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RUNNING HEAD: **MANAGING METADATA INTEROPERABILITY WITHIN AUDIO PRESERVATION FRAMEWORK**

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Abstract

This study investigates the management and interoperability of metadata within audio preservation frameworks. With the intention to harvest all descriptors contained in multichannel audio material semantically linked to bibliographic records, authority files, and other associated digital objects; the researcher attempt to incorporate XML, Dublin Core syntax, and the Metadata Encoding & Transmission Standard as a digital carrier to express stereophonic, multichannel source material, and related objects into a digital library audio collection.

Keywords: audio preservation, digital libraries, digital preservation, metadata-standards, metadata mapping, multimedia, sound archive, sound recordings

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As data consumers become more information literate and savvy, their expectations for value added content has motivated libraries and archives to provide customers with information more dynamically. One way this has been accomplished is by providing an assortment of hypermedia content and services electronically; including finding aids, digital images, video, and sound recordings. These digital libraries over time make up the collective charged with preserving a diverse array audio recorded histories; some examples include oral histories, music productions and performances, and broadcast. This collective includes content creators, publishers, private collectors, libraries and archives and may represent academic and commercial interest. Academic libraries and archives have been digitizing their music collections to aid music instruction and as a strategy towards audio preservation (Fenske & Dunn, 1996; Dunn & Isaacson, 2002; Indiana University; 2008; Maple & Henderson, 2000). Commercial interest and projects aim at building digital music libraries and services for profit (Davidson, 2001; Griscom, 2003). The common theme that unifies both public and private information organizations lies in the necessity to manage audio assets while providing resource discovery to customers. These tasks are accomplished through the creation, implementation, and exchange of various types of descriptive, structural, and administrative metadata.

This study investigates the management and interoperability of metadata within audio preservation frameworks. With the intention to harvest all descriptors contained in multichannel audio material semantically linked to bibliographic records, authority files, and other associated digital objects; the researcher attempt to incorporate XML, Dublin Core syntax, and the

Metadata Encoding & Transmission Standard as a digital carrier to express stereophonic, multichannel source material, and related objects for ingestion into a digital library audio collection.

Further research in bibliographic description, its semantic relationship between audio events and associative derivatives is warranted by the commonalty associated with risk management and the long term preservation of historic audio documents. Many information organizations have been increasingly faced with deteriorating sound objects and immediate actions are necessary to ensure future rendering. Quality digitization has proven to aid in preservation, but no evidence supports the notion that digitization alone is appropriate for audio preservation. To ensure the continued accessibility and validation of signifigent audio objects, special attention is needed to document its history, technical specifications, along with access through bibliographic control.

We will begin with an overview of the two primary digital carriers used during this project (BWF and METS); followed by a literature review covering sound preservation assessment, associated risk involved with audio preservation, discussions on the ethics associated with sound preservation, and conclude the review with a brief discussion on current findings and gaps in audio preservation frameworks. Methods used for this study and outcomes will be presented, and a discussion on challenges encountered and ideas about future research will be shared.

Context and Description

In order to execute this project, the need for two distinctive data carriers will be used to express audio content, its bibliographic information, and the semantic relationship between items

contained in the carrier. They are the Broadcast Wave Format and the Metadata Encoding Transmission Standard.

Broadcast Wave Format (BWF)

