28
Case Studies in Moviemaking and Computer-Aided Design

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A movie which is developed from site location video, sync sound, and computer graphics animation can provide a highly convincing simulation of reality. A movie that conveys a sense of the space, materials and juxtaposition of objects of a proposed architectural design provides a special kind of realism, where the representation may be of a proposed building that exists only within the mind of an architect. For an experienced architect, however, the movie may not provide a good surrogate experience for what it feels like to actually be within the architectural space.

In these case studies, a few projects that combine moviemaking and computer-aided design technologies are examined. These projects were completed using a combination of resources at the MIT School of Architecture and Planning and the Harvard Graduate School of Design. The integrated use of these media is presented as conceptualized with the Electronic Design Studio, a research project that has been supported over the past five years by Project Athena at MIT. The impact of movies and computer-aided design on the perception of architectural space is also reported-based on a pilot study of twenty architectural students.

Introduction

The quest for realism in computer graphics is reflected in efforts to simulate real-time movement through three-dimensional space. Yet, the perception of three-dimensional space acquired from computer animation may be fragmented and illusory. Moviemaking is based on the illusion of taking still images and flipping between them more rapidly than is apparent to the human eye (i.e., typically at greater than 1/18th of a second). We may take it for granted that

greater realism is obtained in movies, and forget that watching a movie is technically a process of watching a sequence of still pictures I

Nevertheless, in some architectural offices, moviemaking has become a routine part of professional practice. For example, at The Architects Collaborative (TAC), the architect may develop a shotboard, a scriptwriter and narrator are hired, and a videotape is carefully produced to convey the issues and key features of a proposed architectural design 2 Although such a production may serve to reach an audience that is unaccustomed to interpreting more traditional paper based presentations, it may not prepare viewers to critically sort out the key elements of a proposed design. In particular, the audience of such a presentation may not have a clear understanding of the scale of an architectural space, the boundaries of an architectural space, the identification of objects within the architectural space, and the juxtaposition of objects to one another.

For a naive member of the audience, motion pictures may convey three-dimensional space with a degree of realism that is not provided by static drawings. For example, during a screening of one of the first of silent films, members of the audience became so frightened by the motion picture images of an oncoming train that they sought to move out of its pathway '. In the case of architectural space, however, the apparent realism of a motion picture may lead to the false presumption that it is more informative than non-animated drawings. In particular, a person may face some cognitive hurdles in attempting to study an architectural space through the use of an animated visual medium. For example, there is a limited opportunity for the sustained observation of objects within the viewing frame of a motion picture as compared with the prolonged opportunity to observe objects within the still frame of a traditional plan, section or elevational drawing. Understanding the shot-to-shot partition of an architectural space in a movie may also require a highly literate orientation to the medium. Rudolf Arnheim claims of some of the more successful film directors that 'their imagination and keen observation could hardly bear such remarkable fruit were it not for the erudition and the sense of quality acquired" during years of scholastic preparation .

The break-up of a motion pictures into sequences of shots and the organization of those shots into a coherent framework is what Eisenstein referred to as the *mise-en-scène . In* the case of a simulated walk through of an architectural space, the moviemaker may decide to take specific liberties with the *mise-en-scène.* In particular, the moviemaker may juxtapose sequences in order to make building components seem to fit together . For example, in the making of the film "Beauty and the Beast", Jean Cocteau constructed a single architectural space from a series of shots recorded at separate site locations [6]:

"One of the advantages of making films is that you can mix, muddle up and reconstruct your place of action just as it suits you. This cresting of wall will become a ramp, this ramp will end in the balustrades which go round the chateau moat."

A person viewing the movie may interpret the montage of shots as representing a single architectural space. As evidenced in some of the case studies below, however, each person may reconstruct the architectural space in a different manner.

Moviemaking and its Relationship to the Electronic Design Studio

The initial concept for the Electronic Design Studio was based on a role for electronic media, including motion pictures, that would mirror the role of traditional drawing media as diagrammed in figure 1. The Electronic Design Studio is an Athena funded research project within the School of Architecture and Planning at MIT. Within this environment, (IA) CAD drafting and solid modeling tools are mirrored by (IB) paper based drawing, and clay or cardboard modeling tools. The (2A) role played by experts within a traditional design studio is mirrored by the (2B) the role of knowledge based or expert systems as an on-line computer resource. Finally, the role of (3A) still and motion picture visual information systems, such as provided by videodisc technology, is mirrored by the role of (3B) visual references, such as slides and archive drawings. These components have been linked within the Electronic Design Studio, as documented elsewhere[7].

