Spatial Multimedia for Planning Support*

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INTRODUCTION: CHALLENGES TO KNOWLEDGE SHARING

Sharing knowledge has become an increasingly important part of the planning process, especially in light of federal, state and local initiatives that mandate a certain degree of public participation. For example, the "Intermodal Surface Transportation Act" of 1990 requires that there be public input at the early stages of any project. This is not necessarily new. The participation of the public has been an important element of planning processes for years (Steger, 1972). There are a variety of political, institutional and administrative limitations to sharing knowledge in public and semi-public forums. Rather than highlighting these, this work sets out to address functional limitations that may exist where all parties are indeed willing to communicate, but where the participation of stakeholders with a wide range of skills and knowledge makes communication difficult.

To better understand these functional limitations, it is first useful to understand how people share knowledge about the future of their communities. Knowledge in the planning context is frequently shared by means of communicating recollections of the past, descriptions of the present, and speculation about the future. We will now briefly explore these three communicative activities and identify some of the challenges associated with each. The next section will explore how spatial multimedia is positioned to address these challenges.

Recollection-related conversations may incorporate what was said, what was done, or what a place was like. For example, members of a group may try to recall the impact of past projects, in order to improve their understanding of what may lie ahead in similar circumstances. Structured recollection can incorporate records and systematic documentation of past interactions. However, access to this information can be dependent on having a specialized information recording and retrieval "system," such as the official minutes of previous meetings. Such methods of recollection rarely incorporate any degree of spatial referencing. Where systematic documentation is lacking, the high level of dependence on human memory can lead to problems of inconsistent individual memories of past experience. This can result in arguments that dominate a discussion and shift the focus of a meeting from the matters at hand.

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* Forthcoming (2000) in: Brail & Klosterman (eds.) "Microcomputers in Urban Planning". New Brunswick, NJ: CUPR Press. Animated illustrations and presentation slides from this paper can be found at: http://yerkes.mit.edu/shiffer/MMGIS/title.html

Descriptions of present conditions generally involve getting everyone in a collaborative situation "on the same page" with respect to an area being discussed, so that everyone can work from a common base of spatial knowledge. Verbal spatial references, such as "near the transit station" can be inappropriate where some participants lack familiarity with a site. This problem can be addressed through the use of an up-to-date map as a central reference point. The map's use can be further enhanced using photos or video. This juxtaposition can strengthen a group's understanding of the various characteristics of a given site. Until recently, however, such juxtapositions have been limited by their dependence on the integration of various physical objects, (such as paper maps and photos), as well as electronic media that could be either analog or digital.

Speculation about the future of an area can be either informal or heuristic (based on "rules of thumb") or it can be systematic and formalized. Informal speculation may involve people applying their memories of past experience (such as perceptions of how traffic changed after a new development opened). More formalized speculation will typically draw upon systematically collected data that indicates a relationship that can be expressed quantitatively (such as with travel demand modeling). Regardless of which form speculation takes, it typically involves learning from past experience and applying those lessons to the future. Real-time augmentation of public discourse using speculative aids (such as computers) has traditionally been limited by a lack of human-computer interactivity and somewhat abstract output. In public situations, this could result in the inadvertent exclusion of various stakeholders from the technical points of a conversation. For example, technical output such as noise or automobile traffic levels can be challenging to convey to non-specialists.

Sharing knowledge in a planning-related setting thus involves difficulties stemming from inconsistencies in recollection of past experience, descriptions of areas of interest that relevant parties may be unfamiliar with, and abstractions resulting from technical explanations that are derived from speculative models. This work will now explore how information technology, "and spatial multimedia in particular," is positioned to address these impediments to knowledge sharing.

IMPLEMENTATIONS OF SPATIAL MULTIMEDIA

Many of the challenges described above have been addressed through various implementations of multimedia information technologies (see, for example Câmara et al, 1991; Fonseca et al, 1993; Jones et al, 1994; Laurini and Milleret-Raffort, 1990; Polyorides, 1993; Shiffer, 1992). Spatial multimedia (as discussed in this context) capitalizes on the integration of video, sound, text, and distributed communication. Recently, MIT's Department of Urban Studies and Planning has been working with several government agencies and private firms to identify effective combinations of tools and techniques for the support of city planning meetings. The overall goal of this research is to improve the communication of planning-related information with a specific focus on the environmental effects of proposed urban interventions.

Annotation Mechanisms to Support Recollection

Spatial annotation mechanisms allow users of an information system to relate their comments to a geographic (or spatial) area. These have essentially been with us since ancient times when humans would draw in sand to illustrate spatial relationships while telling stories. They can be as simple as pens, pins or other devices that might be used to mark up a shared map or diagram. In fact, 3M's Post-It Note® is probably one of the most significant and accessible spatial annotation technologies to be developed in recent times.

Spatial multimedia gives us the capacity to link ideas and comments to simple marks that we make on shared electronic maps either before, during, or after a meeting. It goes further by allowing us to link external resources, such as text, sound or imagery that may be either centrally located or distributed across a network to maps. Planners can take advantage of various types of digital annotation. For instance, at the simplest level such annotations might be simple graphical marks (such as lines, circles, dots, etc.) that are intended to convey spatial flow, physical alterations or a multitude of related concepts. Such graphical marks would likely be tied to a variety of more descriptive annotations. The remainder of this section will describe three types of annotation (text, audio, and video) along with some of the benefits and drawbacks associated with each.

Textual Annotation

Spatially-linked textual annotation typically takes the form of an "Internet-like" discussion thread that is linked to a location on a map shared over a network. In essence, a user could click on a map location to access an "Internet-like" discussion thread that relates to that spatial area. As opposed to the other forms of annotation described below, textual annotation offers the benefits of exceptionally low storage overhead (and subsequently low demands on network resources). Furthermore, its levels of descriptiveness are limited only by the prosaic talents of the contributors.

Audio Annotation

Audio annotation allows one to link verbal comments to a location on a map. This is accomplished by simply speaking into a microphone that is linked to a computer-based digitizer. This can theoretically work more rapidly than other forms of annotation. However, early experiences have demonstrated a reluctance to annotate a map with one's voice due to the awkwardness of stopping a meeting and concern about how one's comments might be viewed out of context.

