

Legislative Digital Policy Advisory Committee (LDPAC)

Report to the Joint Budget Committee and Committee on Legal Services

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EXECUTIVE SUMMARY

Digitization of Legislative Audio Recordings

CHARGE	LDPAC RESPONSE
Define the optimal digital audio format.	The optimum digital audio format is .wav for archival purposes and mp3 format for public access.
Digitize taped archived recordings to the optimal digital file format.	Analog-to-digital conversion will be a dual extraction process where digital files are created in both the optimal digital format (.wav) and the consumer digital access format (mp3) (see Appendix B). Metadata, using best practices, will be created with the migration of the digital files and will be imbedded with those same digital files.
Migrate digital recordings to the optimum format.	Digitization and migration of the 1973-74 analog tapes first, followed by the remaining analog tapes from 1975 through 1997. Investigate the transfer of digital files on the Freedom system to a non-proprietary format. Address the digital data tapes from 1998 through 2001 last.
Provide the information technology system for ongoing archival storage and access.	Original tapes will be relabeled, cataloged and stored in environmentally controlled location. Digital files will be housed in remotely operated digital ("Cloud") storage with mirrored storage in local servers or other digital storage devices.
Identify and prioritize at least two funding options for the plan.	A benchmarked, 5-year appropriation to State Archives above current levels from the General Fund. Collaboration and savings through an economy of scale with similar agencies. Additional spending authority of any cash fund surplus from fees.
Recommend a policy for limited storage for archived recordings, perpetual archival storage, and public access to digital legislative recordings.	Follow the Library of Congress National Recording Preservation Plan. Limited storage will consist of the preservation of both machinery and the tapes within environmentally controlled storage areas. Perpetual storage will include both the original audio and the digital files. Customer access will be through the General Assembly webpage with a link to the servers administered by the various departments.

EXECUTIVE SUMMARY

Implementing Uniform Electronic Legal Materials Act (UELMA)

CHARGE	LDPAC RESPONSE
Recommend a policy for limited-term legislative storage, perpetual archival storage, and public access to electronic legislative records.	The General Assembly, or vendors by agreement with the General Assembly, should maintain not only a secure digital depository for public access, but also a separate system for reliable, perpetual archival storage of electronic legislative records, utilizing cloud storage, secure off-site servers, eBooks, paper books, or similar electronic means that ensure secure, perpetual preservation of the records.
Identify potential authentication systems for an electronic records authentication system, including the vendors and the costs to the state.	Some form of mark-up language combined with a digital signature secured by a hash key is likely the best of the known systems for authenticating future legislative digital records. The Secretary of State's experience moving forward will help verify the accuracy of that premise.
Recommend the best electronic records authentication system for the state and funding options.	All of the information necessary for determining the best and most cost effective electronic records authentication system for the legislature (or the entire state) is not yet available. In addition to the actions listed above, the LDPAC would like to completely survey all U.S. states that have passed UELMA legislation regarding actions they have taken to comply, concerns they have, and/or barriers they face. We would also like to more fully survey Colorado government and its partners regarding current digitization projects already undertaken, specifically their selected processes and procedures.
Any other information that the LDPAC determines to be relevant.	Colorado is at the forefront of UELMA implementation. The LDPAC should continue with additional members added.

INTRODUCTION

Background. A budget request submitted in November 2012 by the Colorado State Archives highlighted the need to preserve Colorado's permanent legal and historical records, both print and legislative audio. These records provide critical historical context to complex legislative and legal issues throughout the state and are at risk of being permanently lost if immediate and ongoing steps are not taken to preserve them.

Currently, legislative recordings from 1973 through 1981 are very difficult to access because of machine and tape degradation due to age. Legislative recordings between 1982 and 1998 could become inaccessible due to the unavailability of historical machines used to play the specialized, multi-track recordings. Additionally, the legislative tapes from 1998 through 2001 are becoming difficult to access due to the degradation of the tapes and the unstable nature of the historical proprietary software. Recordings on the Freedom System (2002-2011) are in a proprietary format. Each era of audio recording utilizes a different historical machine, which are unique proprietary multi-track tape reproducers manufactured in those specific eras, or are recordings in proprietary digital formats.

While these recordings are currently still accessible to professionals trained in the treatment and preservation of historical recordings, the fragility of the machines and the recordings themselves make it impossible to make the legislative recordings available directly to customers. As a result, each of these recordings must be individually accessed by a trained archivist and a digital recording must be made on an ad hoc basis for the customer. This ad hoc approach is not efficient and does not address the increasing inaccessibility of large volumes of historical recordings.

