An Evaluation of Urban Simulation Processes for the Elumens Vision Dome

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Abstract

This paper reports an evaluation of the potential use and value of three digital urban simulations techniques presented on a hemispheric display system made by Elumens®. The utility of this system to engage students and decision-makers in a process of envisioning alternative futures for a community college campus in a Midwestern U.S. city is discussed. Visualization of alternative environments is a critical part of planning and design. The ability of designers, planners and their students to use media to engage and communicate proposals is essential to effective participatory design processes.

1 Overview

The Kansas State University College of Architecure, Planning, and Design has acquired three Elumens Vision Domes to use for visualization of designed environments. Several faculty and students have begun exploring these immersive viewing systems in both the process of design and the communication of designed environments. This paper presents a review of some of our investigations using these visualization tools. As part of this exploration we organized a semester-long collaborative studio of fourth-year architecture and landscape architecture undergraduate students at Kansas State University, and one 5th year landscape architecture student working independently on his senior capstone project. The objective of the studio was to engage the parties-at-interest in the Omaha community in a visioning process that would enable them to begin a dialogue on possible alternative futures for the south campus of the Metropolitan Community College (MCC) in Omaha, Nebraska.

The 80-acre site was once home to the historic Omaha Stockyards. The existing South Omaha campus of the college is on the south side of the stockyard site. The center of the site was recently cleared for redevelopment with the exception of the historic Livestock Exchange Building (Figure 1). This 11-story, Second Renaissance Revival structure is on the National Historic Register (Figure 2). Industrial buildings and food processing facilities occupy much of the western and eastern portions of the site. A shopping center is located on the northwest corner.

Students were organized into multidisciplinary teams. Preliminary site design proposals were created and rendered in plan using traditional presentation media (e.g., Prisma color pencils, graphite, & pens). These proposals were presented to Metropolitan Community College staff during the first four weeks of the spring semester. Following the proposal presentation student teams developed alternative site and building designs.

We hoped to be able to provide the resources to convert the substantial portions of each team's work to formats that would enable them to present their designs on the Vision Dome.

Figure 1. Aerial view of the site. Existing campus buildings located in the lower middle/left, Stockyard Building roughly in the middle of the proposed site (photograph: MCC).

Figure 2. Stockyard Building (photograph: Cody Pilger)

Two advanced students working in the college's visual resource center developed a digital terrain model, including simple block structures representing buildings in the immediate neighborhood bordering the site. This common digital base model was made available to all teams to use as a base on which to apply their master plan proposal. Additionally, the student assistants explored three different processes by which the teams could convert their digital and analog models into formats that would be compatible with the Elumen's Dome.

2 Vision Dome

The Metropolitan Community College project provided an opportunity to use the "Vision Dome" display system with an enthusiastic client. The Vision Dome (http://www.Elumens.com/) is a portable, single-projector immersive, hemispheric viewing system which allows a 180-degree field of view (FOV) as opposed to the typical 60 degree FOV on a standard monitor. The Vision Dome facilitates collaborative viewing since multiple viewers are not required to wear head gear and can simultaneously view the scene and interact with each other. The College has 1-meter and 3-meter domes, and a projector for a 10-meter dome which will eventually be installed in a hemispherical structure to be built. The smallest dome is meant for one or two people, the 10 meter dome will accommodate approximately 20 people. The dome projectors utilize a special convex lens which bends the projected image so that it is perpendicular to the domed surface. The effect is to wrap the projected view just beyond the peripheral vision of the viewer in an attempt to simulate the actual perspective view experienced by a human.

Developing imagery for the dome can be accomplished in several ways. This paper focuses on three imagery production processes:

- Animation using 3D Studio Viz
- Virtual Reality Modeling Language (VRML) and
- a process developed by Integral GIS for viewing 3D GIS models on the Vision Dome.

