4th International Symposium on Virtual Reality, Archaeology and Intelligent Cultural Heritage
VAST (2003)
D. Arnold, A. Chalmers, F. Niccolucci (Editors)

Managing the real with the virtual: A role for digital media recording in archaeological fieldwork

Michael ASHLEY LÓPEZ

Department of Anthropology, University of California, Berkeley, USA

Abstract

Recent innovations in digital media have allowed for a surge of new techniques to be applied to an old problem - how to record and archive the archaeological record and the process of archaeological fieldwork. Like many new technologies, digital recording is rife with limitations and challenges - low resolution when compared to traditional film, a lack of standards for both media types and archiving methods, expensive entry costs and a relatively high technical skill level required for implementing a complete digital recording methodology, to name a few. However, the benefits of embracing digital recording techniques range from the practical to the profound, for once the initial investment has been made, digital media is relatively inexpensive and allows for a more rich and finer grain of recording, including exciting innovations in GIS-information systems and visualization tools. While the benefits may outweigh the costs, there is within the field of archaeology a strong "Resistance To Change" and a feeling that digital media recording, while novel and promising, is nonessential when compared to traditional photography and illustration.

To overcome this 'RTC' factor, archaeologists working at the Neolithic site of Çatalhöyük, Turkey, have developed a set of digital recording practices that augment, rather than replace traditional film photographs and ink illustrations. Over the past five years, many of these practices have proven to be invaluable, especially in rapid recording of friable or at-risk archaeological features, such as burials and painted walls. Digital planning of skeletons, for example, can dramatically reduce desiccation of the bones through exposure by cutting the recording time from hours (or days) to minutes. QuickTime VR technology is allowing us to holistically document pit walls in cuts too narrow to photograph with 'real' film or see with the naked eye. Digital photography and video can provide us with windows into the archaeological process itself, especially when judiciously used as part of a daily recording practice.

This paper describes a few of these recording methodologies in an attempt to discuss the symbiotic relationship between real (archaeological) sites and virtual (web) ones. In many ways, the process of working on archaeological sites and web sites is similar - one develops a set of research aims or designs, collects data, analyzes the results, publishes conclusions and archives and manages the material record. In both cases, the real world pressures of limited time, resources, budget, environmental conditions and the changing needs of both the site (archaeological conservation, technological advances) and the audience requires innovative approaches at every step of the process. By situating digital recording as an integral component of the archaeological process, we are attempting to move away from the 20th century view of a fixed, static archaeology to one where the site is defined by an ever-growing and dynamic web of data, analysis, interpretation and intrigue. The dig site and the web both require management plans and stewardship in order to survive the rapid changes of our new millennium.

Keywords:

Archaeology, Anthropology, Collaboration, Interactivity, Internet, Multimedia, Photography, Recording, Site Management, Standards..

1. Introduction: The Site of Çatalhöyük

Figure 1: *Location of Çatalhöyük in Turkey*

Çatalhöyük. a large Neolithic tell located near Konya, Turkey, is currently excavated by a large international team under the auspices of the British Institute of Archaeology in Ankara. Famous for its wall paintings, well preserved architecture and dense occupational deposits, it was originally excavated in the 1960's by James Mellaart. The current research differs from that conducted by Mellaart in both its long-term scope and 'grain' of investigation. Typically, single buildings are excavated slowly over the course of one season whereas Mellaart excavated over 200 buildings in four years. This fine grain approach is helping us to understand and re-interpret daily life at the site in much greater detail. The excavation is planned to continue for at least twenty more years.

Every season, many teams of archaeologists and specialists come to the site to conduct research. At any given time, as many as 100 team members may live at the site - workers from local villages and international participants from Britain, the United States, Greece, Poland, Serbia, Sweden, Denmark, Germany and Turkey. Çatalhöyük draws interest from beyond the discipline of archaeology. We are visited each year by tourists, school children, local and international press, Goddess tours, filmmakers and many other enthusiasts.

Figure 2. *Çatalhöyük, East Mound, 2002*

One of the great challenges at Çatalhöyük is how to convey the complexity and organization at the site. Most of the architecture remains buried and what is visible is not always easy to comprehend for visitors. Thus, illustration, QuickTime VR, full-scale models and 3-D reconstructions are all employed to help us all imagine what life may have been like here 9000 years ago.

