VidArch: Preserving Meaning of Digital Video over Time through Creating and Capture of Contextual Documentation

Helen R. Tibbo, Christopher A. Lee, Gary Marchionini, and Dawne Howard, School of Information and Library Science, Chapel Hill, NC/USA.[1]

Abstract

The NSF/LC-funded VidArch project is moving beyond a focus on the preservation of data and isolated information objects to the preservation of persistent context that will make today's videos not only accessible, but also understandable far into the future.[1] This project builds from the Reference Model for an Open Archival Information System (OAIS) but also uses the archivist's traditional descriptive tool, the finding aid. The VidArch project is blending the conceptualizing power of the finding aid with the complexity and information-rich nature of video to create the video-, and more generally, multimedia-enhanced finding aid. This paper reports on our progress toward developing a framework of elements to be documented within video collections (related actors, events, objects, places and times), and a cost-effective means to locate, authenticate, select, and capture these materials within preservation environments. In this process we seek to identify those elements that are best documented today and secure contextualizing materials for them while noting other elements that will be more deeply supported by materials available in the future.

Digital Preservation and Video

Digital preservation is one of the grand challenges of the early 21st Century. [1-4] If future generations are to have a record of today's scholarly, scientific, and cultural achievements, we must learn how to preserve digital assets, whether they are textual documents, research data, or complex multimedia objects. To this time, much of the discussion of, and approaches to, digital preservation have focused on 1) technical issues associated with preserving the bits; 2) social engineering as seen in records management compliance and identification of incentives to preserve; and 3) the creation, capture, and acquisition of metadata to support future discovery, administration, integration, and physical preservation of digital files.

Video content offers special challenges for preservation just as it offers special challenges for digitization and retrieval. Most importantly, video is a temporal medium with multiple information representation channels. Multiple visual (primary visual activity, superimpositions of text or graphics) and audio (including the possibility of human speech in multiple languages, music, natural and artificial sound effects) channels may also be augmented by human-readable or machine readable content (e.g., closed captioning or feature vectors, respectively). A video object's meaning is greater than the sum of its parts, and preservation must attend to the whole as well as the parts.

Much of the preservation research to date has centered on text and still images, but moving and multi image materials have received significant attention as well. [5-8] This project builds on earlier work with digital video files and their surrogates seeking ways in which to preserve a video work's context and highlighting its essence, thus making it more understandable and accessible to future generations. [9-10]

For digital objects, preservation and access are integrally intertwined. Conway [11] argues that unlike physical materials, for which active use can make preservation more difficult, only those digital objects that remain accessible and that are used will be preserved over generations of costly changes to software and hardware. Here "preservation is a reality and not merely a metaphor for or symbol of access" and accessibility and use promote longevity. Lavoie and Dempsey [12] illustrate the range of ways that preservation may be viewed and note that "mechanisms to ensure long-term persistence should operate harmoniously with mechanisms supporting dissemination and use." Thus, long-term provision of contextualized access that makes digital objects understandable over time is essential to long-term preservation. It is our contention that metadata is crucial for access and substantial context is crucial for understanding over time. We, therefore, are focusing in this research project on developing a preservation framework for digital video context.

There has been remarkable progress made in creating metadata schemes and standards for digital content (e.g., DC, METS, NLNZ) [13-15] and recent work to develop a strong foundation for digital preservation metadata (PREMIS) [16]. However, much remains to be learned about long-term access considerations and how they should be encoded into information systems and metadata specifications. Although metadata will ultimately specify the infrastructural aspects of context, we have little evidence on the kind or extent of contextual information necessary and sufficient to preserve digital entities (object-specific annotations let alone general 'state of the world' at time of creation) in an accessible and comprehensible manner. This is a general problem for digital preservation, but we posit that it is especially problematic for digital video content.

