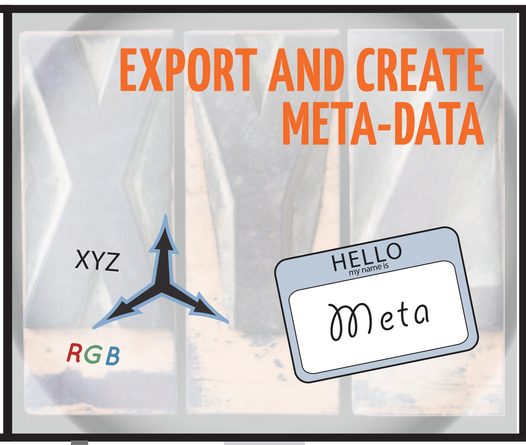
the platform

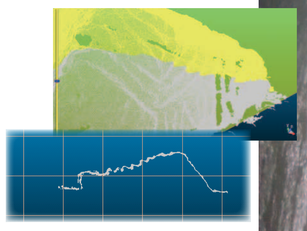


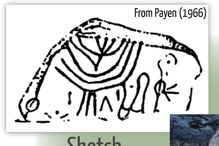
data collection

3d Data Recordation and Immersive Visualization: Considerations for Creative Mitigation Practices

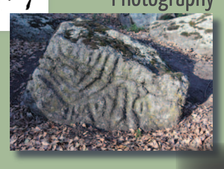
July 2012
Marshall R. Millett
mmillett@mmars4d.com

the pilot project

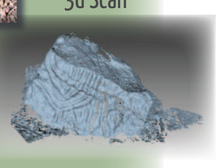




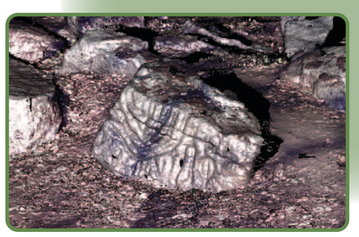
Sketch



Photography



3d Scan



3D Visualization

Abstract and Objectives:

Recent and dynamic advances in emergent technologies have allowed a marked acceleration of 3d recordation techniques, increased accuracies, robust field equipment, lowered costs, high allocation speeds, efficient post processing, increased graphic computing and improved 3d visualization. Previously, advancements of 3d imaging in cultural heritage studies has predominantly been the result of international projects, typically financed by academic research and focused on laboratory or structured studies (Balzani et. al. 2004, Barcelo et. al. 2000, Bianchi 2009, Guidi 2009). However, as streamlined approaches and broad agency interest develops, it is necessary to consider the utility and value of 3d documentation within United States cultural heritage regulations, preservation frameworks and the cultural heritage community.

The current study aims to explore technical requirements, accuracy concerns, utility, ethics, management, and overall value of 3d data within U.S. mitigation and regulation contexts. Investigations include capture resolutions, integration of scanning and imaging equipment, best practices, symbolic representation and reproduction ethics and additionally, the value and interface of data acquisition and visualization as a means of public outreach and scientific analysis. Goals included the full scale documentation of selected cultural resource sites to be actualized within an immersive visualization and experienced by managing agencies and associates. In particular, work was conducted with the Maidu Museum and Historic Site (City of Roseville), the United Auburn Indian Community, Tahoe National Forest, the Bureau of Land Management (Redding Field Office), UC Davis W.M. Keck Center for Active Visualization in the Earth Sciences (keckCAVES) and the UC Davis Tahoe Environmental Research Center (TERC).

Methods:

Field processes incorporated a scaled approach of data coverage by delineating effective visual environment of the site. This includes the surrounding areas, generalizing boundaries of cultural constituents and considerations of micro-scale analysis of culturally modified features. In effect, survey methods were considered alongside compiled resolution capabilities of selected scanning equipment and their compiling algorithms (Agarwal et. al. 2011, Artec 2011, Furukawa et al. 2010, Pollefeys et al. 1999). These comparisons were made along research cost-benefit lines and evaluated for optimization of systematic survey and coverage grids. Survey strategies of existing archaeological data recovery models and statistical methods were adapted to physical surface area volumes in consideration of cultural surfaces to be scanned (i.e. Banning 2002, Jackson et al. 1994). Equipment is then selected according to resolution requirements using a range of scanning equipment, including LiDAR, white-light scanning , stereo photogrammetry and RTI imaging.