3 Animation with 3D Studio Viz

Animation for the dome is similar to an animation developed for conventional monitors, with the exception that four camera virtual viewing positions are used to render the scene instead of one. Using 3D Studio Viz, cameras are attached to a dummy camera directed at the intended view. Attached cameras are aimed above, below, and on either side of the intended view. The dummy camera determines the route the animation will follow through the model. Four separate frame sequences are rendered at 1024 x 1024 pixels. Once the four different sequences are rendered, they are stitched together using TruFrame® software provided by Elumens and output to a sequence of spherically projected (dome-correct) frames. The frames can then be compiled into an .avi movie using any Windows-based video editor such as Adobe Premiere or Adobe After Effects and the TruMotion® video codec provided by Elumens (Knisely, 2002). For this project, the students imported the frame sequence into RAM Player in 3 D Studio Viz and exported it as an AVI file (Pilger, 2002).

Scripted animation offers several advantages, relevant to environmental design studios, over VRML and realtime applications:

- The process permits modeling of buildings and objects with complex shapes.
- Models can incorporate cinematic effects such as cast shadows, reflections, titles, fades, and transitions.
- Scripted animation allows the designer to organize and present the walk-through in a sequence and format as desired.

The primary disadvantage to scripted animation, compared to realtime processes such as VRML, is the extra time and computer resources required to render the scene; rendering to four cameras instead of one. Complex shapes with a high polygon count add to render time. It should be noted that 3D Studio Max has an advantage over 3D Studio Viz in this regard, since all four cameras can be rendered simultaneously by virtue of its video post feature.

4 Realtime Modeling

Because we hoped to enable students to use their virtual models on the dome to explore design alternatives, without the need for extensive rendering and stictching as required for animation, we explored the use of two different realtime processes in the college visual resource center concurrently while the students were working on their designs. The two processes were Virtual Reality Modeling Language (VRML) and 3D GIS using ESRI's Spatial Analyst and 3D Analyst extensions.

Figure 3. **Single frame from .avi file after stitching (source: Cody Pilger).**

Using realtime applications, viewers can select a viewpoint or path through the model at will in realtime. Currently, state-of-the-art realtime modeling is accomplished using software such as MultiGen's Creator or SiteBuilder software, originally created for use in military and space simulators. According to Kristen Darken, educational sales representative for MultiGen, models should be developed in the native software since geometry created in other packages such as AutoCAD often results in problems such as flipped normals. Darken also points out that conversion software such as Okino PolyTrans may be used to import models from non-native formats; however, the process is not always fool proof (Darken, 2001). Given the relatively high cost of these programs however, we decided to pursue VRML as a low-cost entry into realtime presentations. Also, the college has a substantial investment in Form Z, 3D Studio Viz, and ESRI Arc GIS--all of which will export to VRML.

4.1 Virtual Reality Modeling Language (VRML)

According to the web 3d Consortium Web Site, VRML "is the International Standard (ISO/IEC 14772) file format for describing interactive 3D multimedia on the Internet. The first release of the VRML 1.0 specification was created by Silicon Graphics, Inc. and based on the Open Inventor file format" (Anonymous, 2002).

Elumens provides a dome-corrected browser, GLView, which reads Virtual Reality Modeling Language (VRML) files. This browser works much like any other VRML plug in (e.g.; Cosmo Player, Blaxun Contact, or Cortona VRML Client) with the advantage that it will also display a VRML file in dome-corrected view.

By exporting design proposals from Form Z, 3D Studio Viz, ArcView or ArcGIS, into a VRML file, digital models can be viewed in realtime on the dome. VRML files can also be shared over the Internet, allowing anyone with a VRML-equipped browser to navigate through models. Finally, the viewer's route through the model is not predetermined, allowing one the freedom to move about at will and explore different views within the model.

On the negative side, VRML is a dated technology. The interface is awkward and unresponsive compared to currently available realtime game engines. Articulation of the model must be to a minimum to reduce polygons and keep file sizes small enough for realtime applications. File sizes must also be kept small if they are to be served over the Internet. The Vision Dome makes additional demands on VRML applications since the wider FOV requires that 4 times as many pixels (compared to a standard screen) must be rendered in the same amount of time. According to Darken, the secret to successful realtime modeling is to simulate complexity while keeping modeled faces to a minimum (Darken 2001).

For purposes of the Omaha project, the digital elevation model developed for the site, even with simplification, turned out to be far too complex for VRML, due to the high number of faces generated in the terrain model. The student who successfully completed his project using 3D Studio Viz reported approximately 1/2 million faces in his model.

