Making the Problem Visible: Project Specific Information in Collaborative Design

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This paper describes our current work in the development of an interactive, collaborative design space. It attempts to anticipate a future in which complex design problems are undertaken by an interdisciplinary, collaborative group of contributors working within an electronic, networked environment. These networked working groups are made possible by the expanded use of high-speed digital networks and are expected to continue to grow within the design profession Using the design of an academic building as a case study, several new tools and techniques were used to develop an information place superimposed over the three-dimensional digital model of the site and proposed building. These tools allow the user to create a collection of data including site documentation and analysis; propose interventions; and access the data through three-dimensional icons in the model. Several new techniques related to collecting and accessing information within the collaborative space are discussed.

Keywords: collaboration, hypermedia, information visualizer, virtual workspace, image collections.

1 Introduction

When designers come together to collaborate on a project, they each bring to the group a unique set of experiences and personal design knowledge. Throughout the course of the project, the designers continue to expand their knowledge base by learning from the experience of the project, and each contributor brings new discoveries, information and insights to the group in an effort to build a project-specific information base. In a paper world, the cooperative sharing of this information typically occurs by creating a project room or space. Reports, drawings, photographs, models, sketches, and other data/information are displayed on tack boards, accessible from shelves, or just lying about. These project spaces can appear to be disorganized and messy, but in the minds of the team members, a cognitive map of the spatial location and organization of information sources is created with surprisingly efficiency. In many cases serendipitous connections of disparate

U. Flemming and S. Van Wyk (eds.), ***CAAD Futures '93****, pp. 471-480.*

associations and thus highly innovative inspirations, come from seeing the elements of a problem made visible through these project work spaces. In a digital world of electronic media, the collection of a team's early efforts is invisible. This is especially true of a project that includes teams members operating from remote locations and communicating “long distance.” Even when designers work in the same location, the amount of hidden graphic and textual information that resides on the computer's disks.

As the project proceeds and matures, a wealth of information and observations about the nature of the problem is collected. In one sense each new project generates a “library” of information about the problem addressed. As additional consultants and contributors join the project team, the library is an effective means of bringing them up to speed on the course of the project and progress that has been made. This collection of background information and speculations about the problem's solutions have been assembled for most design projects over the centuries. If there had been an effective technique for capturing that information, a valuable and priceless resource would have been built up over the years. Developing effective techniques for capturing this information and making it more visible in a digital world is the essential goal of this research effort. This paper has two segments. The first is a description of the case study and the techniques used to collect visual and other data about the site, program, and problem. The second is a description of the 3D information space created for retrieval and navigation through the information.

2 Case Study

We undertook this research project within the context of cooperative information sharing. The challenge of this project was to make these collections visible to the group within a virtual space. The project selected as a vehicle to explore these issues was the new School of Law building on the campus of Washington University. The program called for a new academic building to be constructed west of the present Law School and to adhere to the campus urban design principles which make the hilltop campus a unique and special place. The campus planning design principles that were established by Cope and Stewardson in 1899 are still the fundamental urban design principles which are apparent in the site today. These underlying principles which need to be understood before building wisely on

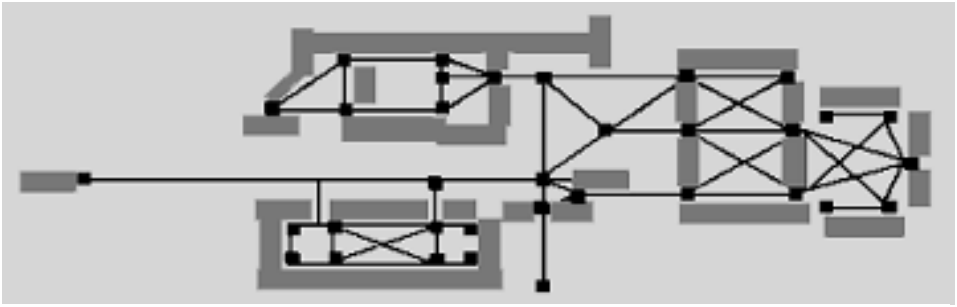

Figure 1. Diagram of the campus walk network system showing nodal points.

campus include the network of walks, long thin buildings, courtyards and quadrangles, the integration of the walk system to the internal order of the buildings, the vocabulary of linking elements and a picturesque skyline. The campus walk system and the experiential qual-

ities of the campus make this project an excellent vehicle for examining the issues of establishing a shared understanding of design principles.