House Bill 13-1182, which created the Legislative Digital Policy Advisory Committee, was introduced in response to the concerns identified in the State Archives' budget request. The LDPAC is required to develop plans for converting existing archived recordings of legislative proceedings into a digital format and implementing the Uniform Electronic Legal Material Act.

COMMITTEE CHARGE

The Legislative Digital Policy Advisory Committee consists of the following individuals, or their designees:

- State Archivist;
- Supreme Court Librarian;
- State Librarian;
- Director of Research of the Legislative Council;
- Director of the Office of Legislative Legal Services;

- Chief Clerk of the House of Representatives; and
- Secretary of the Senate.

Pursuant to House Bill 13-1182, the Legislative Digital Policy Advisory Committee was charged to develop a plan to digitize the archived recordings that:

- Defines the optimal digital audio file format;
- Identifies potential vendors and the cost to the state to:
 - digitize taped archived recordings to the optimal digital audio file format;
 - migrate digital archived recordings to the optimal digital audio file format; and
 - provide the information technology system for the ongoing archival storage and access;
- Identifies and prioritizes at least two funding options for the plan, including any grant opportunities or licensing contracts;
- Recommends a policy for limited-term storage of archived recordings, perpetual archival storage, and public access to all digital legislative audio recordings; and
- includes any other information that the LDPAC determines to be relevant.

The LDPAC was also to develop a plan for implementation of the "Uniform Electronic Legal Material Act" (hereinafter UELMA) for legislative electronic records that:

- Recommends a policy for limited-term legislative storage, perpetual archival storage, and public access to electronic legislative records;
- Identifies potential authentication systems for an electronic records authentication system, including the vendors and the costs to the state;
- Recommends the best electronic records authentication system for the state;
- Identifies funding options for the authentication system; and
- Includes any other information that the LDPAC determines to be relevant.

The committee must report its finding to the Committee on Legal Services and the Joint Budget Committee by November 1, 2013. The LDPAC repeals January 1, 2014.

COMMITTEE ACTIVITIES

The LDPAC met 12 times from June through October 2013 and discussed issues related to digitizing the analog recordings from 1973-2001 as well as potential authentication systems for electronic records to use to comply with UELMA.

Topics discussed during LDPAC meetings and recommendations made by the LDPAC are discussed below.

LDPAC RECOMMENDATIONS

Digitization of Legislative Audio Recordings

Audio recordings of all legislative hearings are stored at the Colorado State Archives, and date back to 1973. These recordings comprise several thousand audio tapes in five different formats. For purposes of the LDPAC, analog audio files from 1973 to 2001 were examined. In this time period, three distinct recording systems were used, including two different reel-to-reel systems and a digital data tape system. All of the tapes during this time period can only be played on their proprietary system. The ability to access these tapes is impacted by age, wear and tear over the years, as well as the deteriorating condition of the playback machines. A detailed overview of the status of the legislative recordings at the Colorado State Archives is included as Appendix A.

The LDPAC recommends the following plan to digitize the archived recordings:

1. Define the optimal digital audio format. The optimal format for audio preservation is PCM wav (.wav) format, as this is a universal audio format used in compact disks, professional audio and most audio applications. It is a lossless format from which all other formats (including mp3) can be down-sampled and compressed. The LDPAC recommends that the .wav format be used for archival storage and the mp3 format be used for public access. Archival standards suggest either high-definition audio or standard CD audio as the best formats from which to derive all other access formats, and to insure readability in the future.

2. Identify potential vendors to digitize in the optimum format, migrate digital recordings to the optimum format, and provide the information technology system for the ongoing archival storage and access.

Short term strategies: In the short term, State Archives should work towards stabilizing its existing analog machines and tapes, and look for ways to enhance these machines to make digitization easier. State Archives is currently working with Jonathan Broyles of Image and Sound Forensics (Parker, CO) to re-build and maintain existing audio tape machines. State Archives has also estimated the amount of storage space necessary to archive the audio content in its digital form. In addition, State Archives is investigating long-term preservation of the actual audio tapes. The LDPAC recommends that State Archives continue these short term endeavors while it works towards long term digital solutions and estimates a 9-12 month timeline for the short term strategies.