Creation and capture of context is central to archival theory and practice. Documentation of context can make materials useful and comprehendible in the future by individuals who were not involved in the activities that are documented by the materials. This is the hallmark of a well-written archival finding aid, a device that has proven useful, if expensive, for describing and providing access to primarily text-based collections. Encoded Archival

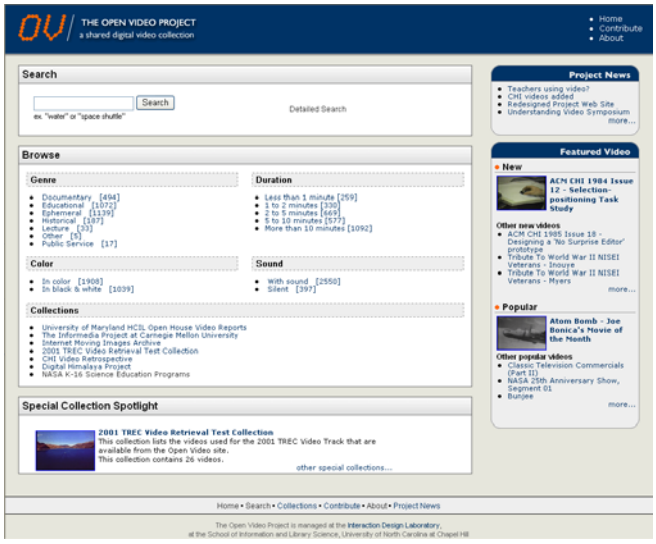
[1] This work was supported by a grant from the National Science Foundation #IIS 0455970

Description (EAD) [17] is a standard designed to make finding aids more accessible and interoperable. As finding aids themselves become digital objects, they can take advantage of the digital medium to include added value elements such as multiple media, hyperlinks, and interactive behaviors that make them more representative and more usable. This project seeks to develop approaches for addressing the capture of existing and creation of new metadata surrogates to ensure that collections of digital video will be meaningful and accessible over the long-term. These surrogates will include text representations, but most importantly and uniquely, will employ elements from video to describe video. More importantly, we aim to define a digital video preservation framework focused on context that can be used by archivists to make preservation decisions and guide the development of description and access systems. The framework will include cost considerations from several angles including the degree to which elements may be automated. We will demonstrate this framework by applying it to two important digital video collections held within the Open Video repository at the University of North Carolina at Chapel Hill.

Open Video

Open Video (OV) (http://www.open-video.org), housed within the School of Information and Library Science at the University of North Carolina at Chapel Hill collects and makes available digitized video content for the digital video, multimedia retrieval, digital library, and other research communities (see Figure 1).

Figure 1. Open Video Website



Significantly, Open Video began as a *project* to provide researchers with *access* to video to facilitate the study of problems, such as the development of algorithms for automatic segmentation, summarization, and creation of surrogates that describe video content; and the creation and evaluation of interfaces that display result sets from multimedia queries. Begun in 1998 with a framework and the digitization of approximately 195 video segments, Open Video has been very successful in collecting a wide range of video content and now finds itself a *repository* with *preservation* as well as access needs. This situation, the diverse nature of the materials, and the complex workflow process that results in multiple surrogates such as fast forwards and storyboards, led the DigArch team to use content from OV as initial case studies. Specifically, we are using video from the U.S. National Aeronautics and Space Administration (NASA) Langley Center for Distance Learning and the Association for Computing Machinery (ACM) collections within OV to explore what types of contextual material digital video curators might preserve along with actual videos so as to facilitate enhanced understanding for future generations of users. We are also developing a decision framework to assist curators in the selection and extent of such contextualizing information using the Open Video environment.