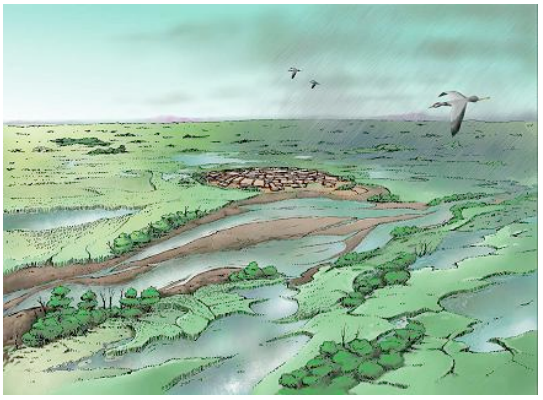

Figure 3. *Artist's reconstruction of the site during spring floods (John-Gordon Swogger, 2001*

Another challenge is the shear size of the project, both in terms of the actual mound and the amount of data that must be managed. Hundreds of thousands of artifacts, over 50,000 associated images, thousands of excavation recording sheets, hundreds of researchers and dozens of teams comprise a part of the data web that must be weaved and constantly maintained. As the project grows, the problem of stewardship becomes ever more pressing.

1.1. DIGITAL SHORTCUTS

Alternative recording practices, digital video, watercolor, pen and ink and other forms of artistic media have been employed at Çatalhöyük since the beginning of the new excavations in 1993. Many of the new media practitioners come to the site due to the project's commitment to multi-vocality and multiple interpretations. Those of us who are dedicated archaeological researchers are attempting to not only experiment with alternative media but are also trying to develop a richer set of minimum field recording methods. Over the past five years, we have developed digital recording practices that augment, rather than replace traditional film photographs and ink illustrations. Many of these practices have proven to be invaluable, especially in recording at-risk archaeological features, such as burials and painted walls. Digital planning of skeletons, for example, can dramatically reduce desiccation of the bones through exposure by cutting the recording time from hours (or days) to minutes. QuickTime VR technology is allowing us to holistically document pit walls in cuts too narrow to photograph with 'real' film or see with the naked eye

Figure 4. *360° VR Panorama of Burial Cut Interior*

Digital photography and video can provide us with windows into the archaeological process itself, especially when judiciously used as part of a daily recording practice. By tying all of the media to the field data through a Digital Asset Management (DAM) application, we are able to capitalize on the immediacy of digital imaging while still in the field.

2. Documenting Archaeology With Digital Artifacts

Paper and pencil, ink, protractor, compass, slide film, black & white negative film, EDM or theodolite, notebook - the essential tools for archaeological documentation. Until very recently, these were the only options for many projects where budget constraints tether the desires to experiment with the latest gadgets and technologies. Time is always an important consideration. Field documentation, especially photography and illustration, can bring an excavation schedule to its knees.

2.1. Why 'Go Digital' ?

On the surface, digital technology appears to be an added layer of complication and expense. The first digital cameras were very expensive and the resolution was (and is) sub-par to 35mm film. 'Real' film provides the assurance that you still have images if a hard disk crashes or the media type becomes obsolete. Why would any field director opt for the added headache of new media? It turns out that there are many compelling reasons to 'go digital':