Long term strategies: Long term digitization will be a difficult process for State Archives. State Archives worked with Image and Sound Forensics to establish a cost baseline for long term digitization. Current cost estimates from potential vendors are \$2,478,100; however, the LDPAC knows that much of the expertise in the digitization of analog to digital exists in the music industry. For instance, it was shared in the committee that the Grateful Dead producers were on the cutting edge of salvaging analog tapes and digitizing them. The LDPAC recommends an additional 12 months to research similar solutions in other industries (i.e., music industry and Department of Defense). Along with results of the short-term baseline, the LDPAC will be able to recommend a more definite figure. The LDPAC believes that long term solutions can occur within a five year period.

The LDPAC recommends that State Archives should do one or more of the following:

- Verify the established baseline through an advertised RFI/RFQ
- Document the knowledge, skills and abilities required to continue audio tape conversion
- Hire additional staff needed to complete conversion of audio tapes in-house
- Advertise for vendor completion of audio tape conversion through the RFP process

A. Digitize taped archived recordings to the optimal digital file format.

Transfer and digitization of the analog tape-based legislative recordings will be accomplished by modifying existing Dictaphone and Magnasync playback devices to allow for multi-track fast speed extraction. Utilizing Library of Congress best practices, the analog-to-digital conversion will be a dual extraction process where digital files are created in both the optimal digital format (.wav) and the consumer digital access format (MP3) (see Appendix B). Metadata, using best practices, will be created with the migration of the digital files and will be imbedded with those same digital files. Steps will be in place to handle issues with tape degradation as needed (see Appendix C).

B. Migrate digital recordings to the optimum format. The LDPAC

recommends the digitization of the 1973-74 analog tapes first. These are the oldest tapes and should be able to be completed in accordance with the with Library of Congress best practices.

The LDPAC then recommends digitizing the remaining analog tapes from 1975 through 1997. The prioritization of these tapes may be determined by significant legislative issues, and not necessarily sequentially. The LDPAC also recommends the transfer of the Freedom system to a non-proprietary format. This will allow some of the most recent legislative audio to be available to the public in an accessible digital format.

Finally, the LDPAC recommends that the digital data tapes from 1998 through 2001 be migrated last. While these tapes and the platform may be the most fragile, the LDPAC recognized that at this time, these recordings are also the most difficult to transfer. In addition, the LDPAC and State Archives have been unable to find a vendor who will work with these tapes. The LDPAC believes that this prioritization will provide the greatest success to the whole digitization project.

The LDPAC recommends the following timeline for converting and migrating audio tapes:

- Short-term: 9-12 months
- Long-term: Currently unknown; preferably five years or less.

C. Provide the information technology system for ongoing archival storage and access. Original antiquated tapes will be relabeled, cataloged and stored in environmentally controlled environment both prior to and after digitization. Digital files will be housed in remotely operated digital ("Cloud") storage with mirrored storage in local servers or other digital storage devices to possibly include traditional disc or solid-state digital storage or long-term refreshable digital tape storage facilities.

Based upon a limited sample of interviews by LDPAC members and presentations to the group at large, the LDPAC believes that storage and access requirements can be grouped together or contracted separately. The LDPAC has already begun the investigation phase concerning possible partners in this endeavor.

The LDPAC recommends compiling a more complete list of proprietary or open source software vendors already contracting with the State of Colorado for inclusion in any future bid process.

The LDPAC recognizes that a total cost is not yet estimable; any attempt to prematurely calculate the number will result in over-paying. The space and related cost for storing digitized audio tape content are only a portion of the amount needed; the space/cost for storing prospective electronic data related to UELMA compliance should be calculated and added to this figure. Taken together, economies of scale are available.

For example, an unlimited cloud storage contract can accompany an enterprise contract, sometimes with generous discounts associated with group licenses for simultaneous access.

3. Identify and prioritize at least two funding options for the plan. There are several viable funding options for the digitization of legislative audio: general funding appropriation, grant money and appropriated transfer of cash from the State Archives cash fund balance. The LDPAC would recommend that the prioritization of these options begin with a benchmarked, 5-year appropriation to State Archives above current levels from the General Fund for audio tape conversion and a content management system capable of searching, accessing, and manipulating the data formatted according to the UELMA recommendations. Cooperation between the various programs subject to UELMA will streamline expenditure by assisting the establishment of the UELMA format, recommend hardware and software standards for creating and editing primary law statewide, recognize State Archives as the official depository of retrospective print materials over 20 years old, and maximize State money already expended under the DPA umbrella.