Video Annotation

We have the capacity to link video images of contributors to maps in a manner similar to audio annotation. Such a system might be employed as part of a kiosk installation in a public place where voluntary comments could be solicited from the public using an embedded camera. This has the effect of enabling one to view "the face behind the name."

On the positive side, this can lead convey expressive and compelling opinions about various proposals. On the negative side, such images can lead to eliciting unintended bias on the part of the viewer (who can, for instance, make judgements based on appearance). Furthermore, video annotation requires significant storage overhead and can be exceptionally difficult to convey through as network using existing technologies. This last concern is being addressed with continual advances in compression technologies and network bandwidth.

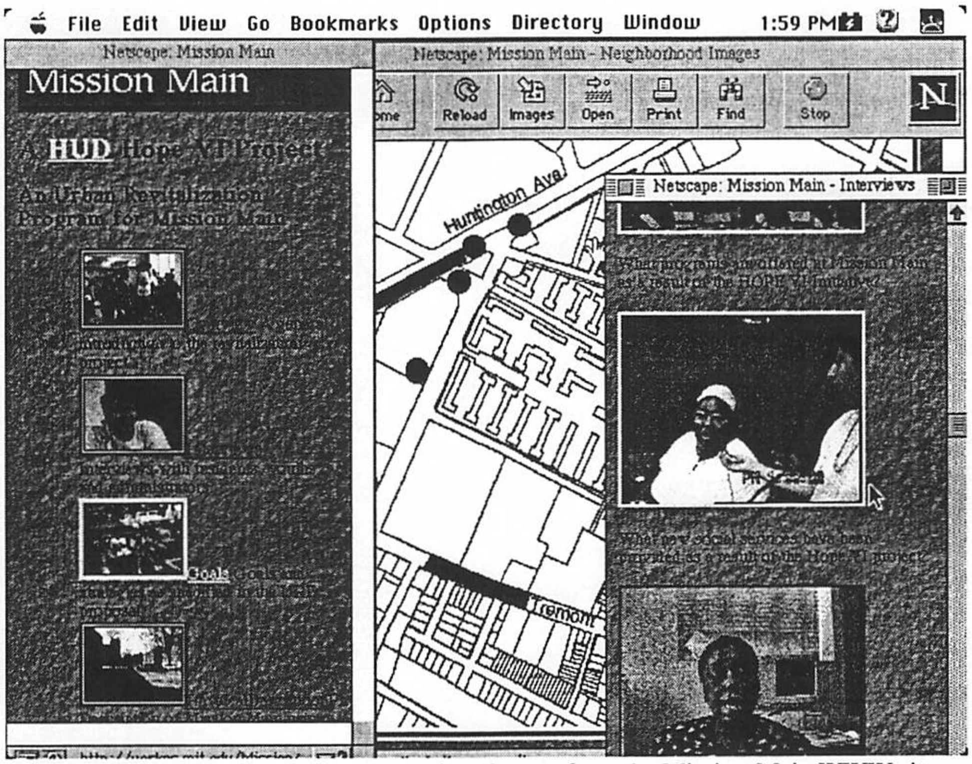

Figure 1: An example of video annotation: Scenes from the Mission-Main WWW site.

Initial Evaluation of Annotation Mechanisms

The archive that results from multiple annotations can assist with recollection during subsequent meetings. Access to this archive can be based on geographic relevance, chronological relevance and associative relevance. Geographic relevance allows users of an information system to search for annotations that are related to a specific region or sub-region using typical GIS spatial selection operations. Chronological relevance allows a user to add the capacity to search for annotations made before, after or between two dates. Finally, associative relevance allows searching by keywords or related concepts that could be linked together in a WWW-like associative structure.

While it is certainly conceivable that GIS-based archival mechanisms can be set up to aid future recollective efforts, this requires that a substantial spatial data infrastructure be already in place. As we are only beginning to realize the development of substantial spatial data infrastructures around the world, we will need to continue to rely on the (frequently paper-based) libraries of local historical societies for more specific spatial descriptions that can effectively convey the character of a local area. Even in this case, the issue becomes a question of what material is worth maintaining, which has profound implications for the scalability of such a system. For instance, is it reasonable to expect a planning council to archive a spatial representation of every proposal made along with the corresponding minutes of every planning meeting? If so, what is a reasonable time frame for keeping the record in the archive? Five years? Fifty Years? Forever? If not every proposal is archived, then how is the choice of "what is relevant" made? These questions aside, such annotations have the capacity to significantly enhance recollection by providing a means of encoding informal memories of a location. These can be juxtaposed with other forms of information, such as those described below.

Visual Navigational Aids to Support Description

Another implementation of spatial multimedia for planning involves visual navigational aids. These have had the capacity to support descriptions of existing, past, or proposed conditions of a place by offering a link between oblique imagery and orthographic maps for many years now. This section will begin by discussing technical developments and early experiences with computer-supported access to imagery. This discussion will briefly take us through analog video disk to digital still and digital motion video along with some planning-related experiences with each. We will conclude by discussing the various techniques that can be employed to support the development of "shared visions" of existing conditions in urban spaces with nodal, navigational, and fixed position imagery.

Figure 2: Panoramic photo of Park St. Station, showing Park St. Church and State House in distance, Boston, Mass. Copyright E. Chickering & Co., October 22, 1903. (From U.S. Library of Congress American Memory Collection).

Evolution of IT to Support Visual Navigational Aids

The whole point of visual navigational aids has been to support a shared vision of an urban area. This has evolved from the panoramic photos of urban landscapes in the early 1900s (see figure 2) to vehicular mounted motion picture cameras from the early days of film in the same era (as illustrated in figure 3). It has also included mid-century interpretation of aerial photos for military intelligence and later urban planning purposes (Branch, 1948) and post-WWII time lapse studies of public spaces (Whyte, 1979).