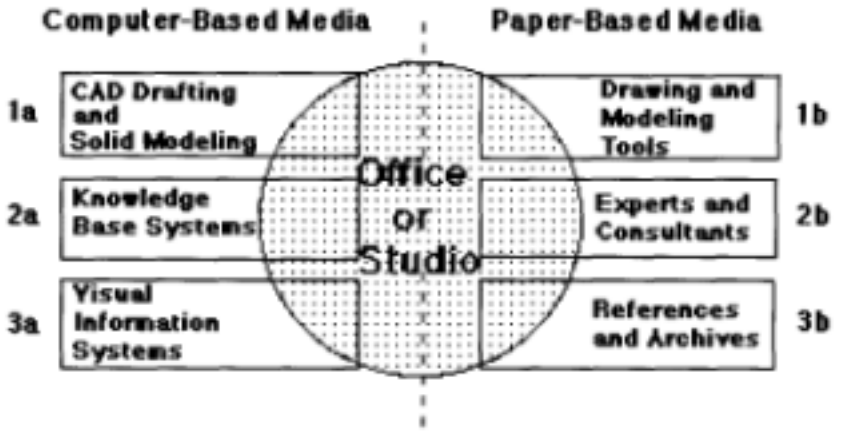

Figure 1

The use of visual information systems as diagrammed in figure 1 presently involves the retrieval of archive movies over both computer and cable television networks from both local and remote videodisc sources. This includes access to slides stored on videodisc at Rotch Visual Collections at MIT. Access to these remote resources has become more convenient than would be possible without the network, but the visual information system does not provide for applications beyond the traditional role of reference material in the design studio. With regard to the role of motion picture production as a potential design medium, however, there is no precedent in the traditional paper-based studio. Nevertheless, it is speculated that moviemaking can work as a design tool in a manner similar to the use of thumbnail sketches.

An architect will make and study a series of thumbnail sketches when contemplating a particular design proposal. Similarly, it is speculated that an architect can also make and study a sequence of motion picture images in the creative design process. As provided by the case studies cited below, an architect may study (1) the movement of an observation point through an architectural space, (2) the movement of people through a proposed architectural space, or (3) the dynamic conditions of light and sound within an architectural space. In general, the movie may represent some key features of a proposed building in a way that will influence an architects development of a particular design proposal. For example, in response to an animated walk-through, the architect may make some modifications to a given layout of spaces that removes impediments to the circulation of people or which provides greater aesthetic coherence to the sequencing of views.

Yet, a number of major obstacles are still apparent. A first major obstacle is that, while ideas may be captured in the fleeting moments of a rapid thumbnail sketch on the back of paper envelope, moviemaking is a relatively protracted, carefully planned and not spontaneous process. (The techniques of cinema verité break many conventions of traditional moviemaking, and offer some hope for a sketchbook like and spontaneous production process. But the turn-around time from image making to image viewing may still be a problem. This discussion is beyond the scope of this paper). A second major obstacle is that it is difficult for the moviemaker to gain control over the animation of many images in the same manner as an architect can control the content of a single image. A fear is that the overwhelming number of animated pictures may 'control the architect" 8 A third major obstacle is that merging animated computer graphics with site location video, which has only been partially addressed in the work referenced below, is a cumbersome undertaking and not without technical limitations. Finally, the illusory power of this simulated movement may not be satisfying to an experienced architect, such as Steen Eiler Rasmussen.

It is not enough to see architecture, you must experience it. You must observe how it was designed for a special purpose and how it was attuned to the entire concept and rhythm of a specific era. You must dwell in the rooms, feel how they close about you, observe how you are naturally led from one to the other."

Three types of movies were experimented with by architecture students of mine in the 1989 Spring semester at MIT 10• They were

1. A computer graphics / site location videotape of moving figures as viewed from a still frame of reference.
2. A computer graphics / site location videotape of moving images as viewed from a moving frame of reference
3. A cinema verité movie using time lapse film and documentary video of an architectural space.

Project One: A Computer Graphics/Site Location Videotape of Moving Figures as Viewed From a Still Frame of Reference

The production process involved the use of a VHS Video Camera, a Computervision CADDS4X CAD system running on a Sun 68020 Workstation, the Artisan Paint Package running on a Sun 386i "Roadrunner" Workstation, an IBM PC-AT based TARGA Board with a chroma key and patched to a video editing production suite. This project concerned the description of a proposed architectural design for residential housing located in the South End of Boston. The basic steps in putting together the production were (see figure 3):

(a) Documentary video footage of the site location was recorded from a steady camera held on a tripod. This included an aerial view from nearby Hancock Tower as well as street level views. Four cardinal views of the site were selected.

(b) Still video frames from the four cardinal views were grabbed by means of the Targa Board attached to a VHS video player. Next, a Targa format bit map file of these still images was produced on the Targa Board system. The format file was then transferred to the Artisan Paint Program running on the Sun 386i "Roadrunner" Workstation.

(c) A three-dimensional surfaced and shaded model of the proposed residential housing was developed on the Computervision CADDS4X Workstation. Perspectives of the model were generated (using software written by the author when he was employed by Computervision). Bit mapped images of these perspectives were then transferred to the Artisan Paint System.