In addition to the economies of scale associated with storing and accessing the audio tape content and the prospective digital content created pursuant to UELMA, the LDPAC recognizes the potential for significant savings to all state agencies who print through DPA/IDS if that unit is selected as the printer of choice for retrospective textual materials corresponding to the audio tape content. Such savings appear to be at least an off-set (more likely a net savings) to the General Fund over the number of years that Archives requests dollars for audio conversion. This approach has the attendant benefit of making all primary law from Statehood through the present available online, in the same format, and similarly searchable.

In exchange for the State Archives providing free access to retrospective primary law materials after audio conversion, the governmental bodies contemplating participation in UELMA could agree to match grant funded monies annually required, up to, but not exceeding, the five-year period during which State Archives would provide the assistance described above. This is a real choice based upon the highly collaborative conversation that the LDPAC has created, and universal agreement that free access to primary law is our common goal; still, it is a distant second choice if for no other reason than it shifts the burden of funding State Archives to other branches of government who already deposit legal content there.

An archival contract for the above-described services in association with one or more similarly-situated state archives in the Rocky Mountain region or beyond might also offer a bargaining position strong enough to discount the retail price of conversion and content management such that it might be affordable using grant funded monies only. This is the least preferred option, since it potentially subordinates the preferred timeline for converting the Colorado audio content to the vagaries of vendor negotiation in a

multi-jurisdiction scenario.

The LDPAC has several reasons for the above listed priorities. First, the current state of the legislative audio tapes and equipment is such that immediate funds need to be earmarked to address the situation. Grant money, while attractive, is not guaranteed and this would lead only to additional delays. Moreover, the LDPAC found that many of the available grants are not available to the State of Colorado because grants require that the information being digitized be free to the public. This is not the case right now with the State Archives as it must charge fees to insure adequate funding. The LDPAC believes that with an initial general fund appropriation and the appropriated spending of the State Archives cash fund balance over the next 5 years, the groundwork will be laid so that general fund money can be phased out. The cash fund balance, matching grant monies from state agencies, and external grants could then potentially fund the digitization after the initial 5 year period.

4. Recommend a policy for limited storage for archived recordings, perpetual archival storage, and public access to all digital legislative recordings.

All standards for best practices concerning storage of both short-term and perpetual recordings will be according to guidelines and practices from the Library of Congress National Recording Preservation Plan as well as other standard best practice publications. Limited storage will consist of the preservation of both rare and antiquated machinery and the tapes within environmentally sound storage areas. Ongoing maintenance will insure the operation of these machines to provide public access during the legislative transfer process.

Perpetual storage will include both the original audio artifacts and the newly created digital files, with best archival practices as a guide to the preservation of both. Analog files will be put in environmentally controlled spaces that insure that they can be accessed indefinitely for file restoration or other needs. Digital files will be stored in their higher-resolution format (archival) and in their customer access (compressed) format in at least three locations, to include a remote server, a mirrored site, and one locally under the control of the State Archives, either as an in-house server or long-term digital storage format (such as tape).

Customer access will be through the General Assembly webpage, so as to create the least confusion in the public as to the origination of the recordings, and then linked to the servers administered by the various departments that will include both the audio files and related printed file materials.

The LDPAC recommends the following funding approaches and requirements for defining short-term legislative storage, perpetual archival storage, and ongoing public access to digital legislative audio records.

- Discontinue access fees for other governmental units in Colorado

- If access fees cannot be discontinued, establish one-time subscription fee schedule to be paid to State Archives as early in the fiscal year as possible (to facilitate fiscal planning), and set a date beyond which access fees will not be paid.
- If access fees must be paid for longer than one fiscal year, add one FTE to State Archives sufficiently skilled, and cross-trained, to fulfill legislative history requests more rapidly.
- Enterprise funding from non-governmental marketplace
- Shared allocation with IDS (General Fund)

5. Other relevant information to be considered. The LDPAC strongly recommends that the committee continue after January 1, 2014. Even if the LDPAC is not statutorily mandated, the members of the committee unanimously agreed that the collaboration between the three branches of government was invaluable and useful service for the citizens of Colorado. The LDPAC had extensive discussions concerning a federated search system in which each governmental entity provides data to a central hub so that Coloradoans need to go only to one location to gain historical legal information. The LDPAC would like to continue to discuss this option for future implementation.

