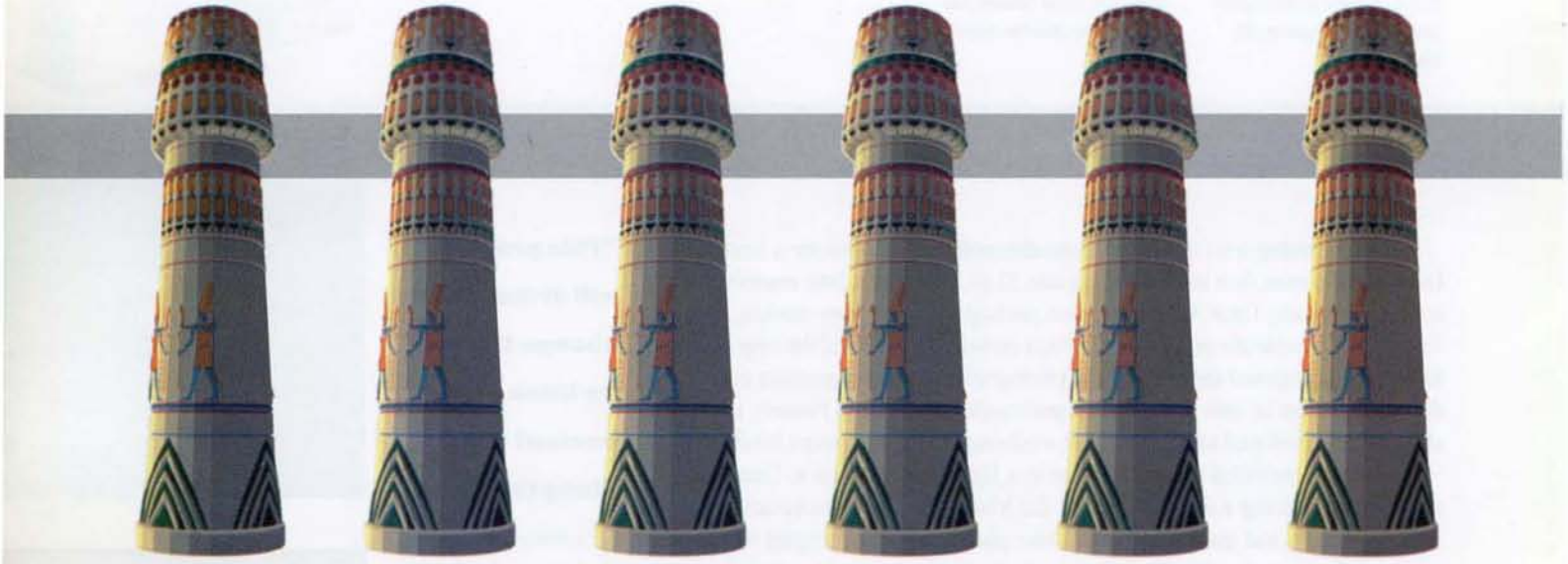
# CAD AMONG THE RUINS



**An ancient religious site returns to life, thanks to an archaeologist's newest tool.**

When the ancient Egyptians and Kushites built the Jebel Barkal sanctuary near the banks of the Nile, they had little more than their hands to work with. But when a team of Boston-based archaeologists wanted to reconstruct the once-great religious center, they had an extra, crucial tool—a computer.

Led by Tim Kendall, associate curator of the Boston Museum of Fine Arts' Department of Egyptian and Ancient Near Eastern Art, a 1987–1989 expedition from the museum did a land survey of the Jebel Barkal site, in what is now the Democratic Republic of Sudan. The site, a complex of 19 main buildings covering a half-square kilometer, was founded by the Egyptians at the base of a steep mountain in approximately 1430 B.C. Expanded sporadically over the centuries, it became the chief religious center of the African Kingdom of Kush in about 750 B.C. At its apex, it included at least eight temples and three palaces, but the area's harsh environment has long since reduced the towering structures to ruins.

After the expedition, Kendall heard from a friend about Bill Riseman, an architect specializing in computer-aided design (CAD) for movie theaters.

Riseman demonstrated that it was possible to create a 3-D computer simulation of Jebel Barkal based on the land survey. As for funding, the nonprofit museum didn't have to go far: Riseman was looking for an opportunity to practice his CAD skills and volunteered his services.

Architectural reconstructions aren't extraordinary in archaeology. However, it's difficult to make two-dimensional hand-drawn images accurate, and impossible to convey on paper the scale and complexity of the original architecture. Riseman's 3-D model allows for a level of conceptualization and accuracy never before possible, Kendall says.

"As an example of ancient African culture, the kingdom and monuments of Kush will be the focus of a lot of national attention. This project will change the way we think about ancient life along the Nile," Kendall says. The use of the computer also allows his team to constantly update the plans with every new relic unearthed or detail discovered in the records of other expeditions, he says.

## CAD: The Project Cornerstone

For the preliminary data-gathering, the Jebel Barkal expedition used sophisticated land-survey equipment and aerial photos to measure the area. Working backwards from remnants of statues and hieroglyphs as well as their knowledge of Egyptian architectural patterns, archaeologists determined the plan and elevation of each structure, including the placement of pylons—monolithic gateways that dominated the front facades of Egyptian temples. This data was supplied to Riseman, along with secondary research material covering expeditions that date back to 1821.