When a design team begins a project, there is a phase of the work which involves a thorough documentation of the problem and the site. The campus of Washington University offers a unique set of complex, interrelated design issues which need to be revealed and understood by designers proposing interventions. This collaborative effort is a means through which the team members develop a collective understanding and a project-specific memory which will guide and influence decisions throughout the course of the project. In this early phase of the project we constructed a virtual workplace for displaying site documentation images, analysis diagrams and early proposals. The objective was to create an electronic version of a situation room in which all information brought to the project could be "pinned up" for sharing among team members.

Several techniques were used to make observations about the special character of the place accessible to the team members.

3 Techniques Described

During the first phase of an architectural or urban design project, members of the design team gather information about the site and its context. Typically, this activity involves collecting drawings and photographs of existing conditions and making them available to the other members of the design team. Record drawings of the site are obtained and usually become the base information for the development of design documentation. Analytical information might include reports, diagrams, interviews, and technical drawings.

Figure 2. Collaborative design space in a paper world. Images, drawings, chip board site models and articles are pinned up and strewn about and visible to team members.

Experiential information might include video segments, photographs, audio recordings, sketches, narrative descriptions, and other representations. This pool of information is project-specific, but also includes references to previous work as well as renowned exem-

plars throughout history. Typically, the design space becomes an information place with the pinup surfaces being transformed into a display of the current and historical collection of reference images and other information. The accessibility of this information is readily available and visible to all team members in the space. New items get posted over the course of the project, and the space changes character as the project matures. The accessibility of this type of information is a crucial part of the design process and is especially useful for group work in which collaboration is essential. The techniques described in this segment were used to electronically capture similar information for use in the information model.

3.1 Historical and Referential Images

We produced an image collection which was comprised of aerial and eye level photographs taken prior to the initiation of the project including historical images collected from the University archives. Images of other similar projects were also gathered for this collection. The photographic images were transferred to an optical memory disc recorder as video stills for quick retrieval and browsing. These archival techniques are well known and have been used in our prior projects (van Bakergem, 1990). Most of these site documentation images were geo-referenced images of the existing conditions.

3.2 Experiential Sequences

In order to work effectively, designers required a clear understanding of the significance of movement through the campus. Movement through the grounds and entry into buildings are best understood through a changing point of view and a sequence of images rather than a conventional still photograph. The passage through quadrangles, courtyards, and along the network of walks is a major component of the campus structure. Short video segments were used as an effective technique to document the experiential qualities of these passages and spaces which were best understood through a sequence of images. These segments were recorded on an optical memory disc recorder in ten to sixty frame segments that could be played back as a still image or as video of up to thirty frames per second. Six to ten frames per second were found to give the illusion of motion and permit an understanding of the spatial qualities of the documented place. The short segments also allowed for browsing the clips at high speed while retaining enough legibility to select one for slower viewing. The capacity of the disc, 24,000 frames, permitted many short segments to be stored. Full motion video at thirty frames per second would result in only thirteen minutes of motion segments and would not enable high-speed browsing.

Two photographic techniques were used. A half-frame 35mm camera was used to produce color film strips of the sequences that, after film processing, was transferred to disc via a Tameron Fotovix film processor. The disadvantages of using film were delays in production due to waiting for film processing and the limited number of sequences possible on a single roll of film. One of the objectives of these techniques was to quickly and conveniently capture visual information about a place. A more convenient technique involved the use of a 8mm camcorder. The primary advantages were the capability for quick production immediately after a site visit and the large image capacity (over 7,000 images). The technique involved using the video camcorder as a still image capturing device to record a series of sequential images. For example, when documenting a rotational pan of a courtyard, two seconds of video were recorded in a still position; the camera was then rotated (to a new object point), and two more seconds were recorded in a still position. By repeating this pattern, the space could be recorded in 12 to 16 positions. On returning to the studio, the video can be played back at thirty frames per second, and, as each still position appears stable on the monitor, a single frame can be recorded on the optical memory

disc recorder. The result is that the rotation pan is captured in very few frames which can be viewed as stills or at other speeds up to thirty frames per second. If the scenes in each frame overlap in thirds, the illusion of motion can be created very efficiently with only a few frames. With no overlap, an illegible staccato effect is produced. Smoother motion can be created by using more frames to cover the same pan. This technique is analogous to producing a cell animation from a live scene. This technique is effective for a rotational pan, a parallel pan (moving the eye an object points along parallel lines), translation through an arc (moving the eye about a stationary object point), and a linear translation (moving the eye toward the object point). Complex combinations of the above moves were also produced. These short video segments proved to be very effective documentation of the campus walks, nodes, and courtyards. The rapid playback of the scenes gives enough information to understand the dynamics of moving through these special places on campus. The capability of varying playback speeds enabled different readings of the spaces. Playback at thirty frames per second conveys a highly impressionistic view of the spatial qualities while at the other extreme each frame can be examined carefully as a still video frame.

