

**Streaming in Digital Libraries:  
A Survey of Current Trends and Applications  
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**Abstract:** *Streaming technology provides great potential for digital libraries to increase access to their specialized video and audio collections over the Internet. In a descriptive survey, eight current adopters of streaming technology who provide Internet access to oral history, video and music collections express positive experiences with the technology. They highlight a wide number of challenges to implementation, such as cost and complexity, but recommend streaming as feasible and beneficial for other digital library collections incorporating sound and video. Two digital library respondents who do not use the technology convey a strong belief in its potential, yet highlight numerous institutional barriers to its adoption. Little scholarly writing is available on the topic, leading to many areas of future study, including more detailed case studies of the current adopters, the impact of streaming on students, and a more robust survey of digital libraries that do not currently use streaming.*

**Introduction**

Audio and video streaming<sup>1</sup> allows content designers to deliver voice, music, and video on-demand to users. The use of streaming for commercial delivery of audio and video services is growing, a trend that is expected to increase as more consumers access broadband telecommunications services in their home, school and/or business (Broadband Worldwide 2004). Many universities provide streaming services, often in the form of capacity on university-owned and operated streaming servers. Professors are

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<sup>1</sup> Streaming involves the digitization, editing, compression, and transcoding of audio and video files into streaming format for delivery on the Internet. Streaming allows users to access large video and audio files almost instantly at a steady stream, rather than downloading them. For background reference on the technology and processes involved, see "Streaming Audio and Video on the Web."

adopting streaming technologies, notably for distance learning and off-campus delivery of lectures and course-materials (Bouthillier). It seems logical that streaming would be incorporated into digital libraries for access to special audio and video collections.

However, a search in November 2004 of Digital Library Federation member collections, the Library Lit database, Google, Singing Fish, and selected digital libraries revealed only nine academic libraries that were using video and audio streaming to provide access to their special audio and video collections. On the one hand, it is virtually impossible to isolate digital libraries with streaming files, and such a search is not expected to return a complete list of all digital libraries that contain streaming files. At the same time, several possible reasons for the limited use of streaming were hypothesized by the author, such as the cost of the technology; the trouble of creating the music and audio content for the files; the complexity of digitizing, compressing, and formatting the files for streaming; the additional complications of making such files accessible to visual and hearing impaired patrons; the difficulty of obtaining required copyright permission for all files; and the time involved for all the above issues.

The same search yielded very little writing on the use of streaming in digital libraries. Background information on streaming technology is plentiful (Morris; StreamingMedia.com; “Video Streaming”), and many how-to articles and streaming tutorials are available on the Web (Kennedy; “Streaming Audio and Video”). The scholarly literature on the Internet is dominated by technical papers that describe new engineering advances in streaming (Google Scholar). A handful of studies describe

streaming applications or the potential use of streaming in universities (Klaas, Rohmann). Only a few items were found in the academic database, Library Lit, including one case study on streaming in digital libraries (Bond, Streaming Audio).

### **Digital Library Streaming Survey**

This aim of this research was to discover the major trends and issues involved in the adoption of streaming for use by digital libraries. Because so little has been written on the topic – the use of streaming to improve access to academic libraries’ digital and video collections – this paper relies on primary research. The nine academic digital libraries that were found to include video and/or audio streaming were contacted to find out how satisfied they are with their end product, issues they overcame, and plans to use (or not to use) streaming in the future. Five academic libraries with notable activities in digital library development that currently do not use streaming were contacted to find out their potential plans to use the technology in the future and the reasoning behind their decision-making. A group of six outside experts was also sent a survey to determine their thoughts on the potential growth of streaming for use within academic digital libraries. The survey, which included broad, open-ended questions, was designed as a tool for observational research that would yield qualitative findings. The exploratory nature of the results lends itself to future areas of study.

E-mail and oral interviews were received and/or conducted with seven of the digital libraries providing streaming, and two digital libraries that do not currently use the technology. No usable surveys were received from the outside expert category.

For this paper, the feedback from the surveys was analyzed to uncover trends on how streaming technology was adopted for use within these digital libraries, including the libraries' choice of streaming formats, e.g. Quicktime, Real Networks (Real), Windows Media, and MPEG; and whether current adopters believe the benefits outweigh the difficulties of implementing streaming files, including "lessons learned" and recommendations for use to other digital libraries. Hopefully, this paper can serve as a blueprint for other organizations who are exploring the use of streaming. Not all information from the surveys could be included, so a full-text copy or transcript of each interview is provided in Appendix A.

Following is a list of the organizations, names and titles of survey participants, a brief description of their streaming applications, and an abbreviation for the organization used in this paper; Figure 1 lists the web sites where their streaming projects can be viewed: The British Library Sound Archive (Richard Ranft, Head of Technical Services, The British Library Sound Archive; music and sound collections; BL), Indiana University's Digital Library Program (John Dunn, Associate Director for Technology, Indiana University; music from Hoagy Carmichael Collection; IU), Library of Congress' American Folklife Center (John Barton, Program Officer, American Folklife Center, Library of Congress; various audio and video collections from the American Memory Project; LOC), Oxford University Library Services (Richard Gartner, Pearson New Media Librarian, Oxford Library Services; not using streaming; Oxford), Stanford University: Digital Library Project (Andreas Paepcke, Senior Research Scientist and

Director, Digital Library Project, Stanford University; not using streaming; Stanford), University of North Carolina: Documenting the American South (Todd Cooper, Research Assistant, Digitization Services Section, Documenting the American South, University of North Carolina; oral history; UNC), University of Virginia: Digital Media Lab (Michael Tuite, Head, Digital Media Lab, University of Virginia; audio and video of selected special collections; UVA), Vanderbilt University: Television News Archive (Marshall Breeding, Library Technology Officer, Jean and Alexander Heard Library, Vanderbilt University, video streaming of news collection; Vanderbilt), and Washington State University Libraries: Manuscripts, Archives, and Special Collections (Trevor James Bond, Special Collections Librarian, Manuscripts, Archives, and Special Collections, Washington State University Libraries; oral history; WSU).

