Audio-Visual Archiving

Comparing Memory Institutions and Commercial Industries

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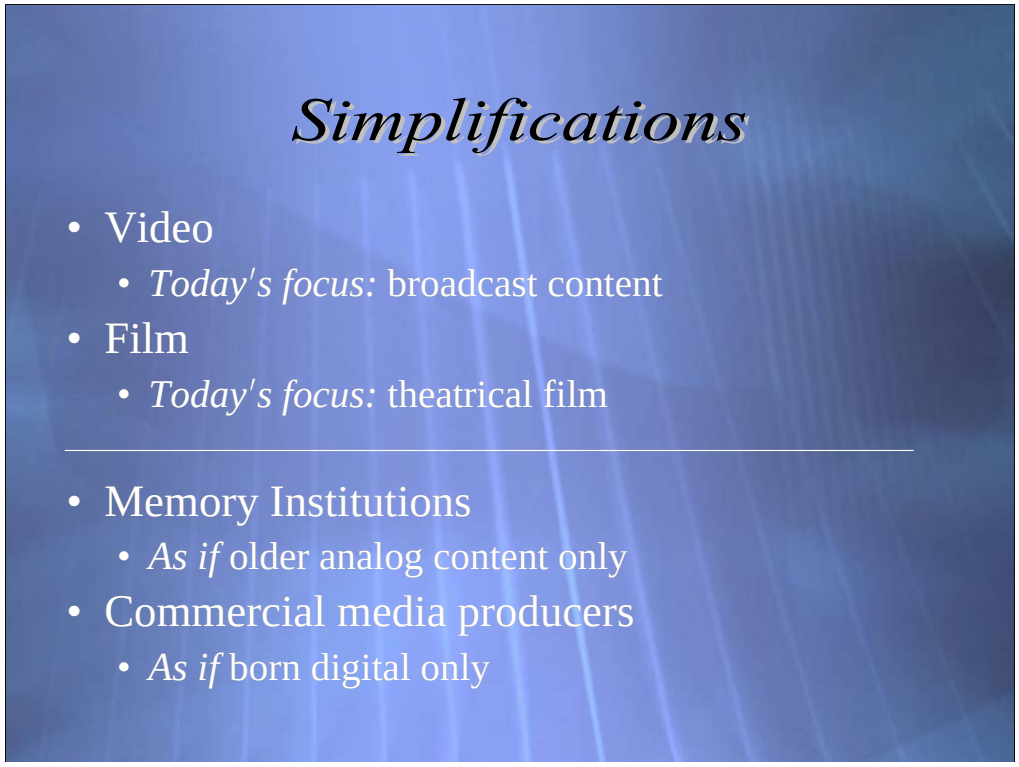
I'd like to give you a snapshot of current activities that bear on sound recordings, video recordings, and film.

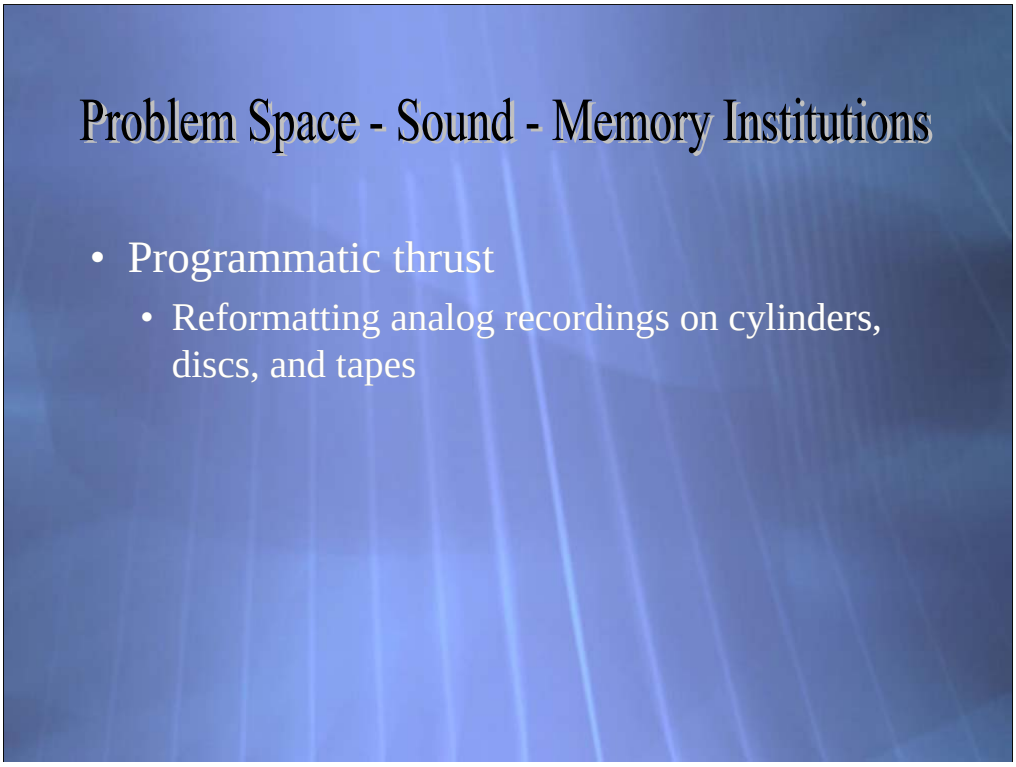
I'll spend more time on sound than video or film, partly because digital practices are more fully realized for sound, and partly because some issues and solutions that pertain to sound also pertain to video and film.

