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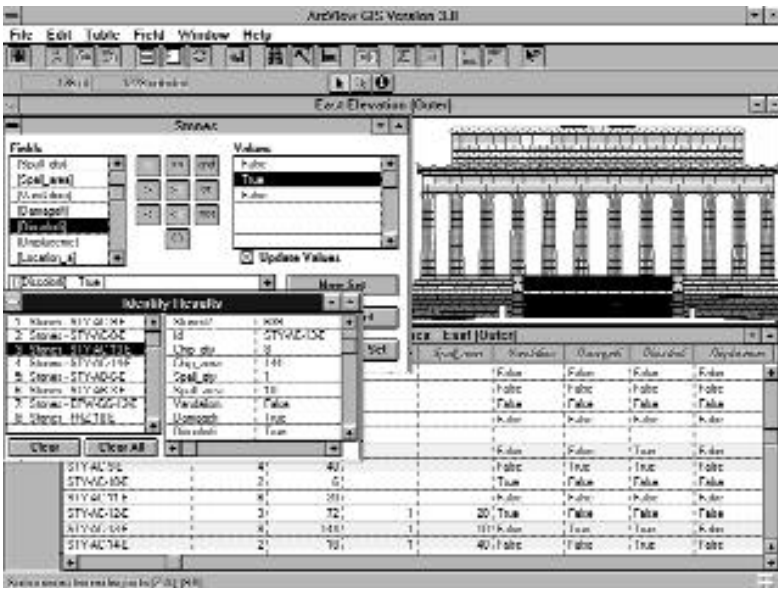
Cultural Resource Applications for a GIS

Stone Conservation at Jefferson and Lincoln Memorials

Geographical information systems are rapidly becoming essential tools for land management. They provide a way to link landscape features to the wide variety of information that managers must consider when formulating plans for a site, designing site improvement and restoration projects, determining maintenance projects and protocols, and even interpreting the site. At the same time, they can be valuable research tools.

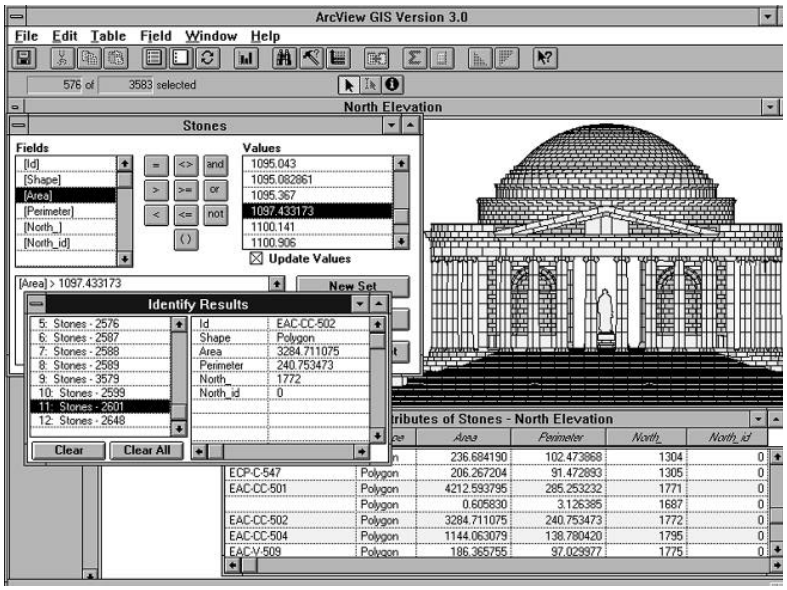
Standing structures offer a sort of geography, even though a humanly contrived one. Therefore, the capability of a geographical information system (GIS) to link geographical units to the information pertinent to site and resource management can be employed in the management of standing structures. This was the idea that inspired the use of a GIS software, ArcView, to link computer aided design (CAD) drawings of the Jefferson and Lincoln Memorials with inventories of the stones in the memorials. Both the CAD drawings and the inventory were in existence; what remained to be done was to modify the CAD files and place the inventory in an appropriately designed computerized database, and then to link the two in a GIS project. This work was carried out at the NPS Denver Service Center, Resource Planning Group, Applied Archeology Center (DSC-RPG-AAC), in Silver Spring, Maryland, with the assistance of US/ICOMOS summer interns Katja Marasovic (Croatia) and Rastislav Gromnica (Slovakia), under the supervision of AAC office manager Douglas Comer. Project guidance was provided by Tony Donald, the Denver Service Center (DSC) project architect for the restoration of the Jefferson and Lincoln Memorials, and GIS consultation services by Kyle Joly.