**Figure 1: Digital Streaming Survey: Respondents' Web Sites**

American Memory from the Library of Congress

<http://memory.loc.gov/ammem/>

Black Oral History Collection (Washington State University)

<http://www.wsulibs.wsu.edu/holland/masc/xblackoralhistory.html>

The British Library Sound Archive (The British Library)

<http://www.bl.uk/collections/sound-archive/nsa.html>

Documenting the American South (University of North Carolina)

<http://docsouth.unc.edu/>

The Hoagy Carmichael Collection (Indiana University)

[http://www.dlib.indiana.edu/collections/hoagy/intro/collec\\_high/2.html](http://www.dlib.indiana.edu/collections/hoagy/intro/collec_high/2.html)

Robertson Media Center Digital Media Lab Portfolio (University of Virginia)

<http://www.lib.virginia.edu/clemons/RMC/DML/portfolio.html>

Vanderbilt Television News Archive (Vanderbilt University)

<http://tvnews.vanderbilt.edu/>

## **Streaming Format Choices**

Survey respondents were asked which of the major streaming formats they use to determine whether one format is dominant in the use of streaming to provide Internet access to academic digital library collections. Four formats were cited: Quicktime, Real, Windows Media, and/or MPEG (MPEG-3 and MPEG-4). Currently, five are using Real, two Quicktime, and two MPEG.<sup>2</sup> However, one Real adopter is switching to Windows (Ranft), and another would select a different format if he could do it over again (Dunn). There were a wide variety of levels of satisfaction with the particular formats. Standards-based formats were highlighted as having a negative impact. Each format elicited praise from at least one developer, although Real and Windows Media received criticism from a number of respondents.

LOC's Barton cites advantages of both Quicktime and Real. "American Memory serves both Real Media and QuickTime versions of videos," he writes. "The small files sizes of Real Media files support quick playback and relatively little storage space although QuickTime video quality is better. Players for both formats are readily available."

IU's Dunn disagrees that the player for Real is easily obtained, and believes other technologies are gaining ground with what used to be Real's technological superiority. "Real makes it very difficult for users to find and download the free RealPlayer application, in comparison with Apple's QuickTime Player or Windows Media Player, and audio codecs have certainly evolved since 1999 [when IU chose Real]." As a result,

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<sup>2</sup> The Library of Congress uses three formats: Quicktime, Real and MPEG.

he believes IU would select a different technology if he were to make the original purchase decision today.

BL's Ranft concurs that other formats are surpassing Real. "We used Real because of these issues: quality, player availability, secure delivery (no downloads), ability to deliver multiple bitrates in a single file," he says. "We are changing to Windows Media because we believe it does all of these better, and the players are bundled with all modern PCs."

"We won't touch Windows Media," counters UVA's Tuite. "That's a horrific platform. They change constantly and have no qualms about abandoning formats. We maintain a Real server, but that's growing a little old. The server is very expensive: \$10,000 for 100 simultaneous users. If you read the license, you can install the Real Player for free or at home. If you want to install it on dozens or hundreds of computers, you have to pay them and it's not inexpensive. We've stepped back from Real. Most of the stuff we run comes off of a QuickTime or Darwin server. Most of it these days is in MP4."

Vanderbilt's Breeding, on the other hand, gave Real high marks for widespread user acceptance. "We did market research, and it appeared that the [Real] format was one the one supported by the most end users, [with plug-ins] already installed in their systems," he explains. "We wanted to select one rather than support several [systems] to make life cheaper and easier for ourselves. MPEG 4...wasn't stable or well-adapted enough to be considered."

The proprietary standards underlying some of the formats, like Real, were cited as areas of concern, although Bond feels Real's benefits outweigh this disadvantage. "In the library world, one's always hesitant to use a proprietary standard like Real Audio," says WSU's Bond. "In this case the functionality of it and benefits outweighed that dilemma."

"As a library, we're very interested in standards," says UVA's Tuite. "The Real and Windows Media format don't come near to adhering to standards. With Quicktime, we can use MP4, and we're encouraged that MP4 has established itself as an open standard."

UNC's Cooper extols the benefits of MPEG-3 (MP3). "It is a ubiquitous and universally supported format, can be streamed, and has facility for embedding metadata and other information in the file itself, including transcripts, etc.," he explains. "MP3 is a bit bigger than Real files, but has superior sound quality. Additionally, Real seems to be losing market share and support; this caused concern about longevity of the format."

### **Pros and Cons of Streaming**

The survey respondents illustrate a multitude of benefits that arise from using streaming to provide access to video and audio collections, including the ability of users to start viewing large files almost immediately (Dunn, Paepcke, Ranft), increased access (Breeding, Tuite), increased interactivity (Bond, Breeding), relative ease of setting up (Dunn, Ranft), relatively good quality of video and audio (Breeding, Ranft), copyright

protection through the inability of users to download files (Breeding, Gartner),<sup>3</sup> ability to better represent a person (Bond), relative ease of use for users (Gartner), no need for large storage space on client side (Paepcke), ability to meet varying user connection speeds by changing variable bit rates from the same file (Ranft), and stability/reliability of the technology (Breeding).

Vanderbilt's Breeding describes a number of the benefits streaming offers for digital library applications. "It provides reasonable access to audio-visual materials. It's interactive. It's what people like to look at for things like TV and film. It's the only way to recreate that experience. It's one of the few ways to provide access to that kind of material," he says. "You can distribute it on CD or DVD, but that would provide access that is not nearly as immediate....Streaming technology is stable and reliable – it's not new or experimental these days."

WSU's Bond emphasizes the increased activity with users that streaming provides, particularly in the context of a classroom tool that provides a full range of multimedia and documentation on a theme or subject. "One of the pros when you mix in audio and video streaming along with other resources such as images and text, is that it provides a greater level of interaction," he says. "I am interested in, and we worked on, the Columbia Basin project. That site provides a good example of how you can take various media in a digital library and package and arrange it to provide useful tools for classroom

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<sup>3</sup> The list of pros and cons for this section was obtained from the specific question "*What are the pros and cons of using streaming in a digital library?*" In the case of the copyright issue, Breeding reiterated its benefit to prevent downloading in another section of the text.

exercises to get context of an ethnic group – to hear and see and read primary resources that relate to that ethnic group. The real benefit is the intimacy of the past that you don't get any other way.”

He also highlights streaming technology's ability to “capture” a person through the use of oral histories. “We're doing a project where we're going to have audio from notable campus figures who have died,” he says. “For alumni, it's a real link to their past, and for future generations to capture the quality of the person you can't get any other way.”

The ability to use streaming to prevent users from downloading audio and video files, and thus protecting copyright licenses, was repeated in several of the interviews. Two respondents, however, refer to new streaming recorders that no longer prohibit users from copying such files (Cooper, Ranft). “At one time [streaming files] offered some security, but now there exist applications to capture streams and record them,” says Cooper.

The list of disadvantages when implementing a streaming system was also wide-ranging. It included expense (Breeding, Cooper, Dunn, Ranft, Tuite), overall difficulty/complexity (Breeding, Bond), need for much greater server capacity (Gartner, Tuite), recent inability to protect copyright infringement (Cooper, Ranft), quality of playback tied to user's network connection speed (Dunn), difficulties in client software installation/configuration/troubleshooting (Dunn), problems caused by network firewalls and routers (Dunn), difficulty of maintaining streaming servers (Paepcke), multiplicity of standards (Paepcke), and multiplicity of formats (Ranft).