(d) On the Artisan Paint System, the still video frames from site (step a and step b) and the CAD perspective renderings (step c) were merged. Step c

Figure 2 Stills from movie 1

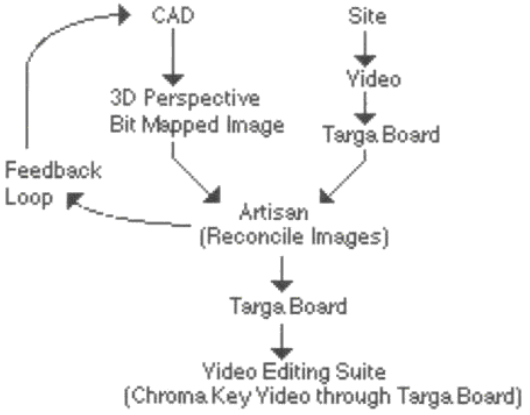

Figure 3 Steps in the production of movie type 1

was repeated until there was a good correspondence between (1) the perspectives generated on the CAD system and (2) the video images from the site location footage.
(e) Once the proper CAD perspective images were obtained, they were prepared for final merging with the motion picture images from the site location video. Each CAD perspective image was transformed on the Artisan system so that the parts of the computer graphics model that would appear in the final movie were isolated. Other parts were painted out with a blue color that could later be used for chroma key mixing (see step f). The resultant painted images was transferred from the Artisan to the Targa Board.
(f) The videotape of the site location was played through the Targa board and then chroma keyed to the blue color that was painted during step (e) onto the CAD generated perspective images.

Project Two: A Computer Graphics/Site Location Videotape of Moving Images as Viewed from a Moving Frame of Reference

The production process involved the use of a VHS Video Camera, a Computervision CADDS4X CAD system running on a Sun 68020 Workstation, the Starbase

Figure 4 Stills from movie 2

Figure 5 Steps in the production of movie type 2

Graphics Package running on a Hewlett-Packard Bobcat Workstation, a broadcast quality 3/4 inch video camera, a VHS video camera, a video editing suite with a/b roll editing and a chroma key switcher. This project was the description of a proposed architectural design for residential housing located in Charlestown, Massachusetts. The basic steps in putting together the production were (see figure 4):

(a) A 3-D computer graphics CAD model of the proposed design was created on the Computervision CADDS4X Workstation.
(b) The 3-D database from the CAD model was then translated to the Starbase Graphics Package. A Translator was developed for the purpose of transferring the data
(c) An animation package was developed on top of the starbase package with several optional methods of moving about the architectural space in real time.[11] The animation package allows a user to script an animation sequence and specify tilt camera position and angle. A front end to the animation package provides for the interpolation of camera movement and angle between explicitly defined camera positions. Two sequences of movement through the architectural space were generated on the animation system, and this movement was then recorded on videotape. Most importantly, the movements include views out of some window, the camera panned from left to right. The

area within the window was filled with a solid shade of blue. These video sequences constitute videotape a.
(d) On-location video documentary footage was recorded of exterior views similar to those that might be observed by looking out the windows of the proposed architectural design. Within one particular sequence, the camera panned from *right to left*. These video sequences constituted videotape b.
(e) Videotape a and videotape b were synchronized within an a/b roll video editing suite. The exterior views recorded in videotape b where chroma keyed over the color of the windows recorded in videotape a. The camera movement from *right to left* in videotape a was synchronized with the panning shot from *left to right* in video to b. The result of this synchronization is the apparent effect of looking from right to left out of the window, and the exterior scenery seeming to change naturally from left to right. The synchronization of these two sequences required a computer video editing capability, and still was lacking in precision.

Project Three: A Cinema Verité Movie Using Time Lapse Film and Documentary Video of an Architectural Space.
This was a less technically ambitious movie that combined time-lapse photography with video documentary footage. The movie included sync and non-sync sound. The purpose of the project was to capture the qualities of the architectural space as reflected in the cycle of its daily use.

The merger of the video and computer graphics in these efforts was achieved with considerable effort. The spontaneous qualities of working with a sketchbook was not achieved. The feedback to the designer was to suggest how the building might appear within the context of dynamic conditions at its site location. As it turns out, the movement of people and traffic are quite distracting in the videotapes, minimizing the attention given to the proposed building. A design which responds more clearly to the movement and the environment might have provided a more significant focus for the case studies. In the aforementioned projects, however, this was not the most obvious concern of the proposed design, and so the purposefulness of using the moviemaking technology was not very clear. Only in the case of the third project, where camera movement was completely unrestricted, was there a more complete sense of the building within the context of moving people and changing shadows in the environment.

Certain design issues may shift closer to the foreground in moviemaking than they do in other media-such as the movement of people, and light and shade at the site location. Further study seems necessary, however, before it is evident which issues are raised in a manner which is meaningful to architectural design.

Some of the technology used to create the animations described here is becoming commercially available on personal computer platforms. In particular, it is not difficult to move from a 3-D CAD model to a computer animation tool within a single PC platform 12 On the other hand, the mixing of computer graphics and video requires the use of more extensive video editing facilities than might be typically found within a School of Architecture and Planning. In particular, a video editing suite with so-called a/b roll editing and a good chroma key switcher is needed for more advanced merging of video and computer graphics. The cognitive and purposeful architectural content of these productions, however, is perhaps less certain than the technology. Therefore, a scheme was piloted for measuring the perception of architectural space arrived at through viewing a movie.

