THE USE OF VIDEO-COMPUTER PRESENTATION TECHNIQUES TO AID IN COMMUNICATION BETWEEN ARCHITECT AND CLIENT

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ABSTRACT

In an attempt to enhance the communication between architect and client, research was conducted in the use of computer modelling and video imaging techniques for the final architectural presentation process. By superimposing the painted building design from the CAD system onto a digitized image of the intended location, a composite image was achieved. These techniques have advantages in creating a realistic composite image of a proposed building design in its intended location within a short period of time.

In order to provide more visual clues, a multiple view presentation format using a series of selected views (multiple views) was used. In addition, the research had further attempted to present the video-computer presentation in an animation sequence. The animation presentations were evaluated by comparing them with the multiple view presentations. Manual rendering and single viewpoint displays were also included in the comparisons in order to validate the results. Questionnaires were used to measure the capability of each presentation format to communicate the intended information to the audiences. The experiments were conducted with non-architecture subject groups in the local Bryan/College Station area.

INTRODUCTION AND BACKGROUND

Good communication between architect and client is one of the keys to a successful architectural project. Communication problems between the architect and the non-architect usually occur because the non-architect is not trained to evaluate the drawings in the same way the experienced architect does. Hasell (1983) described that some jargon and technical design related terms that architects use may not be clear enough to describe design for the non-architect. This problem also occurs for the first year architectural students who do not have much experience in a design studio. Although, many presentation media have been used to prevent communication problems, these presentation media themselves are sometimes difficult to understand for the non-designer.

Manual rendering, a conventional presentation technique, has long been used in the architectural field for communicating the design intent to the client -- the non-designer. This presentation method can give the client an idea of how the building design will look at its intended location. However, the rendering has to be done mostly by hand, which is a time consuming process. These presentations normally have to be done by professional renderers, not the project's designers. Therefore, the architects have to be very careful in communicating the design to the professional renderers in order to get accurate renderings that express the design intent. In order to prevent any discrepancies, architects have to finish the design process early to provide time for
renderings. This problem may obstruct architects from doing their best in the design process. Manual renderings have also received some criticisms about their artistic style, and that they can mislead the client. Furthermore, the surrounding site of the building is very difficult to portray accurately and realistically by this technique. Some renderings even leave out the surrounding environment in order to emphasize the buildings. These presentation styles may easily mislead the non-designer.

Today, computer-aided design (CAD) is accepted by architectural firms because it can raise productivity and, potentially, quality of architectural work. With its capability to interchange between two dimensional (2D) and three dimensional (3D) views, CAD introduces a new way of making presentations using computer generated images. Perspective, or 3D wire frames can be viewed almost instantaneously during conceptual design, design development, and final presentation processes. With rendering packages, such as Big D by Graphics Software, Inc. (Dallas, TX); Architrón by Gimeor Inc. (Washington, DC); and Dyanperspective by Dynaware Corp. (Foster City, CA), a full rendering presentation of a building can be created within a short time period. The advantage of rendering software is that it allows the architect to concentrate on the design process longer and finish closer to the project deadline (Robertson 1990). By combining computer generated presentation with video imaging techniques, a more realistic presentation can be achieved. By using video processing hardware, such as AT&T's TARGA series or Truevision's ATvista series, an actual site image can be captured onto a computer system. The composite image, then, can be created by superimposing the computer rendered image onto the intended site image. These techniques can give a realistic feel of how the building will look in the actual location within a relatively short time compared to the artist rendering techniques. Orland (1987) indicated that since composite images are closely related to scenes from television screens, the non-designers can get used to and understand them easily.

From a practical point of view, video and computer techniques have a great potential to aid in architect and client communication. This research focused on the investigation of video-computer presentation techniques in the final architectural presentation process. The focus was also on the use of low-end equipment, since it would be more accessible for small architectural firms. The advanced stages of the study will employ more advance and sophisticated equipment. The intended audience group for this presentation was the non-designer group. Due to the fact that the non-architect has less design experience than the architect, if these potential presentation techniques can deliver a better understanding to the non-architect, the architects will understand even more. The research, however, did not intend to replace manual rendering with video-computer presentation. The video-computer presentations, using present technologies, have relatively low resolution compared to the artist renderings, and they do not have as high an artistic value as their conventional presentation counterpart. Manual renderings can be seen as a piece of art that can be used for exhibiting or decorating, in lieu of a communication tool, while a video-computer presentation may not. Video-computer presentation, on the other hand, can be created within a much shorter time to let the non-designer visualize how the building design will potentially look at its location. The benefit of video-computer presentation is that it can be used to describe the proposed design briefly and realistically, and that it is more practical during the architectural design process.

