An Interactive Urban Model Prototype: Philadelphia

OSMAN ATAMAN
KATHERINE WINGERT
Temple University

Introduction

Urban planners, designers and researchers look at the same information with different intentions. 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 develop new arguments or to support their hypotheses.

Each one of these groups, however, incorporates a wide diversity of information in their analysis, results and solutions. Footprints of the buildings (in both digital and traditional form), maps, printed reports, minutes of meetings, aerial and eye-level photographs, images, and conversations remembered may all aid in forming a sense of the urban area or problem at hand and in envisioning alternative solutions. 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. Another problem is dealing with a wide range of information that is in a somewhat unorganized condition. None of these groups has adequate tools and models to visualize the information at their disposal. A steady increase of computing power makes it possible to visualize this mostly disorganized and somehow non-visual information. Visualization aids conceptualization in improving, understanding and creative problem solving. Visualization is a method of computing that is not simply a matter of absorbing data in a more manageable or intelligible form, because new patterns in the data can be identified spatially and hence new insights into real world processes generated. Moreover, the power to visualize 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.

This paper focuses on the visualization of the historical development of an urban area. In doing so, it also aims to address the problems as briefly outlined above. In general, our research is aimed at developing a prototype urban database model. 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 , information representation , interactive urban databases , and historical urban analysis . 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 this kind of information is not adequate with newer technology. 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. Most likely they are also difficult to access. As a consequence, this information is not fully utilized. The main reason is that until recently computer hardware and software limitations severely restricted the ability of computers to aid the urban researchers in using these types of information. Furthermore, existing systems do not provide researchers with adequate access to data for unique analyses. Because of the inadequacy of existing systems (both hardware and software), selecting, organizing, and interpreting these data become difficult. Since spatial information is not vertically coded, facilitation of new types of spatial analysis or more complex sets of data is not managed efficiently. This can negatively affect the productivity of the study or the direction of the research.

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 . 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 groups 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 .

