

Prelude to a Digital Music Library at the Pennsylvania State University

Networking Audio for Academic Library Users

Amanda Maple and Tona Henderson

The three significant factors in planning and implementing a digital music initiative are infrastructure, collections, and human resources, with a fourth factor, funding, affecting all decisions. By examining these issues it is possible to describe the Penn State experience in the initial stages of creating a digital music library and offer suggestions and experiences that may assist others in planning, developing, and evaluating a similar service. The benefits of digitizing the music collection include increased access and the potential for enhanced preservation. At Pennsylvania State University, collection decisions have been based on course-related needs.

Music audio materials (compact discs, long-playing records, and cassette tapes) are used by music faculty and students daily throughout the academic year for classroom teaching, study, and research. Students are assigned to listen to and study dozens of specific music works every semester to meet course objectives in music, and these recordings are traditionally placed on course reserve in the library by music faculty. Students must come to the library to listen one at a time to recordings housed physically in the library. Faculty must come to the library to borrow each recording they need to use in the classroom, and immediately return the recordings to the library so their students can study them. Additionally, faculty are limited to using classrooms equipped with playback equipment for sound recordings.

Providing access to these assigned music works over the Internet enables faculty to use the music during classroom teaching from any classroom with a computer and an Internet connection, and also to use the assigned music while working with students individually or in small groups in their offices. Students can study the assigned music from computer labs, dormitory rooms, and homes off campus, or at computers in the library. Most importantly, students and faculty are not limited to listening during regular library hours. Providing audio music information over computer networks also makes possible distance education courses in music that until now have been impractical.

Amanda Maple (a2m@psulias.psu.edu) is Head, Arts and Humanities Libraries, and **Tona Henderson** (tah6@psu.edu) is Head, Gateway Library, at Pennsylvania State University, University Park.

Manuscript received November 1, 1999; accepted for publication February 25, 2000.

Building a Digital Music Library

Our use of the term “digital music library” implies networked access to a digital music audio collection, with or without related visual images and text-based information, developed for and accessible to a defined user community from all desired end-user locations. While there are many issues involved with the creation of a digital music library, three emerge as both critical and comprehensive: infrastructure, collections, and staffing. Pervasive within all three categories is the question of funding. In this report we focus on these issues, using the format of a general discussion followed in each case by a description of our experience at Penn State University.

By examining these issues, we can describe the Penn State experience in the initial stages (the “prelude”) of creating a digital music library and offer suggestions and experiences to assist others in planning, developing, and evaluating a similar service. Within the context of this examination, it is also possible to imagine new applications and future directions, thus balancing the practicality of today’s implementation with the promise of tomorrow’s potential.

A review of the literature, both print and Web-based, uncovered no published reports of similar projects other than Indiana University’s VARIATIONS project (Dunn and Mayer 1999), though informal discussions with music librarians at several institutions indicated that similar projects are underway across the country.

Infrastructure

At a minimum, the technological infrastructure of an online music library consists of servers, clients, network hardware and software, and some type of audio player. Client-server machines communicate with each other in a very specific way based on a query-answer model. Clients query while servers answer. In any networked environment, two or more computers are linked via wires (coaxial, fiber, and so forth) or wireless (that is, antennae) connections while a specialized operating system coordinates the communications between all the computers on the network. Network connectivity is desirable if distributed access is a goal. For an online music library, it is essential that all client machines contain an audio-player software package, sound card, and speakers or headphones.

In addition to the minimum required digital infrastructure, additional hardware and software are required to actually create digital materials from recordings and scores. These devices and associated software are most often considered specialized peripherals and vary widely in cost depending on a variety of factors. Conversion projects are rarely easy and digital music libraries are associated with a

number of traditional problems, such as learning curves for operating scanners and encoders, conversion error, and equipment failure.

Inputs and outputs of the digital music library require storage and delivery capacities that often exceed previous experiences in digitizing print collections. A typical four-minute music audio track equates without compression to about 40 megabytes of data. Although newer computers routinely sport 1 to 3 gigabytes in disk storage, these capacities can be quickly consumed by even a small digitization project. Symphonies are typically 30 to 60 minutes long, and operas can be several hours long. File size, end-user computer processing capability, and network speed all affect the speed of data delivery. Inadequate delivery speed can result in long download time and breaks in audio delivery.

There are many questions to be answered at the outset of a networked digital audio project, including network size and available local technical support. The question of whether to compress files, and if so, what techniques to use is directly related to the quality of audio desired and delivery speed requirements. Most music audio files are large, requiring significant storage space and download time, and the use of compression techniques is highly desirable if not necessary. Answers to these questions help determine decisions about hardware and software.