In addition, the LDPAC discussed several options to provide raw data free to citizens, including enhanced data, such as an e-book subscription, to users for a subscription fee. Such a system would allow State Archives to apply for more grants, as it would be providing information to citizens free of charge. It would also allow State Archives to continue charging fees to users for enhanced services.

Implementation of the Uniform Electronic Legal Material Act (UELMA)

The Uniform Electronic Legal Material Act ("UELMA") was enacted in Colorado in 2012. (H.B. 12-1209 codified at C.R.S. 24-71.5-101, et seq.). It is the legislative response to the increasing demand for electronic distribution of legal information by state governments, and the security concerns related to potential alteration of that information, whether accidentally or maliciously, before it reaches an individual user.

UELMA requires an official publisher of legal material that is published only in an electronic record to designate the electronic record as official and to: (1) authenticate the origin and document integrity of the record; (2) provide for the preservation and security of the electronic record in electronic or non-electronic form; and (3) ensure the legal material is available for permanent public use. An official publisher that publishes legal material in a record other than an electronic format may designate an electronic record as official if UELMA's requirements for authentication, preservation, and permanent availability are met.

UELMA's scope in Colorado is limited: The legal materials it applies to are the Colorado Constitution, Session Laws, and Colorado Revised Statutes, for which the General Assembly is the official publisher, and state agency rules, for which the Secretary of State is the official publisher. (24-71.5-102 (2), (3), C.R.S.).

UELMA does not require any particular technology for authenticating and preserving electronic legal materials. The General Assembly and Secretary of State can choose the same or different technology for authentication and preservation of these legal materials.

Because the Secretary of State currently publishes the official version of Colorado's administrative rules and regulations in electronic format, they must comply with UELMA requirements by March 31, 2014.

The Secretary of State's schedule for complying with UELMA required the dedication of appropriated resources and ultimately a commitment to comply before the LDPAC was able to meaningfully assist in that agency's decision-making process. The SOS has selected one of the authentication methods identified as potentially viable in the LOC/DIIPP white paper. (Appendix D). It remains to be seen if the relatively small volume of records that the SOS publishes each year can be scaled to work in the much larger volume legislative environment.

The printed version of the Colorado Constitution, Session Laws, and Colorado Revised Statutes published by the General Assembly currently is the official record of these legal materials. The General Assembly is not required to comply with UELMA until it designates an electronic format as its official record. For the Colorado Revised Statutes, that designation will require legislation.

UELMA-related information and LDPAC recommendations. Section 24-80-114 (4), C.R.S., directs the LDPAC to develop a plan for implementing UELMA for legislative records, and to report on specific aspects of that plan. The following work resulted in the LDPAC's recommendations and, is required by law to be included in this report.

Eight states, including Colorado, have adopted some form of UELMA; six others introduced it but did not adopt it last session. There is no fully-functioning model from another state that Colorado can use as a template, so we are leading the way nationally on implementation.

For purposes of an implementation plan, the committee considered digital records relating to the specified legal materials enumerated in UELMA, i.e., the Colorado Constitution, the Session Laws of Colorado, the Colorado Revised Statutes, state agency rules, and any other items that could be legal materials under the UELMA, including legislative audio recordings. Other legal materials that might also be included in UELMA are published appellate court opinions, court rules, legislative journals and calendars,

versions of bills, executive orders, and attorney general formal opinions.

During its meetings, the LDPAC members reported on research into known digitization initiatives in various stages of implementation at the federal level and in other states, identified similar information regarding on-going scanning programs in Colorado, met with information technology experts (i.e., government IT professionals, consultants, vendors), and studied the UELMA plan being implemented by the Secretary of State's Office, which participated in several of the LDPAC meetings.

1. Recommendation for a policy for limited-term legislative storage, perpetual archival storage, and public access to electronic legislative records.

In lieu of recommending a preferred digital authentication system for legislative records, the LDPAC offers the following consensus statements in support of its conclusion that further research is necessary.

Electronic legislative records should be easily accessible and widely available to the public at no cost.

A 1-2-3 approach to preservation is advised. That is, one original copy should be maintained in two independent locations and made available on three different platforms if not formats. The General Assembly, or vendors by agreement with the General Assembly, should maintain not only a secure digital depository for public access, but also a separate system for reliable, perpetual archival storage of electronic legislative records, utilizing cloud storage; secure off-site servers, eBooks, paper books, or similar electronic means that ensure secure, perpetual preservation of the records.