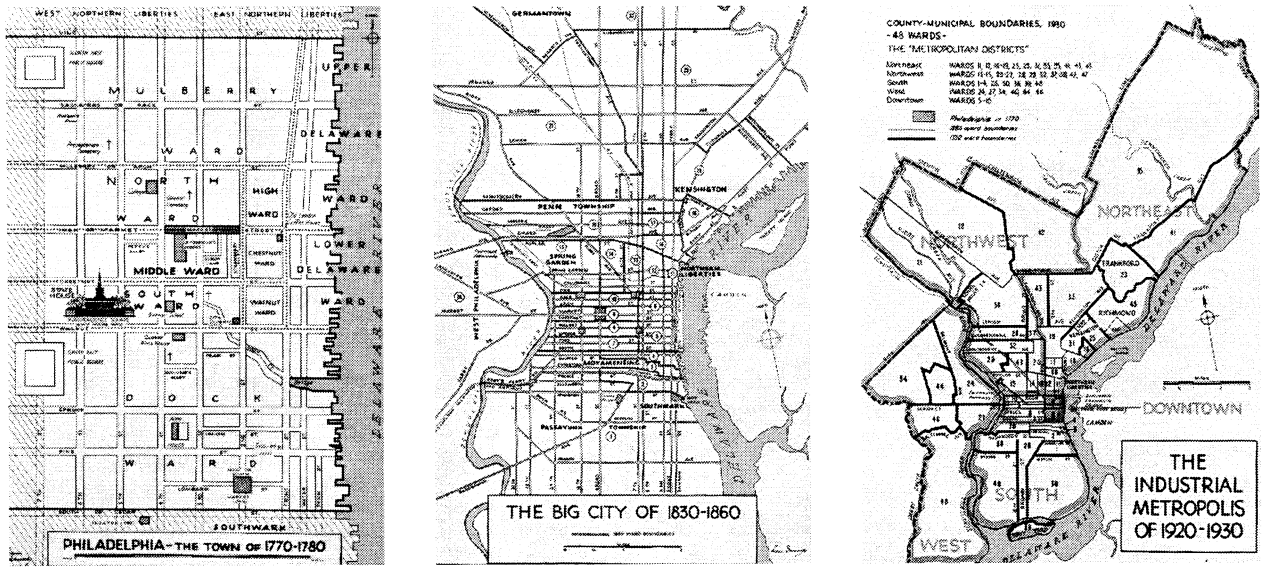

Fig. 1: Philadelphia in different time periods of its growth

Approach

Our approach is to develop a model for archiving and visualizing information on an urban setting that will aid urban researchers. It is assumed here that the organization of data that pertains to the urban setting in a visually structured manner provides a means to study a city's transformation. It is currently difficult to visualize and utilize existing information about any urban context. Source materials are scattered among different disciplines, and exist in different locations and media. To acquire or organize these materials is often not worth the effort. Through the use of carefully structured 3D digital model and interactive database, we propose to create a tool that will surmount these problems. It is our hope that this model will improve the way information is stored, processed, analyzed and reported in urban scale projects. There are several advantages of this approach. First, there is value in making three-dimensional ideas explicit and understandable. Second, because of the scale and complexity of this information, computer-aided visualization can help in organizing, understanding, designing and communicating. Third, the organization of information from a diversity of sources can allow us to comprehend the increasingly complex urban condition.

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 . This examination is important: any study of a civic architecture is most fully realized when contextual i.e., within its formal framework – the city plan. If architecture and the urban condition are contextualized, not only in terms of elements and forces, but also from the past to the present, the future conditions are more fully understood and anticipated. In other words, the transformation of an urban area can be examined in relation to its past for the future.

Both the architecture/plan and history/context relationships can be examined through mapping. The comparison of these would best be expressed by using a layered map 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.

A Case Study: The Philadelphia Project

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 mapping and imaging. The current city form was envisioned and begun as an ideal city in 1683 and as such has been mapped from its inception. The first plan, although not complete until the 1800's, is primary and present in the city's image. 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 been depicted through many early accurate maps, it also was the subject of great delineators from the late 18th century onwards.

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 image and form of early public buildings and open spaces. There is enough information through maps about the massing of the city to understand the 'background' buildings, i.e., housing, commercial, etc. The first time period where accurate maps and consistent public records about the physical aspects of the city were available was in the latter part of the 19th century. In 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. Building heights can be determined through photographs.

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 Chinatown, a ten block area of the city.

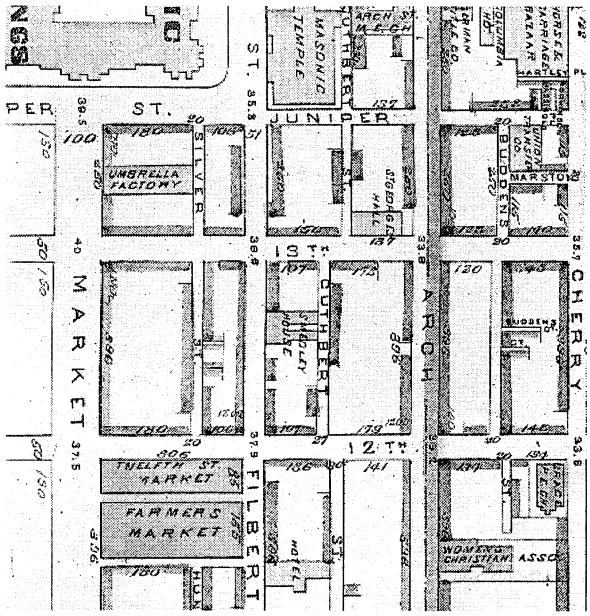

Fig. 2: Market Street study

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 . Through these studies, we have developed the following knowledge-base:

1. In the Market Street mapping project, major works of architecture were studied 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 life, major architectural works often act as the anchors in the city and are therefore important to call out separately in a digital model or map.

1. 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. Here, the 'test' of the validity of hearsay information through map documentation could then be carried out. The information recorded on the map would have been overlooked without the written information.

1. 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.