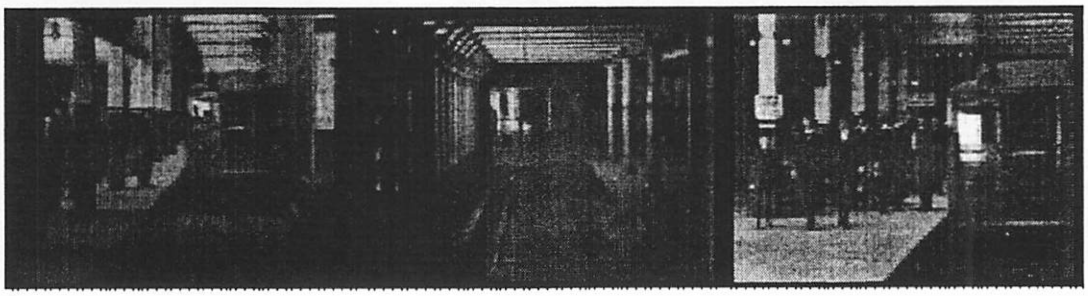

Figure 3: Scenes from navigational film titled: "Interior New York subway, Fourteenth Street to Forty-second Street", Copyright: American Mutoscope & Biograph Co.; 5June1905 (From U.S. Library of Congress American Memory Collection).

- ***Random Access to Images via Computer Controlled Analog Devices***

One of the earliest practical applications of information technology to allow visual surveys of the built environment was the conventional[1] video disk. Applications such as the BBC Domesday Disk (Rhind et. al, 1988) and the "Aspen Disk"

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[1] By "conventional" I refer to the analog video disks that were popularized in the 1980s by Pioneer's Laserdisc system as opposed to the more recent Digital Video Disc (DVD) technologies that have been developed for home entertainment.

developed by the MIT Media Lab (Brand, 1987) provided early examples of how computer control of a video disk machine could provide virtually instant access (frequently under 1second) to any one of 54,000 video frames on a single disk. Still greater capacity could be provided by connecting more than one disk player to the same computer. In some cases, such as with the St. Louis Riverfront project (Shiffer, 1990), a relevant video frame on the disk would be accessed through a look-up table or database that would relate a selected coordinate on a map with the associated video frame(s)[2] . Video disk technology was particularly adept at allowing a user to access information through the navigational metaphor. This is largely due to the technology's design for the playback of motion pictures at variable speed.

This capacity of video disks to allow for variable speed navigation was illustrated during several meetings held by the St. Louis Community Development Agency. In one such meeting, a computer, video disk player and large television monitor were situated at the front of the room. After a brief introduction to the technology, (to prevent later digressions), the meeting proceeded with a proposed bicycle trail along the St. Louis Mississippi Riverfront as the topic of conversation.

In this situation, whoever had "the floor" (typically a planner) would direct a technical specialist to "fly" a conceptual helicopter up and down the river stopping at various locations to examine them further. Further examination would consist of viewing a site from several different perspectives or zooming into a specific location for a closer look. The capacity to view from multiple perspectives was made possible by actually filming the riverfront from the different perspectives and actually relating the different views using the map as the common reference point. Zooming was accomplished (rather crudely) by simply magnifying the image on the television screen.

Although it provided what was (and still is) one of the fastest mechanisms for access to images, video disk technology was not without significant drawbacks. The primary drawback was the added cost that would be incurred for the hardware necessary to display the video images. In the simplest case this might be a video disk player and a separate monitor. A more complex setup would involve the display of the video images on the same screen as the map (made possible through a video overlay board for the computer). Since most conventional video disks were designed as a read-only medium (for example Pioneer's Laserdisc system), still greater cost would be incurred if one were to purchase a recordable video disk machine. These machines were typically 20 to 50 times the price of a conventional video disk player and were thus out of the financial reach of many planning agencies.

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[2] Sometimes more than one frame would relate to a single location such as where images would be available to allow the user to view a site from several different perspectives (or at different points in history).

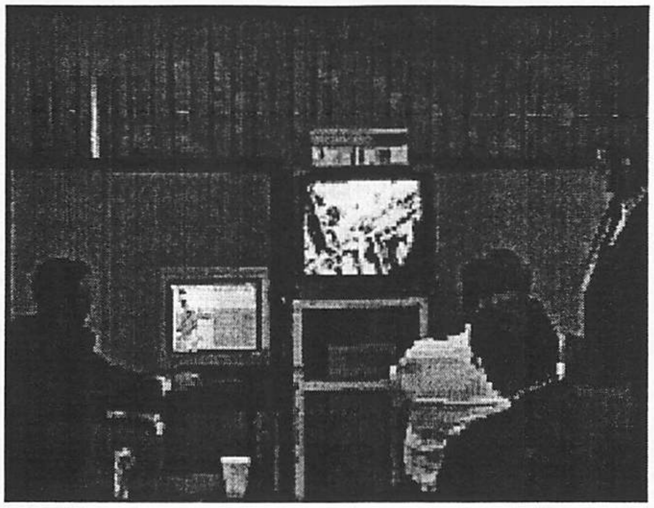

Figure 4: Computer-controlled video disk machine in use during a planning meeting in St. Louis.

Finally, a significant drawback of video disk technology is the fact that the video images stored on the disks are non-digital and would require electronic transfer through a digitizing board if they were to be manipulated on a computer. All of the above drawbacks (and the resulting "customized" hardware setups required to electronically link images with maps) resulted in little adoption of this technology by planning agencies. In the case of the St. Louis example, the inflexibility of the technology to easily adapt to new areas of study (or to be effectively updated for existing areas of study) caused the video disk approach for visual surveys of the built environment to be abandoned after a very limited period of time.

- ***Digital Still Images***

One technology that rapidly began to supplant the use of conventional video disks was the capacity to store large quantities of images on computer-readable media. This was made possible by low-cost advancements in image compression, hard disk (and other high speed storage device) capacities, and effective mechanisms for the capture and subsequent transfer of high quality images into standardized digital files. Thus it has become unnecessary to have a customized hardware configuration to display the images and maps that support visual surveys of the built environmemt.

In the simplest implementation, still images can be linked to points on a map. For example, an application for Crawford County, Illinois provided an example of how scanned maps at varying scales could be linked to digitized photos of specific areas. The implementation was designed to support a historic preservation workshop of students at the University of Illinois at Urbana-Champaign. The system focused on four small towns in the central Illinois county where the project participants were primarily concerned with historic preservation initiatives in the town centers.