Once collected, scan data was post-processed using software designed for respective data collectors. In particular, FARO Scene 5.0, Artec Studio 0.7, Autodesk123d v1.0, Trimble RealWorks 7.1 as well as open source project CloudCompare 2.3, were explored. Scanning registration allowed result tolerances within 2.8 centimeters for medium resolution of the general site environment and 0.5 millimeters for focused high resolution scanning of selected cultural features. After data registration, data is exported as an xyz file extension along with rgb raw color values as a common and stable 3D file format. Varying resolutions of collected data was merged and the resulting data set is coded through a indexed grid caching system. The caching index allows memory access to pull visualized data independent of the file size, allowing extremely large data sets to be loaded and realized (Kreylos et al. 2003; Kreylos 2004, 2011). Data is then uploaded to the open source LiDAR Viewer utilizing VRUI software, both freely available as 3d data visualization packages developed by the UC Davis and the keckCAVES collaborative project.

The selected site environments were then digitally experienced through an immersive CAVE (computer assisted virtual environment) system employing head tracking and wireless hand remote control devices for data interaction. The keckCAVE facility in Davis provides for multiple users to explore the site environment and peers can interact together while and independent of the site's real world physical locality. Files can subsequently or simultaneously be loaded, allowing visualization of distinct or isolated geophysical areas and multiple sites across a broad region. In addition to the fully immersive room, data sets can be experienced through small scale platforms and in consideration of cost effective means using commercially available 3d televisions and monitors. In all instances, digital tools within the open source UC Davis VRUI software allow explorative site analysis, including interactive and high resolution measurement, surface comparison, selection and attribute identification of feature data , data export, variable shading and contrasting, extraction of data points and screen capture imaging.

Rights to access data sets were negotiated between agencies and additional institutions in anticipation of visualization within museum or science facilities as intended for public outreach and analysis. Guidelines for data use and expectations were stipulated in approved work proposals. Participating agency representatives then attended the keckCAVES facility for assessment of the 3d immersive experience. In all instances, cultural ethics of 3d documentation and replication were considered and discussed with participants during the data collection and visualization process within the over arching implications of a 3d digital preservation workflow.

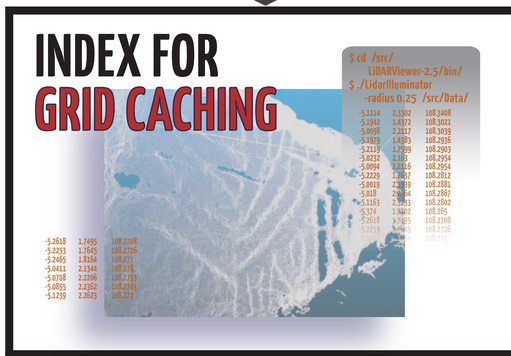
Preliminary Results:

The pilot project suggests that a cultural environment can be richly experienced within an immersive digital environment, and furthermore, that participants can self-explore and thus create a subjectively valuable personal experience of the data set and the cultural constituents of the site environment. The data acquisition of several dislocate sites and use of multiple 3d facilities further demonstrate that a collaborative network of participating agencies and 3d prepared facilities could successfully provide remote digital access to cultural resource environments and constituents, independent of real world physical logistics such as rights of entry issues (as negotiated for digital access), inclement weather, poor access conditions or other physical constraints. These immersive visual experiences provide unique side by side, site by site, comparative analytical opportunities that would otherwise be physically impossible and could be shared digitally by several participants at once. Interaction of digital sites by the public would imply a reduction of potential impacts to the physical resources by allowing a self-explorative and virtual hands on opportunity to study and discover features and constituents. This self actualized experience creates a rewarding exploration by way of virtual learning without physical impacts or disturbances to resource features and can be shared without compromising sensitive site location information. While the value of a digital experience is measured differently by each individual, the overall interactions between users and data appears rewarding. Opportunities for analysis are moderate and in development with software for data integration of various scan types (white light and RTI for example) and interaction functions still in their infancy. Further development of RTI high resolution imaging combined with 3d surface mapping would enable intensive measure of high scale accuracies in addition to the general scale virtualization.