I'll also spend some time on born digital content. Most memory institutions are focused on older content, but born digital is part of everyone's future, very much so for the Library of Congress and the National Digital Information Infrastructure and Preservation Program, or NDIIPP, as we call it.



This topic is complex and I have made some simplifications for this short talk. For video, I focus on broadcast content; for film, on content for theaters.

In addition, I characterize memory institutions--public sector libraries and archives--as if they only reformatted older analog content, and I characterize commercial record labels, broadcasters, and movie studios as if they confronted only born-digital content.



I'll start with sound recordings and memory institutions.

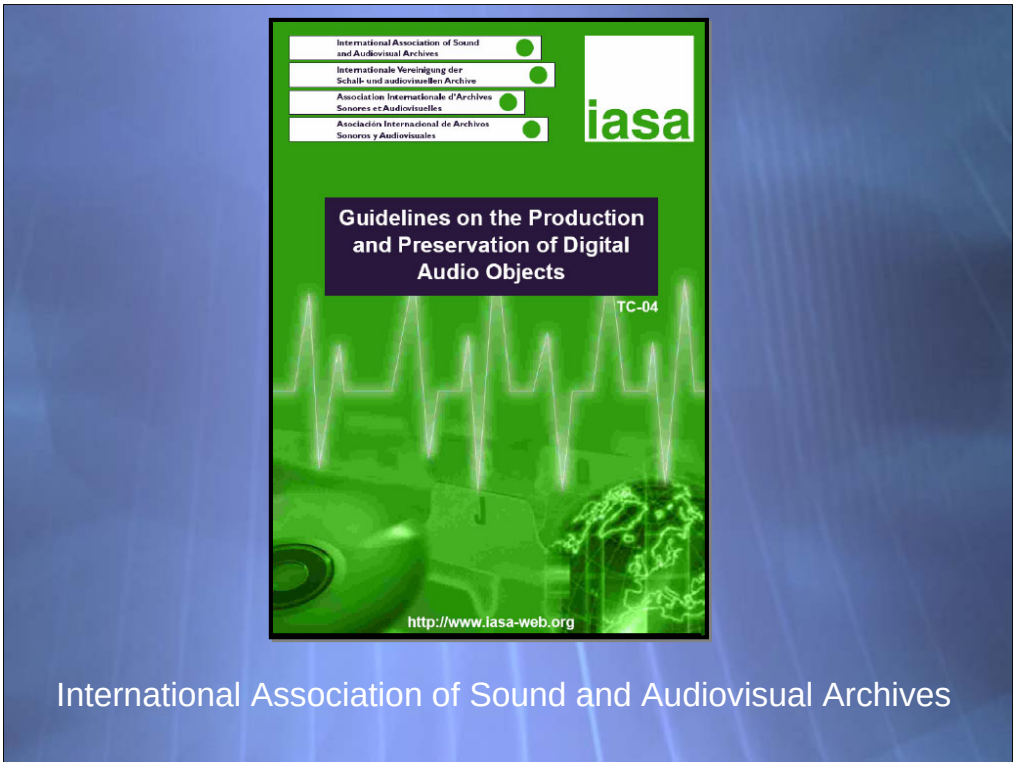
In my simplified picture, their business is reformatting older analog recordings on cylinders, discs, and tapes.