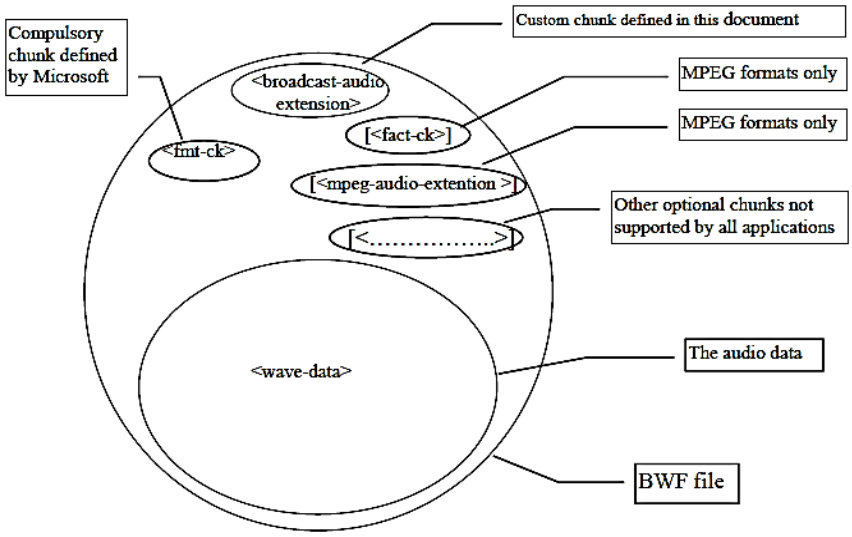

Figure 1: Components of a Broadcast Wave Format file Version 2.0

The Broadcast Wave Format (.BWF) is an extension of the .wav file extension that contains a limited number of core metadata elements essential for broadcast and archival actions. The specification was first introduced in 1997 as EBU Tech 3285 (EDU, 2011). It is based on the Resource Interchange File Format, developed by Microsoft for use with the Windows graphical user interface (Microsoft, 1994). The BWF consist of a series of data clusters referred as chunks and sub-chunks. It has been described as the fundamental building blocks of data types and contains an identifier and a value for its data size (Chalmers, 1997). BWF are also inoperable with legacy systems in which if the software does not understand any chunk in the file, it will simply ignore it and forward the chunk (p.3).

The raw audio data contained in a BWF is encoded in pulse code modulation (PCM). PCM is a modulation process in which an analog signal is digitally encoded as a series of pulses (Woram, 1982, p.495). The file consist of three primary chunk, the format chunk (fmt-ck), the data chunk (wave-data), and the broadcast-audio extension chunk (broadcast-audio chunk) with the option to add industry specific extensions such as the Fact-ck, and mpeg-audio-extension (EBU, 2011).

Fmt-ck

Fmt-ck is a sub-chunk that describes the format of the sound information in the data sub-chunk. This chunk is approximately 24 bytes and contains the fields: Sub-chunk ID, Sub-chunk Size, Audio Format, Number of Channels, Sample Rate, Byte Rate, Block Align & Bite per Sample (IBM, 1991).

Wave-data

Wave-data is another sub-chunk that stores the size of the sound information and it also contains the raw audio data. The first two fields' total 8 bytes and data sub-chunk contains the identification field, a size field, followed by the audio data (IBM, 1991).

Broadcast-audio extension

The broadcast-audio extension chunk provides additional fields, established as being essential in order to facilitate the exchange of content between broadcasters. This chunk contains the fields: Description, Originator, Originator Reference, Origination Date, Origination Time, Time Reference, Version, UMID, Loudness Value, Loudness Range, Max True Peak Level, Max Momentary Loudness, Max Short Term Loudness, a reserved field of 180 bytes for

future revisions, and Coding History field, containing a record of all actions applied to the audio object (EBU, 2011).

Metadata Encoding Transmission Standard (METS)

METS is a schema intended to encode the descriptive, administrative, or structural metadata of a digital item contained in a digital library system (http://www.loc.gov/standards/mets/). It emerged out of the Making of America II project, developed at University of California Berkeley (UC Berkeley, http://sunsite.berkeley.edu/MOA2/). A METS document is comprised of seven fundamental components: the METS Header; Descriptive Metadata; Administrative Metadata; File Section; Structural Map; Structural Links; and a Behavior section (Library of Congress, 2011).

METS header

In the METS Header fields, the most minimum descriptive metadata is entered about the object and may including date of creation, date of last modification, status, and documents rights, agents, their roles, including a note (Library of Congress, 2011).

Descriptive metadata

The descriptive metadata section, represented as <dmdSec> in a METS document, consists of one or many descriptive elements which contain reference to either an external metadata document or an internally embedded metadata element.

Administrative metadata

The administrative metadata section, represented as <amdSec> in a METS document, is used to reference technical information about a digital object including technical metadata; intellectual property rights metadata; source metadata; and information regarding the document source and destination relationship between files; and information regarding the reformatting of files. Each of these four types of administrative metadata has a unique sub element within the <amdSec> portion of a METS document in which that form of metadata can be encoded. They are represented as: 1. <techMD> (technical metadata); 2. <rightsMD> (intellectual property rights metadata); 3. <sourceMD> (source metadata and information regarding the document source and destination relationship between files); and 4. <digiprovMD> (information regarding the reformatting of files) (Library of Congress, 2011; 2013). All of the sub elements are repeatable in a METS document and also carry an ID attribute (Library of Congress, 2011).

