AUGMENTING GEOGRAPHIC INFORMATION WITH COLLABORATIVE MULTIMEDIA TECHNOLOGIES

Michael J. Shiffer
Massachusetts Institute of Technology
Department of Urban Studies and Planning
77 Massachusetts Avenue, Room 9-514
Cambridge, MA 02139

ABSTRACT

Many urban and regional planning situations involve informal queries about physical environments such as "What's there?" or "What would it be like if... ?". These queries may be supplemented with a variety of geographically-based information such as maps, images, narrative descriptions, and the output of analytic tools. Unfortunately, many analytic tools, (such as population forecasting models, etc.), lack the descriptive abilities of images and human gestures. For example, while a spreadsheet macro may supply the population density of a given area, it is not able to provide an example of "how crowded the streets will be". Similarly, quantitative representations of environmental impacts, such as noise, may be meaningless to the lay person. This paper explores the implementation of a collaborative multimedia system designed to improve the communication of planning-related information. This is being accomplished through the integration of maps, analytic tools, multimedia images, and other relevant data. The resulting information base is projected on the wall of a meeting room. Participants interact with the system using cordless pointing devices. An implementation of a collaborative multimedia system in Washington D.C. is described. Following that description, the issues surrounding a more widespread implementation of this and similar technologies will be identified.

INTRODUCTION

Planning commission meetings in large metropolitan areas are frequently concerned with the environmental impacts of proposed developments upon the built environment. These situations often require a set of technical analyses that include changing assumptions and priorities, descriptions of significant visual and audible impacts, and may also involve several geographically separated parties such as consultants, developers, and city planners. Furthermore, these meetings often utilize physical, electronic, and cognitive information. Physical information is typically delivered using documents, maps, and images. Electronic information is typically delivered using computer-based information systems (Klosterman, 1992). Finally, cognitive information is delivered using human recollection and story-telling (Forester, 1982). Difficulties are often encountered when accessing these information types. These include organizing physical information in a cohesive and accessible manner, communicating technical information to non-technical audiences, and the individual orientation of computers. That is, most computers are designed for interaction with one person at a time.

A strategy has been proposed to address the difficulties encountered when accessing information in collaborative planning settings such as the commission meetings described above (Shiffer, 1992). The strategy makes use of a collaborative planning system (CPS) that (1) organizes multimedia information such as renderings, architectural drawings, video clips, and the output of analytic tools in an associative form; (2) provides facilities for the "real time" annotation of maps with text, graphics, audio, and/or video; and (3) aids the representation of normally quantitative information using descriptive images such as digital motion video and sound.

After a brief background description of CPS, this paper will describe a limited implementation of a CPS in Washington D.C. Following that description, the issues surrounding a more widespread implementation of CPS and similar technologies will be identified.

BACKGROUND

Analytic tools such as Geographic Information Systems (GIS) and spreadsheet models have the potential to be tremendously useful to planners for providing forecasts and modeling various phenomena. Yet they can be practically useless to individuals who may not understand how to implement such tools properly. The difficulties encountered in mastering these tools often cause less technically-oriented people to be excluded from the planning process. Thus analytic tools and their outputs need to be made more visually (or audibly) appealing, so that information that would normally be meaningless and intimidating can be made understandable.

A recent technological trend that addresses the need for usable tools has been the development of representation aids for human-computer interaction (Zachary, 1986). Representation aids overcome the need to memorize computer commands by translating the user's 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. By doing this, the user can make "rapid incremental reversible operations whose impact on the object of interest is immediately visible" (Hutchins, Hollan, & Norman, 1986, p. 91). Representation aids will not completely replace quantitative measures of environmental phenomena. Rather they will serve to supplement such measures through multiple representations (Rasmussen, 1986). Multiple representations of a problem enable the user to view information in several different contexts thus offering the potential to generate alternative approaches to a problem.