Figure 3. Typical sequence illustrating a campus linking element.

3.3 Site Video Segments and Comparative Animations

The designers recorded several movement sequences which were expected to be typical approaches or views of the future building. Two major axial walks would connect the site to the campus via the network of walks. Another broad walk which passed by the site would be a common path for pedestrians and would possibly become the most well known view of the new Law School. These significant views and sequences were used for both the site documentation as well as the path for computer animations of proposed interventions for before and after comparisons. The short video segments make possible the process of parallel comparisons of sequences of real photos and synthetic computer animations possible.

3.4 Analytical Diagrams

During the early phase of an urban design project, such as this campus building and its surrounding site, abstractions of principles and propositions are typically represented through diagramming. These site observations need to be shared with the team and communicated in a manner that ensures comprehension. For example, one of the urban design principles which needs to be well understood in site planning deals with the network of walks and the relationship of building entry to network nodes. Diagrams were produced as both hand sketches and CAD drawings. The CAD-based diagrams were linked to images of the places which were instantiations of the idea represented in the diagram. Browsing through the diagram offered opportunities to see manifestations of the principle. This link-

ing of diagram to picture was not dynamic as suggested by Ervin (1992) in that if the diagram were changed the image would somehow be altered. Since the purpose was primarily to build an understanding of existing conditions on the collective mind of the design team, a static link was sufficient. Linking the diagrams to images also provided the team with a common, illustrated reference for interpreting the diagram's symbols.

3.5 Interviews

Developing an understanding of a place through the observations and comments of its users is valuable information to bring to the design group. Using the video camcorder, several short interviews were conducted in which students and faculty of the Law School expressed opinions about the new building. These edited segments were recorded on the disc and made available to the design team. The videodisc allows for random selection and replaying of these segments or selective editing of key phrases. This information was also linked to diagrams and specific places on the site model.

4 Model as an Information Place

"It is not how much information there is, but how it is effectively arranged" (Tufte, 1990). The second component of this research work was the creation of an information model through which the collections could be made visible and accessible. Using the principle that the team's project resources and data should be available in the same workplace where the creative activities were taking place, the CAD model of the site and proposed interventions were used to display the information. Since the proposals were being digitally modeled, the workplace and pin-up "room" were embedded in the model. Using the analogy of a "situation" or "war" room where all project designers and consultants would work within the same space, we speculated that the digital model and its surrounding virtual space could be an effective place to "pin up" our observations, critiques, recordings, analyses, etc. Having to move out of the model by launching a different program would be analogous to moving to a different room if we were working in a paper world— experience indicates such a move is counterproductive to collaboration.

In an effort to foster thinking of the model as an information place as well as a representation of the physical elements of the site and proposed building, the project was set up in the CAD system to display a model of the site in a 3D aerial view when the program was launched. Control commands for loading files were linked to 3D icons in the model. Moving through the project data was managed by selecting objects on the site rather than typing a file name or layer number. Moreover, all the information which had been collected about the project was made accessible and therefore visible through the same model. The model was regarded as a 3D menu which replaced 2D icons typically displayed around the perimeter of the model window. One goals of this effort was to begin to explore techniques for navigation through data and information that might occur in a virtual space. Attempts were made to avoid a more typical picture plane workspace which would break the illusion that the user was in the space. The objective was to place all necessary icons, buttons, and entry points in the three-dimensional model which could be made accessible from any point of view. Several challenging issues emerged from these explorations.

4.1 What Form Does Information Take

One of the most challenging issues was the form of information. The modeling of buildings, the site and other physical objects is a fairly straightforward abstraction of the actual form of the object. Creating a 3D form which represents a view, an interview, a re-

port, an impressionistic image or other non physical entities is not a trivial problem. The image and form that is selected to symbolize this type of information need to be legible to the participants of the group; and, for it to be transferable to other users beyond the current project, the forms should have some visual conventions which need no accompanying narrative. The essential question is similar to reading architecture—what does the form signify. Opportunities for virtual architecture and cities to become windows to information in these collaborative workspaces is intriguing. These new virtual information cities offer the possibility to get around in the same way in which people find their way through a city and read the distinctions of domestic, commercial and civic architecture in the real world. Our research efforts are directed toward exploring these eventual possibilities.