The questions of who will be able to access the music and whether users will be able to download any of the music files are primarily driven by copyright issues. If the music audio being considered for digital networking is protected by copyright, then restricting access to the audio files is usually a requirement. Options include filtering by IP address, using proxy servers, requiring password access, and restricting by physical location of the network (to a single room in the library, for example, or a single building or campus). Copyright protection sometimes has the practical effect of not allowing downloading if there is not technology in place to disallow further forwarding or use of the music from the downloaded file. Some streaming technologies enable the delivery of networked audio while preventing end-user downloading capability, but may not provide CD-quality audio.

Rapid innovation in digital audio technology and competition in the market offers planners many options for proprietary software, but requires care and attention to questions about the longevity of any particular program or file format. Planning for the digital music library must include access to the appropriate audio player on all end-user computers. At present, proprietary systems for the creation and playback of digital audio files are in competition for the market and their players in some cases do not play file formats created by another proprietor’s capture software. Though in the future it is possible that proprietary players will play each other’s file formats, for now planners

must choose one system and make it accessible to end-users either by physically loading it on each end-user's computer or by providing instructions to end-users to do this themselves. A decision must also be made about who pays for the player: the end-user or the audio provider. Most proprietary systems offer downscaled versions of their players for free.

Local Infrastructure Problems and Solutions

The Digital Music Library at Penn State was implemented in 1998 using RealNetworks streaming technology, server, and production software. Choosing among proprietary software brings the risk of creating a collection that will some day be unusable without expensive migration efforts. We considered several factors, including the software's current popularity and the ability of the campus to host it. Penn State's Library Computing Services maintains the server and provides storage space with regular backups for the audio files. The Digital Music Library home page explains that users need a sound card and RealPlayer software, and instructs them to download the RealPlayer (a free version is available) from the RealNetworks Web site. Only institutional IP addresses can access the audio files, and the audio is streamed in real time; end-users cannot download the audio files. Users access the audio files from computers on campus connected to the server via the campus local area network (LAN) and from computers off campus via modem and dial-in connections.

Network audio quality is directly related to the network connection's bandwidth, or amount of data capable of being sent through the network connection in a given time: the higher the bandwidth, the better the audio. The campus network has a higher bandwidth than off-campus modem connections. Therefore, two choices of audio files are offered for each selection of music: a file captured for transfer over an ISDN (integrated services digital network) connection with an approximate bandwidth capability of 112 Kbps (kilobits per second), and a file captured for transfer through a modem capable of handling approximately 28.8 Kbps or higher. This dual capture process doubles staff production time but offers high quality audio for on-campus use while providing the convenience of admittedly lower-quality off-campus access when needed. Informal feedback from users indicates that they use and now expect to have both types of access.

When the Digital Music Library was first implemented, public computers in the University Libraries were not equipped with sound cards and audio players. Thus, users were unable to listen to the audio files inside the library buildings. Not all computer labs on campus provided the necessary hardware and software, and Digital Music Library staff personally researched which computer labs provided

computers with sound cards and audio players and mounted this information on the home page. Because LAN upgrades around campus and computer purchases for faculty are often the responsibility of individual colleges or departments, some faculty experienced access problems associated with inadequate end-user processing speed. These problems have been resolved with installation in the library of public computers equipped for audio access and upgrading of the campus LAN. We also know, however, that as we plan new services, we will have to inform those who are responsible for computer equipment in computer labs and colleges of baseline hardware and software requirements.

Instructors who assigned use of the Digital Music Library found themselves fielding questions in class about problems accessing the audio files. Providing a feedback form and a problem-report form from each page of the Web site has allowed instructors to refer all questions and problems to these forms, which are sent directly to the music librarian. Access problems and questions generally relate to IP filtering, remote authentication, improper installation of the player software, and inability to download the audio files.

Collections

Library collections are the basis on which library services are provided and are the second issue discussed in creating a digital music library. The benefits of digitizing the music collection include increased access and the potential for enhanced preservation. Academic music libraries often address the special needs of their fragile and hard-to-replace recording collections through restrictive access measures such as special circulation procedures, limited physical access in listening rooms, and denial of interlibrary lending. However, in spite of the value of these measures for collection preservation, questions arise about their effect on the use of the collection. Conversion to digital format, while problematic, minimizes damage from physical use while simultaneously improving access. With a virtual format, there is no scratching or breaking of the materials in the traditional sense. And, as an added bonus, appropriate network connections and computing resources enable multiple simultaneous uses of a single resource as well as remote access, allowing users to study the music even when they are unable to make a trip to the library or when the library is closed.