File section

The File section, represented as <fileSec> in a METS document, is used to hold one or more "File Group" elements used together to cluster related files together (Library of Congress, 2011). File Groups list all associated files which make up a single electronic version of a digital library object. Within the File Group element, the physical location to the file is indicated by the <Flocat> element when file location is in the form of a URL (Gartner, 2002). For content embedded in a METS document, the <FContent> element should be used (Library of Congress, 2011).

Structural map

The Structural map, represented as <structMap> in a METS document, describes the outlining structure of an object and its logical relationship (Gartner, 2002). The structural map

purpose is to format structure of information contained in the divisions' element of a METS document for the end user. Each carries attribute information specifying the type of division, and may also contain multiple METS pointer (<mptr>) and file pointer (<fptr>) elements to identify content associated within a division element (Library of Congress, 2011).

Structural links

The Structural links section, represented as <smLink> in a METS document, is a repeatable element that documents hyperlinks between the division elements contained within the structural map (Library of Congress, 2011).

Behavior

The behavior sections, represented as <behavior> in a METS document, transcribes information on how components of a digital object should be rendered for its system user. The Library of Congress (2011) defines the behavior section as "a behavior section can be used to associate executable behaviors with content in the METS object" (http://www.loc.gov/standards/mets/METSOverview.v2.html). It also has a mechanism element represented as <mechanism>, which is used to point to a module of executable code that implement and runs the behavior defined abstractly by the interface definition (http://www.loc.gov/standards/mets/METSOverview.v2.html).

Literature Review

Many organizations are ever more concerned about the conditions of sound recording held across their collections. Harrison (1997) suggests that this urgency to preserve audiovisuals

item is warranted because of the uniqueness and by the possibility of it being the only record for many oral or sonic transmission of the cultures, arts, news, and other current items (p. 182). The rapid rate of deterioration in various analog electromagnetic tape carriers formats in particular, has been problematic, identified as unstable, threatens future access, and has been the topic of audio preservation and archival research (Canazza, 2012; Paton, 1998; Ward, 1990). Paton (1998) also alludes that magnetic tape types not only deteriorates over time, but sometimes catastrophically (p. 193).

State of Sound Preservation

Awareness campaigns through national discussion on the vulnerability and risk associated with losing historical and rare sound recording has prompted custodians of national and research collections to further develop policies, specialized training guidelines, and implement proactive preservation strategies (Ackerman & Lacinak, 2007; Council on Library and Information Resources et al., 2010; IASAA, 2005; Paton, 1998). Even though public awareness has been on the rise in regards to the preservation of historic sound recordings, evidence has shown that an increase in the demand for audio use in instruction and research within academic audio collections has increased, and many organizations still feeling the stress due to underfunding, and lack of trained personnel (Smith et al., 2004).

The size of the collection also poses challenges to the preservation of sound recordings. In a letter to the editor, Peggy Bulger, (2001) of the American Folklife Center at the Library of Congress; discussed the problem about audio preservation and found that “materials are deteriorating faster than they can be transferred to more stable media” (p. 626). In 2001, it was estimated that the Library of Congress had more than 2.5 million sound recordings (p. 626). The challenge of coping with the size of collections is also impacting organizations outside of North

America. In a survey of ten major European public service broadcast archives an estimated ten million hours of national material was at risk and the cost to preserve it is estimated well over one billion Euros (Wright, 2001, p. 47). These challenges are pinning collections holders against a tight window to migrate unstable and legacy audio carriers. Two factors that pose a threat to analog electromagnetic tape carriers are hardware obsolescence and hydrolysis.

Hardware obsolescence

Hardware obsolescence is an issue in the sound preservation community that has seen some attention (Théron, 2008). As equipment manufacturers, skilled technicians, and legacy analog playback devices disappear or become obsolete, the need for standards have emerged which enable the interoperability of audio objects between different environments and equipment (Boston, 1991; IASA, 2005). The use of a standard audio format such as the Broadcast Wave Format (BWF) standard has shown promise (EBU, 1997). The Broadcast Wave Format (BWF) standard was developed by the Digital Audio Production and Archiving Project Group, a working group of the European Broadcast Union in partnership with the audio industry. Their primary objective behind the development of BWF was to provide an environment where program material could be interchanged between audio workstations effortlessly (Chalmers, 1997). Once legacy audio content is digitized, the audio object can be easily managed in a digital mass storage system (Gil-Pita & et al., 2006).