Development of this system consisted of scanning existing topographic maps for each town along with an overview map of Crawford County. Transparent color polygons were overlaid on points of interest. In the case of the county map, a polygon was overlaid on scanned map. The maps also contain transparent color polygons highlighting sites of interest in the towns. Pointing to these areas yield more detailed maps or site sketches that include arrows to represent camera locations and angles for corresponding photographic images that were taken from a ground-level perspective. Selecting an arrow would highlight it and display the appropriate photographic image in a separate window (Figure 5). The users could also search through the photographic images for specific visual criteria and see the corresponding locations highlight on the map.

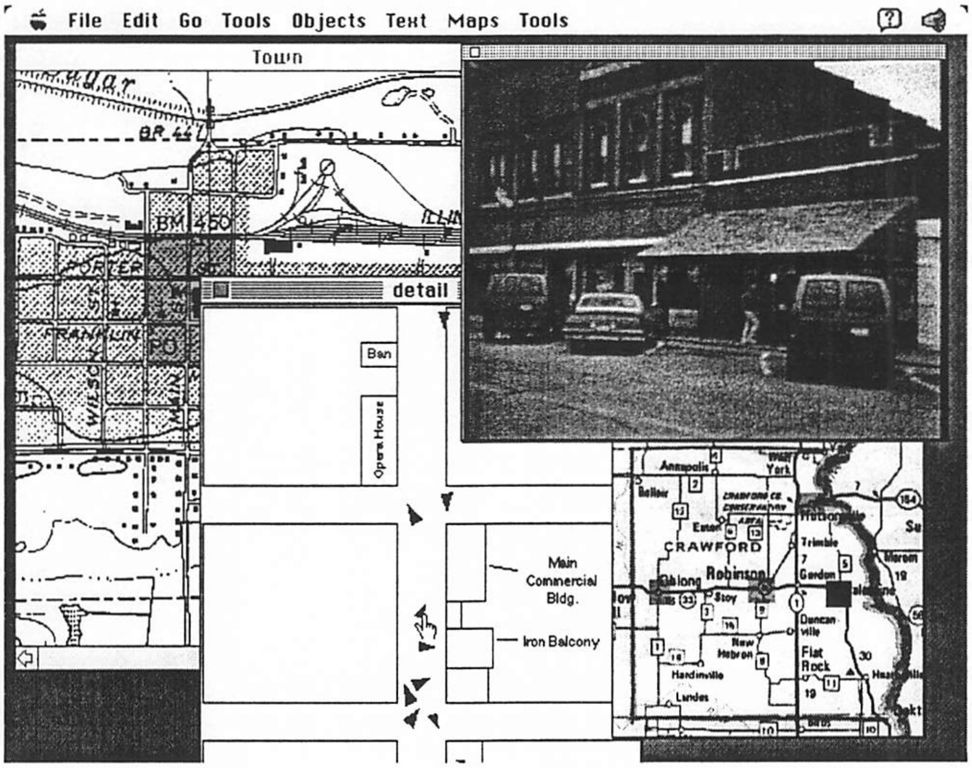

Figure 5: The interface of the Crawford County visualization tool as developed in 1988.

Another relatively early example of how a set of still video images could support visual surveys of a built environment was provided through an experimental collaborative planning system that was developed for Rantoul, Illinois in 1988. Among other things, the system (as described originally in Shiffer, 1992) supported visual surveys of the built environment using a basemap, (consisting of aerial orthographic photos), linked to a digital video window that displayed oblique aerial views of a site looking north or south from a 1000 ft altitude at 45 degrees. This navigator allows one to "fly" around the community looking for specific visual criteria that may not be apparent using orthographic aerial photos or ground level views. The navigator's controls allow one to fly north, south, east, or west while looking north or south. The relative location of the viewing area in relation to the rest of the site is automatically tracked on an overview map of the site during the "flight". A particular viewing area can be accessed in the video window by selecting a location on the overview map with a pointing device. The illusion of forward (or backward) navigation was accomplished by dissolving sequentially through a set of still images. Navigation to the right or left was simulated using graphical visual effects that would "move" still images appropriately.

In addition to the aerial oblique images described above, the Rantoul implementation incorporated panoramic images taken from an "eye level" perspective. This would allow users to select a location on a map that would display an image of a location and "pan" around to view the surrounding area. This was accomplished by rotating a video camera 360 degrees at pre-determined locations. Selected frames from the video would then be digitized and "electronically "pasted" together (in much the same manner someone might tape together holiday snaps of a sweeping vista) to create a very wide 360 degree panoramic image. When viewed in a smaller window on a computer, the act of scrolling to the right or left would give the user a sense of "turning" to the right or left. The resulting video segments would be linked to their corresponding locations on a base map. The capacity of such panoramic images to illustrate the entire area around a selected location proved to be quite useful in the case of Rantoul where specific attention was being paid to the evaluation of a former U.S. Air Force base for re-use alternatives.

- ***Digital Motion Video***

The Crawford County and Rantoul implementations of technology for visual surveys of the built environment offered significantly greater flexibility over video disk-based methods due to their all digital formats. The resulting "animations" (to convey a sense of motion to the user) were crude but effective. Nevertheless, they suffered from the fact that standards for digital video file formats had yet to be invented at the time of their use. Furthermore, these non-standard methods of displaying video tended to be cumbersome due to slow performance and large file sizes.

In the early 1990s several "standards" for digital motion video files began to arise. These included (among others) the Motion Picture Expert's Group (MPEG) standard, Apple's Quicktime, and Microsoft's Video for Windows . These file formats allowed significant space savings due to compression algorithims. They also had the capacity to allow for a variety of playback speeds and control mechanisms. This, combined with a capacity to rapidly access still frames from within a motion picture file, made it possible to effectively mimic the functionality of a laser disk machine entirely within software.