A Pilot Study of Twenty Architectural Students:

A central issue of this study is the role of media as a vehicle for an architect to work with in terms of developing abstractions of a particular design concept. There are many particular applications of moviemaking which seem sufficiently distinct to warrant separate studies. In each case, it would he useful to examine how an abstraction contributes to an architect's understanding of his or her work. This study, however, examined the abstractions available through a single instance of moviemaking in a specific instance of architectural design. This study, although it was focused on one application of moviemaking, was difficult to constrain. It was greatly complicated by consideration of different techniques for making the movie and different levels of audience sophistication. In the process of narrowing down the cognitive study, it was discovered that a seemingly focused testing scenario had to he further constrained in order to capture meaningful results.

A preliminary test was not that very useful. Its purpose was to record students' perceptions of an architectural space that resulted from listening to the sound track of a sequence within the movie "The Third Man.' The sequence takes place within an underground sewer where one character is being chased by a group of pursuers. The long reverberating sync sound of the characters moving within the sewer seem revealing of the architectural space. The architectural critic Steen Eiler Rasmussen wrote of this sequence within the movie that

"The characteristic sounds which tunnels produce are clearly heard in the splashing of the water and the echoes of the men hunting the third man. Here, architecture is certainly heard. Your ear recieves the impact of both the length and the cylindrical form of the tunnel."[13]

Eighteen architecture graduate students all had similar responses to hearing the sound track of the sequence within the movie described by Steen Eiler Rasmussen (figure 6a-d). They were asked to produce drawings and give verbal descriptions of the architectural space that conveyed their impression of listening to the sound track. Their drawings are surprisingly consistent. They describe an underground passageway that is partially flooded by water.

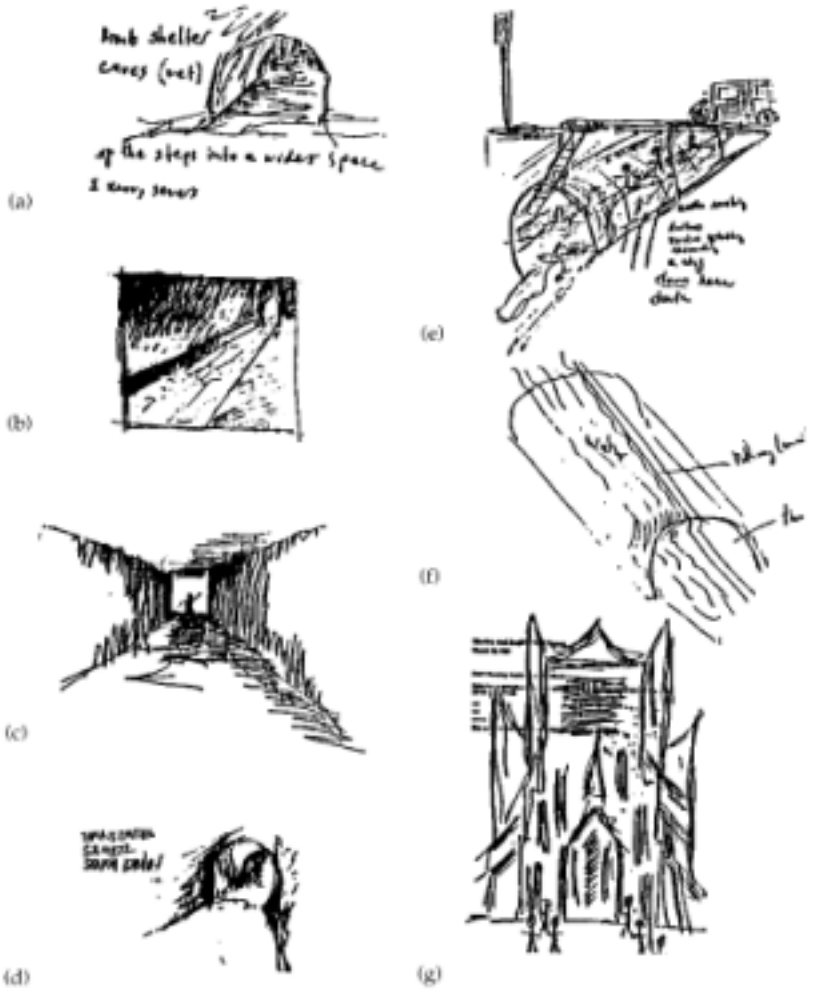

Figure 6 Student responses to sound track

The same test was also given to a similarly sized group of non-architecture graduate students. The drawings produced by these students were not as consistent with one another as those produced by the architecture graduate students nor as focused on the spatial attributes depicted within the movie (figure 6e-g). The persons listening to the sound track from the movie may have been attending to entirely different aspects of it. One person may be thinking about the architectural space whereas a second person may be interested in the narrative. Therefore, in a revised testing scenario, subjects were examined for how well they could reproduce specific characteristics of a given architectural space.

The revised testing scenario compared the responses of two groups of architecture students. The first group of students, Group A, viewed a videotape of an architectural space. The second group of students, Group B, viewed a plan of the same architectural space. Both groups of students were then required to draw a plan of the architectural space. The intent of this comparison was to uncover differences that exposure to each medium had in terms of how the two groups reproduced (1) the boundaries of an architectural space, (2) the identification of objects in the architectural space, and (3) the juxtaposition of objects within the architectural space. The three steps of the testing scenario were:

Step 1:
A-The architectural space was recorded within a two minute videotape:

The two-minute videotape consists of two major sequences and a minor sequence. Each major sequence consists of a combined series of pans that provides a continuous 360 view of the architectural space. The minor sequence consists of a series of still close-up shots of objects in the room. Clearly, the videotaping technique had an impact on what was recorded. For example, the identification of objects in the space might be enhanced by special use of spot and fill lighting. Tracking equipment could have provided smoother continuity between shots. A wider angle lens might have taken in more information. The results of this study, therefore, are only relative to the particular techniques employed in making the movie, and the skills of the moviemaker.