The NASA Collection

In the Fall of 2003 OV began working with NASA Langley's Center for Distance Learning to provide digital video file versions of four educational programs. The programs are designed to (1) enhance and enrich science, technology, engineering, and mathematics (STEM)-related teaching and learning; (2) advance the theory and practice of teaching mathematics, science, and technology; (3) inspire and encourage students (especially women and minorities) to pursue STEM-related courses and careers; and (4) increase (adult) scientific and technological literacy. Through this collaboration, teachers, students, and parents can now access and download the complete set of programs from an Open Video server. The programs -- NASA Kids Science Network,™ the NASA Sci Files™, NASA CONNECT™ and NASA's Destination Tomorrow™ -- air on PBS, cable, and ITV and are used nationally by about 500,000 educators, representing about 10.6 million students. At present, there are 55 segments from NASA Kids Science News Network™, 188 segments from 17 NASA SCI Files™, 222 segments from 35 NASA CONNECT™, and 75 segments from 14 NASA's Destination Tomorrow™ programs. Each segment and program is available in MPEG-1, MPEG-2, MPEG-4, QuickTime, and Real formats to allow users with different connectivity and software to use the materials. Thus, there are 2,700 video files (5 versions of each segment), 540 metadata records in a MySQL database, and more than 11,000 keyframe files (GIFs) used in storyboards as well as 540 QuickTime fast forwards in the collection. Figure 2 illustrates what an OV user would see when coming to *The Red Planet* video from NASA.

Many of the same videos are also available at nasa.ibiblio.org. A collaboration of the Center for the Public Domain and The University of North Carolina - Chapel Hill, ibiblio is "a conservancy of freely available information, including software, music, literature, art, history, science, politics, and cultural studies" (www.ibiblio.org/about.html). The video segments come from NASA and pass through the OV workflow with copies and various surrogates placed in both locations. This is more fully explained in the VidArch section below. See Figure 3 for nasa.ibiblio.org's presentation of the NASA videos. Here the audience is clearly K-16 educators, families, and students while the OV targeted audience also aims to serve video and information science researchers as well as the public. This is an excellent example of how the access systems associated with the same digital objects can be provided very different look and feel. Such

customizable dissemination information packages (DIPs) are an essential element of the OAIS Reference Model.

Figure 2. :The Red Planet" Video from Open Video

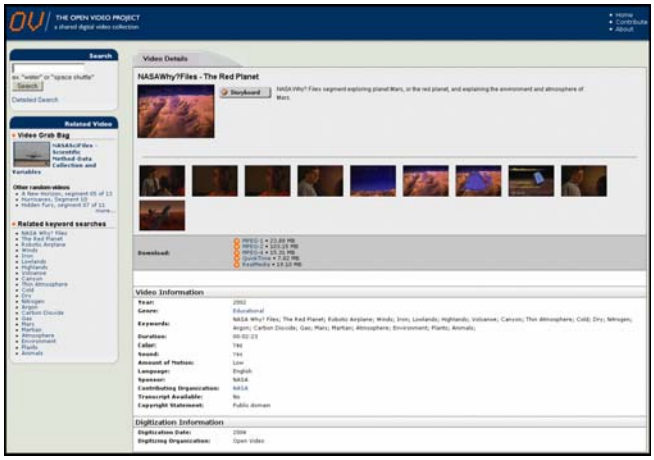


Figure 3. nasa.ibiblio.org.

The ACM Collection

The second collection we are using to evaluate the digital video context preservation framework consists of videos presented at research conferences sponsored by the Association for Computing Machinery (ACM). One conference in particular, the Annual conference of the ACM Special Interest Group in Computer Human Interaction (SIGCHI) has accepted juried videos each year since 1983. From 1983 through 2002 these videos were distributed on NTSC videotape to conference attendees and in more recent years, they were distributed on DVDs. Researchers in human-computer interaction produce these videos at their university or corporate laboratories and submit them for peer review. Each year, a small number (typically around a dozen videos ranging in length from a few minutes to 15 minutes or more) are accepted. Open Video has collected digital versions of all the SIGCHI videos from 1983 through 2003 (427 videos). The process by which these videos were digitized varied. More importantly, these videos were produced by a variety of people around the world with a variety of audio-visual skill and resources (e.g., some were professionally produced by large corporate labs and others shot by hand by university students). Thus, the original visual and audio quality varies enormously. For all of these videos, Open Video includes metadata by using the keywords and other information authors provided to the ACM conference. Thus for the SIGCHI videos, OV has 1,708 video files (4 versions of each video), 427 metadata records in the MySQL database, approximately 15,000 keyframe files (GIFs) as well as 427 QuickTime fast forward files.

