Modeling Urban Spaces: GIS and CAD Compared

Mark Linder and **McLain Clutter**
Syracuse University School of Architecture
Project Team: Allen Williams, Shuan Lin

Abstract

This research is producing *digital cartographic models* of the urban space of Rome, NY. Working between two software packages for spatial visualization that are now ubiquitous in architecture (FormZ) and geography (ArcView), the project takes an interdisciplinary approach to understanding how available data sources and modes of visualization enable or discourage particular understandings of urban space. The project is designed specifically to work within, and develop, a critique of the constraints of the two software packages. Rather than encouraging a deceptively smooth integration of what may be fundamentally incommensurable forms of knowledge, this project begins with the premise that vocabularies and conceptions of space vary considerably in various disciplines, as do the modes of visualization that each has developed to represent, document, examine, and produce space.

1 Project Objectives

The project has three objectives:

1) To compare and demonstrate the various capacities/incapacities of CAD and GIS to visualize, analyze, and represent urban space.

2) To produce models of urban conditions that raise issues (political, formal, practical, historical, environmental, etc.) which other modes of analysis and representation may not address.

3) To provide models of Rome, New York that enable various constituencies to visualize and understand urban spatial conditions, and to guide discussions about current problems and projects, or possibilities for future development.

The project begins with two theoretical agendas. Both are specifically concerned with spatial discourses and the digital tools, techniques, and technologies (D3T) of spatial visualization. They are:

1) a skepticism about the robustness of the concepts of spatiality that are intrinsic to both GIS and CAD modeling, and

2) The development and application of a representational technique called *seæming*.

2 Critique of Spatial Concepts

Over the past few decades, a complex and diverse discourse on urban space has emerged in numerous disciplines including architecture, art, geography, philosophy, cultural studies, and political theory. This discourse, which might be called ‘spatial studies,’ has produced various exchanges between disciplines that likely would not have developed otherwise. However, those exchanges have demonstrated the difficulties, as well as the possibilities, for interdisciplinary research on space. The very diversity of the discourse suggests that the term ‘space’ is quite complex and retains contradictory and multiple implications derived from its different uses in various fields.

This research begins with the premise that vocabularies and conceptions of space are different in various disciplines, as are the modes of visualization that each has developed to represent, document, examine, and produce space. Thus, interdisciplinary research on space that first considers those differences and their implications might enable more productive and precise exchange to occur between disciplines such as architecture and geography. More specifically, this research is an exercise in *trans*disciplinarity: a suspicion of the presumption that disciplines can “share” knowledge or can base their collaborations on a common set of basic concepts. Instead, transdisciplinary research works at the limits of one’s discipline, where disciplinary rigor can still operate but has necessarily abandoned the claims of authority or mastery that pertain at the center. In this sense it follows Homi Bhabha, who suggests that interdisciplinary work is “not an attempt to strengthen one foundation by drawing from another; it is a reaction our living at the real border of our own disciplines, where some of the fundamental ideas of our discipline are being profoundly shaken. So our interdisciplinary moment is a move of survival—the formulation of knowledges that require our disciplinary scholarship and technique but demand that we abandon disciplinary mastery and surveillance.” (Mitchell 1995) In this case, literally, the subject and site of the project is the space between disciplines.

Rather than encouraging a deceptively smooth integration of what may be fundamentally incommensurable forms of knowledge, this project aims to identify specific instances of both compatibility *and* difference in spatial studies. The need for such basic comparisons is particularly urgent in the realm of digital tools, techniques, and technologies that have fostered entirely new modes of spatial investigation in design and research. These D3T not only stretch the capacities of their disciplines, they threaten to outstrip emerging critical discussion about their uses and implications. More important, the conceptions of space that result from the uses of D3T are often reductive and implicit, as opposed to the intricate and explicit formulations that have emerged in the works and writings of spatial studies. Thus D3T begs critical discussion of the conceptual biases coded in their programming.

Architecture and geography have developed new digital technologies to represent spatial conditions. The capacities and uses of the most pervasive digital tools, CAD in architecture and GIS in geography, reveal the distinct differences in the two disciplines’ normative conceptions of space. In fact, D3T such as CAD and GIS tend to exaggerate those differences for several reasons. 1) As relatively new tools, their spatial capacities are limited and favor the most normative (the so-called “Cartesian” and “positivist”) concepts of spatial representation. 2) The medium and its interface -- the image quality, the data structures, the commands that operate software, and the physical properties of keyboard, mouse, and screen -- are highly specified but, for the most part, lacking the kind of nuance or rhetoric of more conventional representational traditions. 3) The rapid development of new software and faster computers has required users to spend much of their time keeping pace with technical change and has not allowed for a serious critique of these technologies. The rapid development and sheer amount of work being produced with CAD and GIS far outpaces critical scrutiny of the tools themselves. 4) Only a fraction of the individuals in each discipline is “literate” with the technologies, producing a discursive divide within each discipline and allowing what amounts to a subculture (or faction) to control the development of D3T.