As for information in any format, copyright is a primary consideration in the selection of recorded music for digitization. Providing access to a digital copy of copyrighted music audio in the context of an electronic course reserves service can be in compliance with copyright law. The Music Library Association (1999) "supports the creation and transmission

of digital audio file copies of copyrighted recordings of musical works for course reserves purposes" as long as access is: "through library-controlled equipment"; restricted to campus networks or authenticated remote users; provided only to music being taught in the course and only for the duration of the course; and the copies are made from legally acquired original sound sources. Other aspects of digitizing music, such as enhancing access to music audio outside of the electronic reserves context through hyperlinks embedded in the library's online catalog, are not covered by this statement. Designers of digital music libraries should address within their individual institutions whether to invoke exemption under fair use when providing such enhanced access in an educational setting.

Though digitization offers the promise of long-term preservation of audio, that promise has not yet been realized. As Smith (1999, 4) notes, "much is gained by digitizing, but permanence and authenticity, at this juncture of technological development, are not among those gains." Magnetic tape is an inherently unstable medium of storage, and proprietary software and hardware necessary to read digital information can become obsolete, requiring regular migration of digital information from medium to medium and consequent potential loss of data. However, as mentioned above, short-term protection of sound recordings is achieved through digitization by lessening the need for multiple users to handle the original sound sources.

Local enhancements that add value to the original sound source further improve the usability of the collection. By incorporating supplemental materials, the digital music library emerges as something more than a one-to-one transcription of audio. These supplemental materials might take the form of composer biographies, critical analysis of the music, discussions of music theory, or information accompanying the original sound sources (such as liner notes). Taking it one step further, associated materials can be synchronized at playback; for example, the "pages" of a scanned score can be "turned" automatically in synchronization with the audio. Complementary materials correlated in this way can enhance the learning experience by providing a combined visual and auditory experience. For example, at Penn State a professor has used the Digital Music Library while teaching an introduction to the study of music for first-year students to demonstrate notational and performance practice issues in baroque music. Sample pages from different editions of a work of baroque music were scanned and made accessible along with the audio to demonstrate in the professor's lecture differences between the notation in the score and notes the performers actually play in this improvisatory style, as well as different editors' approaches to editions of the same music.

Retrieval of music in the library's collection can also be enhanced by linking from the online catalog's bibliographic

descriptions directly to the digitized audio. A consequence of such enhanced access might well be increased use of the collection by students and faculty. Dunn and Mayer (1999, 17) report heavy use of Indiana University's digital music library, VARIATIONS. Their statistics show that, "when given a choice, students are using VARIATIONS rather than traditional materials" and "are listening to far more sound recording titles than they did using traditional formats."

Local Collection Problems and Solutions

At Penn State, selection decisions have been based on course-related needs. This has been an appropriate focus because it meets the most important need as expressed by music faculty and students. Also, we found digitizing the music assigned in music courses has taken up all of the staff time available to date for this project and we have no capacity at this time to go beyond course-related needs. Our efforts to comply with copyright law include the use of streaming technology in which download capabilities are disabled; IP filtering and remote authentication through a secure server; providing access to music assigned in courses only for the duration of the course during the semester it is taught; and digitizing only items the library has purchased and added to the collection. Future collection projects could include digitization of special collections such as those on 78-rpm records and oral histories on cassette tape, and exploring the potential for collaboration with collegiate faculty in the development of distance learning courses in music. If available in the future and affordable for libraries, online commercial sound recordings legally available for networking would obviate both conversion and copyright issues.

Staffing

People involved with the creation and availability of a digital music library include not just music librarians and staff but also computer technical support personnel, other public service staff, senior administrators, collegiate faculty, and students. In general, these staffing and attendant issues can be organized along the lines of the inputs and outputs of a digitization project.

Digitization of library music materials is time-consuming and thus expensive. Training music staff to operate specialized peripherals requires additional time and access to specialists who have the requisite expertise to conduct the training. Technical support from library support units (such as computer teams) can involve lengthier response times for assistance because of inexperience or lack of familiarity with the equipment involved, thus presenting another training

need. Senior library administrators often provide outset funding and organizational support for digital music initiatives. As such, their role as one of the human inputs in a digital music initiative is crucial. Finally, since conversion and creation projects are expensive and time-consuming, selection of these projects is often based on faculty input. It is not possible or desirable to digitize for the sake of digitization. Faculty input insures a relevance and value to the project not present in mass conversions.