Another common problem that faces users of analytic tools is the individual orientation of their delivery mechanism. While these tools can be brought into collaborative environments with the aid of laptop microcomputers, they are often usable by only one or two individuals to the exclusion of other meeting participants (Stefik, et.al., 1988). Computer-supported collaborative work (CSCW) addresses the drawbacks associated with individual computer usage by putting computer-oriented tools into meeting environments which may be physical, as in small group meetings; distributed, as in local area networks; or virtual, as in "meeting rooms" found on electronic bulletin board services (BBS). This paper is concerned primarily with small physical meetings of four to ten people. Stefik et al, (1988) espoused the benefits of collaborative computer systems when they noted that computers are often left behind in favor of more passive media like chalkboards and flip charts when meetings are held. Their development of the Colab at the Xerox Palo Alto Research Center (PARC), represents an attempt to demonstrate the collaborative capabilities of computers using a prototype meeting room.

Collaborative Planning Systems (CPS) are designed to take advantage of both representation aids and CSCW in order to present planning-related information in a form understandable to the heterogeneous groups of people that frequently participate in environmental reviews. In addition to this, CPS are designed with an associative hypermedia data structure (Conklin, 1987; Wiggins and Shiffer, 1990) in order to provide a framework for access to non-standard data types such as anecdotal evidence. In most cases, CPS are implemented in conference rooms where environmental reviews are held. They are used as reference tools and are typically projected on a wall where participants may interact with them using infrared pointing devices.

CPS IMPLEMENTATION: WASHINGTON, D.C.

The Planning Support Systems group of MIT's Department of Urban Studies and Planning has recently completed an investigation of information use and communication in the planning organization. Using the National Capital Planning Commission (NCPC) as a test bed, the research group explored information management difficulties in the context of NCPC's planning process and how new technology and a sustainable information infrastructure could improve the land-use planning process. NCPC is the central planning agency for the Federal Government in the National Capital Region around Washington DC. This case describes a portion of the overall research effort that is concerned with supporting a collaboration between NCPC and the United States Department of Transportation (DOT) to study a corridor along Washington's North Capitol Street for a potential DOT headquarters site. This part of the research involved the development, testing, and initial implementation of a CPS.

CPS Structure

The CPS displays maps with various overlays that are linked to descriptive video images, sounds and text. It is implemented in NCPC's "commission room". The system uses a Macintosh Quadra 900 computer at the "front-end" of a heterogeneous network of IBM Compatible PCs and UNIX workstations at the NCPC. The Quadra, which runs Apple's Quicktime for digital video display and Aldus Supercard for media integration is hooked directly to a video projector and an infrared pointing device for user interaction.

In addition to the digital information contained in the "back-end" of the CPS, (GIS coverages, databases, images, etc.), a variety of physical information is routinely added to the system. This includes maps, images, text and video tape that may have been collected as part of a planning review. This physical information is converted to a digital format using various peripheral devices such as scanners, video digitizing boards, and digitizing tablets. After this, the digital information can be transferred to the collaborative planning system, archived in the repository of digital information using the networked UNIX machines, or both.

There are two types of data communication between the CPS front and back ends, real-time and asynchronous communication. Real-time communication offers immediate responses to the CPS workstation resulting from queries sent to the UNIX network. This works best where information can be attained immediately through direct manipulation. Asynchronous communication is a means for displaying information that is not easily retrievable in real-time. An example of this type of communication is where a model that renders sunlight and shadow patterns may take several hours to generate a viable set of representations, several plausible scenarios can be modeled prior to a given meeting and then incorporated into a library of potential alternatives contained the CPS. The rapid display of this information can be attained using an appropriate interface metaphor, such as the hands of a clock, which would then yield a result.

Activities Supported by the CPS

The CPS supports several planning-related activities that focus on a selected site. These activities include: land use analyses, automobile traffic analyses, assessments of visual environments, and illustrations of proposed changes to the visual environments. These descriptions allow planners to begin the analysis of potential impacts by allowing them to rapidly retrieve, integrate and compare existing and proposed conditions. In this section we discuss several CPS components that make these activities possible.

Land Use Analysis The study of existing land use patterns is implemented through interactive land use, zoning, and building height maps. Each of these maps consists of transparent color polygons overlaid onto an aerial image of the study area. Summaries of the information represented by these polygons appear as the user selects the areas with a pointing device. As the user moves the pointer around the map, the displayed summary changes to reflect the zoning of the currently selected area. For the zoning and land use maps, the polygons and associated summary displays are color-coded to allow the user to visually distinguish them from other adjacent zoning classifications and land uses. In addition to the color coding, the zoning summaries contain a brief textual description of the zoning classification and information about maximum height, maximum lot coverage, and maximum floor area ratio for the selected area. The land use summary uses a color coded descriptor along with a textual descriptor derived from the draft environmental impact statement provided for the site.