The difficulty of establishing and maintaining a streaming system was highlighted by WSU's Bond. "It's a multi step process, and as I found, when you start working on these digital projects, it's a whole new area of collections," describes WSU's Bond. "You develop and they require all the same things, like preservation, upgrading and other things. And when you have a lot of them and have something like a software change or redesign how the site functions, it turns into a pretty large task."

The number one complaint, expense, is summarized by UVA's Tuite. "Digitization of audio and video and its availability on the web is a pro. The con is expense. I and the people who work with me don't come cheap. The equipment is reasonably expensive; the software is expensive; storage is expensive. I have high bandwidth and hard disk space requirements. I want 250 Gigs in a server, and that's expensive."

### **"Lessons Learned"**

The "lessons learned" by the respondents provide useful insights for those evaluating streaming technology. Not surprisingly, there was very little overlap in the answers, since each respondent's experience is so different. The "lessons" fluctuate from specific suggestions on file management to general guidelines, such as the need to accommodate rapid technological innovation.

WSU's Bond reminded others to obtain user consent agreements for oral histories. "One of the big lessons is in the practice of oral history collections in general. We have a

terrific collection of Asian-American oral histories, talking about internment issues. But it was done just before things like consent forms were regular. We don't have good enough documentation to publish the collection on the Internet," he says. "This goes back to basic library practices. If you ever want the opportunity to do an interesting digital project, make sure you have permissions and copyright and bedrock paperwork in place."

UNC's Cooper discusses the need for a clear understanding of the capital expenditures. "Infrastructure and additional resources are necessary for deployment of streaming media," he underscores. "A dedicated streaming server is required." Another piece of information that can help others is the "number of open source projects available for streaming without the encumbrance of license fees (icecast, shoutcast, etc.) SMIL, while a W3C standard, is not necessarily the best choice for streaming multimedia presentations. It has problems across platforms."

BL's Ranft offers succinct counsel on file management: "Always keep master files for future re-encodings to different formats, because the format of choice today will be superseded tomorrow."

Others, like Vanderbilt's Breeding, describe an overall sense of success. "We're fairly happy with the outcome, and don't have any second thoughts about what we've chosen," he says. "We think Real Media is a decent format, but we know it won't last forever. We're happy with the systems we built to deliver the video. The rate of productions for digitizing and transcoding is even higher than expected."

UVA's Tuite provides longer range advice on the need to find standards-based products, better serve uses, and react to change. "Don't rely on Windows Media to maintain a consistent format from year to year, and the same with Real. Stick with the standards like MPEG," he proffers. "Lesson 2, be aware of your audience, the speed of their connection, and what they need the video to do. Lesson 3, be prepared to change every two years. The video that I did two years ago is laughable. As bandwidth and machine speeds improve, I can deliver better video, and it's going to make the stuff I did some time ago look not nearly so good. Create a system that will allow you to update periodically."

### **Respondents' Recommendations**

Overall, the respondents who are using streaming were overwhelmingly positive about its use. Seven planned to use streaming for additional applications or projects, and one (Barton) said the use of streaming would remain the same. All eight recommended streaming to other digital libraries, with a variety of qualifications. The two respondents who do not currently use streaming described institutional barriers that would need to be overcome before streaming would become more prevalent in digital libraries.

LOC's Barton recommends streaming for access, but not necessarily preservation. "It depends on the way the files will be used," he says. "If the intent is to provide quick and easy access for web users, streaming media works well. For archival purposes higher quality formats might be preferable. Although the Library utilizes this technology a high quality archival version of each file is created."

For oral histories, WSU's Bond believes streaming provides unique advantages. "I think it adds something that you don't get from just putting up transcripts. For collections of spoken words, like the Michigan State project, it is a really tremendous feature. Even poorer libraries like us can do it. A lot of libraries have either the exact same toolset or something similar, so it isn't unreachable. If you need to work on the collections anyways, it doesn't take that much longer to convert the files into digital format; or, if you have an active oral history project, it's not that much more work to stream it than it is to fully process the collection. It's just one more step that adds a lot of value."

Vanderbilt's Breeding believes it is the only viable solution for distributing video and audio. "If you're talking about video and audio, then what else is there?" he asks. "If you do want to make it available, I would recommend this as an approach. The considerations are the cost of the infrastructure, and the legal ability to serve it out without violating copyright. The latter is probably more often a consideration than the former."

UNC's Cooper "absolutely" recommends streaming to other digital library developers. "Streaming is still important as broadband networks, despite their rapid proliferation, are not yet ubiquitous. It also serves as a layer of protecting intellectual content, though there are a growing number of tools for capturing and recording streams."

"[It] depends on a library's needs," qualifies BL's Ranft. "Streaming is useful to reduce the risk of unauthorized use of media files, an issue which may not be important to some."

It is also useful for previewing files that may be downloadable later in another format. We do not usually use live streaming for broadcasts but may do so in future.”

UVA’s Tuite recommends the technology, as well as his organization’s streaming procedures. “I think the way we’ve gone about it -- everything from logging our analog captures and storing on DV-CAM tape, and being able to recapture and recompress automatically -- I think it’s a system that works well, and recommend that other people go about it in a similar fashion. It seems sustainable, cost effective, and as a library with increasing numbers of digital assets, it’s also standards-based.”

Institutional barriers, however, are preventing the greater use of streaming in more additional libraries, according to the two respondents who currently do not use the technology. Oxford’s Gartner believes “more interest in the library community in video and audio, possibly kick-started by more use of both in teaching,” is needed to spur greater adoption of the technology. Stanford’s Paepcke describes a number of cost and philosophical barriers, as well. “I suspect that it will still take a while for video streaming to be wide-spread in non-commercial DLs. Storage, while getting cheaper and cheaper, can still be an issue for chronically underfunded public institutions,” he says.

“Another problem is intellectual property,” he continues. “Neither the music nor the movie industry seems willing to invest creative thinking into the use of streaming technology. Rather than participating, they choose to use legal means to obstruct progress in that area. I do believe they will eventually have to find a more intelligent attitude in

this regard. There is precedent for this: Once the movie industry finally lost their law suits against VCRs, they stumbled into a huge business: video rentals. Given the industry's present inability to look ahead, I think there might be a delay before public DLs can start to offer full services," he concludes.

