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BULLETIN

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Hot Topic

3D Imaging

by S. K. Hastings

Editor's Note: Among the many special features at the 2001 ASIST Annual Meeting was a panel session featuring Hot Topics in the world of information science and technology. On this and the following pages, the authors of two of the presentations offer written versions of their work on hot topics.

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Since the National Science Foundation (NSF) began funding Digital Library Initiatives in 1995, numerous digital representations have been bundled into library repositories. Research efforts in standards for storing and serving the data files have resulted in operational, virtual libraries. Recent projects have added multimedia objects including representations of music, video, film and art. 3D representations of these objects in the Web environment have been limited to software-based, plug-in applications that present the image in rotation. The surrogates are built from multiple surface scans and require several manipulations to add texture and color to the object. These representations serve well for viewing the object but do not meet the diverse needs of scientific inquiry. New applications utilizing high resolution, X-ray computed tomography (X-ray CT) provide representations that allow researchers to "see" inside an object, produce resin replicas and ultimately reproduce the object.

Medical applications have been using X-ray CT for years to reproduce images of the human body for diagnostic and anatomical investigations. The Nobel Prize for Medicine was awarded to its inventors, A.M. Cormack and G.N. Hounsfield, in 1979. X-ray CT is used for diverse industrial applications including reverse engineering and rapid prototyping. Recently it has been successfully tested for use in the earth science fields of paleontology and metamorphic petrology. With funding from the NSF Digital Libraries Initiative, a new Digital Morphology Group at the University of Texas is dedicated to the manipulation, interpretation and dissemination of X-ray CT datasets (www.ctlab.geo.utexas.edu). The group includes Timothy Rowe, John Kappelman, William D. Carlson, Richard A. Ketcham and Cambria Denison. Most impressive is the 3D reconstruction of a *Kryptobataar* skull shown in detail in the image library section of the DMG website. Their work also looks at the problem of assembling and serving libraries of large-volume digital datasets.

X-ray CT works by producing two-dimensional images or slices that display differences in density at each of several thousand points. By stacking a series of contiguous equidistant slices, a continuous three-dimensional map of the density variations is constructed. In image reconstruction, the object is represented by a grid of pixels (picture elements) in two dimensions or voxels (volume elements) in three dimensions. The resulting digital dataset lends itself to both quantitative analysis and widespread dissemination.

One of the most visible uses of an X-ray CT 3D dataset is located outside of the National Museum of Natural History in Washington, DC. The bronze skull of a triceratops is five feet high, seven feet long and weighs a ton. From a computer-generated model of the skull, a rubber mold was generated in eight pieces. Sculptors at Millersville University reassembled the pieces and created a wax model to make a ceramic shell that could handle molten bronze. Similar to lost-wax casting, the resulting sculpture represents thousands of hours of reconstruction, combining laser surface scans with the 3D datasets. (Kernan, 2001)

Typically, industrial X-ray CT scanners are custom built. Calibrations of the X-ray signal require constant attention. Objects are placed on a high-speed rotating plate and vibrations must be eliminated. Specific details are described in a Ketchum and Carlson article in *Computers and Geosciences*, 2001, and at the DMG website. The technology is not portable and is limited by size, shape and composition of the subject. Maintenance and support of the machine and software require highly technical skill sets and remind one of the relationship of ENIAC to PCs. This is not prime-time technology. However, as more scientists begin to use the equipment, standards are bound to evolve. Most important here is that the digital 3D datasets are relatively easy to serve to a larger community. Not everyone needs to own an X-ray CT scanner.

Output peripherals such as resin printers are also difficult to maintain and support. Luckily, there are several emerging businesses that will produce a wax or resin replica for you. Most notable are Shared Replicators in Tulsa, OK (www.sharedrplicators.com), 3D Systems in Valencia, CA (www.3dsystems.com) and Scansite in Novato, CA (www.scansite.com). In addition, there is a list of 3D imaging and scanning systems and equipment at Sculptor.org (www.sculptor.org/3d/Scanning/imaging.htm).

Because my primary research interests are in image retrieval systems, I am intrigued by the myriad possibilities for application and research in 3D imaging. What metadata elements are required for the retrieval of 3D datasets? How do we organize the data and what vocabulary do we use? What are the possible applications for this technology in the related fields of the humanities? Is it possible for museums to offer educational programming in school systems by shipping a 3D dataset of an object and producing a resin replica onsite that allows the children to handle the object? Are there applications that will aid visually impaired users to interact with an object? What are the preservation, migration and longevity issues for the 3D datasets? What are the costs of production? What types of collaboration are needed to make product?

The Texas Center for Digital Knowledge is launching a project to investigate possible applications for 3D imaging for libraries and museums and to begin to work on the questions listed above. Included in the project are the design and production of educational programs of study to help train new managers for the 3D imaging technologies. For more information contact Sam Hastings (hastings@lis.admin.unt.edu).

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