Digital Archiving and the OAIS Reference Model

This project builds from the Reference Model for an Open Archival Information System (OAIS), now an ISO standard. [18] The OAIS is a high-level conceptual model, intended to serve as the basis for more specific standards and approaches as it articulates "the functionality and components of any system responsible for preserving any type of information...."[19] It indicates the importance of contextual information, but it does not describe how to specify the contextual information. One of the goals of the VidArch project is to further flesh out the notion of context, particularly as it pertains to the preservation of digital video collections within OAIS repositories.

The OAIS Reference Model distinguishes between three types of information packages. The Submission Information Package (SIP) is "information delivered by the producer of the archival content to the OAIS repository for use in the construction of one or more Archival Information Packages (AIP)." An AIP is "the content information that is a target of preservation and the associated Preservation Description Information (PDI), which is preserved within the repository along with the digital object(s)." Finally, the Dissemination Information Package (DIP) is "information taken from one or more AIPs, and packaged with the target content for the user of the repository." [20] In this project we are investigating reliable and cost-effective approaches for curators of video collections to turn sets of discrete video files into collections of context-rich Archival Information Packages (AIPs).

The VidArch Approach

The Video Enhanced Finding Aid

The NSF/LC-funded VidArch project is moving beyond the focus on the preservation of data and isolated information objects to the preservation of persistent context that will make today's videos not only accessible, but also understandable far into the future. VidArch researchers are blending the conceptualizing power of the finding aid with the complexity and information-rich nature of video to create the video-, and more generally, multimedia-enhanced finding aid. Our first step has been to create conventional Encoded Archival Description (EAD) finding aids for the NASA and ACM collections (see Figure 4). These finding aids contain several levels of hierarchy from the entire collections

through series and subseries of videos down to listing of individual videos and segments broken out of each. These tools provide both a structured hierarchical view of the collections beginning with broad collective descriptions and the opportunity to provide varying degrees of granularity at any given level within the hierarchy.

Figure 4. Finding Aid for the NASA K-16 Science

Traditionally, archivists have used finding aids, first in paper format and more recently encoded in XML and mounted on repository websites, to provide users with contextual information to understand the documents within a collection. This contextual information most frequently relates to the entities involved in the creation of the records -- individuals, organizations and functions -- and the nature of the records themselves. Organization of records by provenance, document type, and often chronological order -- and the capture of this arrangement within the finding aid – can assist users who may be many generations removed from the creation of the original records. Rather than simply being an aggregation of existing metadata, the creation of findings aids often involves substantial intellectual work and professional judgment on the part of archivists. We, therefore, contend that finding aids should be considered not just access devices but also digital objects that themselves should be submitted to and ingested into the OAIS along with the target videos.

With the EAD finding aids as a framework, we are presently identifying a typology of elements (related actors, events, objects, locations, times), to be documented within video collections by examining the contents of video segments. We are starting with videos from the NASA collection, such as *The Red Planet* and seeking approaches for determining how best to locate, authenticate, select, and embed these materials within or attach them to the preservation package. In this process we seek to identify those elements that are best documented today and secure contextualizing materials for them while noting other elements that will be more deeply supported by materials available in the future. Our immediate goal is to produce and test the feasibility of a multimedia finding aid that documents video with not only text but also video and other multimedia objects.

