

Final Report: Digital Artifact Archiving: Three-Dimensional Modeling and Database Development for Internet Dissemination

A grant number from the Northwest Academic Computing Consortium (NWACC) was brought to completion at the end of May, 2001. The NWACC funding (\$30,000) was used to allow faculty and students at North Dakota State University (NDSU), in collaboration with faculty and students at the University of Oregon, to carry out the seed project for an innovative application and dissemination of technology. As stated in the proposal to NWACC:

The goal of the proposed technology application is the creation of a prototype database and procedure for archiving and disseminating three-dimensional (3D) models and assorted textual information. We will focus on two data sets to develop a protocol for digital databases with 3D components: one that concentrates on archaeological artifacts, and the other on hominid cranial endocasts. While these databases will be important contributions to anthropology in their own right, they will serve the more important function of test cases for digital archiving of any type of material objects rendered in 3D. Digital archives and interactive databases offer the most effective method for storage and dissemination of electronic data, and facilitate the enhancement of instructional programs.

As faculty, students, and staff at NDSU Archaeology Technologies Lab (ATL) worked to pursue the goals set out in the proposal to NWACC, a new vision of the project emerged; one that was larger and more ambitious than previously planned. The project that emerged was the development and implementation of a Digital Archive Network for Anthropology (DANA). This network is a federation of distributed, interoperable databases, each with specific content of value to archaeology, physical anthropology, and ethnology. DANA will differ from other anthropological databases in that it will contain accurate, three-dimensional (3D) models of material objects. These models can be variously manipulated so as to be viewed from all angles, and they are sufficiently precise to allow for a wide range of detailed measurements and analyses. While the 3D visualizations are central to DANA, the Archive will not be restricted to data for which accurate models are available. Objects represented by sets of digital photographs can also be archived, and all images will have associated data and documentation as part of the relational database.

DANA will enable dynamic use of digital models, virtual tools, and an array of data supplied by contributing content providers for education and research. This online network of anthropology resources will allow reliable, "anytime, anywhere" access to content and services. DANA will constitute an enormously valuable learning resource. It can be accessed and used at all levels, from K-12, to undergraduate, to post-graduate, to professional, to lifelong learning. Users can take advantage of the Archive for formal research, for comparative purposes, or simply to satisfy curiosity. Some users will also be contributors to DANA, as we will provide a mechanism for qualified professionals to add new data. Once developed, DANA can be used for collaborative research and educational ventures as well as individual interests. The databases developed for the NWACC project provide the test cases for DANA.

ACCOMPLISHMENTS

All of the technical goals outlined in the proposal have been met, although some have been taken further than others. These are enumerated in italics below, followed by assessment evaluations.

1..Establish Web site for Internet/Internet2 that will provide, (a) a description of the project goals, the databases available, and the methods employed, (b) access to the databases, which include the 3D models, and (c) information on how to order digitized artifact collections on CD ROM.

This goal has been accomplished.

2. Carry out 3D scanning of the Samoan stone tools in the Archaeology Lab at NDSU.

This goal has been accomplished, but not all of the 3D adze models created are accessible online. This is due to the large size of some of these files and difficulty of downloading those files for viewing. We are working to develop a solution to this problem, which may involve the use of a compression software package that will allow large files to be easily and quickly delivered. To the Samoan stone tool databases we have added a database of historical materials from the Like-a-Fishhook/Fort Berthold archaeological site in central North Dakota, and are beginning other databases as well.

3. Carry out 3D scanning of a set of hominid cranial endocasts.

The constructin of the 3D models of the endocasts has been accomplished, but the full versions of those models are not yet available online. Those models are again too large to make available until a compression option is fully available. Decimated versions of most of these models can be viewed with a Java Web Start viewer, downloadable from our web site (<http://atl.ndsu.edu>).

4. Create associated databases with contextual information for each collection.

This goal has been accomplished for the Samoan adzes, but is still underway for the endocasts.

5. Write applets for accessing the databases by the end user.

This goal has been accomplished. Moreover, we have written servlets that will allow for the seamless linking of distributed databases to form the DANA confederation. Once implemented, end users will have access to a series of interoperable databases, accessible from a single point of entry.

6. Develop digital calipers for taking various measurements from the 3D models.

This goal has been accomplished. In fact, the second-generation calipers were developed and implemented, and the third generation is under development.

7. Create a security system to protect databases while allowing for easy access by users.

While access to the database and the notebooks is password protected, we had hoped to have a more versatile system in place. We continue to work on that aspect of DANA. We have devised a secure system for controlling data entry.

8. Create system for providing each user who logs in with a personal notebook or log for recording observations, measurements, etc. from the archive. Each log will be security protected for access only by the user.

A Notebook is available in DANA but has glitches. For the present, we have disabled the Notebook, although it is still visible in the interface, but we will have it fully functional in the near future.

9. Test accessibility, usability, delivery, resolution, and other aspects of the digital archive collaborators.

Preliminary tests of DANA accessibility have been accomplished. Our next major test is the linking of databases from multiple institutions. Transmission of large 3D files remains problematic, so we have used decimated versions of the models. We are working on a better solution, which is file compression and decompression.

10. Expand collaborative connections for developing Internet2 delivery system and 3D archiving.

We have had very good success in this effort, and are on the verge of expanding our active collaborations tremendously. A list of developing collaborations follows.