Hydrolysis

Issues of hydrolysis in the sound preservation community are also threatening tape integrity in sound collections. Hydrolysis, more commonly referred to as *Sticky Shed Syndrome* refers to a chemical breakdown in analog tape binder (Arnaldo, 1991; IASA, 2009). In a discussion on the conservation of tape, Ward (1990) describe the characteristics of tape

hydrolysis by suggesting that "cellulose acetate backing is unsatisfactory in the long term as its formulation includes a plasticizer, which mean that it absorbs atmospheric moisture much more readily than polyester" (p. 174). Hydrolysis in collections has been documented outside of archives and the broader preservation field in general. In a discussion on preserving analog audio documents, Schüller (2001) investigates nitrate cellulose film commonly used by the film industry until the mid-1950s and argues that "eighty percent of all silent films and fifty percent of newer nitrate film are inaccessible" (p. 618). A loss of recorded history of this magnitude is not only problematic for preservationist, but it makes me wonder, just as Schüller and others before me; are these problems an indication to some bigger problems yet to be known within audio collections?

Characteristics of Audio Preservation Archives and Sound Recording Collections

In a study on the history of sound archives in the United States, Bucknum (2001) compares and contrast common characteristics identified in music library collections and sound archive and argue that sound archives are vital components to the preservation effort of local, national and international historical records (p. 382). In this investigation, Bucknum argued that sound collection in music libraries traditionally focused on western art music in support of music school pedagogy (Bucknum, p. 381). Six challenges has been identified in sounds archives; including coping with unstable recordings, attaining a balance between efficient and effective cataloging, providing proper storage conditions, planning for future users even when standards are in the infancy stage, sharing discography and content data, while navigating copyright issues (p. 383).

Collections containing ethnographic field recordings contain a rich cultural legacy that transcends the music performance framework found in most western music curriculum. In a

study investigating audio document preservation and restoration of ethnic music collection, Canazza (2012) discusses the philological problems associated with the authenticity and interpretation of documents and argues that "the ethnic music recordings were often made with non-professional systems" and argues that digitization is necessary to actively prevent the document from disappearing (p. 122). These non-professional systems used audio carriers such as cassette, microcassette, or mini-disk.

Audio Preservation Framework

Multiple disciplines outside the archival and library community also has a vested interest in the preservation of sound recordings and are implementing similar standards and procedures to ensure interoperability beyond a physical carrier, including the music industry (Grammy Foundation, 2010), audio engineers and audio hardware designers (AES, 2003, 2011, 2012; EBU, 1997), the Motion Picture Expert Group (Martínez & et al., 2002; Day, & Martínez, 2001), and repositories who preserve digital audio objects, such as national libraries, private or public sound archives (Council on Library and Information Resources et al., 2012; IASA, 2009). Consensus on how to migrate analog audiovisual carriers has not been achieved, but two theories have emerged on the ethical issues associated with audio re-recording research. They include the work of William Storm and Dietrich Schüller.

Storm

In an attempt to establish an international re-recording standard Storm (1980) suggested two paths necessary for sound preservation: including the sound preservation of audio history, more commonly referred as *Type 1 Re-recording*; and the sound preservation of the artist, referred as *Type 2 Re-recording* (Storm, 1980). In the sound preservation of audio history, the general theme aims to preserve the sound of an original recording as it was initially reproduced

and heard by the people of the era (p. 7). In this approach, the use of the original equipment to maintain the aesthetics of the time period is desired. In the case of the preservation of an artist, the idea goes beyond the first school by attempting to search for the true sound of the artist. To achieve this, modern playback equipment and better production techniques may be applied so as long as alterations are objective and reversible, and documented.