Transcription disk on Keith Monks cleaning device
M/B/RS lab, Library of Congress

This source material is absolutely central, challenging to play back with some items in deteriorated condition.

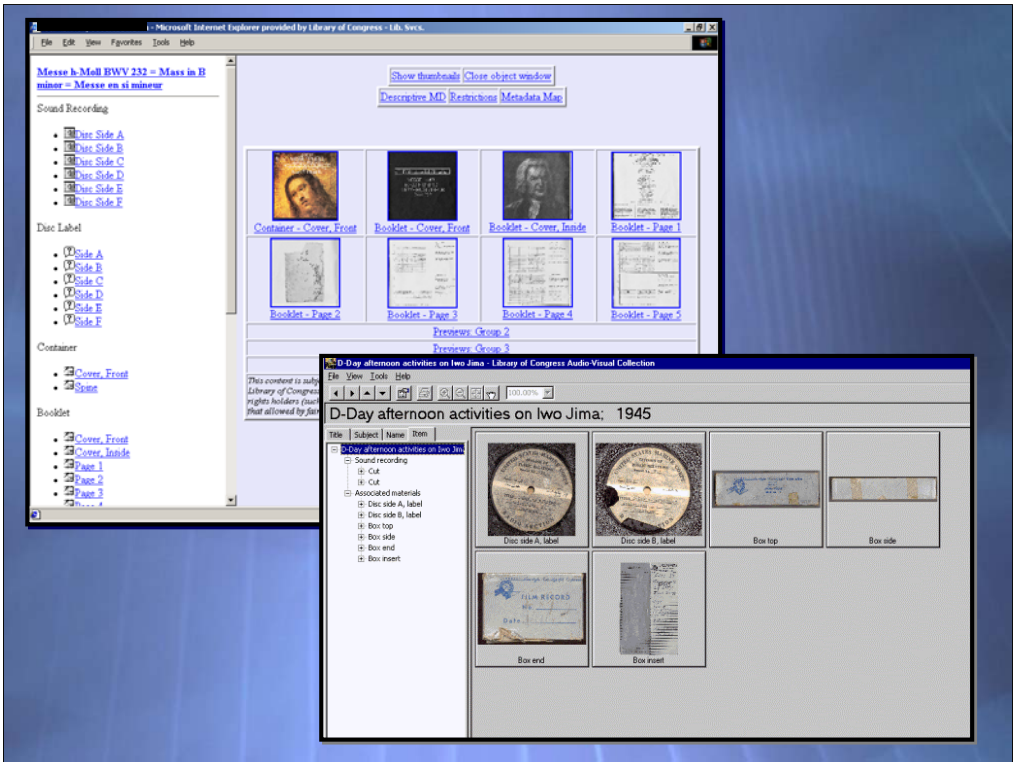
http://www.dlib.indiana.edu/projects/sounddirections/

Mike Casey, the lead audio engineer at the Indiana University Archives of Traditional Music, said, “Playback is the most critical part of the preservation chain.” Casey is a key member of the *Sound Directions* project, executed by Indiana and Harvard, funded by the National Endowment for the Humanities.