Another description of land use is provided using a building height indicator. As the user points to a building on the map, the height of a selected building is indicated by a vertical bar in a window that also contains a representation of the U.S. Capitol building. When the pointer is moved around the map, the bar inside the window will slide up or down to represent the selected building's height in relation to the Capitol building. The selected building's height (in feet) is represented numerically below the bar thus providing an example of multiple representations.

Automobile Traffic Analysis The study of existing automobile traffic flows uses an interactive traffic map that displays values of average daily traffic for selected street links in the study area. Traffic data, located in a window containing multiple representations of average daily traffic, is accessed by pointing to an associated street link on the interactive map. In addition to the traditional numeric representation, the average daily traffic values are represented graphically, with a bar; dynamically, with a clip of digital motion video; and audibly, with the level of traffic noise played back at the level experienced in the field. While the bar graph may look redundant in the static image portrayed in Figure 1, its utility becomes apparent as one points to different streets on the projected map, causing the bar to fluctuate. In this manner, users can compare relative levels of traffic to one another more easily.

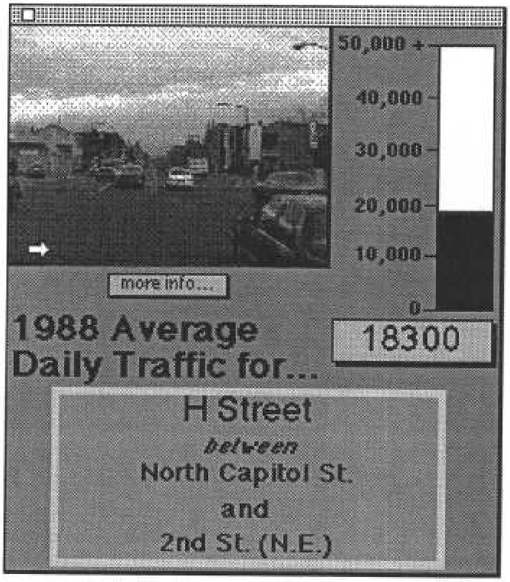

FIGURE 1: Average Daily Traffic Analysis

Assessments of Visual Environments To better understand an area under study, it may be necessary to view it from several different perspectives. The ability to analyze the existing visual environment in the study area is made possible through the use of digital video. Several types of digital video shots have been incorporated into the CPS. The three main shot types are fixed position, 360 degree axial view, and navigation.

The fixed position shots allow the user to view a video clip of a particular site from a fixed camera angle. They are symbolized on the visual quality map as arrows that match the direction of the camera's angle. Some of the sites are viewed from several different angles that allow the user to "switch" perspectives the same way a television director can switch cameras to show different angles of a sporting event. In this manner, a subject can be viewed from several vantage points.

The 360 degree axial view allows the user to look completely around from a fixed vantage point. They are represented as circular symbols on the visual quality map. These views are useful for illustrating the environment surrounding a particular location. They allow the user to pan to the left or right by selecting the appropriate arrows at the bottom of the displayed image. The 360 degree axial views offer an additional view of what is behind the camera by allowing the user to pan around to look at the surrounding area.

The navigation images allow users to drive or fly through the study area. They are designed to aid visual navigation by enabling the user to view a geographic area from a moving perspective such as that experienced when traveling through a region. Navigation images are represented on the map as linear symbols that represent the routes available to the user. They are illustrated as large arrows in the lower right window of Figure 2.