At the Department of Architecture, Texas A&M University, video-computer presentation techniques have been introduced into a design studio. The focus of using video-computer presentation was in the final presentation stage. The intention was to allow the students to see the realistic impact of their designs in the actual surroundings. The benefit of using video-computer presentation in the design studio is increasing the awareness of students towards the shapes and forms of the surrounding buildings and environment.

Although video-computer presentation is very useful, it also has some limitations. Since the digitized image of the intended location and painted proposed design image are in raster formats,
they cannot be rotated to see any other viewpoints. This technical limitation permits only one view to be created at a time. By simply superimposing the proposed design drawing from a CAD system onto the digitized real location image, video-computer presentation can be created within a short period of time. A multiple view presentation can be created in a practical manner. The research focuses on the use of multi-view presentations, because more views should logically provide a better visual clue to the audience than only a single view.

In addition to using multiple views, the research attempted to present video-computer presentation in an animation format in order to give more visual clues of space in the presentation. Hershberger and Cass (1973) conducted experiments for validating various presentation media and maintained that motion presentations, for example a colored film, etc. are better than a series of still frames in duplicating the experience of a real environment.

The animation of video-computer presentation can be done by low-end equipment, but is still quite time consuming. After conducting a preliminary study from a theoretical point of view, two animation models were created from two different buildings. Considering the efforts of producing an animation presentation, multiple view presentation can be produced within a much shorter time. The contributions of multiple view presentation have gained more attention, as evidenced by related research efforts. Hershberger and Cass (1973) argued that although motion presentation can give the feeling of the actual environment, it is more inclined to distort the perceived attributes of the environments. They indicated that a still frame or a series of still frames can portray better in term of details what the designer intended to describe, but it is not good in terms of representing spatial aspects (Hershberger and Cass 1973). Brooks (1988) conducted experiments on video as an aid in teaching architectural design concepts. From the experiments on two presentation formats, animation and a series of still images, he concluded that there is no significant difference between the two in terms of students' learning level. These research results inspired the conduct of the test between animation and multiple views presentation using video-computer presentation techniques in order to bring out the video-computer potentials to aid in architect and client communication. The research primarily concerned with the comparison of animation and multiple views, but it also included single view and manual rendering presentations in order to aid in interpretation of the main comparison result.

CONSTRUCTING VIDEO-COMPUTER PRESENTATION MODELS

The hardware for creating the video-computer presentations included an IBM AT compatible with a TARGA 16, image processing board from AT&T, and a color video camera (SONY DXC/M7). The software was AutoCAD (release 10) from Autodesk Inc., VideoCAD from Mathematika Inc., Truevision Image Processing Software (TIPS) from AT&T and Truevista Slide Presentation Software from AT&T. The system had a resolution of 512 * 480 pixels and could display 32,768 colors at a time.

Two buildings were used as models for constructing the video-computer presentations. Model A was the Horticulture/Forest Science Building (1981) designed by Fisher and Spillman Architects, Inc., Dallas, Texas. The building has five stories with a penthouse on top. It has a long rectangular form with a large, receding triangular-shaped entrance hall, which is its most ambiguous component that requires a good technique to present it adequately (see Figure 1). Model B was the City of Bryan Municipal Building (1986) designed by Williamson Group, Bryan, Texas. This building is smaller but more complicated than Model A. It has three stories, with a long, nearly hexagonal shape. Both wide sides have shear walls from ground to roof with no windows. Both long sides serve as entrances (with no back side) and they have continuous multi-level tinted glass panels with columns of many sizes (see Figure 2).
Three video-computer presentations (animation, multiple views, and single view) were created for each building model. A color slide of a manual rendering was also created for Model A. No manual rendering was available for Model B.

The single view was created by drawing the buildings in 3D, according to the actual blue prints, using AutoCAD. With Dynamic View (DVIEW) command, the intended camera and target positions were input in order to create a perspective view with hidden lines removed. This perspective drawing was saved in an AutoCAD slide file format (.SLD). By using VideoCAD software, a slide file from AutoCAD was converted into TARGA file format (.TGA). From this point, the perspective wire frame image from AutoCAD was imported into TIPS, a TARGA 16 based painting and image processing software, environment. The wire frame was then painted using previously digitized realistic textures, such as brick, brick with shade, glass, etc. From the known camera position and target position, a picture of the intended site from the same viewpoint was taken. Using color video camera, TARGA 16 board, and TIPS software, the image of the actual site was digitized into the computer system. The painted proposed design image, then, was superimposed on top of the intended site image to create a composite image of the proposed building in its real location. After the composite image was finished, it was recorded onto a video tape for presentation to the audience.