### **Future Areas of Study**

The survey yields useful insights into the current use of streaming by eight academic digital library developers to improve access to their audio and video collections. This paper analyzed their responses to questions on choice of format, pros and cons of streaming, lessons learned, and recommendations for use. Additional information from the surveys was not utilized. In this regard, unused information from the transcripts, along with new details found from follow-up questions, could be employed to construct detailed case studies of each organization's use of streaming. The case studies could serve as models for streaming in digital libraries, and provide background and impetus to other organizations considering the adoption of streaming. Another area of future study would be to analyze the impact of streaming on students' educational performance, and verify whether learning outcomes are being met through streaming. In addition, a more robust survey of digital libraries who are potential candidates to adopt streaming could be conducted to determine how widespread knowledge of the technology is, whether more libraries plan to utilize streaming, and which collections will be streamed or would be the most likely candidates for streaming. Such research efforts would help uncover future trends and applications of a technology that, according to the respondents of this initial

survey, is well-suited for delivery of and access to Internet-based video and audio for innovative educational applications.

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Singing Fish. 8 Nov. 2004 <<http://www.singingfish.com/>>. Singingfish is a unique search engine for audio and video streaming files.

The Stanford Digital Libraries Project. Stanford U. 10 Nov. 2004 <<http://www-diglib.stanford.edu/>>. The Stanford Digital Libraries Project goal is to "is to design and implement the infrastructure and services needed for collaboratively creating, disseminating, sharing and managing information in a digital library context." The many projects featured on its web site reflect this aim.

"Streaming Audio and Video on the Web." Academic Technology Center, Cornell University. 10 Nov. 2004 <<http://www.cit.cornell.edu/atc/materials/streaming/index.shtml>>. This is a great online tutorial that teaches you how to stream audio and video. Don't forget to check out the references for more information at <http://www.cit.cornell.edu/atc/materials/streaming/refs.shtml>. These comprise useful information on how to create, digitize, edit, compress, and convert files for streaming.

StreamingMedia.com. 8 Nov. 2004 <<http://www.streamingmedia.com/>>. Streaming Media's aim is "to help streaming media companies build the second-generation Internet by supplying

the community with unparalleled information online.” Although vendor-driven, the site provides some useful information on the streaming industry’s trends, developments and issues.

Tuite, Michael. Telephone interview. 3 Nov. 2004. Michael Tuite, Head, Digital Media Lab, University of Virginia, illustrates the important role of streaming for both classroom curricula and public digital library collections. Check out the Lab’s sample of sites, some of which include streaming, at

<<http://www.lib.virginia.edu/clemons/RMC/DML/portfolio.html>>.

Vanderbilt Television News Archive. Jean and Alexander Heard Library, Vanderbilt U. 11 Nov 2004 <<http://tvnews.vanderbilt.edu/>>

“Video Streaming.” Academic Technologies, U of Iowa. 10 Nov. 2004

<<http://at.its.uiowa.edu/digimedia/webvideo.shtml>>. This web page contains an informative chart comparing the characteristics and benefits of video downloads, progressive downloads, and streaming on the Web.

**Appendix A:  
Digital Library Streaming Surveys  
Transcripts of E-mails and Interviews  
(organized alphabetically by last name of participant)**

**John Barton, Program Officer, American Folklife Center, Library of Congress  
(e-mail interview; 11/04/04)  
<<http://memory.loc.gov/ammem/>>**

*Why did you decide to use streaming?*

Streaming media is useful to many American Memory users, particularly those who still connect to the internet via telephone modem. Since streaming files don't need to be completely downloaded before playing they can be viewed much more quickly than conventional files. Please note that American Memory websites typically serve 3 formats of each video in order to satisfy our users many different needs. Real Media, QuickTime, and MPEG are used.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

American Memory serves both Real Media and QuickTime versions of videos. The small files sizes of Real Media files support quick playback and relatively little storage space although QuickTime video quality is better. Players for both formats are readily available.

*What technological hurdles did you overcome?*

Software tools to create derivatives and edit video needed to be selected; Adobe Premiere is used for QuickTime files and Helix Producer is used for Real Media. Disc space to store the large files has to be planned for and acquired.

*How heavily used are your streaming files?*

I am not aware of statistics we have regarding usage of streaming video versus non-streaming, however, I would imagine that the streaming files are more widely used than the non-streaming files.

*Would you recommend this technology to other digital libraries? Why or why not?*

It depends on the way the files will be used. If the intent is to provide quick and easy access for web users, streaming media works well. For archival purposes higher quality formats might be preferable. Although the Library utilizes this technology a high quality archival version of each file is created.

*What are the pros and cons of using streaming in a digital library?*

See response to question above.

*Do you plan to use more streaming applications for your digital library projects in the future? Why or why not?*

At this time the applications we are using are sufficient. If new and improved applications become available they might possibly be used.

*Please provide your thoughts and satisfaction level with the use of streaming in your digital library.*

Streaming media is an effective way to make American Memory files available to a wide range of users.

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**Trevor James Bond, Special Collections Librarian, Manuscripts, Archives, and Special Collections, Washington State University Libraries**  
(oral interview; 11/03/04)

<<http://www.wsulibs.wsu.edu/holland/masc/xblackoralhistory.html>>

*Why did you decide to use streaming?*

At the time that we did that project [Black Oral History], it was a heady period of experimentation. We were looking at ways to develop our digital collections to include a variety of formats that would better represent our holdings. We had done mainly photograph collections and maybe a few manuscripts, just completed a dynamic map project. But it was essentially coffee with my colleague AI. We were talking about music reserves and the possibility that we could use our already purchased RealAudio Helix server to stream audio.

There's a certain cool factor, but to me what is most interesting and what I like to do best of all is to have the digital surrogates as close to full research quality as possible. With our early Washington maps project (<http://www.wsulibs.wsu.edu/holland/masc/xmaps.html>), you can browse the maps and if you see an area of interest, can zoom and see the finest details. This is what makes it a truly useful collection. Often when I see oral history sites on the web, I find a collection description, maybe a transcript or abstract, but it's nothing like hearing someone's actual voice. That's why streaming audio with that type of collection was so appealing.

*How hard or easy was it to get funding for the project? How was the project funded?*

The IMLS grant provided a couple of thousand dollars. Some of the work we just absorbed internally. We had our graphic designer, a young guy who knows about online music -- he found some good streaming tools and just had a sense of how to do the first part. We knew how to do the second part through my colleague in systems, one of his other jobs is that he coordinates digital reserves, a subset includes music that's streamed online. It's password protected. Students can log in for courses. His background provided the expertise for the second piece. So we have encoded audio and streaming ability. The project was funded with some external funds, but it was kind of a conglomerate of external and internal funds for some temporary help. It was not totally externally funded.