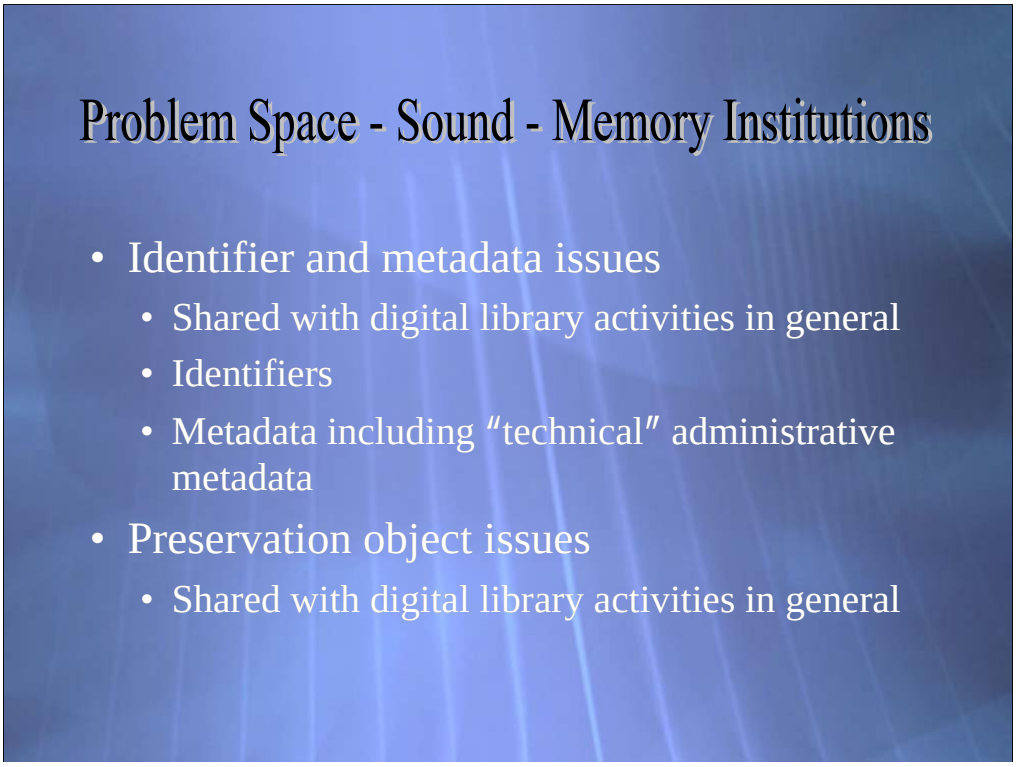


Digital transfer is also part of the problem space -- goals for audio preservation are provided by the IASA: they call for an *unaltered* copy of the original.

Preservation workflows have other desired features. High throughput, for example, will be central to the new Library of Congress National Audio-Visual Conservation Center (NAVCC).



Another part of the problem space has to do with the structure of typical items. Some sound items are singular but many are multipart: a disc with two sides and labels and a box to be imaged, or a longer item in segments.



Some parts of the audio problem space are ubiquitous in the digital library environment:

