the creation of a possible collaborative environment among different interest groups such as facility planners, architectural designers, researchers, and students can provide several possible lines of direction for theoretical and applied research.

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