These digital motion video formats also allowed for the capture and subsequent playback of ambient sound. This, combined with motion images taken from a fixed location, would have the capacity of providing a rich, descriptive representation of an existing urban environment. By linking motion video clips of a site, (that were taken from different angles), to a number specific locations on a map, the planner can play the role of "director" by changing the point of view to support descriptions of that location.

Once again, an example case in a U.S. planning agency provided a glimse of how such technology could support planning-related discussions. In this situation, the National Capital Planning Commission of Washington, D.C. (NCPC) experimented with the use of digital video representations of existing environments to support an ongoing (monthly) environmental design review process of major developments in the Washington D.C. area. In this context, a multimedia database would be made accessible to Commission members and staff in a large meeting room used for monthly public meetings.

Visual Navigational Aid Techniques

Some of the earliest implementations of spatial multimedia technology involved visual surveys of the built environment. In concept, this activitiy can be simply be supported by linking images to locations on a map. The relationship between image and map can support several methods of "browsing". For example, a visual survey can be *geographically driven* by allowing the user to view an associated image by selecting a location on a map; or it can be *navigationally driven* by allowing the user to "move" through a sequence of images (that may or may not be animated to give one the illusion of actual travel). Stopping at a specific site could have the effect of displaying the relative location of the associated map. More sophisticated visual surveys could be created to be content-driven by allowing the user to query a database (or do a hypertext search of the textual annotations described above) that would yield both the appropriate images and their relative locations highlighted on an associated map.

To better understand an area under study, (using visual navigation techniques), it may be necessary to view it from several different perspectives. Several types of video shots can be linked to a map for conducting a visual survey. Three types that have been commonly used through the years include *fixed position*, *360 degree*, *axial view*, and *navigation.*

- ***Fixed Position***

Fixed position shots allow the user to view a video clip of a particular site from a fixed camera angle. These can be symbolized on a map as arrows that match the direction of the camera's angle. Sites can be 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. Fixed position imagery is useful for studies of movement such as with automobile traffic, pedestrian flow, time-lapse studies of public space usage, etc.

- *Digital Nodal Video*

The *Nodal Video* image allows the user to look completely around from a fixed vantage point at a 360 degree axial view. These views are useful for illustrating the environment surrounding a particular location. They allow the user to zoom, pan to the left or right, and tilt up and down. This offers additional views of what is beyond the camera by allowing the user to look around at a surrounding area while "standing" at a single location. This is useful for analysis of relationships between elements of "place." It has been popularized with Quicktime VR® and LivePicture® file formats.

- *Navigational Sequence*

The navigational sequences show users what it would be like to walk, drive or fly through a 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 may be represented on a map as linear symbols that represent the routes available to the user. 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.

Initial Evaluation of Visual Navigational Aids

Visual navigational aids to assist in surveys of the built environment are becoming increasingly distributed through advances in inter-application communication, object linking and embedding, and the WWW. This is rapidly leading to the full integration of digital video representations with GIS (which has been played out in three predominant ways). First, digital video files are now accessible from within most contemporary GIS applications. Thus, by simply selecting a feature on a map, associated images can be displayed either from directly within the GIS application, or through external "viewing" software. Second, digital video files can now communicate the relative position of the "viewer" back to contemporary GIS through inter-application communication protocols. This makes it possible to highlight one's relative location on a map as one "navigates" using the video. Thirdly, GIS and digital video are becoming integrated in entirely new, WWW-based hybrid applications that combine elements of spatial representation and digital imagery in the massive associative information infrastructure that is provided by the WWW. This has been largely made possible by the rapidly growing object-based software development environments (such as Sun's Java).

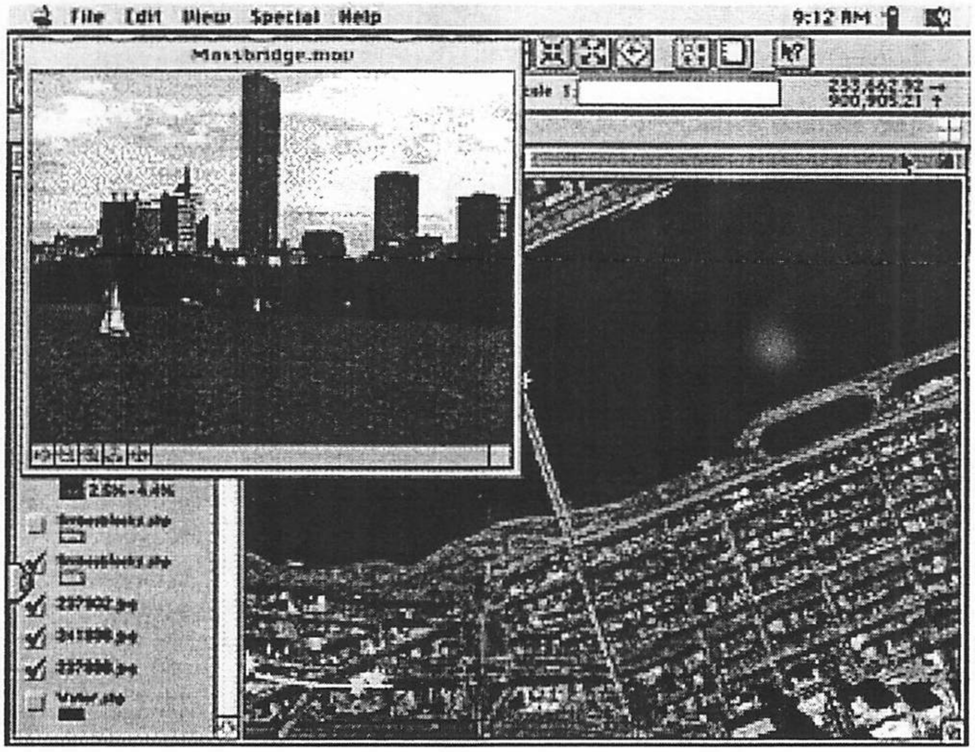

Figure 6: Visual analysis of Boston using navigational images that have been integrated with ArcView GIS software using "hotlinks".

Nevertheless, developers of these systems will continue to make tradeoffs in the production and delivery of such representation. For example, high quality images (for engineering applications, etc.) will remain largely dependent on "local" delivery mechanisms such as CD-ROM rather than the Internet, due to bandwidth constraints.