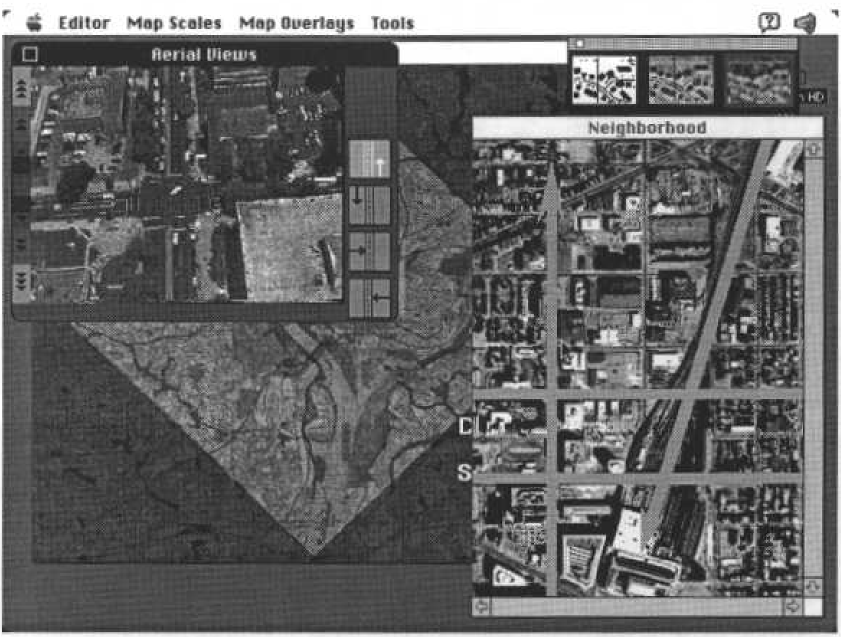

FIGURE 2: Visual Analysis using Aerial Images

The video image in the upper left corner of Figure 2 represents an oblique navigation image of a selected street from an altitude of 500 feet. The controller at the left edge of the "Aerial Views" window, (the upper left window), allows the user to control the direction of flight (forward or reverse), as well as the speed of flight, by sliding the pointer towards either end of the controller. The user can determine the camera angle by selecting one of the iconic buttons at the right side of the "Aerial Views" window. The arrows on the icons represent the direction the camera was pointing with respect to the subject (in this case, the subject is the street).

Illustrations of Proposed Changes to Visual Environments The CPS enables users to qualitatively assess proposed changes to the visual environment by allowing easy access to images of architectural models and artists' renderings. By selecting the appropriate map overlay, a rendering of a proposed development appears at the appropriate geographic location on the base map along with arrows that are linked to various perspective views as shown in Figure 3. Selecting an arrow yields an image of an architectural model or rendering in a separate window, with controls allowing users to navigate around the image by "zooming" or "panning".

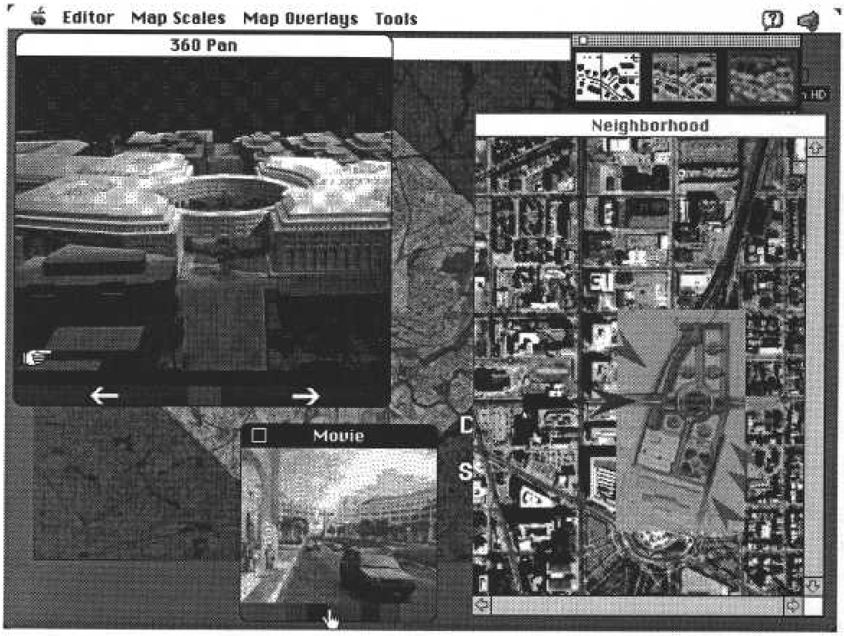

FIGURE 3: Illustrations of Proposed Changes to Visual Environments

These options allow users to inspect the proposed site in three ways. First, they can view the proposal from various perspectives around the site by selecting appropriate arrows linked to the map. Second, users can sequentially move through a series of site images while an associated arrow highlights on the map as each image is displayed. Finally, they can navigate around a specific rendering by zooming or panning with on-screen controls.