Schüller

The work of Schüller approaches audio preservation from a practitioner point of view. In his discussion on preservation ethics, Schüller (2001) attempts to "analyze what the original carrier represents; technically, and artistically, and proposes that the engineer start from that analysis in defining what the various aims of re-recording" (p. 1014). His theory deals with signal alteration in terms of intentional and unintentional. The former include recording, equalization, and noise reduction, while the latter can be described as either signal alterations caused by the imperfection of the recording techniques of the time or caused by the misalignment of the recording equipment (Orio & et al., 2009).

Current Research Finding and Gaps

As collections migrate from physical carriers to digital mass storage, not only will accessibility to audio assets become ever more important, but also how consumer behavior interacts with audio objects, digital music services, and related information accumulated over the life cycle of the item. Some research suggests that descriptive fields established in bibliographic standards such as MARC, Dublin Core, and MODS works well for known-item music searches, such as searching by title, artist, or genre (Cunningham, 2002; Cunningham et al., 2003). However, other studies suggest that current bibliographic carriers do not express the semantic relationships between manifestations of works efficiently (Minibayeva & Dunn, 2002; Rook,

2011; Tennant, 2004; Hemmasi, 2002). Numerous studies have mentioned the difficulties associated with the interoperability of sound recordings and musical information (Cannam & et al., 2010; Lai et al., 2005; Freeborn, 2001; Tennant, 2004; Roper, 2012; Scheirer, 2002). One observation worth noting is the difference in quality and granularity between various schemas.

In a study introducing a metadata dictionary design to aid migration of analog sound recordings into a digital collections, Lai and Fujinaga (2006) suggested that a comprehensive data dictionary should be able to facilitate metadata exchange between different systems and guide the design of solutions to validate, manage, and migrate all metadata schemas related to analog sound recordings and future derivatives (p. 344). Some solutions aimed at metadata exchange include the use of application profiles to merge various metadata schemas (Clair, 2008; Dovey, 2001; Lai, Fujinaga, & et al., 2007). The Library of Congress has excellent resources and example documents of audio objects (http://www.loc.gov/standards/mets/mets-examples.html), including for compact disk and other sound recording formats, but after reviewing previous literature, I was not able to locate any documentation referencing the implementation of METS expressing multichannel audio sources beyond stereophonic files. As academic and heritage institutions digitize, migrate or preserve unique sound documents and legacy audio carriers, research on multichannel and related music information is warranted.

Methodology

A METS record has been constructed using DC-XML to create descriptive metadata for the bibliographic record. The information contained in the record was transcribed directly from the copyright certificate issued by US Copyright Office of the Library of Congress. The METS document consists of a total of 15 files. They include two JPEG images; one high resolution 16 bit, 44.1 kHz stereo wave file; one 192kbps stereo, mpeg layer 3 file (.mp3); and eleven 16 bit,

44.1 kHz mono wave files. The mono files included in the METS document are the original source material from the production. The stereo wave file is the master copy used for distribution, publishing, and replication. The lower resolution mpeg file will serve as the access copy.

Review of Metadata Schema

An extensive review of literature pertaining to bibliographic metadata schemas suitable for use multichannel sound recordings was identified; they include MARC (http://www.loc.gov/marc/), MODS (http://www.loc.gov/standards/mods/), Dublin Core (http://dublincore.org/), EBUcore (https://tech.ebu.ch/MetadataEbuCore), PBcore (http://www.pbcore.org/), and MXF (http://standards.smpte.org/content/978-1-61482-517-3/st-377-1-2011/SEC1.refs). Qualified Dublin Core was selected for its low learning curve, readily available tools to create, exchange data, and for enabling interoperability with OAI clients.

Generating Bibliographic Record

The approach taken to generate the bibliographic record was guided by the common descriptive elements in a typical MARC/RDA record. They included the 245 field (*Title Statement*), 264 (*Pub/Distribution*), 300 (*Physical Description*), 336 (*RDA Content*), 337 (*RDA Media*), 338 (*RDA Carrier*), and 500 (*General Note*). In addition, access points were encoded with the use of Library of Congress Subject Headings (LCSH) for the subject field and Getty's Thesaurus of Geographic Names (TGN) for the coverage field (LCSH, http://authorities.loc.gov/; TGN, https://www.getty.edu/research/tools/vocabularies/tgn/).