Representational Aids to Support Speculation

For many years planning professionals have had the challenge of describing technical information to non-technical audiences. For example, where abstractions have been used to convey concepts such as noise and traffic levels, more descriptive indicators have been somewhat elusive. Representational aids are designed to make the abstract more concrete by employing a richer set of descriptions. They have evolved from gestural and verbal tactics (such as waving of hands and copious use of adjectives), to artistic conceptualizations, and on to the employment of linked media. The intent has been to close "the gap of understanding" between technical specialists and key stakeholders. This has most recently been accomplished through the augmentation of typically abstract environmental representations with direct manipulation interfaces and multimedia representational aids, which have been made available in planning settings through recent increases in computing power. Unlike the cases of annotation mechanisms and visual navigational aids, it is difficult to easily classify the various types of representational aids. Therefore, the remainder of this section will discuss two implementations of representational aids, automobile traffic scenarios and urban transit visualization.

Automobile Traffic Scenarios
Many potential urban developments are evaluated in planning contexts for their impact on a community's existing transportation infrastructure. In particular, this impact is frequently represented as a projected change in traffic conditions. Several measures have been used to represent perceived changes in traffic conditions. Some of the more popular measures include average daily traffic (ADT) measures and standardized levels of service (LOS).

ADT is usually expressed as a numeric value that describes the average number of vehicles passing a fixed point over a 24-hour period. In the context of a planning meeting, a use of ADT might be to describe the impact of a new development on an existing traffic network. For example, a traffic specialist might convey this information to a city planning meeting by saying, "If the new shopping center is built, the ADT at that location is projected to rise from 11,300 to 14,500." Unfortunately, this numeric value may have very little meaning for meeting participants who are not familiar with these types of measurements.

One approach to conveying traffic information, as described in the Highway Capacity Manual (Transportation Research Board, 1985) has been to classify or "grade" traffic conditions using a measure known as Level of Service (LOS). In most cases, LOS is represented as a discrete scale from "A" to "F" where "A" represents very good traffic conditions and "F" represents very poor traffic conditions. While LOS measures are designed to simplify projected traffic levels through the assignment of a letter grade, this simplification continues to provide a level of abstraction that is frequently difficult for members of the general public and decision makers to comprehend. This is not so much due to complexity as it is due to a lack of rich descriptions of conditions that the various participants in a meeting can effectively relate to.

An early attempt to make LOS measures more descriptive has involved a juxtaposition of LOS representations as described in the Highway Capacity Manual with a library of generic indicative images. The images are taken as digital video clips that represent approximately ten seconds of traffic at a given LOS. The user, (after selecting a traffic situation such as three lanes of continuous flow), can then explore how that traffic is likely to behave under various predicted LOS conditions. This yields the associated digital video clips and a brief textual description of traffic and driver behaviors under those conditions, (as is illustrated in figure 7). The user can then select other LOS scenarios for comparisons of varying traffic levels at the same type of location.

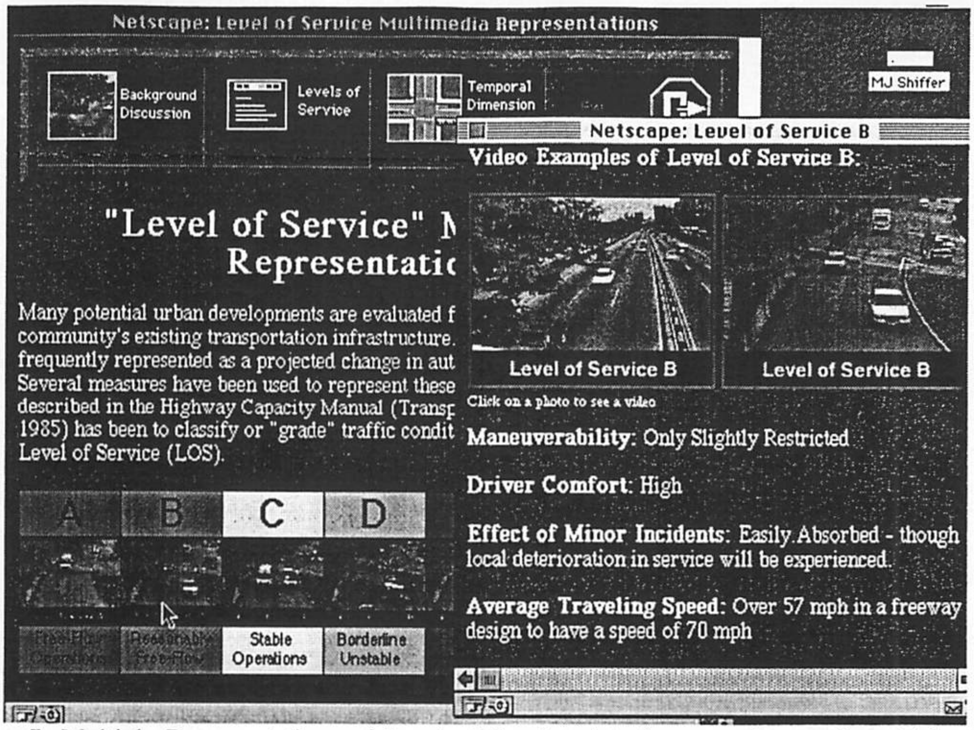

Figure 7: Multiple Representations of Level of Service data for a continuous flow highway as represented on the WWW.

The electronic library of LOS descriptions can be effectively delivered to various planning organizations using the WWW, provided that the representations are drawn from a fairly generic set of situations. This data can be provided and maintained in a distributed manner by these organizations using an overall structure such as that which is being developed in this research as a guideline. While this type of analysis can lead to a broadened understanding of how one LOS for a given set of physical conditions compares to another, it assumes that the user has some concept of existing or predicted LOS for their area. Where this is not the case, it may be desirable to predict future, or describe existing, LOS using the standard metrics published in the Highway Capacity Manual. Future implementations will likely include a mechanism for calculating and predicting LOS.