Although we're doing that now with a new project, a WSU oral history, with the class of '54 donating money, and this will be totally done with those grant funds.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

We're going to go along the same model [Note: the use of Real Media Networks, as described in Mr. Bond's article listed under "Works Consulted"] I tried to bring this out in my article. In the library world, one's always hesitant to use a proprietary standard like Real Audio. In this case the functionality of it and benefits outweighed that dilemma. For the so-called archival copy, we'll keep it in that .wav, uncompressed format so down the road if we decide to switch formats, we can convert that file into a different format. There are other issues, too. Since the .wav file is uncompressed, it really is a monster file. You can have that pure file in a tiny snippet or convert it to something else that is more functional in terms of performance.

*What technological hurdles did you overcome?*

There's a dilemma that I faced. I think it's indicative of these projects: How do you get the best quality audio? I've heard some complaints from a colleague about the quality of the encoding, but the original sound file is really bad quality, and you can't really overcome that. It was a good project, since a lot of our oral histories are on poor audio tapes that are going to deteriorate. If you have deteriorating things, the expectation is that it will sound better, but it's hard to overcome that low initial quality.

*What are the most important lessons you learned in implementing streaming?*

One of the big lessons is in the practice of oral history collections in general. We have a terrific collection of Asian-American oral histories, talking about internment issues. But it was done just before things like consent forms were regular. We don't have good enough documentation to publish the collection on the Internet. This goes back to basic library practices. If you ever want the opportunity to do an interesting digital project, make sure you have permissions and copyright and bedrock paperwork in place.

*Would you recommend this technology to other digital libraries? Why or why not?*

I think it adds something that you don't get from just putting up transcripts. For collections of spoken words, like the Michigan State project, it is a really tremendous feature. Even poorer libraries like us can do it. A lot of libraries have either the exact same toolset or something similar, so it isn't unreachable. If you need to work on the collections anyways, it doesn't take that much longer to convert the files into digital format; or, if you have an active oral history project, it's not that much more work to stream it than it is to fully process the collection. It's just one more step that adds a lot of value.

*What are the pros and cons of using streaming in a digital library?*

One of the pros when you mix in audio and video streaming along with other resources such as images and text, is that it provides a greater level of interaction. I am interested in, and we worked on, the Columbia Basin project. That site provides a good example of how you can take various media in a digital library and package and arrange it to provide

useful tools for classroom exercises to get context of an ethnic group -- to hear and see and read primary resources that relate to that ethnic group. The real benefit is the intimacy of the past that you don't get any other way.

We're doing a project where we're going to have audio from notable campus figures who have died. For alumni, it's a real link to their past, and for future generations to capture the quality of the person you can't get any other way.

The cons: It's a multi step process, and as I found, when you start working on these digital projects, it's a whole new area of collections. You develop and they require all the same things, like preservation, upgrading and other things. And when you have a lot of them and have something like a software change or redesign how the site functions, it turns into a pretty large task.

*Do you plan to use more streaming applications for your digital library projects in the future? Why or why not?*

That's going on right now. This next round is going to be really nice, since we're going back to do retrospective conversion of earlier oral history collections and going out and doing new ones. We're going to have transcript text stream at the same time as the audio so you can see it as well as hear it.

*Please provide your thoughts and satisfaction level with the use of streaming in your digital library.*

I tend to go out on the road a fair amount and talk to donors and have fundraising meetings. It's a nice way to highlight unique collections in a special collection. I did one of these classes to alumni and students recently, and I could really highlight our collections. It's a tremendous way to do outreach. The downside, you are only going to reach a portion of your audience in that not everyone has fast enough connections or good quality machines, but as technology improves those problems will be less so.

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**Marshall Breeding, Library Technology Officer, Jean and Alexander Heard  
Library, Vanderbilt University  
(oral interview; 11/12/04)  
<<http://www.library.vanderbilt.edu/>>**

*What type of streaming projects do you have at Vanderbilt?*

We have a number of streaming projects. One of our major initiatives is the Vanderbilt Television News Archive <<http://tvnews.vanderbilt.edu/>>, a unit of the library that makes significant use of streaming technology. We have an archive of off-air news that we've been creating since 1968 -- a library of 40,000 hours of video, which we're in the process of digitizing. The video is made available internally through streaming. Pieces of it are streamed to subscribers of the service. It's a fee-based service based on streaming video. These two different [types of] users are entitled to different things. For on-site users,

we're able to stream anything we have, especially to our archives staff. For subscribers outside of Vanderbilt, the limitation is they can only get the CNN portion from 1995 forward. We have an agreement [with CNN] to provide streaming access for that. With the other networks, we haven't signed that kind of agreement. These are contractual relations related to copyright.

*Why did you decide to use streaming?*

As opposed to what else? If we wanted to provide access to a video collection, streaming video is the appropriate way to do that. We could have non-streaming access in the form of downloadable files. But the streaming benefit is that there's more controlled use, and it does not allow users to download files, which is part of our legal requirement. We have to preclude downloading, and that makes it safer from a copyright point of view.

*How hard or easy was it to get funding for the project? How was the project funded?*

The streaming was not in itself something that was more or less difficult [to be funded]. We had to obtain funding for the infrastructure and the project to digitize the collection. We did this through a series of grants from the National Science Foundation, the National Endowment for the Humanities, and a local foundation that's anonymous. The funding for the streaming was a component of all of those.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

We selected Real Media. We did market research, and it appeared that the [Real] format was one the one supported by the most end users, [with plug-ins] already installed in their systems. We wanted to select one rather than support several [systems] to make life cheaper and easier for ourselves. MPEG 4... wasn't stable or well-adapted enough to be considered.

*What technological hurdles did you overcome?*

There were several things that had to be done. We didn't invent anything new. But we had to set up 14 Terabytes of storage for our media servers, and install and configure the Real Media server. This is part of a larger project that interfaces with our current database system. So, we had a great deal of programming done to create linkages between the database and the video clips. Then, there is the digitizing of the videotape and off-air material into MPEG; and, we set up a large-scale, automated system to transcode the MPEG into Real Media.

*What are the most important lessons you learned in implementing streaming?*

We're fairly happy with the outcome, and don't have any second thoughts about what we've chosen. We think Real Media is a decent format, but we know it won't last forever. We're happy with the systems we built to deliver the video. The rate of productions for digitizing and transcoding is even higher than expected.

*How heavily used are your streaming files?*

We're currently seeing 1,000 to 2,000 requests for video files per month, for both internal users and [outside] subscribers. The use is modest, in my mind, so far.

*Would you recommend this technology to other digital libraries? Why or why not?*

If you're talking about video and audio, then what else is there? If you do want to make it available, I would recommend this as an approach. The considerations are the cost of the infrastructure, and the legal ability to serve it out without violating copyright. The latter is probably more often a consideration than the former.