We decided to try to avoid representing information by its format or medium, e.g. representing a video segment by a model of a camera or video monitor. One principle we established was that the content should be legible and the format unimportant. If we were "pinning up" information about the network of walks, it made no difference whether the data was a video, still, text, or interview. The goal was to build a model of the information in a collaborative space which encouraged informed browsing. The form of the entry point to information should reveal the essential information content possibilities. Moreover, sole reliance upon a taxonomy of textual labels for queries was discouraged. We were striving for a visual database accessed through a visual database of 3D objects.

One technique tried was building models representing the paths of the short video segments that documented various views around the campus. As the collection grew, the information model became more complex and took on unexpected sculptural qualities. New questions, regarding what form a view or an interview should take so that all users could understand what the objects represented. If these elements were interpreted too subjectively, the effectiveness of sharing the insights about the project might be lost. This problem conflicted with the stated principle discouraging the use of well-known metaphors such as cameras, eyeballs, etc., for representing the views. In addition the models were becoming cluttered with a confusing array of weird sculptural objects which had no recognizable typology whose meaning could be shared by the group without explanation. To deal with this problem we added another layer or filter through which these information models could be understood and the data could be called.

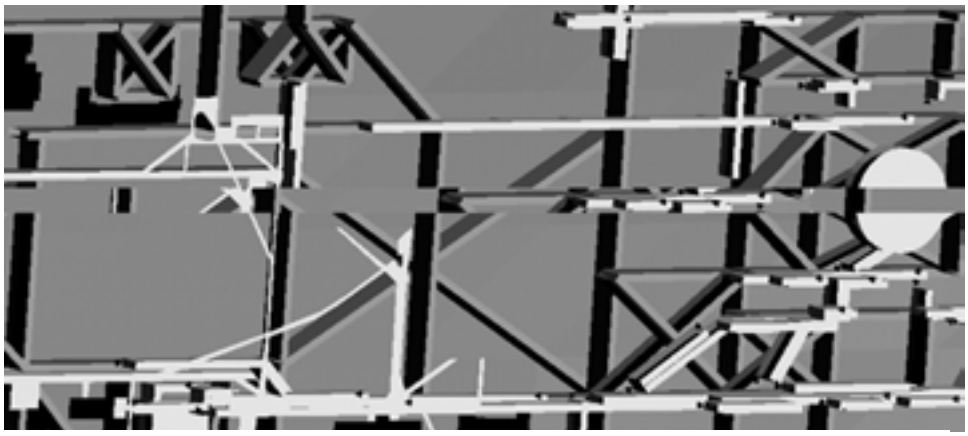

Figure 4. Three-dimensional representation of video paths through the campus.

In response to the apparent clutter in the model which represented the site and building, we experimented with using scale pedestrian figures to represent information while other conventional forms represented the physical environment and architectural form. This opened up new and fascinating opportunities for symbolizing the information collections. These figures, in fact, represented "experts" who had contributed to the collection of information about the site and problem. Now the model of the site and building was populated with pedestrian figures which appeared natural and added "scale" to the models. These figures took on two roles: they enabled a better reading of the model by providing scale and they were entry points to the information models. There was no need to invent a new typology of forms at this higher level since most participants in the design team could