Urban Transit Mode Representations

Another project uses multimedia representational aids to convey the operating characteristics of mass transit vehicles in various environments. The intent of this approach is to provide a multimedia repository where the experiences of various localities with different transit configurations can be shared on a national scale. Like the automobile traffic representations, this implementation makes use of motion video clips and descriptive text. The tool is designed to augment standard quantitative measures of transit operations, with qualitative characteristics drawing upon a range of comparable examples from across the country. The hope is that this resource can lead conversations concerning proposed transit alternatives to rely less on hyperbole and more on the practical experiences of similar communities.

The transit visualization prototype (illustrated in figure 8) grew out of situations where communities are contemplating new transit lines, but are uncertain of the various operating characteristics and environments of a broad range of transit vehicles. While several studies of quantitative performance measures exist, there is very little that describes the qualitative aspects of various transit modes (such as noise, visual impact, etc.), which often become a point of debate amongst decision-makers (many of whom are not transit specialists). Thus, the purpose of the project is to 1) provide qualitative descriptions (using text, video and sound) of the operating characteristics of the various transit modes and operating environments; 2) provide a comprehensible structure to which further quantitative and qualitative descriptions of transit modes, best practices, etc. can be attached; and 3) to provide a central forum through which an informed discussion of the environmental characteristics of various transit modes can be organized.

The potential users of such a system are state and local government officials (including elected representatives), transit professionals, environmental professionals, academics, and others concerned with specific modal selection for the supply and improvement of transit services (where levels of demand have already been determined).

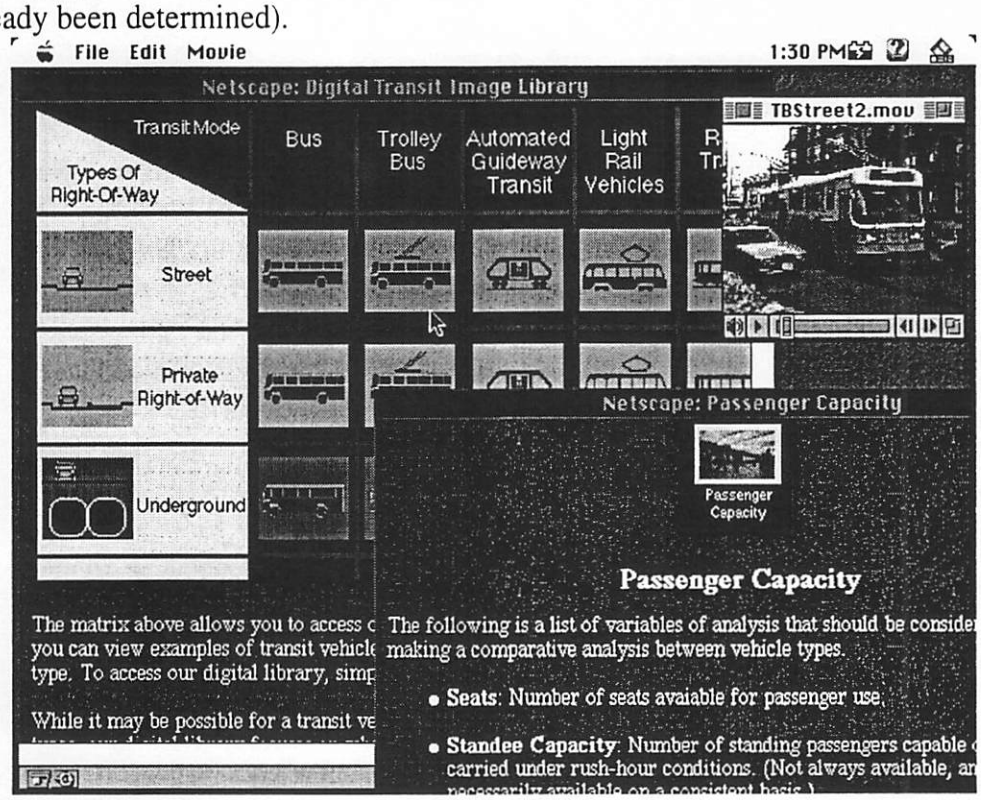

Figure 8: A WWW site that illustrates the characteristics of urban transit vehicles and operating environments using digital motion video and sound.

The ability to widely distribute this information using the Internet and the World-Wide Web, can allow many smaller to medium-sized communities to benefit from a large information base constructed to reflect the experiences of other communities with similar challenges. Thus, many small planning agencies without the resources necessary to perform exhaustive analyses can learn from the experiences of others. This can result in a more effective public review of the potential effects of transportation planning-related projects.

The intended result of the examples of representational aids described above is to make analytic tools and their outputs more manipulable, understandable, and appealing, so that information that would normally be inaccessible to the layperson can be more effectively comprehended. Nevertheless, just as this technolgy has the capacity to deliver compelling and descriptive representations, it can deliver compelling and descriptive misrepresentations. It is therefore necessary for users to understand how to avoid making simple mistakes in representation. A good place to start is with the works of Mark Monmonier (1991), and Edward R. Tufte (1983, 1990 and 1997).

IMPLEMENTING SPATIAL MULTIMEDIA

There are several types of environments in which people are likely to access planning-related information. They include face-to-face meetings, centralized resources (such as libraries), or distributed resources (such as the news media). This section will explore some of the environments where the concepts of spatial multimedia have been implemented.

Face-to-Face

This scenario represents situations (such as town meetings) where people meet face-to-face to discuss the future of their community. Recent advances have made it possible to augment this kind of environment with a Collaborative Planning System (CPS). Such tools have been implemented on an experimental basis as described in Shiffer (1993, 1995a, 1995b). A CPS makes significant use of the *Annotation Mechanisms*, *Navigational Aids* and *Representational Aids* (described above) projected on the wall of a meeting room. Participants interact with the system using cordless pointing devices or a technical facilitator to elicit information about selected geographic areas through a graphical interface.

Some valuable lessons were learned from early experiences with CPS. For instance, early tests illustrated a reluctance on the part of users to pick up a pointing device and directly interact with the system during a meeting. Most preferred to interact with the CPS through an "expert" who is familiar with the system's content. Such an individual could anticipate group needs and display relevant information when called upon. Thus, while it would be necessary for the expert to be familiar with a meeting's agenda, this person could also track a random conversation and display maps and images as they came up in the context of conversation.