During the CAD project's two-year life span, Riseman used an array of drawing and rendering packages. The first step was to make wire-frame models from the reconstruction blueprints. After experimenting with a series of CAD packages, he settled on DataCAD because of its highly accurate 3-D capabilities and its architectural orientation. The program was destined to become the cornerstone of the project.

**1 Hardware**
Uniq Technologies 33-MHz 386 PC with 16 MB of RAM and 387 Intel math coprocessor; Priam 360-MB internal hard drive; Everex Vision 16 image-capture card; Hewlett-Packard LaserJet II printer; Logitech ScanMan handheld scanner; JVC video camera

**2 Software**
Microsoft Windows, Cadkey DataCAD, Cadkey Velocity, Computer Presentations ImagePrep, Time Arts Lumena, CorelTrace, CorelDraw, ZSoft Publisher's Paintbrush, Pixar RenderMan, Unique Software polyline-to-polygon conversion macro

**3 Communications**
Artisoft LANtastic operating system and 20-MHz 386 PC with two 65-MB Miniscribe hard disks as file server

## William Riseman Associates Boston, Massachusetts

After creating a set of wire-frame models with DataCAD, Riseman then rendered them into 32-bit solid models using DataCAD's companion package, Velocity. To provide the proper geographical context, Riseman superimposed the models onto photographs through a process he calls "inverse photogrammetrics," also commonly referred to as "composite rendering."

Riseman provided a map of the site to a Japanese film crew doing a documentary on the Jebel Barkal sanctuary and instructed them to take photographs at designated points. By entering into DataCAD the lens size and exact angle of the camera for each photo, the solid models could be accurately positioned over the 24-bit scanned photos, which had already been color-balanced in Publisher's Paintbrush. Riseman also used frames captured from live video with a Vision 16 board.

### Adding Photorealistic Details

Kendall and Riseman have now progressed beyond this massing study, which shows the proportion and relation of all the architectural elements, to adding details such as the hieroglyphic wall reliefs. "It's getting more and more photorealistic," Riseman says.

To keep up with the demands of realism, however, Riseman had to add to his 3-D palette. For the latest set of images, he scanned black-and-white line art of the hieroglyphic reliefs using a ScanMan handheld scanner and converted the raster images to vector files with CorelTrace. After creating 2-D polyline representations of each image and converting them to EPS files in CorelTrace, he imported the files into CorelDraw and exported them as DXF files compatible with DataCAD. With a conversion macro provided by Unique Software of Freeport, Maine, the polyline images can be converted to 3-D polygons in DataCAD and added to the original wire-frame representations (which remain the basis for updating the 3-D solid models). As well as adding accuracy, the new details are used to double-check the architectural dimensions already established.

To provide a more photorealistic rendering of the new models, Riseman enlisted the help of computer-graphics consultant David Pendery to use his custom RenderMan interface to DataCAD. Whereas Velocity's texture mapping would create a patchwork surface pieced together from scanned photographic brick samples, RenderMan's programmable procedural shading language can take those samples and create a seamless 3-D surface of infinite area. RenderMan can also be used to create shadowing effects for the hieroglyphs, the outlines of which are usually carved into wall surfaces.

**"This project will dramatically change the way we think about ancient life along the Nile."**

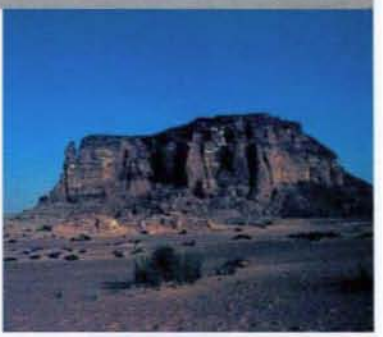
Though his process may seem convoluted, Riseman says that he gets more functionality from using different packages that address specific needs instead of using programs that promise everything in one box. "You have to watch out for dead ends and make sure you're working with open architecture," Riseman says.

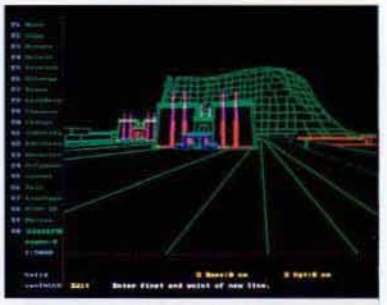
### Resurrecting the Past

Coinciding with an increased national focus on African history, the expedition and the first set of CAD models have already been featured in the November 1990 issue of *National Geographic* and a documentary aired on Japanese television in Fall 1991.

Future plans include the possibility of a Public Broadcasting System children's documentary featuring a combination of the 3-D models and live video that will give the appearance of children wandering among the ancient ruins. A similar animated film might also accompany the museum's Spring exhibit of Kushite art, according to Kendall.

Because of Riseman's computers and technical stamina, the ruins of Jebel Barkal have now achieved a kind of permanence their creators were unable to provide. — *Clair Whitmer*





**Get Real**
*Opposite page and top right, Riseman brought images into DataCad and placed them onto columns or other structures. Top, a photo of the original religious site. Middle, the wireframe model, created with DataCAD. Bottom, the resurrected temple at Jebel Barkal, composited with Velocity and Publisher's Paintbrush.*