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 base 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

The study 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. Time periods for architectural development (depending on the portion of the city to be mapped) include 1770's, 1850/60's, 1870/90's, 1920's, 1950's, 1980's current and future conditions. These correspond to periods of growth in the city. In each instance, the Center City (Ideal plan) acts as a reference base.

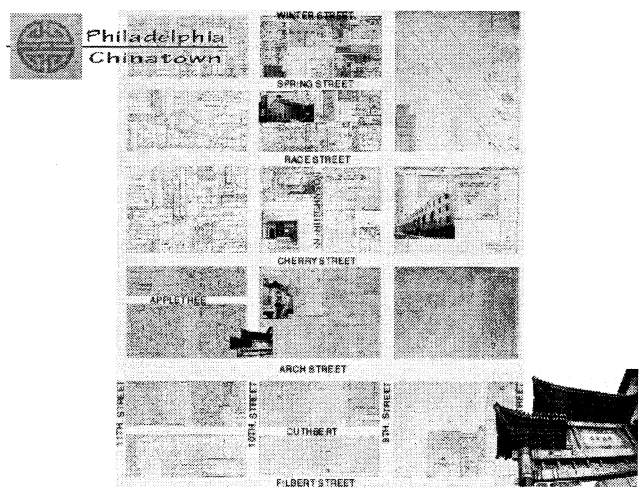

Fig. 3: Chinatown study.

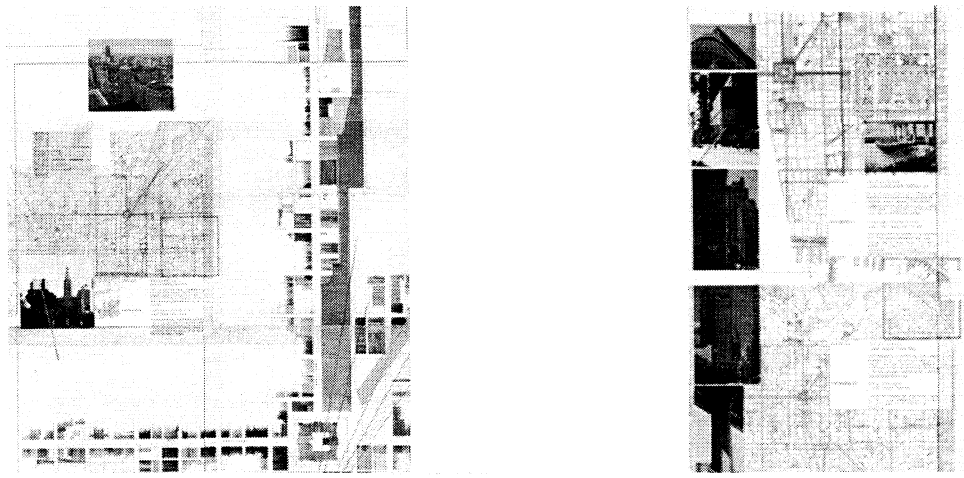

Fig. 4: Broad Street study

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

A 3D digital model will be created by using one or more CAD Drafting software (ACAD and Microstation), rendering software (3D Max), and animation software (3D Max). Building models will be created using architectural plans, 2D digital files, elevations as well as site measurements and photographs. The digital models are not single representations of each building but rather three separate models, which represent three different resolutions:

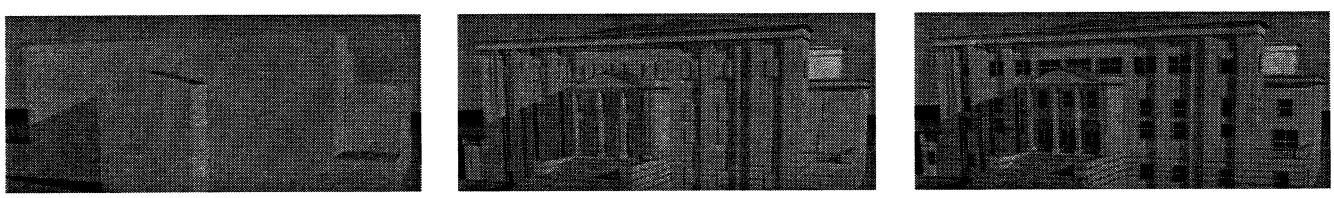

Fig. 5: Three separate model representations

1. Mass modeling
2. Accurately detailed flatshaded model
3. Photo-realistic

The organization of information 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 6).