This process should begin with the end-users' experience clearly defined.

A centralized administration for statewide UELMA compliance (hub and spokes content management structure) would maximize efficiency and reduce unnecessary time and expense. Such a structure would also provide the general public a better customer service experience when inevitable questions arise about how to navigate the system. Other advantages are the ability to identify, negotiate and provide common equipment, software and training for the creation of and conversion to common formats, statewide.

A common language is necessary to forecast and manage emerging technology. Should the General Assembly decide to include retrospective (historical) primary law into the UELMA digital records depository, a shared vocabulary will assist in the conversion of those documents to digital form. The same is true of preserving historical administrative rules and regulations. It is the committee's opinion that end users would be better served and the Secretary of State's workflow assisted if the Code of Colorado Regulations were numbered in a uniform manner. We acknowledge that this would

require legislative action, and that the transition process would have to be phased. Such a change is not absolutely necessary, however, should it be desired, this would be an expedient moment to begin the dialogue, as correlation tables could be created and linked to prospective digital files under UELMA.

2. Identification of potential authentication systems for an electronic records authentication system, including vendors and the costs to the state.

The plan being implemented by the Secretary of State will produce an HTML format created using JAVA-code, which is then converted to an archival PDF that is authenticated using a proprietary Adobe certificate. The Secretary of State's Office has elected to manage its authentication system in-house.

The LDPAC currently believes that some form of mark-up language combined with a digital signature secured by a hash key is likely the best of the known systems for authenticating future legislative digital records. The Secretary of State's experience moving forward will help verify the accuracy of that premise.

The Office of Legislative Legal Services currently contracts with a vendor to print its official primary law. A conversation with that vendor would be a next step toward UELMA compliance. The state should also consider advertising to other vendors via an RFI/RFQ to further explore available options and to quantify associated costs.

3. Recommendation for the best electronic records authentication system for the state and funding options for the authentication system.

All of the information necessary for determining the best and most cost effective electronic records authentication system for the legislature (or the entire state) is not yet available. In addition to the actions listed above, the Committee would like to completely survey all U.S. states that have passed UELMA legislation regarding actions they have taken to comply, concerns they have, and/or barriers they face. We would also like to more fully survey Colorado government and its partners regarding current digitization projects already undertaken, specifically their selected processes and procedures.

4. Other relevant information to be considered.

As discussed previously, the LDPAC should continue to meet for the purpose of evaluating information that best implements UELMA and facilitates access to electronic legal materials by Colorado's citizens at no charge. Ongoing communication between the legislative, judicial, and executive branches of Colorado state government may, in addition to ensuring efficiencies in implementing UELMA, result in the recommendation of

future legislative changes necessary to that implementation. It may also result in helpful recommendations relating to the ongoing conversion of legislative audio tapes.

As the legislature faces no deadline to comply with UELMA, the LDPAC respectfully requests a one-year extension to more completely research the information and technical requirements necessary to optimally implement the UELMA portion of its charge. Alternatively, the LDPAC could meet as an informal inter-branch group on a regular basis to evaluate information that will further the implementation of UELMA.

The members of the LDPAC unanimously agree that the collegiality and cooperation among the group contributed to a highly informative and productive process. If allowed to continue, the group recommends adding the Director of the Business and Licensing Division of the Secretary of State's Office, the Legislative Council Librarian, the Revisor of Statutes, the Senior IT Manager of the Legislative Counsel, and the Director of Statewide Programs in the Department of Personnel and Administration to the next iteration of the LDPAC.

In addition, the LDPAC would like to thank the following non-members who provided generously of their time, energy and expertise:

- State Archive staff, including Lance Christensen and Tracie Seurer
- The Director of Statewide Programs & Chief Administrative Law Judge, Matthew Azer
- Secretary of State staff members, including D.J. Davis, Deanna Maiolo, Phil Gehlich, Setareh Saadat, Carla Hoke, Joe Ingle and Ben Rector
- State Library staff member Deborah MacLeod
- Legislative Council Librarian Molly Otto
- Legislative Council IT staff Manish Jani and Zack Wimberly
- Legislative Legal Services staff Ed DeCecco
- Jonathan Broyles of Image & Sound Forensics

APPENDIX A

The Status of the Legislative Tapes at the Colorado State Archives

Issue: The Legislative Tapes at the Colorado State Archives are in danger of becoming unusable due to the age of the recordings and the rarity of the antiquated orphan machines designed to play them.