B-A measured plan drawing of the architectural space was also made.

The measured plan was a conventional plan drawing that incorporated standard notations for doors, windows, and other objects.

Step 2: The two groups of architecture students were tested.

Each group consisted of ten graduate and upper level undergraduate students. Each student was tested separately and then interviewed. Each student from

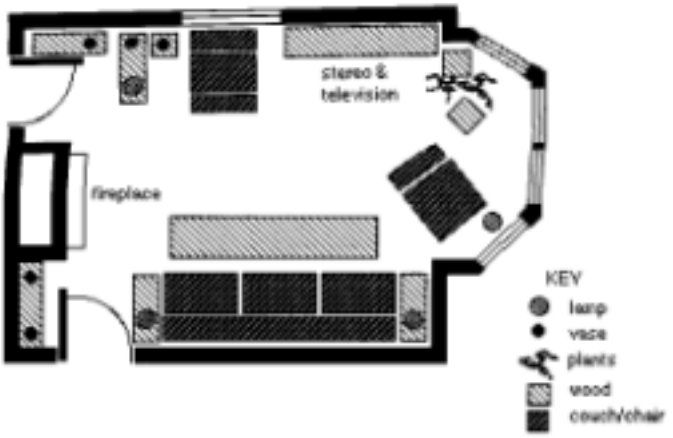

Figure 7 Measured Plan

Group A viewed the videotape once for its two-minute duration, and then was not permitted to see it again. Each student from Group B viewed the plan, also once for two minutes, and then was not permitted to see it again. After viewing the videotape or the plan for two minutes, each student was asked to draw a plan of the architectural space. The plan drawing was to include all of the objects that could be recalled from the within the architectural space.

Step 3: The student's plan drawings were scored:
Each students plan reproduction of the architectural space was scored according to the following system (ideal scores in each category of performance are shown in bold face):

* number of non-wall furniture objects found: 24
* number of non-wall furniture objects invented: 0
* number of wall objects found: 8
* number of wall objects correctly placed: 8
* number of wall objects invented: 0
* correct order of walls: (1 to 4) 4
* correct proportions / delineation of walls
(rated on a scale of I to 5): 5

Within this scoring scheme, a 'non-wall object is any material item which may be seen within the room, such as a vase, a lamp, or a table which is not physically built into the wall. A "wall" object is any material item which is incorporated into a wall, such as a door, a window, or a fireplace. Also within this scheme, the order of the four walls in the architectural space is scored as

correct if the walls are accurately positioned relative to one another. Finally, the walls are judged to be correctly delineated if they correspond to the actual layout of the four walls in the room enough that there is a faithful representation of the dimensions, symmetry, angles, little nooks, etc.

The plan drawings of students in Group A, the Videotape Group, and of Group B, the Plan Group, are shown in figures 9 and 10. Each of the plan drawings within these figures has been reduced from an original size of approximately 8 1/2 by 11 inches. In all categories, the average scores of students within Group A were lower than the average scores of students in Group B.

The test had an obvious asymmetry. On the one hand, one group of students, Group B, saw a plan of the architectural space and were then ask to reproduce it in plan. On the other hand, the other group of students, Group A, saw the videotape of the architectural space and where then asked to switch media and reproduce it in plan. Therefore, the test did not fully measure a student's recollection of architectural space from plan versus a student's recollection from videotape, but rather, the test only measured what could be reproduced in plan. Yet, it may be advantageous to examine how the impressions from both mediums could be conveyed in a context that is limited to a "plan" drawing. For example, if the boundaries of a space are accurately recorded by both groups of students within their plan drawings, then it is an indication that the videotape communicates to one group of students, Group A, the same information about boundaries of an architectural space that was communicated by the initial plan drawing to the other group, Group B. In the same way, it could also be determined how similar was the information perceived about the identification and the juxtaposition of objects within the architectural space. Still, a key disadvantage due to the asymmetry of this approach is that it was not possible to learn about what information was conveyed in the videotape that could not be reproduced in plan. This is a key limitation in that the particularly unique contribution made by moviemaking to the perception of architectural space is not isolated.

The evaluation of each student's performance in reproducing the plan of the architectural space was measured in terms of three areas:

1) the number of objects that were recalled;
2) the correct placement of objects;
3) the correct proportions / delineations of walls.