*What are the pros and cons of using streaming in a digital library?*

It depends on what you're comparing it to. The pros: It provides reasonable access to audio-visual materials. It's interactive. It's what people like to look at for things like TV and film. It's the only way to recreate that experience. It's one of the few ways to provide access to that kind of material. You can distribute it on CD or DVD, but that would provide access that is not nearly as immediate. We do offer a fee-based service to get material to users on videotape or DVD, but it takes a couple of weeks. Streaming technology is stable and reliable – it's not new or experimental these days.

On the negative side, you have the cost and complexity of establishing the service. It's not necessarily a negative, just something that has to be done.

*Do you plan to use more streaming applications for your digital library projects in the future? Why or why not?*

We have others already. The Voices of Vanderbilt <<http://lib11.library.vanderbilt.edu/diglib/voices-search.pl>> uses streaming audio to provide access to oral histories about the history of Vanderbilt. We have an audio reserves project for the Blair School of Music library. We have an audio reserves project to provide access to assignments that are commercial recordings needed for classroom use. We have pieces of music made available [through streaming].

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**Todd Cooper, Research Assistant, Digitization Services Section, Documenting the American South, University of North Carolina**  
**(e-mail interview; 11/15/04)**  
<<http://docsouth.unc.edu>>

*Why did you decide to use streaming?*

It sort of chose us. Ibiblio <[ibiblio.org](http://ibiblio.org)> is our host, and they provide streaming with Icecast. Streaming offers some advantages, such as allowing the user to begin playing back the content while the files download. At one time they offered some security, but now there exist applications to capture streams and record them.

*How hard or easy was it to get funding for the project? How was the project funded?*

We are currently in the process of writing a grant proposal to IMLS for a grant to continue the project beyond its pilot stage.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

We are using the WAVE format for our preservation or safety copy, which will be stored on CD-R. For our deliverables, we are using MP3. It is a ubiquitous and universally supported format, can be streamed, and has facility for embedding metadata and other information in the file itself, including transcripts, etc. MP3, is a bit bigger than Real files, but has superior sound quality. Additionally, Real seems to be losing market share and support; this caused concern about longevity of the format. At issue with MP3 is that it has been a licensed format since 1998. This may cause problems in the future. But, open formats such as Ogg Vorbis are becoming more popular and better supported.

*What technological hurdles did you overcome?*

We are overcoming tech hurdles every day. Well, at least confronting them. One was support. We depend on our host for services.

At first we thought that ibiblio only had an rtsp server, which may have placed constraints on our choices. But, as it turns out, they have an rtsp enabled server that allows for a wider variety of options than we first thought. So, infrastructure plays a vital role.

Our greatest challenges now are in affixing metadata and timestamps to audio files so that they can be searched more effectively. We are investigating a variety of solutions for this. Currently we are looking at some open source tools that allow us to affix timestamps and metadata manually. This is very time consuming and may not scale well, but it will yield a richer product. Also, we are looking for the most effective ways of presentation of this material. In particular, synchronizing transcript text with audio.

There are storage and architecture issues as well. Lossless WAVE files are too large to store on a Web or file server, so will be stored on CD-R.

Storage of MP3s--should they be put in the relational database or stored in the document tree? We chose not to store them in the database, as this seemed to confer no advantages.

*What are the most important lessons you learned in implementing streaming?*

Infrastructure and additional resources are necessary for deployment of streaming media. A dedicated streaming server is required. Streaming is useful for multimedia presentations, and in some cases necessary.

There are a number of open source projects available for streaming without the encumbrance of license fees (icecast, shoutcast, etc.) SMIL, while a W3C standard, is not necessarily the best choice for streaming multimedia presentations. It has problems across platforms.

*How heavily used are your streaming files?*

This project is still in its pilot phase and has yet to see real use.

*Would you recommend this technology to other digital libraries? Why or why not?*  
Absolutely. Streaming is still important as broadband networks, despite their rapid proliferation, are not yet ubiquitous. It also serves as a layer of protecting intellectual content, though there are a growing number of tools for capturing and recording streams.

*What are the pros and cons of using streaming in a digital library?*

Pros

Streaming offers some improved access to users on low-bandwidth networks.

Cons

Streaming no longer offer any assurance of protection of intellectual content.

Requires additional infrastructure to deploy.

Can be potentially exorbitant.

If outsourcing hosting, less control.

*Do you plan to use more streaming applications for your digital library projects in the future? Why or why not?*

We are investigating ways that we might extend our offerings through streaming media. We are very interested currently in delivering most of our content through a browser rather than through media players. We have access to a number of options through our host, including Real, Darwin server/QuickTime, etc. that we'll be looking at as we further develop the project.

*Please provide your thoughts and satisfaction level with the use of streaming in your digital library.*

As we haven't yet deployed the project, we aren't yet ready to say how well it will work for us...

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**John Dunn, Associate Director for Technology, Digital Library Program, Indiana University**

**(e-mail interview; 11/03/04)**

[http://www.dlib.indiana.edu/collections/hoagy/intro/collec\\_high/2.html](http://www.dlib.indiana.edu/collections/hoagy/intro/collec_high/2.html)

*Why did you decide to use streaming?*

We decided to use streaming to provide online access to rare or unique sound recordings from the Hoagy Carmichael Collection at Indiana University, alongside visual and textual materials from the collection such as photographs, correspondence, sheet music, music manuscripts, and a variety of other formats.

[The number of files currently available for Internet streaming in the Hoagy Carmichael Collection is 17. About 350 files are available for on-campus streaming, and we plan to make more of those available for Internet streaming in the near future. *From follow-up e-mail 11/03/04.*]

*How hard or easy was it to get funding for the project? How was the project funded?*  
The Hoagy Carmichael Collection project was funded by a National Leadership Grant from the Institute of Museum and Library Services.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

For this project, which was done in 1999, we chose Real, because at the time, it was the most prevalent media player out there, and its audio compression scheme produced the least number of artifacts from the source material we had (mainly old 78 RPM records). We also tried QuickTime (QDesign Music Codec). We did not evaluate Windows Media, because at the time, it did not support Macintosh clients.

If we were doing the evaluation again today, we might end up with a different choice. In particular, Real makes it very difficult for users to find and download the free RealPlayer application, in comparison with Apple's QuickTime Player or Windows Media Player, and audio codecs have certainly evolved since 1999 (with other formats emerging such as MPEG-4 AAC).

*What technological hurdles did you overcome?*

Specifically talking about the streaming portion of the project, the main technological hurdle was finding an audio encoding that worked over modems but did not introduce excessive artifacts in the audio from the pops, clicks, and other noise present on the original recordings.