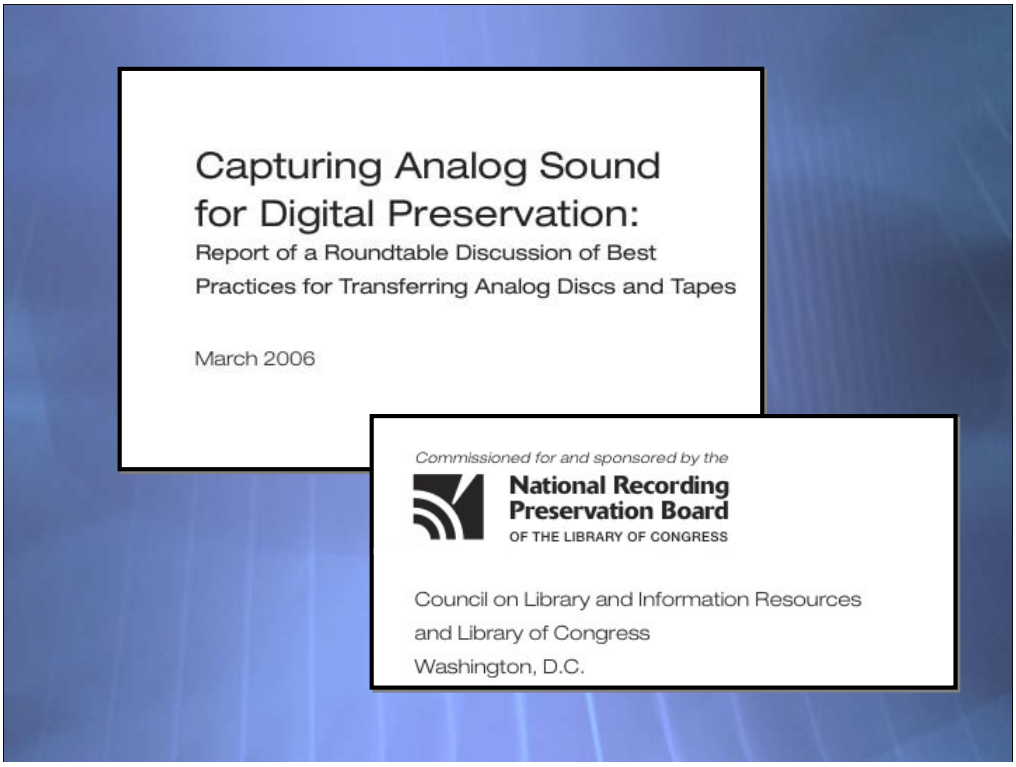
identifiers,

metadata, including administrative metadata tailored to each form of content,

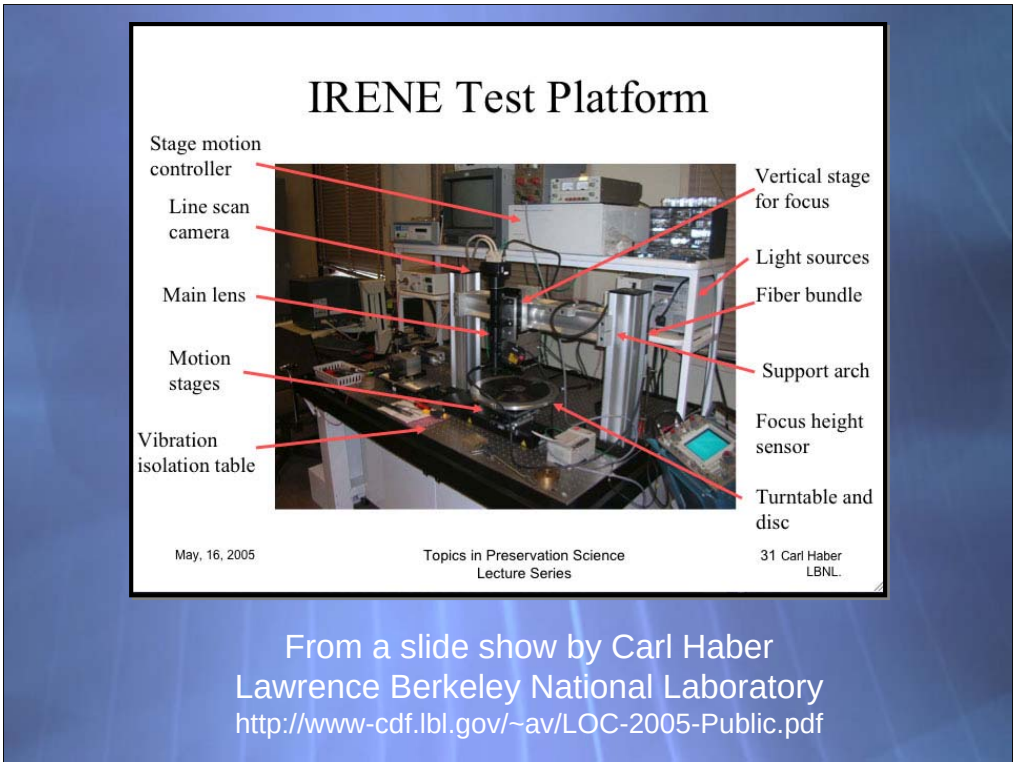
and the packaging of preservation objects for a repository.

What strategies and solutions have memory institutions developed? First and foremost is the general acceptance of digital files as preservation masters for sound. The production of analog preservation tapes has pretty much stopped.

The creation of an unaltered copy depends upon correct playback. How much of this is art, and how much science? Mike Casey named a few science items, including the calibration of equipment and starting the process of picking a stylus by examining an old disc with a microscope. But the importance of art brought him back to the engineer's *ears* and experience: "We would not use student labor to do playback."



A recent report published by CLIR offers good information on playback. This study was sponsored by the National Recording Preservation Board, based at the Library of Congress and administered by the Motion Picture, Broadcasting, and Recorded Sound Division (M/B/RS).



From a slide show by Carl Haber
Lawrence Berkeley National Laboratory
http://www-cdf.lbl.gov/~av/LOC-2005-Public.pdf

Meanwhile, this division is testing the IRENE optical system for extracting sound from discs—nothing physical touches the disc—still in its early development.

The preferred computer file formats include WAVE, its variant called Broadcast WAVE, and Apple’s AIFF. Inside the wrapper, there is a consensus in favor of linear Pulse Code Modulated encoding, *linear PCM*, and for very high resolution preservation masters, typically sampled at 96 kilohertz with a word length of 24.