Product

The Dublin Core XML used in the descriptive metadata section, along with the METS document and checksums were encoded using the UF METS Metadata Editor and Viewer

version 1.1.0 (http://ufdc.ufl.edu/?m=hesoftware_mets/). To review the METS document please see Appendix A.

Conclusion

Using METS to represent audiovisual carriers are sufficient for audio asset management; however, evidence and documentation of its implementation is limited for multichannel audio source material. Another challenge that needs to be addressed is how local institutions implement descriptive metadata for digital audio. For example EBUcore was designed as an extension to Dublin Core descriptive metadata. Currently, Library of Congress is investigating the AudioMD schema (http://www.loc.gov/standards/amdvmd/audiovideoMDschemas.html), intended to plug into the administrative metadata section of a METS document. This audio schema incorporates both AES57-2011 (http://www.aes.org/publications/standards/search.cfm?docID=84) and AES60-2011 (http://www.aes.org/publications/standards/search.cfm?docID=85). Further investigations in how users interact with digital audio collections should guide where audio administrative metadata should be placed in the METS carrier.

Possible future research should investigate the development of a new application profile for multichannel audio sources that enables the open harvesting of metadata from any stage in the content creation/knowledge discovery process. The current tools available seem to focus on static physical and born digital objects. This proposed new application profile would focus on time-based digital media and the cross walking of interrelated metadata descriptors contained in the raw data file or other authorized repositories.

Another possible research study should investigate the overlap of various metadata elements used in various XML schemas to express time-based media objects. This quantitative

investigation would audit descriptors and attempt to identify frequently applied and outliers in regards to common metadata elements used.

This study investigated the management and interoperability of metadata within audio preservation frameworks. By incorporating XML, Dublin Core, and the Metadata Encoding & Transmission Standard as a digital carrier, the expression of stereophonic, multichannel source materials and related objects has been created for ingestion into digital audio collections and content management systems.

Reference

Ackerman, D., & Lacinak, C. (2007). Technical committee on archiving, restoration and digital libraries report on emerging trends (TC ARDL Emerging Trends Report 2008-9-25). New York, NY: Audio Engineering Society.

Arnaldo, C. A. (1991). The story of Rhea-the growth of an archive. In G. Boston (Ed.), *Guide to the basic technical equipment required by audio, film and television archives* (pp. 4-7). Paris, France: UNESCO.

Audio Engineering Society. (2003). Recommendation for delivery of recorded music projects, *(AESTD1002.1.03-10).* Retrieved from: http://www.aes.org/technical/documents/AESTD1002.1.03-10_1.pdf

Audio Engineering Society. (2011). AES standard for network and file transfer of audio - Audio-file transfer and exchange - Part 1: *Disk format (AES31-1-2001 [r2011]).* Retrieved from: http://tech.ebu.ch/publications/tech3285

Audio Engineering Society. (2012). AES standard for network and file transfer of audio - Audio-file transfer and exchange – File format for transferring digital audio data between systems of different type and manufacture *(AES31-2-2012).* Retrieved from: http://www.aes.org/publications/standards/search.cfm?docID=53

Boston, G. (Ed.). (1991). *Guide to the basic technical equipment required by audio, film and television archives*. Paris, France: UNESCO.

Bucknum, M. R. (2001). Music sound archives in the United States. *Fontes Artis Musicae*, *48*(4), 381-390.

Bulger, P. (2001). Saving Americas's aural legacy. *Journal of the Audio Engineering Society*. *49*(7/8). 626-627.

Canazza, S. (2012). The digital curation of ethnic music audio archives: From preservation to restoration. *International Journal on Digital Libraries*, *12*(2-3), 121-135.

Cannam, C., Sandler, M., Jewell, M. O., Rhodes, C., & d'Inverno, M. (2010). Linked data and you: Bringing music research software into the semantic web. *Journal of New Music Research*, *39*(4), 313-325.

Chalmers, R. (1997). The Broadcast Wave Format. *EBU Technical Review*, 3-6.

Clair, K. (2008). Developing an audiovisual metadata application profile: A case study. *Library Collections, Acquisitions, & Technical Services, 32*, 53-57.

Council on Library and Information Resources, & Library of Congress. (2010). The state of recorded sound preservation in the United States: A national legacy at risk in the digital age.

Council on Library and Information Resources, & Library of Congress. (2012). The Library of Congress national recording preservation plan.

