
Archaeological Site Reconstruction with Autodesk's 3D Studio

by Douglas Gann

3D Studio is an IBM-compatible computer modeling program that enables users to create three-dimensional renderings of a variety of objects. In its ability to import a wide variety of maps and other images, 3D Studio allows for the realistic rendering of models created within AutoCAD or other 3D CAD packages. Over the past year, the Homol'ovi research program has been utilizing this software to create near photo-realistic renderings of conjectural site models.

My own interests in three-dimensional computer modeling developed out of work at the site of Homol'ovi IV, a 150-room pueblo site located near Winslow, Arizona. The site was situated upon a steep 30-meter bluff with a bedrock cap. Approximately 24 rooms were located on top of the bedrock cap, with another 125 rooms situated on the slope of the butte. During the 1989 field season five structures were excavated, while a separate crew worked clearing and mapping the tops of walls. Mapping was accomplished with a Topcon EDM/theodolite station, and a standard map was created from this process. (See Fig. 3.) While the map was sufficient to show the general layout of the site, I remained unsatisfied; a 2D plan view simply did not convey the vertical dimension of the pueblo. At this point the Homol'ovi Research Program purchased a copy of AutoCAD in order to begin exploring three-dimensional mapping and modeling.

In order to model the site properly, it was first determined that an accurate 3D mesh or Digital Elevation Model (DEM) needed to be created. The DEM would need to model both the butte and surrounding ground surface. To this end I utilized the Ohio School of Cartography's Geographic Information System software, Idrisi. Within Idrisi the mapping data collected with the theodolite was first converted into a topographic map. The topographic map was then used to interpolate a DEM with a 1-meter spacing interval, effectively matching the grid established during excavation. Once the DEM had been created within Idrisi, the model was converted to an ASCII file that was then converted to an AutoCAD script file via a simple program in BASIC. The script file converted the linear data set from the DEM into an AutoCAD 3D mesh format. The results were quite striking in the scale of detail as well as accuracy.

With the butte and the surrounding ground surface modeled, the original mapping data points were imported into the AutoCAD model. From these points, 3D models of architecture, bedrock, boulders and other features could be created. Compared to the generation of the DEM, the reconstruction of the architecture was quite simple. The results of the modeling in AutoCAD are seen in Fig. 4. With the completion of the 3D model it was then possible to show the general public how the site may have looked. The model would go on to be used in the stabilization and interpretation of the site by state parks personnel. Probably the most difficult aspect of modeling the site was the patience and machine time necessary to create the hidden line drawings. Stuck on a 20 MHz 386-SX, running AutoCAD release 10, invoking the "hide" command could take well over 4 days of processing time! Three years later, the Homol'ovi research program would be fortunate enough to purchase an educational copy of 3D Studio, in order to begin exploring a variety of anthropological issues regarding socially constructed space and architecture. 3D Studio allows users to increase dramatically the realism of images rendered, as well as allowing for better control of lighting and perception within a 3D model. By utilizing a variety of advanced rendering techniques to simulate real materials and surfaces, the software allows for much more accurate renderings while avoiding the memory constraints of large models in AutoCAD. (See Fig. 5 for illustrations of texture and bump maps and their applications to surfaces, Fig. 6 for a rendering of Homol'ovi IV.) For example, to model every stone of every wall in a single pueblo room is possible in

AutoCAD, but such a file will easily use between 8 and 10 megabytes of disk storage space. By utilizing a wire-frame model of the wall's structure, with scanned photographs acting as texture maps, only .25 megabytes of disk space is needed.

Upon returning to the Homol'ovi region for fieldwork in 1994, I returned to Homol'ovi IV in order to collect photographs to use as texture maps for the original site model created in 1990. The photographs of existing architecture, bedrock and soils at Homol'ovi IV were then scanned at rather low 72 d.p.i. resolution, and converted to GIF format in Adobe Photoshop. The GIF files were then exported to be used as texture maps. The GIF images were also converted to grayscale and enhanced for use as bump maps.

The original Homol'ovi IV model was then imported into 3D Studio. The GIF files were turned into 3D Studio material types, which were then applied to the appropriate parts of the model. The model could then be rendered at a variety of resolutions. Rendering the Homol'ovi IV model at an 800x600 pixel resolution took roughly 2 hours on a 25 MHz 386; on a 60 MHz Pentium rendering took roughly 8 minutes.

Another part of 3D Studio that creates quite stunning visualizations is the Keyframer module. Within the Keyframer a site model can be used to create dramatic architectural walk-throughs and fly-overs. The process is incredibly simple; to create an animated fly-over, one decides how many animation frames will be needed and specifies where the virtual camera should be on which frame. For instance, to create an orbiting view the user simply defines four "keys," with each key located in a cardinal direction away from the site. A fifth key is then assigned to the last animation frame so that the virtual camera will return to it's starting position. At this point, the rendering option is invoked, and the Keyframer calculates the rendering of all of the frames between the assigned keys. Unfortunately, this is a very time consuming process as, at even low resolutions, each frame may take up to 30 minutes to generate. A 210-frame fly-over of the site took roughly 3 days of computer time to finish rendering.

The finished animations go a long way in helping to explain the site to the general public. To the untrained eye, the sites at the Homol'ovi Ruins State Park look like simple mounds of rubble. Videotapes of the rendered animations are currently being used by state parks personal to show people what the sites used to look like, without resorting to costly and often inaccurate archaeological reconstructions. By 1995 the Homol'ovi Research Program hopes to incorporate these animated walk-throughs and fly-overs in a freestanding, interactive multimedia exhibit at the park's visitors' center.

Visualization software such as 3D Studio shows much promise, not only in public interpretation of archaeological sites but in anthropological research as well. By using methods such as line-of-site analysis, I am hoping to be able to explore issues relating to prehistoric conceptualization of space.

For other *Newsletter* articles concerning [the applications of CAD modelling in archaeology and architectural history](#), consult the Subject index.

[Next Article: Vessel Capacity from Pottery Profiles: Notice of an Upcoming Publication](#)

[Table of Contents for the November, 1994 issue of the CSA Newsletter \(Vol. 7, no. 3\)](#)

 [Table of Contents for all CSA Newsletter issues on the Web](#)

[Go to CSA Home Page](#)