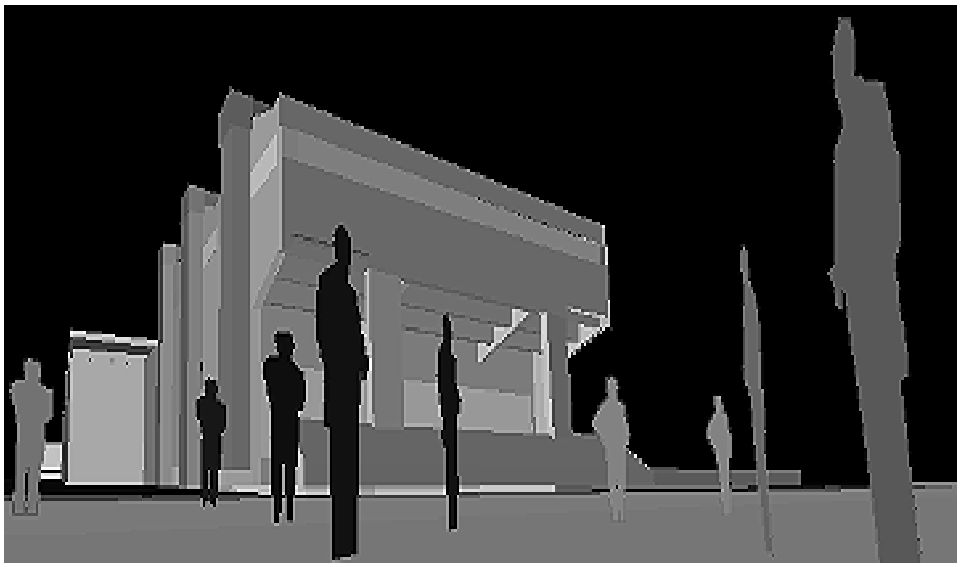

Figure 5. Scale pedestrian figures doubling as information entry points.

"read" the possible meaning of these figures. Each figure could take on subtle differences related to position, shape, wardrobe, accessories, etc. Each team member might have a representative surrogate in the model which would link to critical commentary on the project or any contributions from their personal experience. Essentially these figures could be assigned any function and act as an agent to help the designers reveal information. Moreover, although these agents are currently "dumb" in the sense that they exist only through the explicit links assigned by the user, as new, more intelligent queries and linking mechanisms are developed these agents could activate any function or process. These scale figure agents are expected to become a useful tool in the evolution of information spaces.

Another metaphor examined was the use of a virtual "situation" room. Here a scale shift from the site model to a model of the room was used. The scale shift was employed because the model of the site and building was created within a world coordinate system which modeled the campus at full scale and was contained within the room. The room, several thousand feet wide, represented a collaborative workspace where the model appears as a "scale" model in the space. Entrance to the room was accomplished by backing up into an aerial view in which the full scale representation of the campus took on a relative scale to the huge room. The room became a place where references to the collections could be

made visible without cluttering the project model. The walls of the room were then available for pinned up images and drawings. This technique required the user to leave the site and the active workspace in which the proposed model was being built; it conflicted with the principle of information accessibility within the model's workspace.

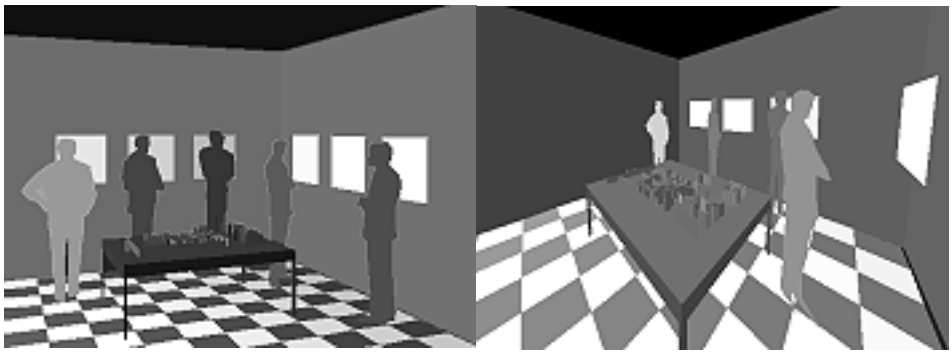

Figure 6. The virtual situation room with a full-scale model of the site on a "table." The view on the right is from the perspective of a participant.

4.2 Some Management Concerns

The ease of producing the information and creating the links became a significant issue in the actual use of the collaborative space. Early procedures involved many steps in inputting the data, photos, videos, etc., and the assignment of labels, names, and placement required too much time to manage the links. The objective was to refine the collection procedures so that the creation of the information space is almost as easy as creating a more traditional pin-up space. Contributors to this project-specific information world should be able to capture the data, place it in the space and make appropriate links in an intuitive and "on-the-fly" mode. This aspect of this system requires further study.

5 Conclusion and Future Work

Many multimedia/hypermedia research projects propose huge libraries with complex interfaces that represent a known body of knowledge. But these systems are expensive and in many ways highly-personalized views of how the information should be organized and accessed. Moreover, only rarely does anyone actually create the immense collection of information and make it available to anyone other than the system designers. We produced one such system in 1989. No one uses it (van Bakergem & Massanat, 1989). Here, we have attempted to tap into the typical design process and capture the information which is collected, recorded, and suggested by a design team working cooperatively on a complex design project. These data will be collected even without digital augmentation as they have been for centuries of work in a paper world. We propose to take advantage of these ongoing processes and build digital project-specific information models which enable the sharing of observations and ideas. We see this work evolving to anticipate future working methods of collaboration in virtual information worlds and remote cooperative design work.

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