CPS Implementation

There are several specific contexts in which a CPS can be implemented. The system's wide range of usability makes it possible to adapt it to a variety of situations. Several of these situations are described below.

Demonstration of Capabilities Here the implementation of the tool serves to educate others about its power and capabilities. This education is also an important precursor to system implementation as a reference, data collection, or visualization tool. Often times, this is the only context in which the system is implemented.

User introduction to the system can be accomplished by relating the system to a familiar metaphor such as a slide show or a map. The next aspect of system implementation involves user familiarization with the system's geographic coverage area. This familiarization involves using system metaphors such as ground level images, aerial photos, and maps, to help users to orient themselves geographically to the community or study area. To familiarize users with the system's analytic tools, an example of an addressable problem can be worked through. In the context of such a problem, the users can familiarize themselves with the geographic coverage of the system and the analytical tools that the system contains. In this manner, the range of questions that the system can address can be defined for the users.

Presentation Tool In this context, the system can be used for the presentation of various proposals. The system's multimedia aspects make it a strong tool of persuasion. In particular, the ability of the system to use different media to represent different aspects of the same phenomena can enable a wide range of participants to reach a common understanding.

The systems persuasive abilities can also open the door to misuse. While it can clarify truths, it can also cast a veneer of legitimacy over untruths. This can be either an intended consequence or an unintended one. One can tell very different stories by presenting the same materials in different contexts. The use of representation aids can also aid the understanding of various models and scenarios. However, there is concern that representation aids can over simplify the output of a particular tool. This simplification can lead to a "black box" effect.

Facilitated Reference In this context the system acts as an information resource that can be drawn upon when needed. Information within the system can be attained 1) geographically, by participants pointing to a map, 2) visually, by participants scanning through a set of images while looking for specific visual criteria, and 3) textually, by searching for key words and phrases. These three avenues into the information will yield the display of phenomena using several media.

Data Visualization This context allows users to visualize large amounts of data such as traffic projections or shifts in demographics. This visualization is accomplished with the help of multiple representation aids. Representation aids can influence the display of various types of data so that they may be more readily understood by the users. This can be accomplished using multimedia tools such as digital video, animated graphics, and sound to make the human-machine interaction so engaging that the computer essentially becomes "transparent" to the human.

CONCLUSIONS

There is a considerable amount of work that is yet to be done in order to institutionalize this technology so that it can be routinely used in an organization without the need for extensive construction and reprogramming. On the software side, more effective tools need to be created that allow the rapid creation, organization, and linking of multimedia information by relative novices. Similarly, object-based programming tools need to mature to a point where they can be used by planning staff who are not "computer programmers". At the institutional level, there needs to be a commitment of staff time for training as well as the management of such a system. Additionally, there are several areas that beg further investigation as a result of this initial implementation. These include:

Analyzing public impact of the technology.

It is necessary to explore the benefits and drawbacks experienced when attempting to implement this technology in an environment intended to facilitate public discourse. The visualization tools contained in collaborative planning systems can empower groups and individuals who have traditionally been informationally disadvantaged due to a lack of technical sophistication, thereby allowing more people to become involved in the generation of alternatives. Exactly who benefits from such empowerment will depend on the situations in which the technology is implemented and begs further research.

Representation of information.

Just as these tools have the capacity to provide rich and compelling representations of environmental conditions, they have the capacity to provide rich and compelling misrepresentations. The issue of the relative trustworthiness of the information presented is going to float to the top of the discussions with increasing frequency.

Assessment of the cost-effectiveness of these tools.

While these systems have been demonstrated to be effective presentation aids, their cost effectiveness depends upon whether they are customized systems built entirely for a single 'presentation'; or generalizable, 'pre-fabricated' components that are easily assembled in Lego-like fashion from data, model, and graphics repositories.

Finally, the research opens the door to experimentation with more proactive planning styles using the new computing environment and information infrastructures. It is hoped that the planning process could be democratized using tools such as the Collaborative Planning System to bring data and analyses to a wider audience.

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