In subsequent work we hope to determine the feasible upper limits of digital elevation models for use in VRML, given the limitations of our available computing resources. According to an engineer at MultiGen, an 850 MHz. PentiumIII running Windows 2000, with 800 MB Ram and a Wildcat video card, can render a simulation modeled in Creator or SiteBuilder in realtime with approximately 20,000 polygons (Darken 2000). Unfortunately, we have no such benchmarks for VRML at this time.

4.2 3D GIS

The primary utility of GIS lies is its ability to analyze spatial data. Although GIS tools have been used for some time by urban planners, there are infrequent references in the literature about the use of GIS for urban design. The traditional urban design approach and format for the studio course and limited experience with GIS software among most of the students and faculty made its use impractial for most of the participants. We chose to simply assess the 3D realtime modeling and presentation capability of 3D Analyst on the Vision Dome.

Viewing 3D Analyst models on the dome can currently be accomplished in two ways. The first involves the use of a spherical interface module, SPIView, developed by Integral GIS for the Disney Imagineers (GeoWorld 2001). The spherical dome view is activated from within 3D Analyst.

A second method of viewing 3D Analyst models on the dome entails exporting them to VRML, where viewers such as GLView may be used to view the files on the dome. We were able to obtain very good static views of the site by draping an aerial oblique photograph over the terrain model; however, due to limited computing resources at the time, we have yet to examine VRML files from GIS in static or realtime mode on the Vision Dome. We also encountered these limitations or issues related to 3D Analyst:

- Buildings cannot be directly imported from common modeling programs such as 3D Viz, Form Z, or AutoCAD. The building footprint must be imported and then extruded, which is time-consuming. This process also limits buildings to basic box-like forms with no surface or rooftop articulation
- Images and materials cannot be bit mapped to the building surfaces, and objects such as trees cannot be placed in the scene without some knowledge of programming (Avenue scripts in ArcView, Visual Basic in ArcGIS).
- It is difficult to move or re-shape objects within the scene. (Vadapalli, 2002)

For these reasons, we found that 3D Analyst had limitations for use as a modeling and presentation software on the Vision Dome for our purposes on this project. Despite these shortcomings, 3D Analyst may prove useful in conceptual modeling of building masses in the early stages of project development, or in the analysis of spatial relationships before design begins.

5 3D Viz

Autodesk's 3D Studio Viz figured prominently in our work because it can be used for scripted animation as well as export to VRML. It is also well suited for modeling complex buildings. Trees and other objects can also be easily placed and moved. On the negative side, Viz has a steep learning curve. Only one student, the 5th year Landscape Architecture capstone student, developed the skill necessary to work in 3D Studio Viz. This student had extensive use of the software prior to the course, and had funded his own training from special seminars set up for that purpose. Even with advanced training,the student had to rely on technical assistance from the college technical support staff when he rendered his project.

A render farm comprised of twenty Pentium 4's with single processors, 512 MB RAM and 20 Gigabyte hard drives, along with 5 miscellaneous high-end PC work stations were set up to render out the single project that eventually found its way on to the dome. Rendering time took approximately 30 hours in order to render the 15,000 frames in the final presentation (Pilger, 2002).

6 Observations

On May 17th, students presented their design proposals to parties-at-interest in Omaha. Cody Pilger, the 5th year Landscape Architecture student working on his capstone project, was the only student to present his design proposals on the Vision Dome (Figure 4).

Students on the remaining four teams presented their work using a combination of media which included Form Z, physical models and traditional media techniques (Figure 5).

Although poised to convert their presentations into digital formats compatible with the dome the majority of students, who during the final weeks of the semester students were running out of time, opted to play to their strengths and decided to use representation techniques they were comfortable with. Even with support from our visual resource center our students chose to use techniques they were familiar with instead of a technique that was unfamiliar to them. Unfortunately, we had assumed that given the necessary support students would choose to use the Vision Dome technology. In retrospect we now recognize the necessity of devoting time early in the process to instructional strategies that build student confidence. When time runs out and we are pressed to perform we play to our strengths.