In general, Group A did worse in that fewer objects were recalled, more objects were invented, the order of the walls was not always correctly perceived, and the proportioning and layout of the walls was least faithful to the actual

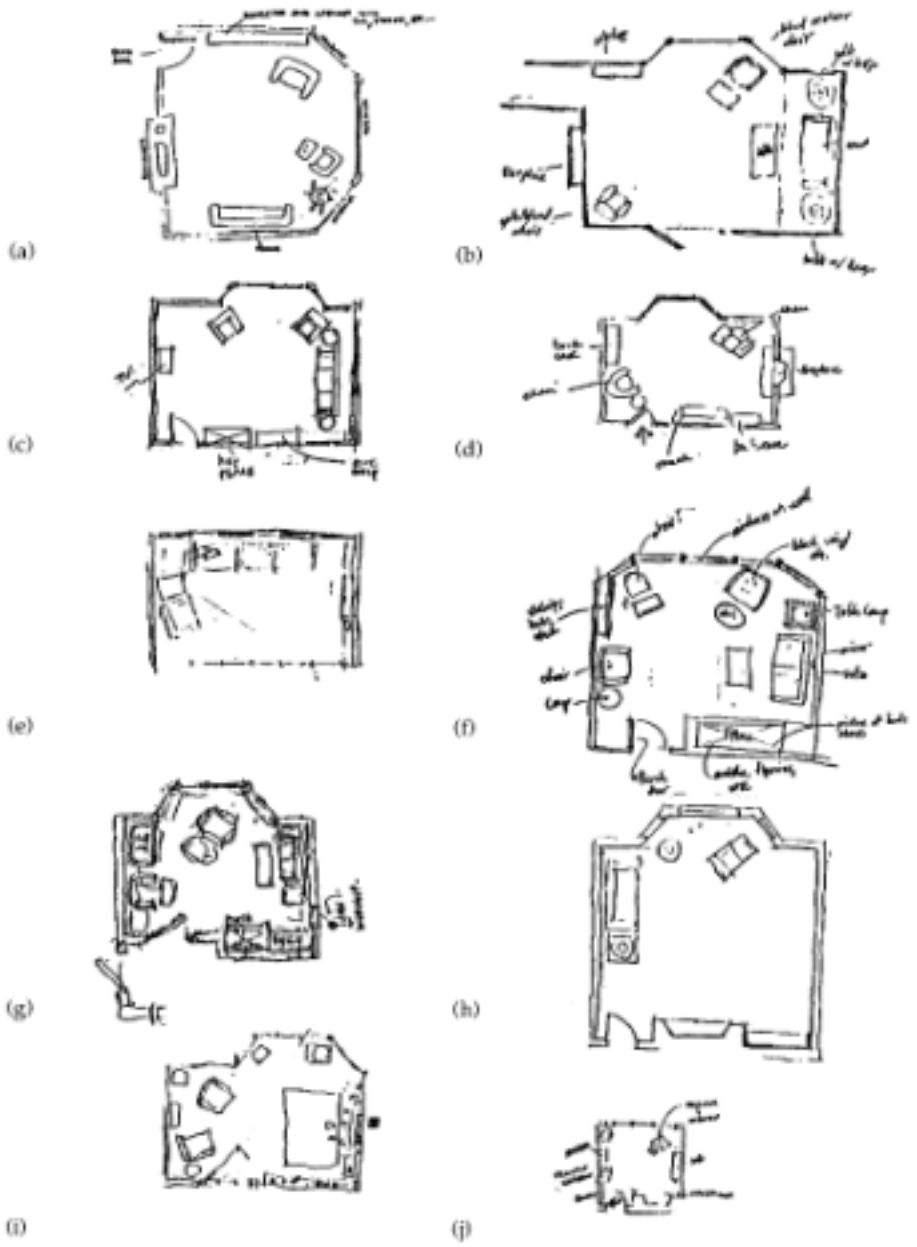

Figure 9 Recollection of architectural space from *videotape.* Responses ordered from top to bottom of page in terms of least experienced to most experienced architectural students. The most experienced students include practicing architects.