Creation of the multiple view presentation was done by the same method as above, but repeatedly done for the extra views from the different view angles. By using Truevision Slide Presentation Software, the series of still frames was arranged as an infinite loop from the first frame to the last.
frame and back to the first frame again, and so on. The series of selected views were, then, recorded onto a video tape. This series of selected views was composed of three composite images from different view angles.

For the animation presentation, in addition to the use of basic methods, as in single view presentation, many techniques were used. In order to present the model in real time animation, 24-30 continuous frames were needed. This is quite an arduous task with low-end video-computer presentation techniques. Therefore, the idea of repeating the short animation section into an infinite loop was adopted in order to reduce the number of animation frames. Next, the animation path was determined. For simplification, a half circle animation path was selected. By using a straight line segmented animation curve, one new animation frame was created when the animation path moved forward one degree of angle. The total number of frames needed, in this case, was 180 frames. This animation path simulated walking around the building site in a counter-clockwise direction. After a half circle animation path was determined, coordinates of each camera position were calculated. Position of the sun, a source of light, from the real site were also taken into account. By creating an AutoLISP program, the sequence of building wire frames in perspective with hidden line removed were generated automatically in AutoCAD. Stadia method--one of the surveying methods for measuring levels and distances in a natural terrain--was used to plot each corresponding camera position on the actual site (see Figure 3). According to these positions, a series of pictures were taken and were digitized into the computer system. The series of proposed design wire frames were painted and superimposed onto the corresponding site images (see Figure 4). By using the video recording technique, the composite sequence images were recorded as a forward loop and then a backward loop and a forward loop again and so on as an infinite loop. The presentation, then, was successfully played back in real time.

* Indicate camera positions

Figure 3 Diagram shows half circle animation path and the camera positions
Since two different models were used, two sets of presentation were constructed. Model A had four presentations: animation, multiple views, single view, and manual rendering. Model B had only animation, multiple views, and single view presentations.

MEASUREMENT INSTRUMENT

After video-computer presentation models were created, the research proposed to evaluate them in terms of communicative effectiveness. The term communicative effectiveness, in this case, refers to the power or capacity to accurately transfer information or ideas of exterior architectural design from the architect to the non-architect. To aid in determining the results, single views of video-computer presentation and manual rendering were included in the comparisons. Since multiple view presentations are logically more effective than a single view, the measurement tool was designed to show the results according to this logic. If the measurement tool is sensitive enough, it should be able to distinguish different between the multiple view presentations and the single view presentations. In an attempt to be able to determine the differences between the two presentation formats, measuring instruments (questionnaires) were designed. These measurement instruments consisted of not-to-scale outline drawings of the buildings and 25 questions about each one (Figure 5). Twenty-two of the questions required multiple choice answers and confidence ratings on a 5-point scale; from very unsure (1 point) to very sure (5 points). These questions were asked in 5 categories of visual clues, including (1) depth (relative distance to surfaces), (2) shape (form of the building or its components), (3) size (relative proportion or scale of one building or its components to another), (4) relationship (the arrangement of building parts), and (5) textures (grain or substance of the building or its components). The scores from multiple choice will be addressed as raw score. Scores from the
raw score and the confidence rating score were used to calculate the final scores. Question 23 asked the subject to rate the presentation medium in representing the real situation on a 5 point scale from very poor (1 point) to very good (5 points). Question 24 required a similar rating on the resolution or clarity of the presentation medium on a 5 point scale from low (1 point) to high (5 points). Question 25 asked the subject to report the time used to answer the questionnaire.

Figure 5 An example of guidelines and questions used in the questionnaires

CONDUCTING EXPERIMENTS

The subject group used in the experiments was non-architecture subjects, which was composed of 56 males and 74 females. These non-architecture audiences were randomly assigned to view separately the presentation from video tape (on a 25” Television screen) or from a projected screen (for manual rendering). In each presentation group, the presentations were shown continuously to the audiences for a maximum of 15 minutes. Questionnaires were used to access the information in the five areas mentioned earlier. In order to make fair comparisons, all questions asked information that can be seen from only one view, but may need more visual clues to understand them.

