VISUALIZING THE NATIVE AMERICAN CULTURAL LANDSCAPE: A SIGNIFICANT NEW RESEARCH AND IMAGING METHOD

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A new portable imaging technique couples with a geographic information systems (GIS) database constitutes significant progress to the challenge of inadequate documentation in the Native American cultural landscape. The new photographic technique creates a research-quality digital image with a mobile, variable light source called a reflectance transformation image. This technique renewed the understanding of site CA-RIV-528 (a painted boulder). An indistinct design was shown to be an incised pictograph. Linking visual data to GIS enables Native Americans, conservators, and other researchers to preserve data with incredible visualization capabilities, including the significance of sites in a landscape context.

Researchers at the University of Southern California have been imaging Native American rock art sites in southern California using innovative, affordable methods providing research-quality results. The purpose of this research is to document, preserve, and understand the cultural landscape. We endeavor to do this by linking Reflectance Transformation Images (RTIs) with a GIS database to form an interactive map that displays the visual, cultural, and spatial aspects of Native American sites. Additionally, the combination of these images with a GIS database creates a persuasive presentation tool to demonstrate the significance of incised or painted rock art sites to those with the political and economic power to preserve or destroy them.

In order to better explain this tool, the first part of this paper will explain the development of this technique from its initial usage with small objects in a laboratory to an effective field technology. Then we will demonstrate the pairing of reflectance transformation imaging with geographic data in a single GIS database. This pairing enables a GIS database to function as part of a preservation advocacy effort by linking research-quality documentation with landscape visualization and analysis tools.

The underlying concept of the RTI technique was brought to USC five years ago by two researchers from Hewlett Packard (HP), Tom Malzbender and Dan Gelb. The technique requires a dome-shaped imaging device with lights arranged at equidistant points facing the interior (the dome initially used at USC had 32 lights). Along with a Canon Rebel camera, Adobe Photoshop software, and a program written by Malzbender and Gelb, the dome was used to image an ancient cuneiform tablet from the USC collection. The resulting image allowed the tablet to be seen on a computer screen with light modeling across the tablet at various angles, similarly to how someone held the tablet in their hand, moving it so that light moved across its surface. A still image from the original RTI can be viewed at this website: http://www.hpl.hp.com/research/ptm/

This method is used to image small objects. The object is placed inside the dome, while a camera is placed at the apex of the dome, pointed down at the object. Both the camera and the lights in the dome are connected to a computer. The computer is used to take a sequence of 32 photos of the object, one photograph per each light flash. This produces 32 images, each with a different light angle. These images are then placed into a file hierarchy and are processed using a program developed by HP researchers. This program originally ran in conjunction with Adobe Photoshop. The resulting RTI was made by triangulating the known, fixed positions of the lights in relation to the reflection of each light on the object's surface. Essentially, this imaging method creates a high-resolution, micro-topographic map of the object, called an RTI. HP and the Cultural Heritage Imaging Organization (CHI) make these RTI-creation tools freely available through their websites.

The image can then be digitally manipulated, allowing the viewer to see the texture of the object.

The RTI of the cuneiform tablet highlighted features that were difficult to see in normal light. Fingerprints and the faint raised relief left by a cylinder seal impression are clearly visible in the RTI. Traditional photographs are not able to capture both features in one image.

Although this method works well with small objects, it does not accommodate much larger ones. Existing domes vary in size from 12 to 24 in., making it impractical for significantly larger objects. The dome is also heavy and fragile, making it impractical for fieldwork. The founders of CHI, Mark Mudge and Carla Schroer, created a portable version of the dome method. Their method obviates the need for a dome and allows the size and location of the artifact being photographed to vary. The portability of this technique is ideal for incised rock art panels, which are often large and nearly always immobile. Schroer and Mudge used the new technique to photograph rock art in Portugal's Coa Valley. The results of that work can be found at this website: <http://www.c-h-i.org/featured_projects/feat_proj_pavc.html>.