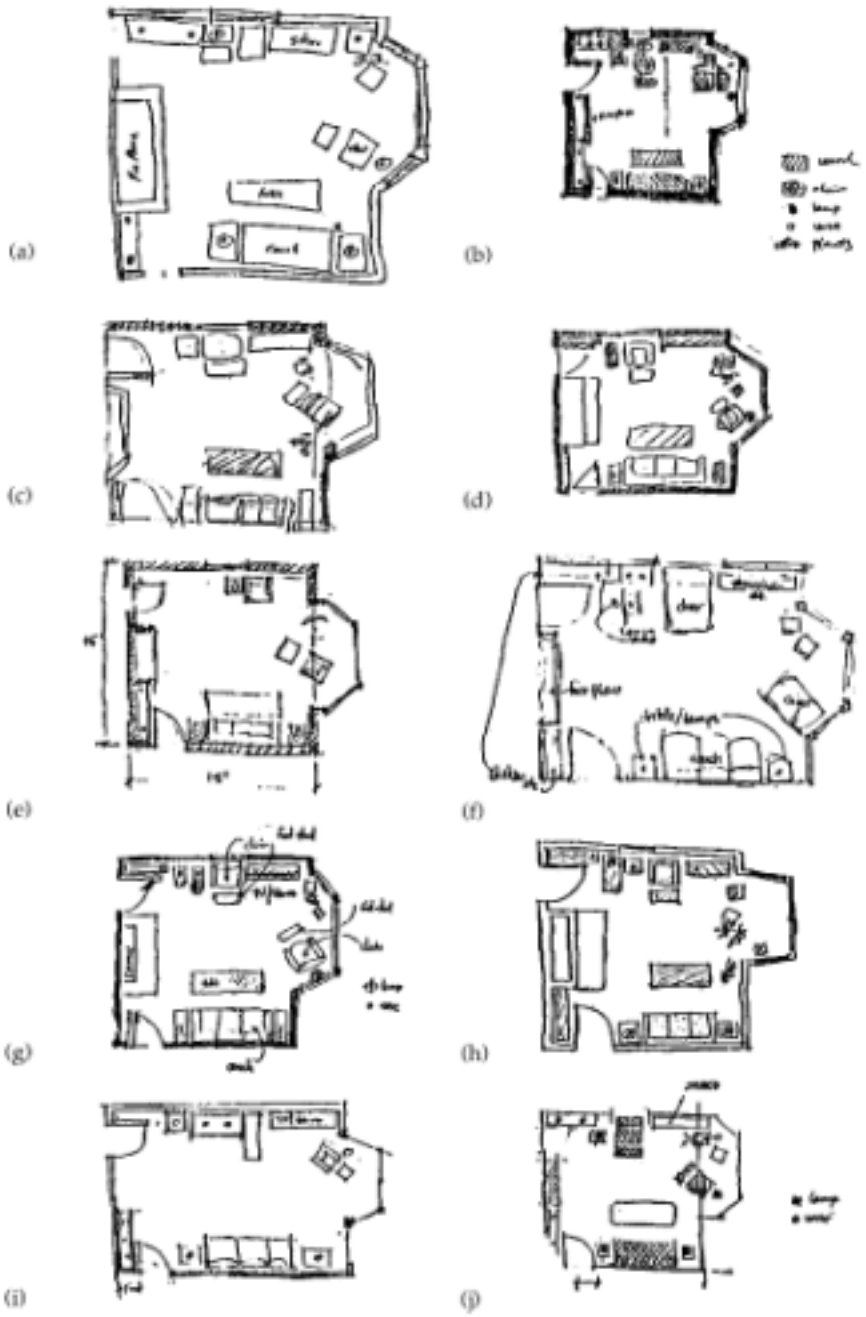

Figure 10 Recollection of architectural space from Plan. Responses ordered from top to bottom of page in terms of least experienced to most experienced architectural students. The most experienced students include practicing architects.

Average Results of "Videotape" Group A:	Average Results of Plan' Group B:
* number of non-wall furniture objects found: 7.4	* number of non-wall furniture objects found: 18.7
* number of non-wall furniture objects invented: 1.4	* number of non-wall furniture objects invented: .9
* number of wall objects found: 5.5	* number of wall objects found: 7.2
* number of wall objects correctly placed: 4.1	* number of wall objects correctly placed: 6.9
* number of wall objects invented: .7	* number of wall objects invented: .3
* correct order of walls: (1 to 4) 3.4	* correct order of walls: (1 to 4) 4
* correct proportions/delineation of walls rated on scale of 1 to 5): 2.6	* correct proportions/delineation of walls rated on scale of 1 to 5): 4.5

Figure 11 Average results of Group A and Group B

layout of the architectural space (figure 11). The Videotape group was less accurate on (1) the number of objects in the space, (2) the juxtaposition of objects in the space, and (3) the boundaries of the space. They were more likely to (4) draw plans which included organizational symmetries not present in the architectural space. It also appears that the more experienced students had more accurate recall. On the other hand, in the Plan group, (5) the accuracy of the recall was independent of the level of the student.

Most striking is the lack of consistency of the drawings of students in Group A versus the consistency of the drawings in Group B. The degree of distortion of some students in Group A (figure 9a-e) compares with the relatively faithful reproductions of other students in Group A, such as 9f and especially 9g. In the case of figure 9g, the student did better job at some aspects of proportioning and delineating the room than some students in Group B. It is also indicated in figure 9g that the student included a door which could be glimpsed outside of the room (at lower left of drawing). Without the inclusion of this exceptional drawing, however, the results would suggest that there was not enough information within the movie to convey a faithful representation of the architectural space. With this exceptional drawing, it is speculated that the information was available, but that most students in Group A were not able to perceive it.

Insights Gained from the three Case Studies

The results of these case studies suggest that movies may not have the capacity to convey the precise arrangement of objects within a scene. As suggested by the student responses to the movie "The Third Man", a videotape may also communicate distinct impressions that are highly dependent upon the disposition and sensitivities of the viewer. On the whole, it is necessary to better identify the particular abstraction which moviemaking does provide

and to clarify what it informs us about architectural design that other media do not.

On the one hand, the use of a medium in a particular area of design problem solving may be constrained by its capacity to abstract information. For example, a motion picture abstraction may be useful in helping to characterize the aesthetic qualities of some vases in the room, but not useful in describing the locations of the vases. Similarly, a plan drawing may help to locate the vases in an architectural space, but not convey their color, texture and sculptural qualities. The combined use of both videotape and plan representations, however, may provide a more complete representation of an architectural space. For example, to more thoroughly understand the Taj Mahal, it may be useful to view a videotape of it, and to see it drawn in plan, section and elevation.