When available, a "plan view aerial photographs" procedure will be employed. The aerial photos are a quick, easy and accurate way to obtain up-to-date information on street widths, building footprints, foliage, etc. The photos are scanned into the computer and appropriately scaled and rotated to fit into the "real world" coordinate system chosen for the project. The photos can then be used as the base upon which the geometric model is built. Streets and blocks can be quickly identified, outlined and inserted into the database using AutoCAD, MicroStation, and 3D Studio Max. If available a digital plan in a DXF format can be calibrated to the aerial photograph. In order to link closely with the GIS database, a common base map should be used. As a result, it is preferable to build the map in either AutoCAD or MicroStation, which provides DXF output. Thus the initial base map becomes the basis for both the three-dimensional model and the GIS entity database.

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 other studies where volumetric factors such as building heights, building types, shadows, or viewsheds are at issue there is stronger motive to use geometric models in combination with maps. The choice of a base for organization of the data and model depends on intent. In this study, we use GIS. It works well as a base where different coverages are to be studied and analysis is critical. In the case of this model, crude building forms can be extruded from 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 to be 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 Rea-

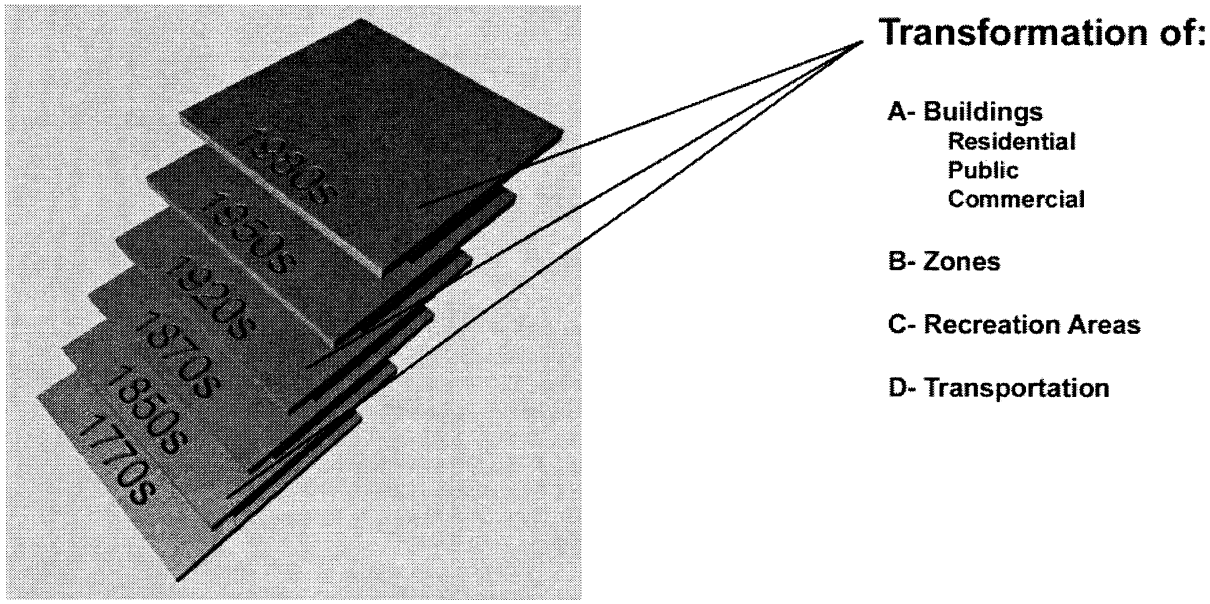

Fig. 6: The organization of the studied transformations in different time periods

soning (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 . 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 . 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.