The field version of the RTI technique uses a hand-held flash unit, a glossy billiard ball, and a software program called Light Position Tracker (LP Tracker). The hand-held flash unit is used to mimic the positions of the lights in the dome. Within the dome, there is no need to map the position of the 32 lights, because they are fixed and therefore known. In the field, the light positions vary, and the glossy ball is used in conjunction with LP Tracker to define each position based on the flash reflections on the ball in each image and the known size and shape of the ball. After the 32 photos are taken in the field, they are downloaded to a computer and loaded into LP Tracker. The software then creates a file listing the coordinates of each flash reflection in each of the 32 photos. With this file, we are able to run the program developed by HP researchers to produce an RTI.

At USC, we have linked these reflectance transformation images in a GIS database to various maps. The layers in each map include site locations, land-use polygons, streams and rivers, water-bodies, and a number of modern cultural sites such as Native American reservations. The points in Figure 1 are pictograph sites linked to mobile light images. The polygon layer in the background shows the varied land uses of southern California. The various shades of purple show residential regions. As you can see in the illustration, these cultural sites are in the vicinity of densely populated neighborhoods.

One goal of the maps in this database is to give preservation advocates and tribes a more persuasive means of showing the significance of these sites. For example, the Invisible Maze (RIV-19**)** is an incised rock art site located in Riverside County on private land adjacent to a motor home neighborhood. This land is currently in danger of being sold to developers, and the land around it has already been heavily developed. Although the land on which the site is located has not been developed yet, the site has suffered the effects of access by people living in the adjacent neighborhood. White graffiti covers most of the boulder on which the maze appears, and some nearby boulders have graffiti tags littering every surface. Due to the vandalism, as well as the nature of the Invisible Maze itself, a simple photograph is not high enough in quality and resolution to reflect its cultural significance. In contrast, a mobile light image has the ability to display the topography of the boulder in greater detail, while also negating the modern graffiti. In this case, the combination of this image with a digital map of the boulder's location will hopefully work toward the preservation of the incised pictograph, both because this technique provides baseline documentation and because the intricacy of the site’s incised designs is very clear in a mobile light image. Our goal is for stakeholders to use the database as a resource which can accompany presentations to potential developers and planners, in order to persuade them to preserve the boulder in a culturally acceptable manner.

This marriage of mobile light imagery with GIS can be applied to a wide range of sites, artifacts, and regions. Its dynamic way of visualizing sites is a significant preservation and advocacy tool. Looking at the mobile light image allows us to experience a site without physically impacting it. A mobile light image gives the viewer the interpretive experience of walking up to rock panels in order to investigate them closely. What a developer or property owner might have dismissed as merely a big rock before can now be shown, in a much more compelling fashion, to be a significant cultural heritage site.