An expert movie goer or critic may be more sensitive to the way in which a particular editing sequence is used, and because of his or her familiarity with the pattern of editing, could be more receptive to the structure that joins together different sequences within the movie. As a result of understanding the structure of the movie better, such an expert may be in a better position to find a scheme by which different objects within the movie of an architectural space could be related into a coherent whole. This is related to De Groot's expert chess player study [14]. In De Groot's study, the ability of a chess master to recall the locations of chess pieces more easily than a novice was only evident when the chess pieces were in legal positions (as might be experienced in tournament play). It was speculated by De Groot that the masters were able to recall more pieces because they were located in patterns that were meaningful to an expert.

Similarly, the better performance in reproducing a floor plan of the architectural space by the student in Group A who completed plan 9g may have resulted from his greater expertise in movies. In a separate questioning of his interests, he indicated that he had a strong interest in the use moviemaking 'to experiment with modes of expression" of architectural concepts. Yet, the impact that a person's expertise may have had in viewing the movie is only speculated upon here. Therefore, any conclusions from the evidence gained must be cautiously considered with regard to both the nature of the movie made and the varying levels of expertise of the participants within the study.

Conclusion

In the first case study of moviemaking cited in this paper, the position of the observer was fixed, whereas people and cars moved through the scene. In the second case study, the position of the observer could move, but only where the movement of the camera recording the computer graphics was coordinated with

the movement of the camera which was used to record the site. The next technical leap forward is perhaps to provide complete freedom of movement of the viewing position in real time. The Aspen Colorado Videodisc Project completed at the Architecture Machine Group at MIT in the early 1980's simulated such freedom of movement of the observation point, although it was restricted to predefined images stored on a videodisc. More recently, Professor Patrick Purcell at the Media Lab transferred a CAD model of Frank Lloyd Wright's Robie House to a Trillium real time animation computer. In attempting to provide an environment in which the camera can move about unrestricted, he was unable to completely merge the 3D coordinate systems of both a video recording and a 3D CAD model. The result was that if you moved the observation point around the scene, the Robie house would occasionally "take off like a Harrier Jump jet " [15]

The quest for realism may be relatively unimportant in moviemaking and computer aided design. Technical advances should perhaps not strive to provide greater proximity to the perceptual experience of being within an architectural space, but rather provide the visual abstractions that better take into account the cognitive styles of architects engaged in design. In all potential scenarios, architects will need to be trained in the use of the media technology, and will need to incorporate it purposefully into their cognitive processes. On the one hand, the use of such tools may burn "new brain cells" in the mind's of the architect, and identify unprecedented aesthetic domains and design methods 16 On the other hand, architects may always need traditional plan, section and elevation drawings to be certain about such important considerations as: (1) the boundaries and scale of architectural space; (2) the identification of objects within architectural space; (3) and the relationship of objects within architectural space. In some incompletely understood cases, moviemaking and real time animation may make a contribution to the cognitive process of architectural design.

Notes and References

1 The term movie is used to avoid making the distinction between motion picture film, video production, and computer animation.

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6 Cocteau. Jean. 1972. *Beauty and the Beast: Diary of A Film.* New York: Dover Publications. p. 47.

7 Mark. Earl and Frank Miller. 1988. 'Report to Project Athena: The Electronic Design Studio Project'. Presented at Computers in Design Research Symposium. Chicago. Illinois. May 3.

8 Professor Morris Smith, School of Architecture and Planning, M.I.T., expressed his reservations about moviemaking as a design medium because he felt it may overwhelm and control the aesthetic decisions of the designer. His remarks were expressed to me in informal conversation during a faculty meeting in May 1989.

9 Rasmussen. Steen Eiler. 1959. *Experiencing Architecture.* Cambridge: M.I.T. Press. pp. 33 - 34.

10 The computer animation / video work referenced here was performed with the considerable efforts of Branko Kolarevic on the South End Project, and Pegor Papazian and Iffat Mai on the Charlestown project. The cinema verité movie was completed by Aniruddha Das Gupta, Geno Fruet, Anurudha Joshi, Lei Xi and Jian Zhao. There were a total of eighteen students enrolled in the subject.

11 This animation package was principally developed by undergraduate student Bob Sabiston. A front end to the animation package was developed by undergraduate student Chris Thorman working in consultation with graduate student Brian Press.

12 For a recent description of PC based CAD and Animation tools, see the June 1989 edition of MACWORLD, Volume 6, Number 6, Published by IDG Communications, Inc., San Francisco, California. This issue is devoted to use of the MacIntosh computer in film and video animation.

13 Rasmussen, Op. Cit., p. 224.

14 Anderson. John. 1985. *Cognitive Psychology and Its Implications.* New York: *W.H. Freeman. pp. 243* - 244..

15 Purcell. Patrick. October 1987. Lecture to a Computers & Architecture subject at M.I.T.

16 Hubert Lundqvist, The National College of Arts and Design, Stockholm, Sweden, used the term burn new brain cells' with respect to discovering computer aided design methods at a Seminar on "What Would The Architect Gaudi Have Created With A Computer", May 30 - June 6, 1985, Barcelona, Spain, Sponsored by the Swedish National Board of Universities and Colleges.