Conclusive Remarks and 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 an urban plan and its 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. Even though the underlying framework of this model is generic and applicable to any urban area, this research uses Philadelphia as a case study. In so doing, it provides an electronic document for archiving and visualizing information on Philadelphia, which provides the city with an interactive tool for visualizing and 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 investigation have arisen from these considerations and questions. Four main objectives are as follows:

- To conduct a research about the urban scale models and databases
- To develop a comprehensive computerized 3-D model of Philadelphia.
- To store and link all forms of information in a single work area
- To create a flexible interface tool to interactively assemble and edit information.

We argue that the organization and utilization of the non-visual information in an interactive way can make it possible to analyze the historical development of an urban setting. Furthermore, 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.

BIBLIOGRAPHY

Alkhoven, P. "The reconstruction of the past: the application of new techniques for visualization and research in architectural history." In *CAAD Futures '91*, edited by G. Schmitt, 549-566. Braunschweig, Germany: Vieweg & Sohn Verlagsgesellschaft mbH, 1991.

Arnheim, Rudolf. *Art and Visual Perception: A Psychology of the Creative Eye*. Berkeley, CA: University of California Press, 1974.

Batty, M., and P. Longley. "The fractal simulation of urban form." *Environment and Planning A*, no. 18 (1986): 1143-1179.

Batty, M., and P. Longley. "Fractal-based description of urban form." *Environment and Planning B: Planning and Design*, no. 14 (1987): 123-134.

Beal, E. "Breaking new ground, Mass. DPW turns to AEC and mapping technology to bring major Boston freeway underground." *Computer Graphics World* 14, no. 2 (1991): 101-107.

Dave, B., and G. Schmitt. "Information Systems for Urban Analysis and Design Development." *Environment and Planning B: Planning and Design* 21 (1994): 83-96.

Fox, C. W. "An Interactive Urban Database." *ACADIA '93: Education and Practice* (1993): 69-75.

Gibson, James J. *The Perception of the Visual World*. Cambridge, MA: The Riverside Press, 1950.

Giger-Hofmann, C. "The historical information system." *Computer Graphik Topics*, no. 3 (1991): 10-11.

Hilgard, E R. "The Goals of Perception." In *Humanscape: Environments for People*, edited by Stephen Kaplan and Rachel Kaplan, 36-41. North Scituate, MA: Duxbury Press, 1978.

Kaplan, Stephen. "Perception of an uncertain Environment." In *Humanscape: Environments for People*, edited by Stephen Kaplan and Rachel Kaplan, 30-58. North Scituate, MA: Duxbury Press, 1978.

Lang, John. *Urban Design: The American Experience*. New York, NY: Van Nostrand Reinhold, 1994.

Lang, J., C. Burnette, M. Walter, and D. Vachon, eds. *Designing for Human Behavior*. Stroudsburg, PA: Dowden, Hutchingon & Ross, Inc., 1974.

Marble, F., and E. Amundson. "Microcomputer-Based Geographic Information Systems and their role in Urban and Regional Planning." *Environment and Planning B: Planning and Design*, no. 15 (1988): 305-324.

McCullough, M. "Interactive Urban Models." *ACADIA '93: Education and Practice* (1993): 57-68.

Schiffman, Harvey Richard. *Sensation and Perception*. 4th ed. ed. New York, NY: John Wiley & Sons, 1996.

Seebohm, T. "Discoursing on Urban History Through Structured Typologies." Paper presented at the ACADIA '92 Proceedings: Mission, Method, Madness, University of Southern California 1992.

Skauge, J. "An Electronic Tool for Urban Design Analysis." *ACADIA '93: Education and Practice* (1993): 77-85.

Warner, Sam. *The Private City*. Philadelphia, PA: University of Pennsylvania Press, 1968.

Yapa, S. "Low-cost map overlay analysis using Computer -Aided Design." *Environment and Planning B: Planning and Design*, no. 16 (1989): 377-391.