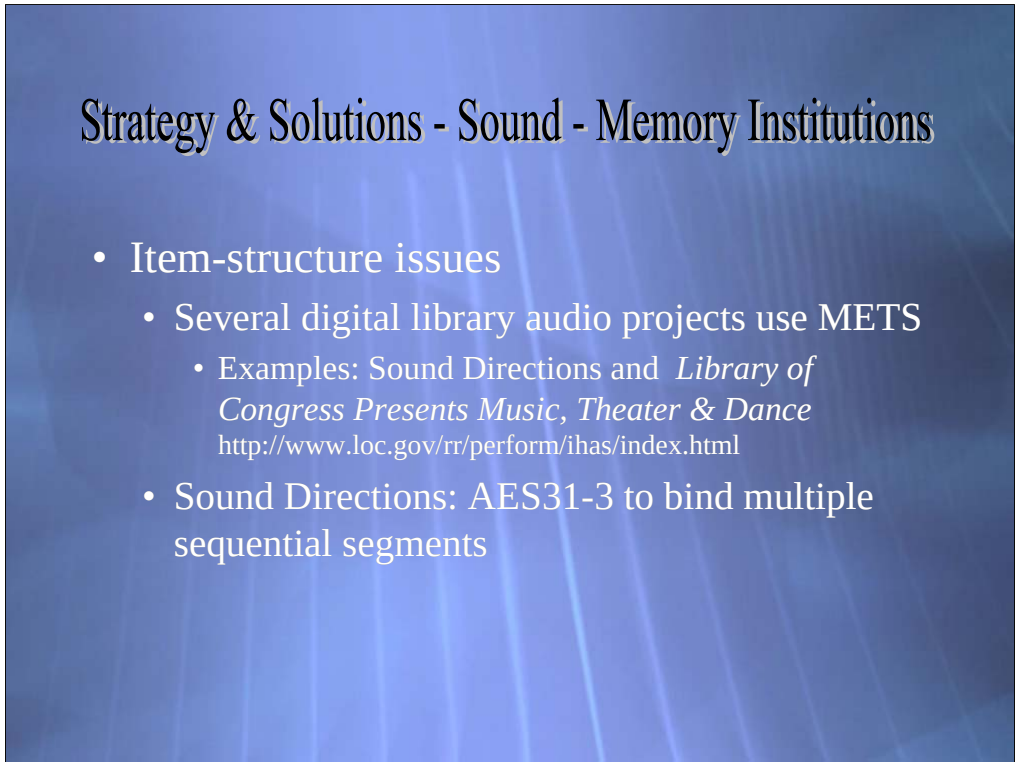
Roughly speaking, LPCM encoding can be thought of as the audio equivalent of an uncompressed image bitmap.

Strategy & Solutions - Sound - Memory Institutions

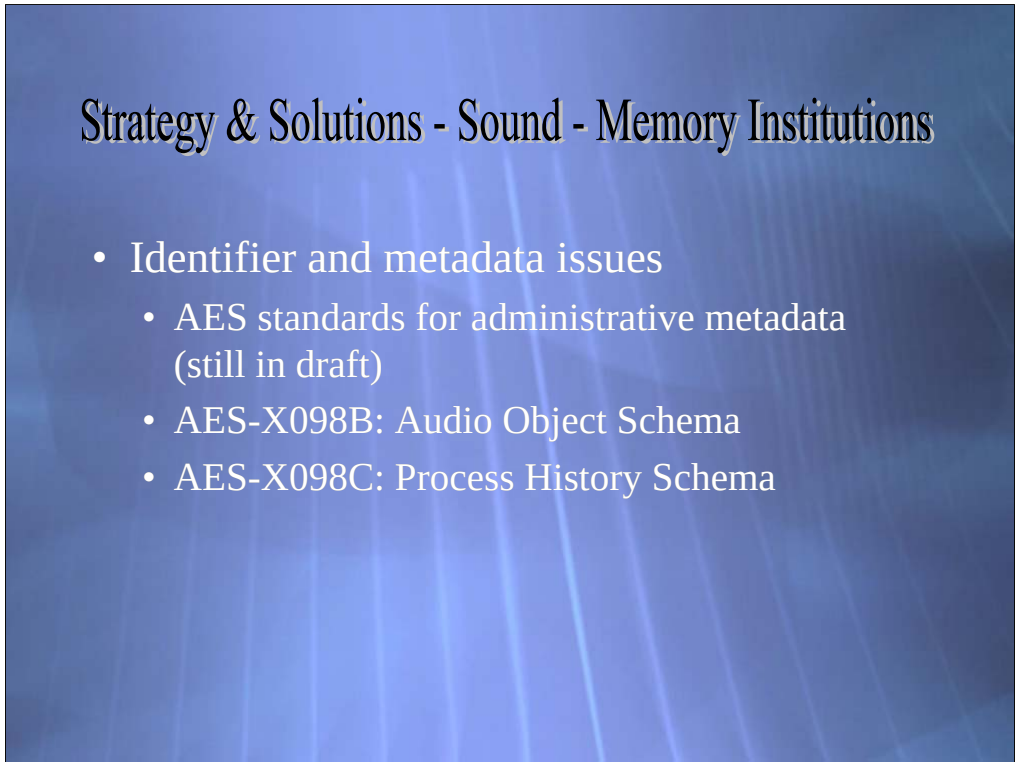
- Digital transfer issues
  - Professional gear, esp. A-to-D converter