- **Cost** - In 1998, the Çatalhöyük Research Project photographed with slide and negative film only. Each image we took with either media cost us just over $1.00 per image for film, processing and digital scanning. The BACH team alone took over 2000 images, yielding an expense in excess of many project budgets. While the outlying expense for high-end digital equipment can be quite high, backup media such as CD-ROMs are very inexpensive and quite reliable. This allows the documentation specialists to be far more flexible and free with their picture taking.
- **Rapid Access to Media Data** - In most cases, especially in overseas projects, the media record is unavailable until returning home where film can be developed and videotape copied. Digital media is immediately available to the field researchers, providing important feedback and confidence that the feature or archaeological situation is properly documented.
- **Organization** - There are many inexpensive and powerful media cataloging software applications available that can make the nightmare of managing the mass of digital 'artifacts' a reasonable task. Extensis Portfolio, for example, can catalog, manage and track digital assets. The application works on multiple operating systems and serve as the backend for a web-based, searchable database for all project-associated photographs, video and illustrations. Using off-the-shelf products, a digital archiving solution can be designed that will provide in-the-field access to annotated images and video, an exceptional resource for field research. Images can be tagged and described on the spot and additional photos or video footage can be shot if necessary to assure adequate coverage.
- **Environmental Control** - Changing weather and lighting conditions from one time of day to the next can challenge anyone who is trying to document an excavation. Different work areas at Çatalhöyük are sheltered and others are not, the color of each shelter is different and the exposed sun is exceptionally bright. Most digital cameras can be 'white-balanced' to match the changing lighting conditions. This is very useful, especially when trying to methodically document features such as painted walls or colored objects in the field.
- **Metadata and Standards** - Many digital recoring devices, cameras and video cameras create files that include important data that can be automatically retrieved at a later time. This can include date and time to the second, shutter speed, color balance information, file type, camera model and resolution. Tagging and metadata communication protocols, such as EXIF and XML, are embedded into the actual file data, making the images themselves *digital artifacts*. Standardized, raw file formats are common on higher end digital cameras, helping to assure file readability in the future.
- **Creativity** - The freedom of low-cost, rapid access, easy to manage, high quality digital media offers an opportunity for field recorders and archaeologists alike to create richly authored presentations. Some of the most interesting situations in archaeology happen behind the scenes and inexpensive digital imaging can help these untold stories come to light, almost guilt free.

2.2. Practical Considerations

As rapid as the changes in digital technology may seem (if you listen to the media and advertising), things are not advancing as rapidly as the hype may espouse (or perhaps as we would like). However, digital photography became affordable in 1999 with the introduction of

pro-sumer (professional-consumer) grade digital still cameras capable of producing 2+ megapixel (over two million pixel) images for less than $1000. Today, it is possible to buy a 5 mega-pixel camera for about the same price, roughly two and a half times the resolution. In the same period, mass storage drives have become dramatically less expensive, with 100 gigabit hard drives selling for less than $200 and 700 megabyte CD-R disks for 20¢. $1.00 of CD storage will hold about 700 uncompressed 5 mega-pixel images. CD-Read/Writable drives are standard equipment in many laptop computers, making it possible to have a portable and affordable archiving station in the field.

Dust, heat and unreliable power conditions can make a digital alternative to film less than ideal. We use Nikon digital cameras on site and have never had problems with them, but we do not generally use *laptops* in the field. The extreme heat makes the fan come on constantly, attracting the exceptionally fine dust that covers everything on the site. We do use Palm Pilots equipped with foldable keyboards for data entry in the field and transfer the files (in Filemaker Mobile databases) to the laptops during lab hours. Please see the Technical Notes in Section 3 for more details.

The system is not infallible. This past season, one of our hard disks corrupted during a backup and we lost six weeks of images. The images are recoverable but it is expensive, over $1000. Fortunately, the majority of site images were taken and stored on a different system and we have a full visual record of what is lost through the Portfolio catalog, plus we do still shoot pictures on slide film. Clearly, this is a case where film (and more diligent backups) could have saved the day.

2.3. Digital Artifacts

In any given field season at Çatalhöyük, the media team will generate over 10,000 still images and log over 40 hours of video. The question that looms is 'what use is all of this media if no one can find or access it?' If all of the slides are stored in archive boxes in Cambridge or Berkeley, we have blinded our researchers and the public to the site in the off-season. In other words, while it is typical to develop an excellent and useful recording system for the artifacts and units we uncover, it is less typical and quite difficult to build a system for the artifacts we *create*, the **media record**.

2.4. Archive Stewardship

Slide and illustration project archives are usually guarded and conserved with great care. Slide film for color photographs, typically Kodachrome for its stability, slow ISO negative film for black and white, acid free paper and vellum, India ink for illustrations. Dark, dry, humidity controlled conditions. Originals are treated with great care, for once the archaeological site is excavated, it is gone, it cannot put it back together again. Thus, it is typical to create duplicate slides or to scan them and create digital copies for publication and general use.