At the completion of the studio, we asked the student who was successful in developing an animation for the dome, Cody Pilger, to evaluate his experience with two primary questions: "What do you believe were the greatest values in conducting your project with 3D VIZ and the dome?" and "What advice and recommendations would you have for others who might like to try this approach in the future?"

Figure 4. Student proposal displayed on the 3 meter Vision Dome (Source: Author).

Figure 5. Presentation of student projects in Omaha (Source: Author).

Pilger felt that there were two very important benefits to conducting this project with 3D VIZ and the Vision Dome. First, he believes that clients, stakeholders and the general public were better able to understand the design proposals. They could see what was going on in the design and they could ask more informed questions and felt more confident that they knew what the designer was recommending. Second, he felt that as a designer he produced a better design. During the process of design, he was able to see the consequences of design decisions and could react to modify and improve the design. Pilger believes that his use of these visualization tools helped him to make much better design decisions than he probably would have done using traditional CAD or traditional non-electronic drawing and sketching.

When asked about advice for future users, he had a number of suggestions. First and most important he believes that being able to explore a design proposal in realtime enhances understanding about design intent and alternatives. Pilger also believes that the designer needs to start early, since the process, like the exploratory application of new technology, takes time and experimentation to be successful. It is important to have experienced computing technical support when the challenges of hardware, software and network management create glitches and difficulties. Pilger also said that access to network rendering was essential. Because of the high processing requirements of this visualization technology, it is still difficult to execute the work without multiple processors.

Lastly, Pilger felt that his previous experience with CAD and 3D Viz was critical to hs success. This especially included his knowledge of the theory of simulating viewing points and camera angles with the software to control viewing positions. If he had tried to carry out the project with teaching himself the CAD and 3D Viz programs while learning about visualization on the Dome and trying to develop a complex design project, the combination would probably have impeded the project.

7 Public Response to the Dome

During an all-university open house, in April, Pilger presented a preliminary version of his design proposals on the dome. His proposal appeared on the front page of the college newspaper, which suggests that the domes are effective publicity generators. His display was a gathering point for large groups of people. A previous exhibit by the College’s Department of Interior Architecture at the 2000 NeoCon exhibit in Chicago, and a previous Open House display generated similar results.

During the final presentation in Omaha the student designs were enthusiastically received. All five presentations appeared to receive relatively equal attention. We were told, however, that the dome created unexpected interest in the presentations as a whole. In addition, the dome’s simulated walk through provided the opportunity for the MCC faculty and staff to envision and think about the campus “as a place not a picture.” The dome apparently stimulated unanticipated conversation about the design proposals because viewers reported feeling more confident about what they saw on the dome, that is they felt they understood the proposals on the dome.

Viewing one’s work in the Vision Dome appeals to at least some students who are highly skilled and motivated with computers. These students will work very hard to see the results of their work on the large wraparound screen of the Vision Dome. Other students and faculty are indifferent to the technology.

8 Future Explorations

We expect to continue to explore the use of the domes with various software and design development strategies. Students in the college purchase computers early in their studies. They then enroll in a computer applications class and begin using the computer in studio. Form Z is the primary application used in architectural studios. AutoCAD, Land Development Desktop, and GIS applications are used primarily in landscape architectural studios. During the design stage of the Omaha studio, student teams used a combination of physical models, traditional rendering media, AutoCAD and Form Z. Pilger used computer-based media, including 3D Studio Viz, almost exclusively. We also have begun exploring the design value and pedagogical benefits of SketchUp® software for preliminary design. SketchUp's simplicity may make it easier to bring preliminary design to the Vision Dome. We also hope to test Form Z as an animation method for the vision dome.

The authors believe that the Vision Dome offers a unique perspective not easily attained with traditional monitors or projectors. Whether the wider viewing angle and immersive evironment of the dome is warranted, given the higher cost of the equipment, requires further study. For now it appears that the dome is successful in generating publicity for projects, and in stirring up enthusiasm among clients who are anxious to see their visions realized. For design students who have the talent and technical ability to pull off such a challenging endeavor, immersive projection systems such as the Vision Dome provide a view of their projects unattainable by other means.

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Endnote

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