*How heavily used are your streaming files?*

For the Hoagy Carmichael Collection, we get several hundred accesses per month. We have plans to place significantly more recordings from the collection online at some point in the near future, at which time we expect use to go up some more.

*Would you recommend this technology to other digital libraries? Why or why not?*

Yes, if they have audio or video to make available to remote or local users, and streaming offers sufficient quality for the intended use.

*What are the pros and cons of using streaming in a digital library?*

If you are talking about streaming vs. downloading for providing access to audio and video files:

Pros for streaming: allows user to start listening/viewing immediately, provides some protection against copying, relatively easy to setup

Cons for streaming: quality of playback is limited by the user's network connection, difficulties in client software installation/configuration/troubleshooting, problems sometimes caused by network firewalls and routers, cost of streaming server software (for some technologies, i.e. Real)

*Do you plan to use more streaming applications for your digital library projects in the future? Why or why not?*

Yes, we already have several other projects that use audio and/or video streaming:

Variations digital music library production system:

<http://www.dlib.indiana.edu/variations/>

Variations2 digital music library R&D project: <http://variations2.indiana.edu/>

EVIA Digital Archive: <http://www.indiana.edu/~evia/>

We are also conducting a pilot test of a video electronic reserves service, using QuickTime and Real streaming technologies.

*Please provide your thoughts and satisfaction level with the use of streaming in your digital library.*

I don't have much more to add to my responses above. Overall, we are satisfied with our use of streaming technologies in digital library projects.

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**Richard Gartner, Pearson New Media Librarian, Oxford University Library Services**

**(e-mail interview; 11/17/04)**

<http://www.odl.ox.ac.uk/>

*Do you plan to or have you considered using streaming files in any of your digital library projects?*

Not at present.

*Which of your projects are most suitable for this application?*

Any future video or audio projects, but there are none planned at present.

*What are the pros and cons of using streaming in a digital library?*

Pros: Greater security against downloading and misuse is prime consideration, easier for user than downloading if equipment is powerful enough:

Cons: higher server capacity required.

*What hurdles must be overcome to implement streaming in your digital library?*

More interest in the library community in video and audio, possibly kick-started by more use of both in teaching.

*Do you think this technology would be beneficial to your patrons? Please describe.*

Undoubtedly, once the materials have been added to our digital collections.

*Do you think we will see more use of streaming in digital libraries in the near future?*

*Why or why not?*

Definitely - see [www.emol.ac.uk](http://www.emol.ac.uk) a national project to stream video.

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**Andreas Paepcke, Senior Research Scientist and Director, Digital Library Project,  
Stanford University**  
(e-mail interview, 11/05/04)  
<<http://www-diglib.stanford.edu/>>

*Do you currently use streaming in any of your projects? Is so, which ones?  
If not, why not?*

We don't work with audio/video. Ours is a research project on technologies that might one day benefit DLs. However, we have (or at least used to have) about three 15-minute videos online that show user interfaces that we constructed.

We do use streaming in a different sense: We crawl many millions of Web pages throughout the year. Other researchers around the world can stream that content over at high speed to perform large-scale analyses. (Look for 'Stanford Webbase' on Google).

*What are the pros and cons of using streaming in a digital library?*

Pro: - Much faster start of large-content display: it would take a long time to first download a video and only start playing it in the end.

- Receiving client does not need storage space for a whole movie. The player can display the content and throw it away without using much disk space.

Con: - Still difficult to maintain streaming servers

- Last I looked there were several standards

*What hurdles must be overcome to implement streaming in your digital library?*

Again, we are a research project, not an operating digital library.

Even for us, though, video streams would be great for our user interface demonstrations. Somebody has to produce these videos, though, which is very time consuming.

In a functioning DL I would love access to training videos, like car repair, electrical home wiring, etc.

*Do you think we will see more use of streaming in digital libraries in the near future?  
Why or why not?*

I suspect that it will still take a while for video streaming to be wide-spread in non-commercial DLs. Storage, while getting cheaper and cheaper, can still be an issue for chronically underfunded public institutions. Particularly as trillions of dollars are pumped into a war that we started.

Another problem is intellectual property. Neither the music nor the movie industry seems willing to invest creative thinking into the use of streaming technology. Rather than participating, they choose to use legal means to obstruct progress in that area.

I do believe they will eventually have to find a more intelligent attitude in this regard. There is precedent for this: Once the movie industry finally lost their law suits against VCRs, they stumbled into a huge business: video rentals.

Given the industry's present inability to look ahead, I think there might be a delay before public DLs can start to offer full services.

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**Richard Ranft, Head of Technical Services, The British Library Sound Archive**

**Link to Collection:** <http://www.bl.uk/soundarchive>

**(e-mail interview; 11/02/04)**

[<http://www.bl.uk/collections/sound-archive/nsa.html>](http://www.bl.uk/collections/sound-archive/nsa.html)

*Why did you decide to use streaming?*

Desirable for delivery of audio and video files over www: the web user hears (or sees) the files almost immediately, regardless of connection bandwidth and file size.

*How hard or easy was it to get funding for the project? How was the project funded?*

Funded as part of The British Library's website development, from internal funds.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

We use Real. We are about to switch over to Windows Streaming Media.

We used Real because of these issues: quality, player availability, secure delivery (no downloads), ability to deliver multiple bitrates in a single file. We are changing to Windows Media because we believe it does all of these better, and the players are bundled with all modern PCs.

*What technological hurdles did you overcome?*

Installation and testing of encoder software, server and its server software, webpage encoding, batch encoding.

*What are the most important lessons you learned in implementing streaming?*

Always keep master files for future re-encodings to different formats, because the format of choice today will be superseded tomorrow.

*How heavily used are your streaming files?*

Typically 20,000 streams per month.

*Would you recommend this technology to other digital libraries? Why or why not?*

Depends on a library's needs. Streaming is useful to reduce the risk of unauthorized use of media files, an issue which may not be important to some. It is also useful for

previewing files that may be downloadable later in another format. We do not usually use live streaming for broadcasts but may do so in future.

*What are the pros and cons of using streaming in a digital library?*

Pros: fast delivery; DRM management; fairly good quality; variable bitrates from single file; simple to encode and publish

Cons: set-up costs including training; no single streaming format satisfies all users; new capture software defeats the download prevention

*Do you plan to use more streaming applications for your digital library projects in the future? Why or why not?*

We plan to use more.

*Please provide your thoughts and satisfaction level with the use of streaming in your digital library.*

We are fairly satisfied, although some users have complained to us about our choice of a particular streaming format.