The ArcView screen display in response to a query asking the location of discolored stones.

Both the CAD drawings and the stone surveys that eventually comprised the two halves of the ArcView project had been produced in response to deterioration of the marble and limestone from which the Jefferson and Lincoln Memorials had been constructed. Following the unexpected failure of a column volute at the Jefferson Memorial in May 1990, an extensive stone survey of the Jefferson and Lincoln Memorials was initiated by National Capitol Parks-Central, the National Capital Region and the Denver Service Center. In conjunction with this undertaking, the Historic American Buildings Survey (HABS) produced highly detailed CAD drawings of the memorials using photogrammetric software called PhotoCAD. Both projects provided excellent and previously unavailable baseline data that has been used extensively during the planning, design, and construction process and will be invaluable for future work at both of these sites. Accessing the database (in its original form) and relating it to the CAD drawings, however, proved to be so cumbersome as to be impractical. Integration of these two products (the stone survey and CAD drawings) into a GIS has had a synergistic effect. Not only are both products more user friendly, but both are more powerful analytically. The project team is now able to interpret a large amount of data in a visual format that is easier to comprehend and interpret. It will also provide a superior communications tool for the team when it comes time to interpret the issues at hand with park management.

The stone survey, begun in September of 1991 by a local architectural/engineering contractor hired by DSC, examined the integrity and appearance of the marble and limestone that com-



The ArcView screen display in response to a query asking the location of stones area greater then 1,100 sq. inches. Stones are shown on the North Elevation of Jefferson Memorial.

prise the memorials. Stone types considered, *a priori*, at greatest risk were 100% surveyed "by hand," while a proportion of the rest (often 10%) were investigated. The survey was comprised of six primary components: existing conditions, damage (cracking), discoloration, displacement, color, and mineral inclusions. The separate components were fused into one dBASE database using Excel.

While the CAD drawings have remarkable detail of the intricately carved stones, they are saved as vector lines in the AutoCAD program in which they were produced, not as the discreet planes of stone—the geographical areas—that were the subject of the stone survey. That is, the lines that compose the drawings represent only the outline of the stone rather the region that is exposed face of the stone. Another difficulty presented by the CAD drawings stemmed from the detail they had captured; because of this, file sizes were extremely large. The drawings were simplified by removing detailed and redundant CAD layers, thus leaving only complete, detail-void stone faces, which significantly reduced file size. These polylines (outlines) were converted into regions via ArcCAD's "Clean" command. This converted file was exported to ArcView and turned into a shapefile for editing purposes.

The last important step in the integration process was to develop a unique identifier for each stone that was exactly the same in both the shapefile and the stone survey database. The identifier was based on the original stone setting numbers for the memorials. Included in the identifier were a combination of stone type (i.e., cornice, stylobate, architrave, etc.), course, setting, elevation (i.e., east, west, north, south), and survey quadrant. The stones in the shapefile were tagged with the identifier using ArcView. Columns in the database, containing the information embodied in the identifier, were merged using Word to add the identifier to the database. Once both products had matching identifiers, the two were fully integrated using ArcView's "Join" capability.

The use of ArcView has several advantages. It is, first of all, the National Park Service standard. Moreover, it is simple enough that most people with basic Windows skills can operate it, at least superficially. However, it is powerful enough that it can be used in structural analyses of the memorials. A cookbook style protocol was developed so that personnel unfamiliar with ArcView could query the database. One can easily run a query to identify stones that have particular attributes, such as discoloration. The stones with this attribute are highlighted on the shapefile (on screen image) and in the database, thus rendering them easy to find on the real world memorials. The protocol, then, provides a vehicle for developing a systematic maintenance routine schedule. More advanced queries and analysis have the potential for identifying stones at risk and developing correlations between stone attributes and structural integrity. In addition to this, as mentioned above, these data provide excellent baseline data. Researchers in the future working on stone conservation will be able to use this data to determine what damage is ongoing, cyclical, and/or static.

GIS, long used by natural resource personnel, is a powerful, effective, and, especially over the long run, efficient conservation tool. Both as a monitoring and analytical tool, the cultural resource community can benefit from the use of a GIS. Other uses to which a GIS is being used at the DSC-RPG Applied Archeology Center for cultural resource management purposes are numerous and varied. They include identifying and mapping historical and archeological features such as trails and structures, annotating site features, mapping artifact distributions, and attaching information to components of an ancient water management system at the World Heritage archeological site of Petra, in Jordan. The latter application builds upon research by the Petra National Trust in Jordan, which has identified numerous components of the complex water system.

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