Cunningham, S. J. (2002). What people do when they look for music: Implications for design of a music digital library. In E.P. Lim, S. Foo, C. Khoo, H. Chen, E. Fox, S. Urs, & T. Costantino (Eds.), *Digital Libraries: People, Knowledge, and Technology: 5th International Conference on Asian Digital Libraries* (pp. 177-178).

Cunningham, S. J., Reeves, N., & Britland, M. (2003). An ethnographic study of music information seeking: implications for the design of a music digital library. In *Proceedings of the 3rd ACM/IEEE-CS Joint Conference on Digital Libraries* (pp. 5-16).

Davidson, M. W. (2001). Trends and issues in digital technology. *Fontes Artis Musicae, 48*(4), 398-410.

Day, N., & Martínez, J. M. (2001). Introduction to MPEG-7 (v. 3.0). *International Organization for Standardization, ISO/IEC JTC1/SC29/WG11, Coding of Moving Pictures and Audio N*, *4032*, 1-10.

Dovey, M. J. (2001). Adding content-based searching to a traditional music library catalogue server. In *Proceedings of the 1st ACM/IEEE-CS Joint Conference on Digital Libraries* (pp. 249-250).

Dunn, J. W., & Isaacson, E. J. (2002, July). Variations2: A digital music library system. In *Proceedings of the 2nd ACM/IEEE-CS Joint Conference on Digital Libraries*, 374.

European Broadcasting Union. (1997). Specification of the broadcast wave format: A format for audio data files in broadcasting, supplement 1 – MPEG audio (EBU-TECH 3285-E-S1).

European Broadcasting Union. (2011). Specification of the broadcast wave format: A format for audio data files in broadcasting, version 2.0 (EBU-TECH 3285).

Fenske, D. E., & Dunn, J. W. (1996). The variations project at Indiana University's music library. *D-lib Magazine*, *9*.

Freeborn, R., B. (2001). Cataloging non-music sound recordings. *Cataloging & Classification Quarterly, 31*(2), 37-51.

Gartner, R. (2002). METS: Metadata Encoding and Transmission Standard. JISC Techwatch Report TSW 02-05. Retrieved from: http://www.jisc.ac.uk/uploaded_documents/tsw_02-05.pdf

Gil-Pita, R., Vicen-Bueno, R., Alexandre-Cortizo, E., Gómez-Cornejo, J. C., & Arráez, M. J. R. (2006). Quality control in the Radio Nacional de España sound archive digitization process. In *Proceedings of the 5th WSEAS International Conference on Signal Processing, Robotics and Automation*. *World Scientific and Engineering Academy and Society.*

Grammy Foundation. (2010). Basic methodology for preservation, conservation and archiving recorded media.

Griscom, R. (2003). Distant music: Delivering audio over the internet. *Notes*, *59*(3), 521-541.

Harrison, H. P. (1997). Audiovisual archives worldwide. In Y. Courrier & A. Large (Eds.), *World Information Report 1997/1998* (pp. 182-189). Paris, France: UNESCO.

Hemmasi, H. (2002). Why not MARC?. In *Proceedings International Symposium on Music Information Retrieval*. Retrieved from: http://variations.indiana.edu/pdf/hemmasi-ismir2002.pdf

IBM Corp., & Microsoft Corp. (1991). Multimedia Programming Interface and Data Specifications 1.0. Retrieved from: http://www-mmsp.ece.mcgill.ca/Documents/AudioFormats/WAVE/Docs/riffmci.pdf

Indiana University Digital Library Program. (2008). *Variations3: An integrated digital library and learning system for the music community*. Retrieved from the VARIATIONS3

website: http://www.dlib.indiana.edu/projects/variations3/docs/Indiana_University_IMLS_2005-02-01.pdf

International Association of Sound and Audiovisual Archives, Technical Committee, Standards Recommended Practices and Strategies. (2005). *The safeguarding of the audio heritage: Ethics, principles and preservation strategy* (IASA-TC03).

International Association of Sound and Audiovisual Archives, Technical Committee, Standards Recommended Practices and Strategies. (2009). *Guidelines on the production and preservation of digital audio objects* (IASA-TC04).