Part 1 - The Tapes: The Legislative Tapes at the Colorado State Archives comprise several thousand audiotapes utilizing five different formats. Of these, a partial group of tapes ¼ inch tapes (containing recordings of the House and Senate Chambers from 1973) were transferred to a digital format in 2006 and a further group of cassettes (containing committee hearings from early 1973) were transferred to a digital format in 2012. There are three distinct formats and types:

1973 – 1981: Half-inch 10 track tape held on NAB 10 ½” reels, playable on Dictaphone Corporation 4000/5000 logging machines only. One track holds SMPTE-style code in H/M/S format.¹ All tapes in this collection suffer from varying degrees of hydrolysis, sticky-tape syndrome and other defects that are the result of age and decay, the emulsions in the tapes and poor storage conditions. Many tapes have suffered breakage, have poor splices and suffer from loss of data.

1982 – 1998: 1-inch 20 track logging tape on NAB 10 ½” reels, playable only on Magnasync/Moviola Company logging machines and fitted with custom-built SMPTE-style readers, or machines modified to emulate these proprietary devices. One track holds time code in D/H/M/S format.² While the tapes are in good condition, they too are exhibiting early signs of wear and oxide loss due to age and storage issues. Many tapes have suffered breakage and have poor splices and loss of data.

1997 – 2004: 4mm 4 GB DDC data tapes, playable only on the software platform designed by Lanier and abandoned in 2001. The tapes are proprietary data burst format, loaded onto a Windows 3.1-based system utilizing software that is incompatible with modern operating systems. The data on the tapes is fragile and while there are backups of many of the tapes, many of the originals are no longer recognized by the system and are unplayable. While some years of these tapes are repeated in other formats, there is no replacement for the years 1999 – 2001. Neither the tapes nor the software designed for them were intended for extended life or use.

¹ Hour/Minute/Second. Hours are on a 24-hour clock. SMPTE refers to the Society of Motion Picture and Television Engineers and is one format of time code in use in film, television and in any situation where specific time and synchronization is required.

² Day/Hour/Minute/Second. 365-day calendar with 24-hour clock format.

In the case of all systems, the tapes hold several days of hearings with all rooms in use recorded at the same time. All of the tapes can only be played on their proprietary systems. Wear and non-archival storage facilities have adversely impacted all of the tapes, which are also affected by the deteriorating condition of the playback machines.

The total numbers for each format of tape are:

1. 1973 – 1982: 1,144 Half-inch Tapes
2. 1982 – 1998: 881 1 inch Tapes
3. 1998 – 2004: 167 DDC Tapes (1999 – 2001: 100 DDC Tapes)

(Note: if only tapes not covered by overlapping formats are considered, the DDC tapes for which there is no other format is 100 total).

Part 2 - The Machines: As stated earlier, there are three types of machines that play these recordings. All are either proprietary and unique, or use software that is proprietary, unsupported and on an antiquated platform. These machines should only be operated by individuals with specific training and expertise in analog tape systems, transfer formats and digital audio workstations, with an emphasis on industry experience and audio archival methodology. The three systems and their condition follows:

1973 – 1981: Dictaphone 4000/5000

These machines are open-reel players, manufactured by Dictaphone. They have push-button mechanisms and a separate SMPTE-style module located above the reels. Both Dictaphone machines were repaired by Jonathan Broyles of Image And Sound Forensics(R) in 2012, a process which replaced rubber parts, many electronic components and returned both machines to functional operation at a total cost of \$5000 each. At the present time, these machines should have many years of functionality, assuming operation by trained personnel and periodic maintenance, calibration and repair.

1982 – 1998: Magnasync/Moviola

These machines are open-reel players with custom-built time-code readers installed. Unlike the Dictaphone machines, these machines maintain constant contact with the tape even during fast-winding.

With the loss of functionality of these machines, Dictaphone 5000 machines were utilized and modified to handle these tapes and to read the time code on them. Two machines are being fitted in this manner, at a cost of \$5000 each, and are scheduled to be in service in November 2013.

1999-2001: DDC Computers (Window 3.1 OS, Lanier software with 4mm Data Drives). There are two of these machines, both of which are functional. One machine has had its data drive rebuilt. While the machines are fairly stable, they are 1st generation Pentium machines with unsupported operating systems that may become more fragile with age. Additionally, the tapes were of a format never intended for daily use, and are becoming unstable with age.