An example from a NASA video about hurricanes is indicative of these efforts. Weather balloons are mentioned in this program as a tool that helped meteorologists forecast and assess hurricanes and it is noted that they are being replaced with data from satellites and other sensor systems. Given the progress of weather forecasting tools and technologies it is very likely that in 50 years few individuals viewing this educational program would have any idea how today's weather balloons are used or what they looked like, even though the hurricane program gives a fairly clear discussion of the device's purpose and the type of data it collected. This seems an excellent element to document with images and not merely descriptive text. Also, it would seem prudent to document this object now, while images and video of weather balloons are easy to locate and preserve along with the target hurricane video.

Contextual Elements from the Open Video Workflow Process

Simultaneously, we are developing a framework of contextual elements to be documented from creator-provided information at the time of ingest. Our work begins with a general model of the life cycle of video objects.

Figure 5. Life Cycle of Digital Videos from NASA in Open Video

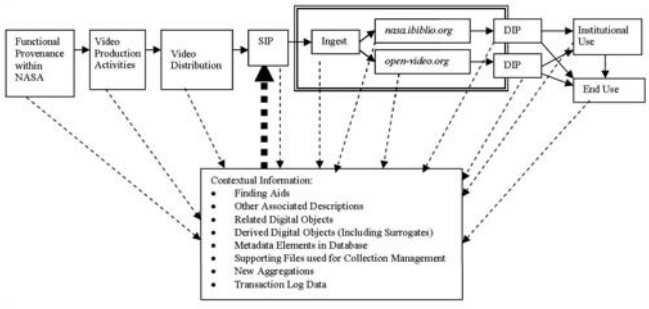
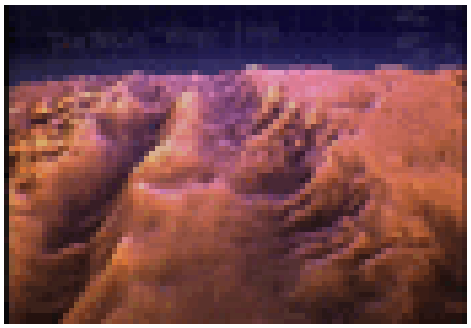


Figure 5 represents a series of stages in the life cycle of digital videos from NASA that are available from Open Video and nasa.ibiblio. The solid arrows in the figure show current information flows, while the dashed arrows indicate potential for capturing further contextual information. The first point in the life cycle is the functional provenance within NASA. This includes the mission, goals, objectives and programs within NASA that generated the videos. The second stage involves the activities undertaken by both NASA and its contractors to produce the videos. Next is NASA distribution of the video, which includes television broadcasts, posting to NASA web sites, and NASA direct dissemination to classrooms.

Periodically, NASA sends to the Open Video team[2] a physical medium -- either video tape or DVD -- through postal mail and a SMIL file (including transcript and timestamp data) separately as an email attachment. The Open Video team views the analog segments contained on the physical media and reviews associated NASA documentation to generate metadata elements, which they use to populate database records associated with each video. Then the team uses Final Cut Pro to generate a large master digital video file in .mov format. Again using Final Cut Pro, they

divide each video into a set of much smaller segments, based on what they judge to be useful cut points. For each segment, the Open Video team uses a product called MediaCleaner to derive copies in five different and smaller formats: MPEG-1, MPEG-2, MPEG-4, QuickTime and Real. They also create a .RAM file for the audio that accompanies the Real version.[3] Next they create storyboards that contain representative keyframes. They use a program called MERIT to generate a set of candidate keyframes for each video segment. They then manually choose a set of approximately 18-36 keyframes that they judge to be most representative of the segment and discard the rest. While making these choices they also categorize keyframes that contain faces and text superimpositions. They also choose one of the keyframes to serve as the single "posterframe" to be a useful representation of the entire segment (see the larger image of the Martian surface in Figure 6 for *The Red Planet*). Next, they also generate "fast forwards," which are surrogates that present every nth frame, allowing users to quickly get a sense of what the segment contains. Seven-second excerpts of the video are also extracted to serve as a third kind of non-textual surrogate. The resulting set of video segments, surrogates, and other metadata elements are served from the Open Video site. The video and metadata are served from the nasa.ibiblio.org site. The experience of navigating the two sites is quite different, because they are designed for different use scenarios.