Managing a media archive is expensive and painstaking. Editorial decisions are made to limit the amount of images considered the primary, publishable archive. Often this is done before the season begins by limiting under what circumstances pictures and drawings are taken or made in the field to begin with. High resolution scanning of slides and negatives can be outsourced, saving time but at increased expense. Please see Section 3, **Technical Notes**, for more details.

Digital photography has many advantages over traditional film photography in this scenario. We shoot digital images at a ratio of 20:1 to slide film, coming home with a reasonable 500 slides and 10,000 digital images per season. The great fear among all of us is the ephemeral nature of digital images and the relatively short shelf life of digital media. How does one assure that the images will be preserved for future generations who may not have the technical means to view them?

2.5. Digital Originals

One answer lies in treating the digital images exactly the same as 'real' slides or prints, as *Digital Originals*. This concept means that the digital archive gains the same level of respect and care as the physical media archive and requires similar maintenance and upkeep in order to assure data integrity. We call this D.U.M.P., a *Digital Upgrade and Migration Program*. Digital sources are stored on high grade CD-ROMS but also on hard disks and network servers. Digital originals are migrated from one media source to another at the first sign of physical degradation. Fortunately, CD media quality is stable and safe so long as, like slides, it is stored in archival conditions.

2.6. Managing The *Real* With The *Virtual*

Creating digital originals protects the original media from loss and damage from over-handling and exposure. The original media becomes another archive resource and the digital originals are what we use for lectures and presentations. High-resolution digital originals, either from slide scans or digital cameras can be converted into physical slides and prints and are usually acceptable for publication purposes. The original physical media is always available for high-resolution posters and books, but for the most part, the digital originals are usually adequate.

At the heart of our media recording system is a Digital Asset Management program (DAM). DAMs come in

many varieties, from custom programmed, high-end solutions to the thumbnail browser built into Windows XP. In essence, any system that manages collections of images is a digital asset manager. We use Extensis Portfolio, a robust and flexible application that is cross-platform compatible and highly customizable. We believe in using off-the-shelf solutions whenever possible for two reasons. First, custom solutions are usually very expensive and labor intensive to develop. The benefits of having a 'glove-fit' solution have rarely outweighed the disaster created when the developer, usually an underpaid graduate student, moves on from the project, leaving those who stay behind with a poorly documented and inflexible disaster.

The other reason is just as practical. Companies such as Extensis and Filemaker are in business to make money and continue research and development of their products to stay competitive. Recent versions of both Portfolio and Filemaker Pro are sufficient for our needs and are highly customizable. Off-the-shelf solutions allow us to focus on our specialty, archaeology, and to develop systems and protocols that will work for other projects and in other disciplines in terms of ease of use, availability and expense.

2.7. D-COMMUNICATION: THE SITES OF ÇATALHÖYÜK

The research project at Çatalhöyük is rather unique in that one of the requirements for working there is that you must centrally share all of your data. Typically on archaeological projects of this scale, specialists and excavators gather data and then report or publish their findings, sometimes including tables or appendices with a sub-set of the original data, enough to back up the analysis. By having all of the data available to everyone, it is hoped that deeper, more interdisciplinary approaches to interpretation of the site will be adopted.

For the most part, this works very well. The field data is entered into a single database matrix from which all teams and specialists write up archive reports. Many members also contribute to the annual newsletters available on the *Çatalhöyük website*. Further, all of the data is available to the public on the website. Discussion, contributions and debates are encouraged between all interested groups.

We are taking a similar approach to the image data by making the images available online through the same Portfolio database system we use in the field. In the field we are careful to use a file naming strategy that will allow us easily upload the images to our website while maintaining high image quality for archiving purposes.

There are serious issues with allowing carte blanche access to the image archive. Images are raw data but they are also finished works of intellectual property. For some of us, the photographs *are* the interpretation. We use the power of the web server to track and manage this potential problem. Any visitor may view the thumbnails and perform searches on the database, but if they wish to view the screen-sized file, they must obtain a login and password. Images are digitally and physically watermarked for our protection and full-sized, high-resolution images require the visitor to e-mail us for access. Please see Section 3, **Technical Notes**, for more information on digital watermarking.