APPENDIX B

Digital formats: the initial transfer storage format from tape should be the highest quality that will capture with "no loss" from tape to digital format. Since the bandwidth of the recorders is specified at 300 to 3000Hz (-3dB), and since these analog recorders have a typical useful frequency response to 6000Hz, the minimum digital format should be 12KHz sample rate and 16bit amplitude resolution to ensure that all of the usable bandwidth of the audio format is captured.

The ideal file format will be one that reaches beyond simply preservation and exceeds the minimum standards. Many universities and the Library of Congress recommend a high definition standard of 92KHz/24 bit resolution, also known as 'high definition audio.' For the purposes of these recordings, this would result in a very large file size. For the purposes of easier access and standardization, the recommended format is the CD standard of 44.1KHz/16 bit. This is both for best audio preservation as well as for ease of access in the future. This is also an optimum format for down-sampling to access formats.

Storage requirements. This would be for the preservation format as well as the compressed format for public access. code audio should also be recorded from one of the channels on the tape. Information such as time and origination should be preserved at the point of transfer as part of the metadata stream.

The formula for stating the size of audio files in a lossless wav format is:
$$\text{MB/Hour} = x \text{ bits/sample} * x \text{ samples/second} * \text{bytes}/8 \text{ bits} * \text{KB}/1024 \text{ bytes} * \text{MB}/1024 \text{KB} * 60 \text{ seconds/minute} * 60 \text{ minutes/hour} * \text{number of channels}$$

For 44.1/16 audio, this would result in 605mb per hour or .591gb per hour of data. Assuming the current estimate of 500,000 hours of audio, this would indicate 295 terabytes of data storage necessary for the archival format storage needs.

Calculating the public access MP3 format audio, results in MP3 at a 128 bit rate would result in 56.3 MB/hour or approximately 28 terabytes of data.

Total storage needs would result in a requirement of at least 323 terabytes of storage. However, the true amount of storage necessary would be contingent on the actual amount of hours per year, which cannot be determined until a full year of audio is transferred.

APPENDIX C

Examination and Research of Potential Tape Problems [1]

After examination and testing of the ½" and 1" tapes from the Colorado Archives I have been able to determine that the Dictaphone (½") recorded tapes' back coating is deteriorating due to absorption of moisture or hydrolysis of the tape's back coating[1]. Further, an examination of the material that deposits on the tape heads contains mostly back coating and very little iron oxide and is the same as the material found on the tape lifters which contact the back side of the tape. The deteriorating back coating is transferring to the front/recording surface through contact when the tape is wound on a reel [1]. The longer this goes unchecked, the more the deteriorating back coating will break down and transfer to the front surface of the tape which could eventually "glue" the layers of the tape together making it unplayable. The contamination of the recording surface with the deteriorating back coating will interfere with the playback quality by putting a space between the recording surface and the playback head. This type of signal loss is very difficult or impossible to be fully compensated for by downstream digital processing [3].

Dictaphone tapes exhibiting this deterioration require head and tape guide cleaning after approximately 15 minutes of playback [2].

Further examination shows that the Magnasync tapes (1") do not have a back coating and also do not exhibit any symptoms of hydrolysis deterioration. The oxide build up that appears on the playback heads after 8 hours of use appears to be more or less consistent with normal tape wear [1][2].

Possible Solutions Include:

1. Chemical Removal of Back Coating
2. Environmental Controls
3. Vacuum Dehydrator

References

1. Jonathan Broyles, Senior Forensic Examiner, Image And Sound Forensics®, Parker, Colorado.
2. Lance Christensen, Digital and Audio Archivist, Colorado State Archives.
3. Bertram, H.N. and E.F. Cuddihy, "Kinetics of the Humid Aging of Magnetic Recording Tape, IEEE Trans. Magn., MAG-18, No. 5, pp993-999, Sep. 1982.

APPENDIX D

The LDPAC reviewed the following 32 page White Paper concerning Minnesota's UELMA strategies. For brevity of this report, a hyperlink has been provided.

Minnesota Historical Society – “Preserving State Government Digital Information:

http://www.mnhs.org/preserve/records/legislative/records/carol/docs_pdfs/MHS-NDIIPP_FinalReport02_29_2012.pdf