Figure 6. Posterframe for "The Red Planet"



This is again an excellent example of how information from the producer at the time of ingest can be used and presented in specific ways to meet the needs of varying audiences.

The final stage of the videos' life cycle is use. This takes the form of both institutional use (e.g. by schools and research projects), direct end use, and end use that is mediated through institutional users (e.g. students viewing videos selected by their teacher).

At each stage in the life cycle, there are numerous pieces of contextual information that do not travel along with the videos to the next stage. In Figure 5, we have placed particular emphasis on the arrow pointing from "Contextual Information" up to "SIP." An OAIS differs from other types of information systems in that it accepts "responsibility to preserve information and make it available for a Designated Community" over the "long-term." However, this responsibility is only assured for information that has been submitted to the OAIS as an SIP and then ingested in order to become an AIP. Curators of digital video collections must decide what subset of the total potential documentation (existing or created by the curator) related to the digital videos should be (1) reflected in the descriptive and access tools of the archive and (2) submitted to the archive as SIPs in order to be ingested for long-term preservation.

Conclusion

The VidArch Project is looking beyond the traditional finding aid and the role of the archivist as researcher for a way to help extend the understandability of videos far into the future. VidArch will result in a descriptive framework that extends the traditional finding aid and builds the ground work for customizable DIPs within OAIS video repositories. It will provide a methodology by which curators can enhance the utility of their collections and customize contextual support of their materials for both diverse user audiences and future researchers.

References

[1] Council on Library and Information Resources, *The State of Digital Preservation: An International Perspective* (CLIR, Washington, D.C., 2002). http://www.clir.org/pubs/abstract/pub107abst.html.

[2] Margaret Hedstrom, Seamus Ross, *et al*., *Invest to Save: Report and Recommendations of the NSF-DELOS Working Group on Digital Archiving and Preservation* (2003). http://delos-noe.iei.pi.cnr.it/activities/ internationalforum/Joint-WGs/digitalarchiving/ Digitalarchiving.pdf

[3] Library of Congress, *National Digital Information Infrastructure and Preservation Program* (LOC, Washinton, DC, 2003). http://digitalpreservation.gov.

[4} National Science Foundation/Library of Congress, Workshop on Research Challenges in Digital Archiving Organizing Committee, *It's about Time: Research Challenges in Digital Archiving and Long-Term Preservation: Final Report on the NSF Workshop on Research Challenges in Digital Archiving and Long-Term Preservation, April 12-13, 2002* (NSF & LOC, Washington, DC, 2003). http://www.digitalpreservation.gov/about/NSF.pdf.

[5] CAMiLEON Project, http://www.si.umich.edu/CAMILEON/. See: BBC Domesday: http://www.si.umich.edu/CAMILEON/domesday/domesday.html

[6] Council on Library and Information Resources, *Building a National Strategy for Digital Preservation: Issues in Digital Media Archiving*. (CLIR, Washington, D.C., 2002). http://www.clir.org/pubs/abstract/pub106abst.html

[7] Mary Ide et al., "Understanding the Preservation Challenge of Digital Television," In *Building a National Strategy for Digital Preservation: Issues in Digital Media Archiving, Commissioned for and Sponsored by the National Digital Information Infrastructure and Preservation Program, Library of Congress, April, 2002, 67-79* (LOC, Washington, DC, 2002) http://www.clir.org/pubs/reports/pub106/television.html.

[8] PrestoSpace, Preservation Towards Storage and Access. Standardised Practices for Audiovisual Contents in Europe. http://www.prestospace.org/.

[9] Gary Marchionini, "Video and Learning Redux: New Capabilities for Practical Use," *Educational Technology*, 43(2), 36-41 (2003).