The prototype CPS implementations have led to the identification of a broad set of issues ranging from institutionalization to technical infrastructure (some of which are discussed in Shiffer, 1995b). The benefits are that it is fast and self-contained.

However, key participants may not be able to attend meetings due to place and time constraints as described in the scenarios below.

Centralized Resources

This scenario represents situations where physical media are left in a physical location for the review of a broad group of individuals over a period of time. Interaction in this case is usually limited and has traditionally taken the form of written comments that could be entered into a notebook. Recent implementations of this have included access to GIS or other types of information systems through the employment of electronic information kiosks. Kiosks make it somewhat easier to control access to the information due to the fact that they are frequently strategically placed in the communities that they are designed to serve (located in libraries and municipal buildings). They also have the capacity to deliver large amounts of information (such as video) more rapidly and reliably than the WWW. Some of the more sophisticated kiosks have actually been designed to allow public interaction with GIS through the employment of graphical user interface modifications that are made possible using some of the more recent GIS tool kits.

The likely users of kiosks tend to include individuals with a broad variety of skill levels. Therefore, specific attention needs to be paid to human-computer interaction issues related to the design of the software interface. The drawbacks are that they can't be everywhere and a physical deployment infrastructure (such as computers with touch screens and protective cases) is needed, which can be costly.

Distributed Resources

In this type of situation, a person may be unable to attend the meeting of the planning review board in their home community because they may be at work during relevant meetings. Here, their participation is often limited to physical forms of discourse, such as letter writing and reading news items in the local paper. A significant difficulty of this is that local news editors often become filters through which the information must flow. Furthermore, archiving or categorizing exchanges in this kind of situation can prove to be challenging due to the physical media limitations.

The Internet, (most specifically the WWW) makes it possible to conduct a more deliberative review of planning-related proposals. For example, the prototype depicted in figure 9 illustrates a WWW-based implementation of a "virtual streetscape" for Washington D.C. that allows the user to explore an area using either an orthographic photo and map overlay, or by using a nodal digital video. A text annotation capability allows the user to attach comments to specific nodes identified on the map. Limited network bandwidth, and ensuring access to relevant parties continues to be a potential drawback of this approach to planning-related discourse. This last scenario for deployment of spatial multimedia appears to be the most rapidly growing due to the popularity of the Internet.

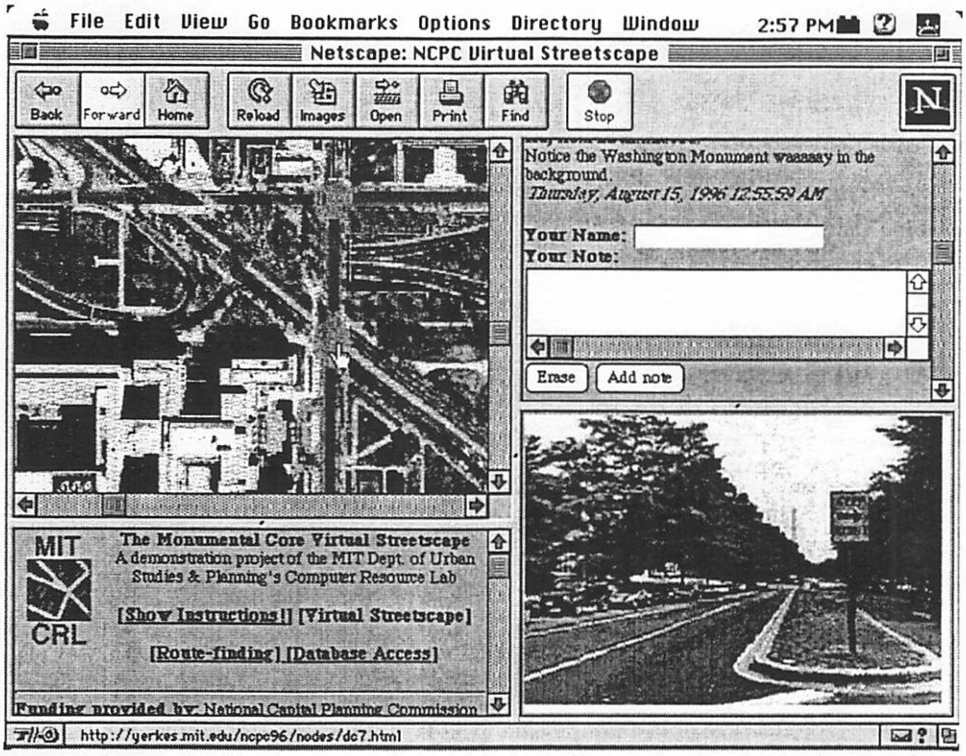

Figure 9: A test of a planning annotation and digital video navigational aid being tested in a "Different Place/ Different Time" environment using the WWW to study the characteristics of various locations in Washington, DC.

CONTINUING RESEARCH AREAS

The initial investigations into the potential roles of Spatial Multimedia for planning raise many questions. What follows is an attempt to organize them into to three overlapping areas where further research inquiry is needed.

Innovation

What IT models are most appropriate for delivery of this technology (GIS, Internet, Kiosk)? How can we accommodate new media? How will Internet II enable us to leverage distributed information more effectively? Who will pay for development? What will be the implications of "e-commerce" and sponsorship for planning-related media implementations? How are public/private partnerships working?

Implementation

How can we effectively match an appropriate mix of technology to fit the resources of particular planning processes & environments? How can we "repurpose" existing IT? Who is responsible for the maintenance and the integrity of the information contained in these systems? What are the best means for delivering this technology to those who might benefit from its use? What economic (and institutional) limitations to implementation exist?

Impact

How can we evaluate the effects of these technologies in public environments? Is there something inherent in Spatial Multimedia that makes it more (or less) biased than other forms of media (such as traditional maps, television or the printed word)? How does the use of this technology change the nature of community-related conversations?

This chapter may have raised more questions than it has answered. It will be shared responsibilities of the practioners, industry leaders, and academics to work together to begin to address these as we move ahead.

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