- Our project continues to be a multidisciplinary effort involving faculty, students, and staff at NDSU in the departments of Sociology and Anthropology, Computer Science, Electrical and Computer Engineering, and Information Technology Services at NDSU, and to this group we have added students and faculty with backgrounds in History, English, Mechanical Engineering, and Architecture and Landscape Architecture. While we plan to continue our collaboration with Dr. William Ayres at the University of Oregon, Anthropology Department, other collaborations have advanced and been initiated.
- The Archaeology Technologies Lab at NDSU has established a collaborative arrangement with the Partnership for Research in Stereo Modeling (PRISM) at Arizona State University (ASU). PRISM is an interdisciplinary lab for computer-based 3D research with several ongoing projects, three of which are anthropological. Arleyn Simon and colleagues at the Archaeological Research Institute (ARI 2000) are working with PRISM to record and archive morphological features of pottery vessels as well as study vessel symmetry and classification. We plan to link the PRISM archaeology database with ours to create the beginnings of the distributed network for anthropology.
- The Center for Digital Shape-Archaeology-Photogrammetry-and Entropy (or SHAPE Lab) at

Brown University (founded in 1999) is also a leader in interdisciplinary approaches to 3D visualization for archaeology. The SHAPE Lab is developing virtual archaeological sites (e.g., Petra) (Leymarie and Gruber 1997), databases of archaeological projects, QuickTime VR fly-through movies of archaeological sites, and 3D digitization of ceramics. Dr. Eileen Vote (archaeology and computer science), Frederic Leymarie (engineering), and Daniel Acevedo (computer science) in particular have been actively pursuing various aspects of 3D modeling and analysis for archaeology. We are just now beginning an active collaboration with Brown.

- Locally, we are working with the State Historical Society of North Dakota (SHSND) and Historic Preservation Office (specifically, Claudia Berg, Director of the Museum and Education Division of the SHSND, and Fern Swenson, Chief Archaeologist and Acting Director of Historic Preservation for the SHSND) to digitize portions of their extensive collection from the Like-a-Fishhook Village site (also known as Fort Berthold, and hereafter LF/FB). This site was one of the last earth-lodge villages along the upper Missouri, from the last half of the 19th Century. Joined populations of Mandan, Hidatsa, and Arikara occupied the site, which documents changing cultures as Native American populations were affected by the settlement of their traditional lands by White Americans (Smith 1972). Our goal in the project is to scan and enter artifacts from the LF/FB collection, and include these models in DANA. We are planning to display 3D models of objects in the collection by way of kiosks in the upcoming permanent exhibit, "Era of Change."
- The NDSU DANA team has begun work on the creation of an interactive Immersive virtual environment (IVE) of Like-a-Fishhook/Fort Berthold. This environment will consist of virtual creations of site structures, and visitors/users can engage in a fly-through of the site and selected structures. 3D models of site artifacts stored in DANA will be made accessible from within the IVE so that a click on a small image will open a viewer in which a 3D model of the object will appear for closer inspection. Various text documents and 2D images will also be used in the IVE. Ultimately, virtual LF/FB will be developed as a learning environment for archaeology, history, and literature (dealing with the time and place of LF/FB). (Support for this project is being requested in separate proposal.)
- Doctoral candidate Anne Weaver from the University of New Mexico used our equipment to scan a series of cranial endocasts in the collection of Dr. Ralph Holloway at Columbia University, and those scans played a central role in the completion of her doctoral dissertation on changes in brain structure during human evolution. Weaver, Holloway, and Clark plan to expand the endocast database in the near future.
- We are continuing our collaboration with the Historic Preservation Office in American Samoa, as we develop the Samoan adze database. We are now also working with Dr. John Dockall at the Bernice P. Bishop Museum in Honolulu on expanding the adze database, and we are collaborating on a project to create a Hawaiian adze database also accessible via DANA.
- We have established a formal collaboration with Gerfried Müller, Würzburg University, Germany. He and his colleagues recently were awarded a grant to continue their work digitally modeling (scanning) a collection of cuneiform clay tablets to create 3D models that will be archived in a digital database they will create (Müller 2000). We have a joint proposal currently under review by NSF and the corresponding German agency to support a collaboration that will result in adding the cuneiform models and database to DANA. We are also beginning to scan and

model a small collection of cueiform tablets in the collections at the SHSND.

- Dr. Vinod Nautiyal at Garhwal University, Srinagar, India, and colleagues are creating 3D models of prehistoric Indian ceramics. Currently, they are creating the models with CAD programs, but we have a joint proposal under review by NSF and the corresponding Indian agency for support that would allow us to collaborate on the creation of digitized models and associated database in India. We will make that database accessible via DANA.
- As a participant in the NSF Digital Libraries program, we are automatically collaborating with a group of institutions all pursuing similar ends, but for different content.
- We are actively seeking other collaborative arrangements both domestically and internationally that will enable us to expand DANA enormously over the next couple of years.

11. Use the NWACC funding as leverage for securing other funding.

While prior funding got our research effort underway, the NWACC grant played a critical role in accelerating our work and in leading to successful follow-up grants from other agencies. Since receiving the NWACC funds, ATL DANA staff have submitted several proposals for additional funding. The list of successes follows.

- A grant from the NDSU Technology Fees Advisory Committee (TDAC) for \$7,200, primarily for additional hardware and some student assistance. That proposal was funded due in part to the matching contribution of the NWACC grant.
- A grant from the NSF Digital Libraries Initiative for \$712,846 for a two-year period to develop DANA.
- A grant from the NDSU Technology Fees Advisory Committee (TDAC) for \$66,583, for additional hardware, software, and student assistants.
- Grant in Aid, NDSU Research Council, for \$6,000.
- In addition to these grants, we have four other proposals still under review for a total of over close to \$1,000,000. Still other proposals are under development.