The three main independent variables were presentation technique (animation, multiple views, single view, manual rendering), question category (depth, shape, size, relationship, and texture), and model (A and B). These variables were combined factorially in a split-plot design that was unbalanced in two ways: (1) there was no manual rendering for Model B, and (2) the number of subjects in each group was not equal. The original experimental design was based on independent subject design, each experimental group containing different subject groups. This was done to eliminate subjects gaining experience from the former experimental settings. Subjects gain experience when the presentation that they saw from the first experiment describe the same building model in the second experiment. Although the presentation formats are different, the content of the questionnaire was the same. The subjects would have used their previous experience to aid in decision making in the second group and, therefore, bias the results.
However, when the former group contained a presentation from the different model and different questionnaire the gaining experience effects did not occur. For this reason, the experiments were designed to allow each audience to participate in the two experimental settings that described the different building models. This method effectively reduced the number of subjects needed and, at the same time, increased the practicality of the experimental process. After allowing one subject to participate in two experimental settings, another concern was the order of presentation. To eliminate the order effects, each experimental group was divided into two sections; the first section viewed presentations from model A and then B while the second section viewed presentations from model B and then A. This technique counterbalanced the order effect. The number of subjects in each experimental group were: 34 in animation - Model A; 31 in multiple views - Model A; 30 in single view - Model A; 25 in manual rendering - Model A; 31 in animation - Model B; 42 in multiple views - Model B; 42 in single view - Model B. For more details on the proportion of male and female and subjects' background, see Sirikasem (1990).

The standard experimental procedure allowed a maximum of 8 subjects to be tested at a time. Subjects were seated within 5' to 10' from the television monitor and within 6' to 10' from the projection screen. The standard instructions were recorded and played before each session. A wall clock was provided for the subjects to calculate the time they had used to answer the questionnaires.

RESULTS

The data analyses were performed using the general linear model (GLM) from the SAS package. Analysis of variances (ANOVA) was conducted first and the individual mean comparisons were made when significant differences in the means were indicated. T-tests were done using Fisher's least significant difference of the GLM procedure using a 95% confidence level.

Realistic, Resolution/Clarity, and Time Used. Table 1 illustrates the means of realistic, resolution/clarity, and time used rating. The ANOVA tests showed there were significant differences in the means for realistic rating \( F(3,228) = 13.53, p < .001 \) and resolution/clarity rating \( F(3,229) = 10.25, p < .001 \). However, there were no significant differences in the time used \( F(3,1460) = 0.72, p > 0.5401 \).

<table>
<thead>
<tr>
<th>Categories</th>
<th>Animation A</th>
<th>Multiple Views A</th>
<th>Single View A</th>
<th>Manual Rendering A</th>
<th>Animation B</th>
<th>Multiple Views B</th>
<th>Single View B</th>
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<tbody>
<tr>
<td>Realistic Representation</td>
<td>4.00</td>
<td>3.64</td>
<td>3.16</td>
<td>3.48</td>
<td>4.16</td>
<td>3.31</td>
<td>2.76</td>
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<tr>
<td>Resolution/Clarity</td>
<td>3.85</td>
<td>3.71</td>
<td>2.90</td>
<td>3.40</td>
<td>3.87</td>
<td>3.14</td>
<td>2.59</td>
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<tr>
<td>Time Used (minutes)</td>
<td>9.75</td>
<td>9.10</td>
<td>9.08</td>
<td>9.75</td>
<td>8.70</td>
<td>7.85</td>
<td>8.88</td>
</tr>
</tbody>
</table>

Table 1 Means of realistic representation and resolution/clarity ratings and time used
For realistic rating, both animation Model A and Model B were rated highest followed by multiple views and single view, respectively. In Model A, manual rendering was rated higher than single view, but lower than animation and multiple views. In Model A, T-tests indicated only significant differences between animation (4.00) and single view (3.16). In Model B, on the other hand, all the differences were significant.

For the resolution/clarity rating, the order of rating was the same as that of the realistic rating. In Model A, the differences of animation (3.85) vs. single view (2.90) and multiple views (3.71) vs. single view were significant. In Model B, all the differences were significant.

**Raw Score.** Figure 6 illustrates the pattern of significant differences for the scores from multiple choices or raw score as a function of presentation technique, question category, and model. The results from ANOVA showed there were significant main effects of presentation technique ($F(3, 1138) = 3.81, p < .01$), question category ($F(4, 1138) = 24.77, p < .001$), and model ($F(1, 1138) = 5.99, p < .05$). There were also significant interactions between presentation technique and model ($F(2, 1138) = 6.44, p < .01$) and between question category and model ($F(4, 1138) = 12.63, p < .001$). For the results of T-test in Model A, multiple views was significantly superior to animation in size and texture categories, in contrast to the results from the realistic and resolution/clarity ratings, which indicated animation yielded the highest rating. Although animation was superior to single view in shape judgement, it was not superior to multiple views in any other categories. In addition, multiple views was also significantly superior to single view in the texture category, and manual rendering was significantly superior to single view in the shape category. In Model B, the results were more consistent with the realistic and resolution/clarity rating. Animation was significantly superior to multiple views and single view in both depth and texture categories.