[10] Gary Marchionini & Gary Geisler, "The Open Video Digital Library," *D-Lib Magazine*, 8(12). (2002). http://www.dlib.org/dlib/december02/marchionini/12marchionini.html

[11] Paul Conway, Overview: "Rational for Digitization and Preservation," In *Handbook for Digital Projects: A Management Tool*

for Preservation and Access (Northeast Document Conservation Center, Andover, MA, 2000). http://www.nedcc.org/digital/dman.pdf.
[12] Brian Lavoie & Lorcan Dempsey, "Thirteen Ways of Looking at...Digital Preservation," *D-Lib Magazine*, 10(7/8). (2004). http://www.dlib.org/dlib/july04/lavoie/07lavoie.html.
[13] Dublin Core (DC) Metadata Initiative, http://dublincore.org/.
[14] METS. Library of Congress. Metadata Encoding & Transmission Standard (METS). http://www.loc.gov/standards/mets/.
[15] NLNZ. National Library of New Zealand (Te Puna Mâtauranga o Aotearoa). New Zealand Metadata Standards Framework – Preservation Metadata. (2003) http://www.natlib.govt.nz/files/4initiatives_metaschema_revised.pdf.
[16] PREMIS. "PREservation Metadata: Implementation Strategies." http://www.oclc.org/research/projects/pmwg/ and http://www.loc.gov/standards/premis/.
[17] Encoded Archival Description (EAD). Official EAD Version 2002 Web Site. http://www.loc.gov/ead/.
[18] Consultative Committee for Space Data Systems, "Reference Model for an Open Archival Information System (OAIS)" Blue Book. (January 2002). http://public.ccsds.org/publications/archive/650x0b1.pdf.
[19] Kenneth Thibodeau, "Building the Archives of the Future: Advances in Preserving Electronic Records at the National Archives and Records Administration," *D-Lib Magazine* 7(2) (2001). http://www.dlib.org/dlib/february01/thibodeau/02thibodeau.html
[20] OAIS Reference Model, "Definitions," 1-6 through 1-13.

Author Biographies

Helen Tibbo is a Professor in the School of Information and Library Science at the University of North Carolina, Chapel Hill. She teaches in the areas of archival and records management, and digital curation. As well as being a co-investigator on the VidArch project with Gary Marchionini, Cal Lee, and Paul Jones, Dr. Tibbo is co-principle investigator for the Mellon-sponsored Developing Standardized Metrics Project, and directs the NHPRC Electronic Records Research Fellowships.

Christopher (Cal) Lee is Assistant Professor at the School of Information and Library Science at the University of North Carolina, Chapel Hill, where he teaches classes in archives, records, management and collection development. His research interests include digital preservation, electronic records management and standardization. Lee is helping to lead an effort to design and built a long-term institutional repository at UNC. He has an MSI and PhD from the University of Michigan School of Information.

Gary Marchionini, Cary C. Boshamer Professor, School of Information and Library Science, UNC-Chapel Hill teaches courses in human-information interaction, interface design and testing, and digital libraries and heads the Interaction Design Laboratory (ils.unc.edu/idl) at SILS. He has had numerous grants or contracts from the National Science Foundation, Council on Library Resources, the National Library of Medicine, the Library of Congress, Bureau of Labor Statistics, Kellogg Foundation, and NASA, among others.

Dawne Howard is a master's student at the School of Information and Library Science at UNC, focusing on archival studies. She is currently President of the UNC Student Chapter of the Society of American Archivists (SCOSAA).

---

[1] Many thanks to the entire VidArch team who have assisted with this research: Paul Jones, Sanghee Oh, Terrell Russell, Yaxiao Song, and Gary Geisler.

[2] The Open Video team includes Ron Brown, Gary Marchionini and Yaxiao Song, School of Information and Library Science at the University of North Carolina – Chapel Hill, and Gary Geisler, School of Information at the University of Texas.

[3] In the current workflow, the Open Video team discards the large .mov file after they have generated the five smaller derived formats.