For those reasons, a transdisciplinary project to compare how urban space is conceived, construed, and constructed in architecture and geography might begin with a comparison of the unintended capacities and logical limitations of CAD and GIS software as tools to analyze and represent *urban* spatial conditions. Modeling, rather than mapping, will be the term used to describe this work. Though mapping is generally understood in terms of systems of *projection*, modeling can be characterized in terms of *simulation*. Modeling also raises distinct disciplinary issues because the term is used in fundamentally different ways in architecture and geography. Those differences align with philosopher Max Black’s classic distinction between two types of models: scale models and analog models. (Black 1962) Scale models have a mimetic (or iconic) relationship to an original whereas analog models employ isomorphism or abstract depictions of a structure or web of relations. Architects and urban designers tend to employ scale models whereas geographers and planners have traditionally used analog models. (This aligns with the distinction between projection and simulation.) A parallel also can be constructed between Black’s theory and Graham Nerlich’s discussion of “absolute” versus “relational” space. (Nerlich 1976) In distinction from the predominant Western tradition of spatial relationism (an understanding of space itself as nothing but the relationships between things), architects tend toward spatial absolutism (an understanding of space as “an entity in its own right”). Further, the use of CAD to produce what are basically digital scale models reinforces this absolutist tendency. The logic of GIS, on the other hand, is distinctly relational and its models are analog.

This project involves the simultaneous production of two digital models of the same urban conditions using the same data (digitized maps, publicly available digital maps, and geographic information). The aim is to examine and to make manifest the problematic aspects of the theoretical frameworks that have emerged to explain the uses and value of GIS (ArcView) as a tool to analyze and represent space. As a means of comparison, this project will also produce spatial models using CAD software (FormZ) that is pervasive in architecture.

The project focuses on one of the primary applications of GIS known as "spatial analysis" which, according to one recent account, is "the heart of GIS" and "the foundation of modern geography." (DeMers 1997) Another describes spatial analysis as the application of GIS that is "likely to become the most widely accepted by the GIS community." (Monmonier 1990) In simple terms, spatial analysis in GIS allows a user to correlate and sort two kinds of data: *features* (or *entities*), which are considered "spatial" data because they are defined by their location on the earth's surface ("geo-coded"), and *attributes*, which are the so-called "non-spatial" characteristics of those features. For example, a feature such as a house has attributes such as size, value, owner, age, and construction type. Thus, through spatial analysis a GIS user could generate a map depicting the relative locations of houses with similar attributes, or displaying the attributes of houses in a particular location.

This mode of spatial understanding is fundamentally two-dimensional. Even when geo-coded data includes topography, it remains tied to a particular datum: a projection of the earth as a spherical form. No matter how complex the projection or how adjusted its geometry, GIS is never quite three-dimensional. (CAD, on the other hand, is a truly three-dimensional database. That technical fact, however, does not necessarily make CAD a more sophisticated spatial tool.) In fact, when topographies are modeled in GIS, height is an attribute of a feature and GIS therefore should be understood as "2.5D." (Heywood and Cornelius 1995, Bernhardsen 1999) As Bernhardson notes, this limitation is particularly troublesome for urban applications of GIS:

> *"Today we see that users have an increasing need for digital three-dimensional map data. This applies in particular for applications connected to urban areas. At present, commercial GIS is still only capable of handling two-dimensional topology. Even though relational databases support binary large objects (BLOBs) for storage of texture (building facades or similar), this type of data cannot be searched for as with other data. Therefore, new database techniques have to be developed in addition to relational databases and the special databases which are in use today. Models can be constructed, but should in this case be carried out in systems for computer-aided design (CAD)."*

At its most reductive, space in GIS is simply information that is tied to location. (Clarke 1999) In GIS, 'spatial' and 'geographical' are often used interchangeably. (Maguire 1991) Most important, the technical capacity of GIS to organize, analyze, and display data is not matched by a comparable complexity regarding spatial concepts, leading some to argue that GIS is inherently a tool for surveillance and control. Peter Taylor writes: "The merging of this technology-led mentality with the propensity of geography to study anything that is 'spatial' (i.e., everything) produces the imperialism of the new geography." (Taylor 1990) Other problems with GIS include its dependence on databases that are expensive to produce and often exclude "qualitative" data. (A notable attempt to address qualitative issues, though quite rudimentary from the point of view of architecture, is Parsons, 1995.) Michael Curry argues that GIS struggles to 'represent everyday practices' and there are severe 'limits' to representational capacity of GIS which he describes as: 1) the system's language and reason, 2) its weak modes of space, 3) its treatment of location as local and simply information. Curry proposes the notion of a "GIS2" which might provide more complete and diverse–hence, more "accurate"--representations, and be able to address issues of accessibility, power, privacy, and community. (Curry, 1998) Bernhardsen argues for "new database techniques" that include "searchable" 3D map data, especially for the study of urban areas. For these and other reasons, many commentators have criticized the lack of a sustained discourse on the ethics of GIS. (Lake 1993, Curry 1996)