2.8. Documenting the Invisible

So far, I have argued some of the reasons for 'going digital' in site recording primarily from a data-management and cost perspective. There are less practical but exciting reasons for exploring other methods of documenting archaeological sites. Alternative recording techniques, such as Quicktime VR, video diaries, time-lapse photography, micro-photography, digital infrared and ultra-violet, digital x-ray, 3-D modeling via uncalibrated digital imaging and tent-aerial photography can breathe life and imagination into an otherwise static and stale image record. Most of these techniques are not complicated to learn or employ and are practically 'free' of cost once the initial equipment investment is made.

But why do them? Time on an excavation is precious and expensive enough that sometimes getting the minimum amount of documentation is a challenge. There are many creative ways to minimize the cost in time and energy that alternative documentation can cause, but the key is to think about it creatively. We are fortunate at Çatalhöyük to not only have individuals whose full time job is documentation, but also a project wide understanding that alternative media is not, in fact, alternative, but an integral part of the archaeological process. Most members of the teams contribute in one way or another, from simply picking up a digital camera and taking a few snaps to participating in interviews or making suggestions for new ways to tackle some aspect of field recording.

The rewards of the effort are paramount. We use the media record for print and online publication, lectures and presentations, museum installations and on-site seminars. We allow students to have full access to the materials in courses taught at UC Berkeley, where they are encourages to produce self-authored multimedia projects, many of which are adopted for other undergraduate courses or for our outreach program with the local primary and secondary schools.

From a more methodological perspective, we use alternative media to assist the archaeologists make decisions in the field or to feel confident that a certain feature or artifact is properly documented so they may move forward with the excavation. We can carefully document ephemeral materials, such as small bits of

colored pigment or a friable pot in situ more thoroughly and with better accuracy than with traditional film. Time-lapse photography allows us to see the subtle play of light across the mound, both under shelter and the exposed sun, providing useful information for planning future shelters and insight into what lighting conditions may have been like for the original inhabitants at Çatalhöyük.

A discussion of some of these techniques follows in Section 3.

3. Technical Notes

I will briefly outline some of the techniques we use at Çatalhöyük on a regular basis. Examples of these can be found on our website, www.mactia.berkeley.edu/catal Please feel free to contact me if you would like additional details, mashley@uclink.berkeley.edu.

3.1. Digital Asset Management

3.1.1. From Field to Web

To track all the media on site - slide or black and white film, digital images, video and illustrations - we use a system of log numbers and paper sheets, one for each device (or person, in the case of illustrations). Log sheets are entered in the field using Filemaker Mobile on Palm Pilots in shorthand, recoding the essential information only. The files are downloaded to Apple Macintosh laptops at during lab hours. We keep to one log sheet per device per day and find that this helps to reduce confusion and chaos.

During lab hours, we use the paper log sheets and the images themselves to complete the entries in Filemaker Pro. Images are downloaded from the media cards and automatically renamed and catalogued with Extensis Portfolio. We use a simple export script in Filemaker to export out the records and import them into Portfolio. Finally, the complete archive is backed up onto three separate hard disks and periodically written to CD or DVD-R.

Back at home, we merge the new season additions with our master catalog. We serve the catalog using Extensis' Portweb, a free plug-in for servers that comes with Portfolio. Portweb uses a macro language that makes it easy to create query templates for searching the catalog dynamically. We can make modifications and additions to the catalog entries and the changes will appear live on the online version.

We create two versions of the image files using an action in Photoshop or Graphic Converter Pro.

1. *Digital Original* - The original image file or a high resolution slide scan is archived on CD-ROM and stored under archival conditions in multiple locations. One copy at this resolution is accessible to the online catalog system.

2. *Screen Version* - A screen sized version is made that contains a physical watermark and digital copyright information. The physical watermark is placed on the bottom right corner of each image, demarking the photographer and a web address. The embedded digital copyright information is added to the file itself in Photoshop. Images opened in a graphics program will show a © copyright symbol in the title bar.