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**Figure 6 Means of the scores in the raw score category**
Confidence Rating Score. Figure 7 illustrates the pattern of significant differences for confidence ratings as a function of presentation technique, question category, and model. The ANOVA results indicated there was a significant difference in the mean of the main effect, presentation technique $[F(5, 1138) = 11.23, p < .001]$ and significant interaction between presentation technique and model $[F(2, 1138) = 7.79, p < .01]$. For the results of T-test in Model A, multiple views was significantly superior to animation and single view in size and relationship categories, respectively. Single view also was significantly superior to animation in the size category. In Model B, animation was significantly superior to multiple views in the depth category and superior to single view in depth, shape, size, and texture categories. Multiple views was significantly superior to single view in shape, size and texture categories.

![MODEL A](image)

![MODEL B](image)

Figure 7 Means of the scores in the confidence rating score category

Final Score. Figure 8 illustrates the pattern of significant differences for final score as a function of presentation technique, question category, and model. The results from ANOVA showed there were significant differences in the means of the main effect, presentation technique, $[F(3, 1139) = 7.77, p < .001]$ and question category $[F(4, 1139) = 26.93, p < .001]$. There were also significant interactions between model and presentation technique $[F(2, 1139) = 6.23, p < .01]$ and between model and question category $[F(4, 1139) = 13.27, p < .001]$. For the results of T-test in Model A, multiple views was significantly superior to animation in size and texture categories, superior to single view in the texture category, and superior to manual rendering in size, relationship, and texture categories. Animation was significantly superior to single view in the shape category and superior to manual rendering in the relationship category. For the results of T-test in Model B, animation was significantly superior to multiple views and single view in
DISCUSSION AND CONCLUSION

The results from realistic and resolution/clarity ratings revealed that the non-architecture subjects believed that the animation presentation was the most realistic and had the highest resolution over multiple views, single view, and manual rendering. In fact, all video computer images used in animation, multiple view, and single view presentations were created in the same manner and had the same resolution and picture quality. In addition, manual rendering had the highest resolution, but the subjects still found animation had the best quality. This may be because when the number of pictures increases, subjects did not have enough time to see the actual details of the picture resolution. When the pictures were presented at 30 frame per second, they created an illusion of real movement. This might be the reasons why the subjects rated animation the highest in both the realistic and resolution categories. In some cases, subjects did not get the most accurate information from animation, which they thought to be the most realistic and had highest resolution, such as in Model A. In this case, the subjects had a high false confidence that their erroneous perceptions were correct. For animation presentation, the confidence ratings tended to be high whether or not the specific judgements were correct. Animation was the most effective technique for communicating depth, which probably stems from the information provided by motion parallax. Animation, on the other hand, incorporated with the continual motion, sometimes degrade size and texture judgments. The subjects neither directly reported this degradation nor indirectly expressed it through low confidence ratings. These results suggested
that while animation has some advantages, it also has some potential limitations in terms of false perception.

Compared to multiple views presentation, animation presentation required a higher effort and time to create, and the question remains, is it worth the extra expense in architectural designs. The results suggest that client will like animation the most, and they will believe that it provides the most realistic representation. In fact, the client will see depth more accurately with animation, but they might see size less accurately. In addition, animation seems to produce a halo effect by carrying over the high overall confidence to inaccurate perceptions of specific aspects. An architectural firm might be well advised to wait for more research so that they will be able to capitalize on the advantages of animation, while minimizing the limitations of false perceptions. Follow up research might give the subjects some control over the animation and allow them to stop and look at multiple stationary views to make specific size judgements. The additional time necessary to complete more research might also allow a drop in the cost of animation. In the mean time, the results suggest that architectural firms would be wise to invest in the less expensive technology required for multiple view presentations. This conclusion is supported most clearly in the final scores, which take into account the raw scores and confidence rating scores. Compared to manual rendering, multiple views were not worse in any category, but were better in size, relationship, and texture categories. Furthermore, multiple views did not produce false confidence. It sometimes was even superior to animation presentation in size and texture categories. These are impressive results considering that the multiple views in this study only used three viewpoints. Better performance might be achieved with more viewpoints, which could be done for little or no extra cost.

REFERENCES