**Michael Tuite, Head, Digital Media Lab, University of Virginia  
(oral interview; 11/03/04)**

<http://www.lib.virginia.edu/clemons/RMC/DML/portfolio.html>

*How many projects at UVA utilize streaming?*

There are a lot of projects that involve streaming material, both audio and video. Of the projects that include multiple clips, there are 20 sizable ones that involve streaming video or audio. We also help students and faculty place small files on their own accounts. We are the library -- we deal with the digitization of resources. But the lab I head is a resource for the entire university. So I might have an engineer, architect, classics professor, American Studies student digitizing something, and we're here to help them. A lot of digitization that we do is not collection oriented.

*Why did you decide to use streaming?*

We have so much of that material. The UVA library includes the Robertson Media Center with a 20,000-item video collection—among libraries, this is a really big size collection. Audio and video have been part of our collections for a long time before I ever got here. It was natural to want to distribute that material on the web. Part of that is that we work closely with faculty, and many of them who use those audio and video materials want to use them in the classroom, and don't want to haul a VHS tape to class.

We have two classes of streaming projects. Many you won't see because they're curriculum-based and use copyright-protected materials. In some respects, those projects have propelled us furthest along, because they've been based on the demands of faculty.

Publicly-accessible projects—such as the Tibet and Civil Rights TV [digital libraries] — we own and manufacture that material ourselves, and we can share it.

*How hard or easy was it to get funding for the project? How was the project funded?*  
By and large, they're not funded. Most of our curriculum-based projects – for example, “Viewing America” is a big course by Prof. Brian Balogh, which uses many videos. You can't see that, because it employs a lot of copyrighted materials under fair use provisions, but we don't dare open that up to the public. Civil Rights Television -- that is a project we've worked on with the Virginia Center for Digital History. They've gotten some funding. Essentially, we provide the hardware, software, and expertise, and they're paying for the labor. Ultimately the stuff is labor intensive.

In the case of the Tibet project, the video and audio are just one aspect of a very large project, which has funding from many sources, including the Education Department, State Department, NEH, and many others. None of that money goes into our projects. We don't charge anything.

Some things come from our own collections. Civil Rights TV -- we acquired the film from WSL in Roanoke, and we digitized it as part of our collection. We're digitizing it in conjunction with VCH and they hired a graduate assistant for digitizing the film.

We use material from Films from Humanities and California Newsreel, and we have negotiated digital licenses, which traditionally have distributed on VHS. We have permission to digitize them, put them online and make them available to the university community. We're paying more money for these licenses. We're doing the work as part of our collection building effort. William Faulkner taught here in the late 50s. We're digitizing those [tapes] over time, but there's no grant money. We absorb the cost of that.

Sometimes money comes in. We look for money for all different aspects, and we may use it to buy hardware and software, and really we don't charge anyone. If someone has a large collection of video materials, they're going to need to find someone to do the routine digitization. They'll find some kind of funding. They can pay a student. We'll teach them what to do.

Right now I'm working on the Explorations in Black Leadership Project, which are films generated here at the university. I'm working with a faculty member who is paying to have these interviews conducted and have a student do the digitization, but that's going into our collection.

*Which format, e.g. Real, Quicktime, Windows Streaming Media, MP4, did you select and why? Which format do you think is best?*

We use MP4 wrapped up in QuickTime. We won't touch Windows Media. That's a horrific platform. They change constantly and have no qualms about abandoning formats. We maintain a Real server, but that's growing a little old. The server is very expensive: \$10,000 for 100 simultaneous users. If you read the license, you can install the Real Player for free or at home. If you want to install it on dozens or hundreds of computers,

you have to pay them and it's not inexpensive. We've stepped back from Real. Most of the stuff we run comes off of a QuickTime or Darwin server. Most of it these days is in MP4. As a library, we're very interested in standards. The Real and Windows Media format don't come near to adhering to standards. With Quicktime, we can use MP4, and we're encouraged that MP4 has established itself as an open standard.

*What technological hurdles did you overcome?*

Probably the biggest hurdle is often the end user. Not because people are stupid or bad, but because it's so difficult to cater to the lowest common denominator. You have video: Do you prepare it so it's accessible to the T1 user as well as the 56 k user? If so, do you send out multiple streams? Or, one stream that only the slowest will get and the high users are cheated? Or, do you send it at just the high data rate and the low end people just don't get it. Increasingly, our projects are destined for the outside world. I can't put out the data rate that I could if I knew it was just going to go out here at the university, and I can't ensure the quality of the experience at the other end.

Another problem is that people...have firewalls that won't allow streams through. They don't have QuickTime installed. To get video to 20 people, you wind up talking to 15 of them on the phone just to make sure they can get the stream.

*What are the most important lessons you learned in implementing streaming?*

Don't rely on Windows Media to maintain a consistent format from year to year, and the same with Real. Stick with the standards like MPEG. Lesson 2, be aware of your audience, the speed of their connection, and what they need the video to do. Lesson 3, be prepared to change every two years. The video that I did two years ago is laughable. As bandwidth and machine speeds improve, I can deliver better video, and it's going to make the stuff I did some time ago look not nearly so good. Create a system that will allow you to update periodically.

*How heavily used are your streaming files?*

That's a really good question. I should know, but I don't. But, last year, at Apple's Expo, as a big surprise to us, there was the UVA's library listed as a leading QT user.

*Would you recommend this technology to other digital libraries? Why or why not?*

I would. I think the way we've gone about it -- everything from logging our analog captures and storing on DV-CAM tape, and being able to recapture and recompress automatically -- I think it's a system that works well, and recommend that other people go about it in a similar fashion. It seems sustainable, cost effective, and as a library with increasing numbers of digital assets, it's also standards-based.

*What are the pros and cons of using streaming in a digital library?*

Pros: access. At UVA's library, the emphasis definitely is on access as opposed to preservation. We want our materials out and useful, and we work with faculty in the development of media in the curriculum. Digitization of audio and video and its availability on the web is a pro. The con is expense. I and the people who work with me don't come cheap. The equipment is reasonably expensive; the software is expensive;

storage is expensive. I have high bandwidth and hard disk space requirements. I want 250 Gigs in a server, and that's expensive.

*Please provide your thoughts and satisfaction level with the use of streaming in your digital library.*

We continue to hone our technical approach. We've gotten better at it. The class "Viewing America" I mentioned earlier is a big class, 300 plus. The bandwidth to that classroom last year was terrible. I was at every lecture pulling my hair out. Sometimes I had to bring the videos on CD. Sometimes the satisfaction by the users is not what I would like it to be. It's the exception. Networking frustrations can certainly influence the satisfaction level our users get, but by and large students are happy they don't have to come in and view things, and teachers are highly satisfied having access to the video they shot of Pompeii on the web.