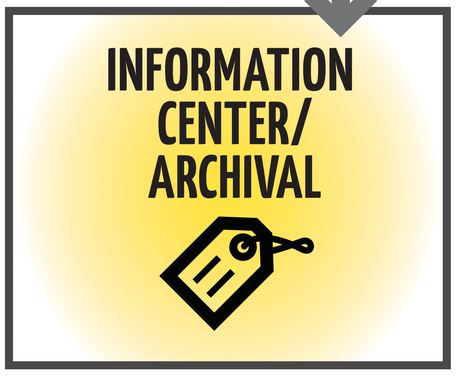
Summary:

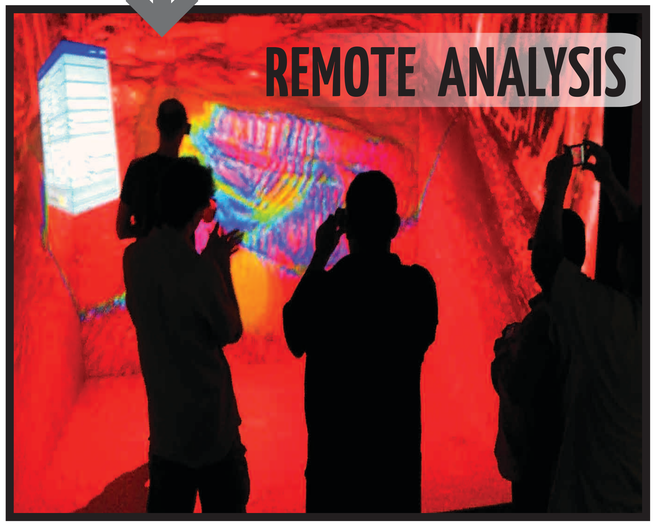
The pilot project as conducted suggests an achievable and viable digital documentation platform can be realized while carefully considering ethics and purpose, resolution requirements and cost. The visualization experience explored through the UC Davis keckCAVES program further suggests the opportunity for archaeological analysis, remote monitoring and management deliverables, and overall, an effective digital experience for the public. The value of such a system suggests further collaboration, such as a regulating body or developing framework could be established for studying and exploring data collection standards, best practices, cultural ethics, and appropriate measures of digital storage and archiving. Strategies could be established of requirements similar to existing HABS, HEAR, HALS and CRGIS documentation with the goal to form a digital network for field documentation and remote visualization standards. With continued exploration, efforts could provide unique preservation solutions with long term research benefits, even in instances where adverse impacts or destruction of a resource cannot be avoided. The implications suggest that rigorous data acquisition techniques combined with immersive visualization systems could provide a valuable product deliverable for cultural resource management as could be achieved within a regulatory goals parallel to preserving and communicating a cultural heritage experience.

visualization



data output





Presentation Produced by:
mars 4D Cultural Services
mmillett@mmars4d.com

Presentation Produced For:
NCPTT National Center for Preservation Technology and Training
3D digital documentation summit

With Deep Gratitude to:
uc davis KECK CAVES
UNITED AUBURN INDIAN COMMUNITY
ROSEVILLE Maidu Museum and Historic Site
TAHOE National Forest
USDA Forest Service
Tahoe National Forest
Truckee Ranger District
BLM
Redding Field Office
CALIFORNIA SURVEYING & DRAFTING SUPPLY
CSDS Sacramento, CA