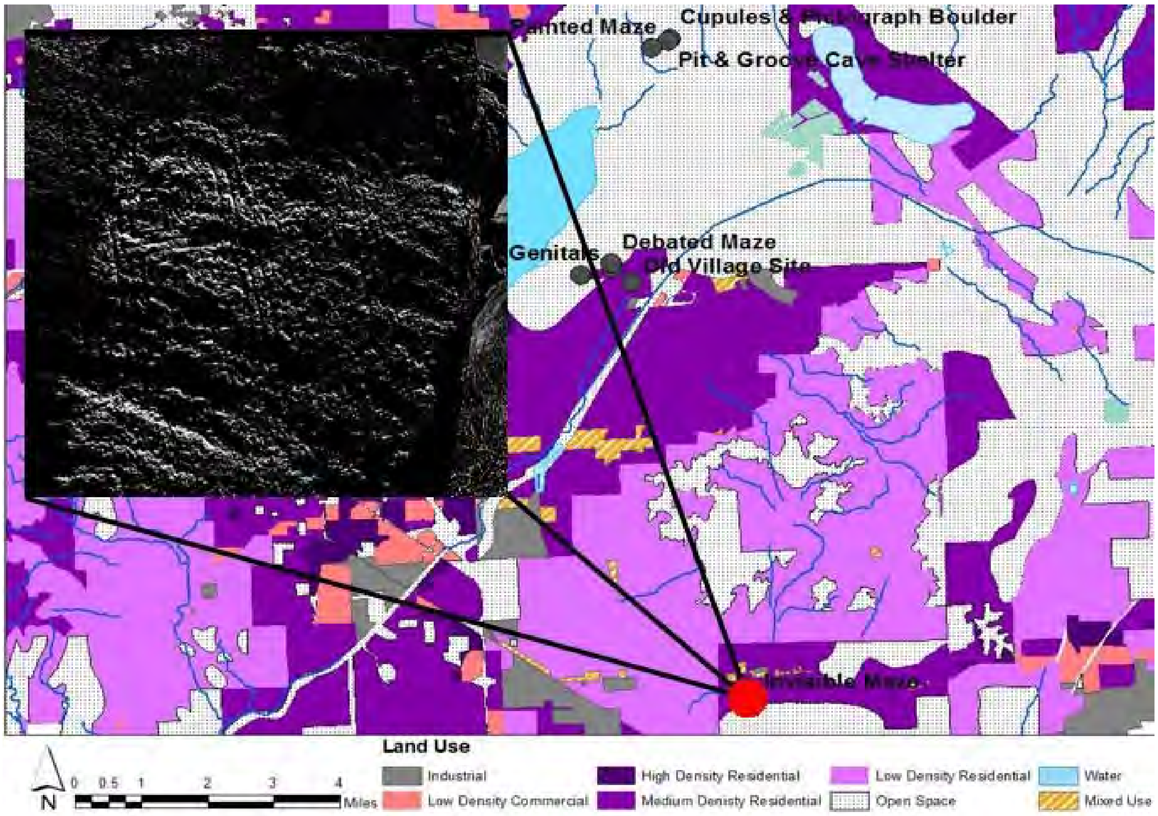

Figure 1. Map showing pictograph site locations and land use.

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This technique can also be used as an interactive, high-quality research tool. Reflectance transformation imaging creates an image that is a computation of the real surface topography of an object at a very high resolution, higher than 3D scanners. Therefore, each image represents concrete data that can be used reliably for research purposes and archival documentation. Another benefit is that this technique relies on freely available software, off-the-shelf Adobe programs, and relatively inexpensive photography equipment. Therefore, this form of documentation can easily be made widely available. For this reason there are major implications for the future analysis and study of pictographs and petroglyphs.

We all know that GIS databases have enabled researchers to develop new and sophisticated ways of interpreting modern and ancient landscapes because they allow us to visualize complex relationships between ancient and modern features in situ. By linking RTIs to a GIS database, we now have a much more dynamic way to view these sites from remote locations, thus allowing people to virtually visit rock art without physically hiking out to it and consequently impacting the integrity of the site. Often the RTI creates the possibility for a virtual visit, which affords a more compelling perception of the incised images than is achievable by visiting the site itself. This will allow researchers across the world to study southern California rock art in a way that has never been possible before. Of course, in order to perceive some aspects of the site, its surroundings, its feel, there never will be a way to replace the direct experience. For this reason, any technique or tool that contributes to preservation of culturally significant sites in situ is of benefit.

It is our hope that preservation advocates, tribes, and other stakeholders will be able to use this tool as an effective new mode of education and persuasion. GIS databases are widely used by developers, city planners and policy makers. This dynamic image-GIS database will allow preservation advocates to educate developers about important sites lying in areas being considered for development. With these images available at the touch of a button from a GIS screen, we believe that it will be easier for preservation advocates to make a persuasive case to end site destruction, and improve site preservation in the future.