Lai, C., Fujinaga, I., & Leive, C. (2005). Metadata for phonograph records: Facilitating new forms of use and access to analog sound recordings. In *Proceedings of the 5th ACM/IEEE-CS Joint Conference on Digital Libraries* (pp. 385-385).

Lai, C., & Fujinaga, I. (2006). Metadata data dictionary for analog sound recordings. In *Proceedings of the 6th ACM/IEEE-CS Joint Conference on Digital Libraries* (p. 344).

Lai, C., Fujinaga, I., Descheneau, D., Frishkopf, M., Riley, J., Hafner, J., & McMillan, B. (2007). Metadata Infrastructure for Sound Recordings. In *Proceedings International Symposium on Music Information Retrieval* (pp. 157-158).

Library of Congress. (2011, September 16). Metadata Encoding & Transmission Standard. *Loc.gov*. Retrieved March 1, 2014, from http://www.loc.gov/standards/mets/

Library of Congress. (2013, July). METS schema v 1.10. *Loc.gov*. Retrieved March 1, 2014, from http://www.loc.gov/standards/mets/mets.xsd

Maple, A., & Henderson, T. A. (2000). Prelude to a digital music library at the Pennsylvania State University: Networking audio for academic library users. *Library Resources & Technical Services, 44*(4), 190-195.

Martínez, J. M., Koenen, R., & Pereira, F. (2002). MPEG-7: the generic multimedia content description standard, part 1. *MultiMedia, IEEE*, *9*(2), 78-87.

Microsoft Corp. (1994). Microsoft Resource Interchange File Format, RIFF – part of the Multimedia Registration Kit, rev 3.0.

Minibayeva, N., & Dunn, J. W. (2002). A digital library data model for music. In *Proceedings of the 2nd ACM/IEEE-CS Joint Conference on Digital Libraries* (pp. 154-155).

Orio, N., Snidaro, L., & Canazza, S. (2009). Methodologies and tools for audio digital archives. *International Journal of Digital Libraries. 10*, 201-220.

Paton, C. A. (1998). Preservation re-recording of audio recordings in archives: Problems, priorities, technologies, and recommendations. *The American Archivist, 61*, 188-219.

Rook, S. (2011). Organizing knowledge: Ok! what our catalogues and metadata have to do with the semantic web and linked data. *IASA Journal,* 37, 7-15.

Roper, J. O. (2012). Sound bytes: Audio metadata standards in slightly more than six seconds. a report of the ALCT Metadata Interest Group Program, American Library Association Annual Conference, New Orleans, June 2011. *Technical Service Quarterly, 29*(3), 217-219.

Scheirer, E. D. (2002). About this business of metadata. In *Proceedings International Symposium on Music Information Retrieval* (pp. 252-254).

Schüller, D. (2001). Preserving the facts for the future: Principles and practices for the transfer of analog audio documents into the digital domain. *Journal of the Audio Engineering Society*, *49*(7/8), 618-621.

Smith, A., Allen, D., A., & Allen, K. (2004). Survey of the state of audio collections in academic libraries. Washington, D.C.: Council on Library and Information Resources.

Storm, W. (1980). The establishment of international re-recording standards. *Phonographic Bulletin*, *27*, 5-12.

Tennant, R. (2004). A bibliographic metadata infrastructure for the 21st century. *Library Hi Tech, 22*(2), 175-181.

Théron, D. (2008). Digitization of sound archives at the National Library of France. *International Preservation News, 46*, 19-20.

Ward, A. (1990). *A manual of sound archive administration*. Burlington, VT: Ashgate Publishing Company.

Woram, J. M. (1982). *The recording studio handbook* (1st ed). New York: ELAR Publishing Company, Inc.

Wright, R. (2001). Broadcast archives: Preserving the future. In D. Bearman, & F. Garzotto (Eds.), *Proceedings of the International Cultural Heritage Informatics Meeting, Milano, Italy, Pittsburgh, Pennsylvania, USA*, 47-55.

Appendix A


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Supertasty Demo 2011 ( Audio )
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    http://www.loc.gov/standards/mets/mets.xsd http://purl.org/dc/elements/1.1/
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<dc:contributor>Garnica, Erick</dc:contributor>
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<dc:contributor>Godfrey, Michelle</dc:contributor>
<dc:contributor>Grieselhuber, Paul</dc:contributor>
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