3 SEÆMING

Seæming is a technique that developed out of several design collaborations, beginning in 1991. There are intriguing relationships to what Mark Taylor, in 1993, introduced as "the question of seeming/seaming." Taylor's use of the slash, or separatrix, reinstates the opposition between two homonyms, and thus *signifies* seæming. The use of the ligature "æ" ties the slash in a knot. Or, in other words, seæming takes Jeffery Kipnis's notion of "Twisting the Separatrix" entirely literally. (Kipnis

1991) Seæming can be described variously as i) a mode of diagramming that mimics the "ligature" of two terms: seam and seem; ii) "third generation" figure-ground; and iii) a mode of formalism that insists on merging "literalism" with more conventional pictorial and graphic modes. In each case, seæming is conceived as a specifically architectural practice that is concerned with the relationships between surface and space (or, "superficial space"). Seæming combines immeasurable concepts and modes of representation to produce hybrid representations that conjoin otherwise separate discourses. Emphasis is placed on the difficulties and complexity of the junction itself, and neither of the discourses is considered primary. In a mapping project, this means there can be no "base" map. What is of interest are the discrepancies, slippages, and combinations that are produced by joining discourses. An obvious example would be the joining of text and image. In fact, the word seæming itself demonstrates this conjunction of incommensurables: a ligature such as 'æ' can be understood as text and/or image depending on how the 'character' is treated. In the word seæm the ligature operates as both a letter and a literal knot: the word is also a picture. The technique can be applied to various complex spatial conditions and used to represent an understanding of space that is necessarily complex and multivalent. Seæming is used in this project to 1) address and supplement the reductive aspects of spatial thinking inherent in GIS terms such as "gap analysis" and "sliver polygon," and 2) explore and expand the capacities of CAD to depict data as an articulation of surface. (The Gap Analysis Project seeks to identify vegetation types and species that are not adequately represented in the current network of special management areas. These are the "gaps" in the present-day overall mix of conservation lands and conservation activities. This information is intended to be used by decision makers for proactive land management planning which we hope will lead to fewer species becoming endangered, and thus reduce the number of future conflicts regarding natural resource issues. It needs to be stressed, though, that Gap Analysis is intended to complement, not replace, the species-by-species approach to preserving biodiversity which is so critical to the survival of species now nearing extinction. The main goal of Gap Analysis is to prevent additional species from being listed as threatened or endangered."

References

Bernhardsen, Tor. *GIS: An Introduction*. 2nd ed., New York: John Wiley and Sons, 1999, 45, 85-6, 135.

Black, Max. Models and metaphors; studies in language and philosophy. Ithaca: Cornell University Press, 1962.

Clarke, Keith. Getting Started with GIS. 2nd ed., Prentice Hall Series in Geographic Information Science, ed. Kieth Clarke. Upper Saddle River, NJ: Prentice Hall, 1999, 2-3.

Curry, Michael. The Work in the World: geographical practice and the written word. Minneapolis: University of Minnesota Press, 1996.

Curry, Michael. *Digital Places: Living With Geographic Information Technologies*. N.Y.: Routledge,1998.

Heywood, Ian and Sarah Cornelius*. An Introduction to GIS*. Prentice Hall Series in Geographic Information Science, ed. Keith Clarke. Upper Saddle River, NJ: Prentice Hall, 63.

DeMers, Michael. Fundamentals of GIS. New York: John Wiley & Sons, 1997, 181, 21.

Kipnis, Jeffrey. "Twisting the separatix," *Assemblage* 14 (April 1991): 30-61.

Lake, Robert. "Planning and Applied Geography: Positivism, Ethics, and Geographic Information Systems," Progress in Human Geography 17 (September 1993): 404-13.

Maguire, David. "An Overview and Definition of GIS," 9-20, in David Maguire, Michael Goodchild, and David Rhind, eds., Geographic Information Systems: Principles and Applications, Volume 1: Principles, Essaex: Longman Scientific and Technical, 1991, 12

Mitchell, W.J.T. "Translator Translated: W.J.T. Mitchell Talks with Homi Bhabha," Artforum 33 (March 1995): 118.

Monmonier, Mark. "Geographic Information Systems. " In *Information Sources in Cartography*, eds. C. Perkins and R. Parry, New York: Bowker-Saur, 1990, 14.

Nerlich, Graham. The Shape of Space, London: Cambridge University Press, 1976.

Parsons, Ed. "GIS Visualization Tools for Qualitative Spatial Information," 201-10, in Peter Fisher, ed. *Innovations in GIS 2*, London: Taylor & Francis, 1995..

Taylor, Peter. "Editorial Comment: GKS," Political Geography Quarterly 9 (July 1990): 211-2.

Walsby, Jennifer. "The Causes and Effects of Manual Digitizing on Error Creation in Data Input to GIS." In Innovations in GIS 2, 113-22, ed. Peter Fisher, London: Taylor and Francis, 1995.