Once digital music materials are converted, their availability and use becomes a responsibility of reference staff in reference interactions at the desk, via e-mail or telephone, and in general as well as music locations. While many librarians and staff are familiar with the basics of a Web browser, identifying materials and troubleshooting retrieval of digital music collections involves an additional level of expertise. As the output point of contact for a digital music project, the reference desk staff must know about all the issues involved with retrieval including network infrastructure, variations in access methods, sound cards and audio players, and local cataloging conventions and points of access. While technostress emerged several years ago as a byproduct of increasing automation activities within the library, music librarians and staff appreciate the additional dimensions of technostress created by the addition of digitized sound.

Staffing Problems and Solutions at Pennsylvania State University

Audio capture has been accomplished to date with a single personal computer equipped with RealNetworks production software and a sound card connected physically to audio source devices (CD player, turntable, cassette player, and DAT player) and networked for transfer of files. The project director trains staff to: capture audio at different encoding levels; name the audio files according to local filenaming procedures; create text files that RealAudio uses to point from HTML hyperlinks to the audio files on the RealServer; and create Web access to the audio files using HTML. Funding from research and special project grants from the Dean of the University Libraries has staffed the project in its initial stages. When time allows, staff are also trained to scan scores and create synchronized audiovisual files that allow users to read the digitized scores while listening to the music. Staff maintain a database that tracks items digitized, their filenames, course numbers and titles, and semester used. Required qualifications for staff include a strong music background and knowledge of HTML and Web page design. Technical support is provided by Library Computing Services.

At Penn State, staffing levels are a primary concern. The university is a complex organization pursuing an elec-

tronic agenda that includes projects and initiatives on several fronts. Coordinating a digital music project with other university or library initiatives requires significant time and frequently influences decisions of the music librarian on this project as well as in general collection development. We have learned that incorporating an organizationwide view of the present and future networking capacity and capacity for digitization is important for fully leveraging the computing infrastructure into music library priorities and activities.

Reception of this service by faculty and students has been extremely positive, and the potential for enhancing learning and developing new distance learning initiatives motivates us to explore ways to reallocate permanent staff hours to this project in lieu of future grant funding. This project is in its infancy and we are still learning how much staff time is required to keep up with digitizing the assigned music for courses in each semester. Impending improvements in technology will almost certainly reduce the staff time now needed for capture and synchronization although implementing new technological developments is a time commitment for project planners.

Conclusion

As more classrooms are equipped with computer and projection equipment, the potential for collaborating with collegiate faculty to enhance teaching and learning in the classroom is significant for music courses and other courses in the arts and humanities in which audio is becoming increasingly important (for example, history, language, communications, and integrative arts). As more institutions implement music digitization projects, the potential exists for consortial digital music collections that could be the basis for collaborative distance learning courses with faculty from different institutions. The potential also exists for sharing the work of digitization among institutions, though this would require working out differences in platforms, file formats, delivery mechanisms, and copyright issues.

Enthusiastic response and increasing demand for this new service from faculty and students indicate that Penn State's beginning effort to create a digital music library has been worth the investment. We are fortunate to have strong interest in and support for the project from our Library Computing Services, who make available the server, storage space, and excellent technical support. At Penn State, the university and library administrations are both highly supportive of exploring ways to use technology to enhance learning, and a technological infrastructure was already in place that contributed to a successful outcome.

We learned through this initiative that creation and maintenance of a digital music library is time-intensive on an ongoing basis and requires either external funding or reallo-

cation of existing human resources within the institution (in our case, both) to make sustained service possible. It demands top-notch technical support and a project manager interested in learning the details of capturing and making accessible the audio files, working within an institution that values such work and therefore makes it possible for the project manager to devote time to the work. We learned to involve permanent staff as early as possible in the process of creation of the new service rather than to rely heavily on part-time workers. We also learned to separate the work of capturing from creation of HTML for access, as the two activities can be done by different people with different skills at different times.

It was a surprise to us that many students love the off-campus access and use the service at all hours of the day and (especially) night. With increasing demand for this service, we consider the possibility that in the future digital music libraries in academic institutions might provide networked

access to music audio from a variety of sources, including in-house capture, consortial projects among institutions, and networked files purchased or licensed from commercial vendors.

Works Cited

- Dunn, Jon W., and Constance A. Mayer. 1999. VARIATIONS: A digital music library system at Indiana University. In *DL '99: Proceedings of the fourth ACM conference on digital libraries*, 12–19. New York: ACM. Also available at www.music.indiana.edu/variations/VARIATIONS-DL99.pdf (Accessed October 26, 1999).
- Music Library Association. 1999. Statement on the digital transmission of electronic reserves. Accessed October 26, 1999. www.musiclibraryassoc.org/Copyright/ereserves.htm.
- Smith, Abby. 1999. *Why digitize?* Washington, D.C.: Council on Library and Information Resources.