Figure 5. *Physical watermark on screen-sized image*

3.1.2. Slide Conversion

Due to the high cost and proprietary format of Kodak PhotoCDs, we opted to buy a professional slide scanner. We use a Nikon Coolscan LS-2000 with the auto-load feeder. The LS-2000 scans 20 slides per hour. In a typical day, we can scan 100-140 slides, thus scanning 2000 images can take a month with a dedicated, full-time person managing the scanner. A new generation of scanners offers much faster scanning and higher resolution. We look forward to the day when the quality and resolution of digital imaging matches film.

3.2. Digi-Planning

Traditional hand illustration is a time consuming process. Whenever possible, we use rectilinear, high-resolution digital photography in conjunction with or in place of hand drawing. We place planar points around the object or area to be drawn using an EDM (Electronic Distance Measurer), then photograph the scene from as far away as possible in order to use a long lens and reduce distortion. The digital image is scaled in Photoshop to match the EDM points, usually at either 1:5 or 1:10, depending on the requirements of the drawing.

Hard copy printouts are taken back to the site and extensive notes are made. The feature is drawn off-site using a Wacom digitizing tablet and spot-checked for accuracy against the actual situation in the field. This process can save considerable time because we move directly to a 'traced,' digital, publication-ready illustra-

tion and much of the work is done during non-excavation lab time.

3.3. 'Sheltered' Aerial Photography

Figure 6. *Jason Quinlan shoots a digi-plan of a burial.*

Obtaining rectilinear, high-resolution images of the full excavation area is very difficult, especially in the sheltered areas where using a crane, 'fishing pole' or scaffold is not possible. Beginning in 2001, the BACH media team devised a system of ropes and webbing, traditionally used for 'big wall' mountain climbing. Load bearing on the tent and other safety factors required three months of research and training in the pre-season. Now that the system is in place, we typically shoot aerial or digi-plan shots on a daily basis during the regular season site-wide.

3.4. Quicktime VR

Quicktime Virtual Reality is an Apple Computer technology where a series of images are sewn together with software to produce a seamless panorama image. The technology all but died until recently when QTVR has made a comeback, especially in commercial fields such as real estate. We use it to holistically document stages of the excavation but also to record features we cannot see, such as small floor cuts where traditional cameras simply do not fit. The stitched files can yield high-resolution images of 50 megabytes or larger. If carefully shot, distortion can be dramatically reduced such that the images can be used for digi-planning.

3.5. Video Diaries

Video has been an integral recording method at the site since 1997. Some teams use it more than others, but all periodic informational tours are recorded and digitized. The BACH team, for example, records short 'digital diaries' every morning prior to excavating. The timing is deliberate, for it allows the directors to collect their thoughts overnight and after the previous day's work has been assessed and the current day's work has been planned.

3.6. Other Technologies

Please see the website accompanying this paper for further techniques, examples and details. Additions will be made to the site in the coming weeks and months. The direct address is

www.mactia.berkeley.edu/vast2003

4. Conclusions

Digital media recording techniques offer many benefits for field recording of sites ranging from the practical to the artistic. The recent explosion in digital photography has made digital imaging affordable, especially when one leverages the cost against film, developing and scanning. By developing a digital asset management system using off-the-shelf software applications, it is possible to create powerful and meaningful media collections that are accessible to anyone who is interested while still maintaining access control and high archiving standards.

5. Acknowledgements

I would like to thank the many team members and associates who have worked and lived at Çatalhöyük over the years, especially the BACH media specialists Jason Quinlan, Adriana Garza, Sabrina Maras, Caitlin Gordon; thanks also to the Science Museum of Minnesota team, Director Ian Hodder, Field Director Shahina Farid for putting up with me and Ruth Tringham for making it all possible.

Figures

1. 2002. *Location of Çatalhöyük in Turkey*
2. Ashley LÓPEZ, MICHAEL. 2002. *Çatalhöyük, East Mound*
3. SWOGGER, JOHN-GORDON. 2001. *Artist's Reconstruction of the site during spring floods*
4. Ashley LÓPEZ, MICHAEL. 2002. *360° VR Panorama of Burial Cut Interior*
5. Ashley LÓPEZ, MICHAEL. 2002. *Example of Physical Watermark on Screen-Sized Image*
6. Ashley LÓPEZ, MICHAEL. 2002. *Jason Quinlan shoots a digi-plan of a burial.*