  - More . . . .
    - Quality review
    - Sound Directions produces two masters at high resolution: preservation master (unaltered) and production master (reduced noise, reassembled segments, etc.)
    - High-volume, efficient production via parallel streams still very exploratory

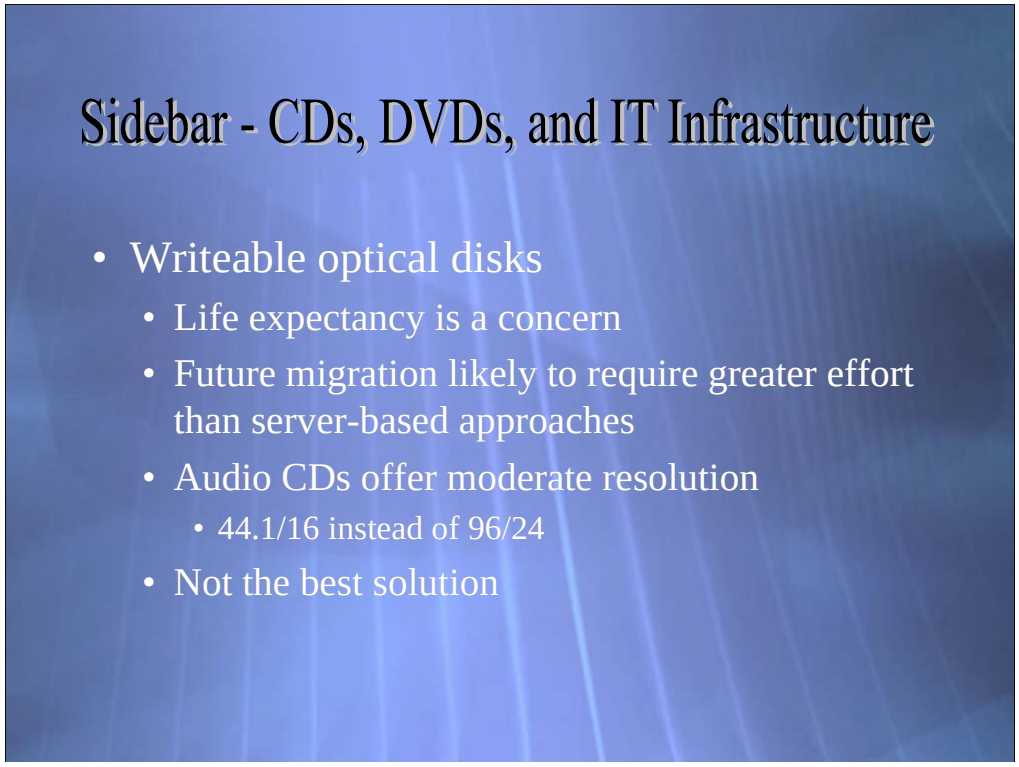
Professional devices are as important as the engineer's ears, and the most important of these is the analog-to-digital converter. High end professional models tend to be external, not built into a workstation. There is more to say about transfer, no time today . . . .



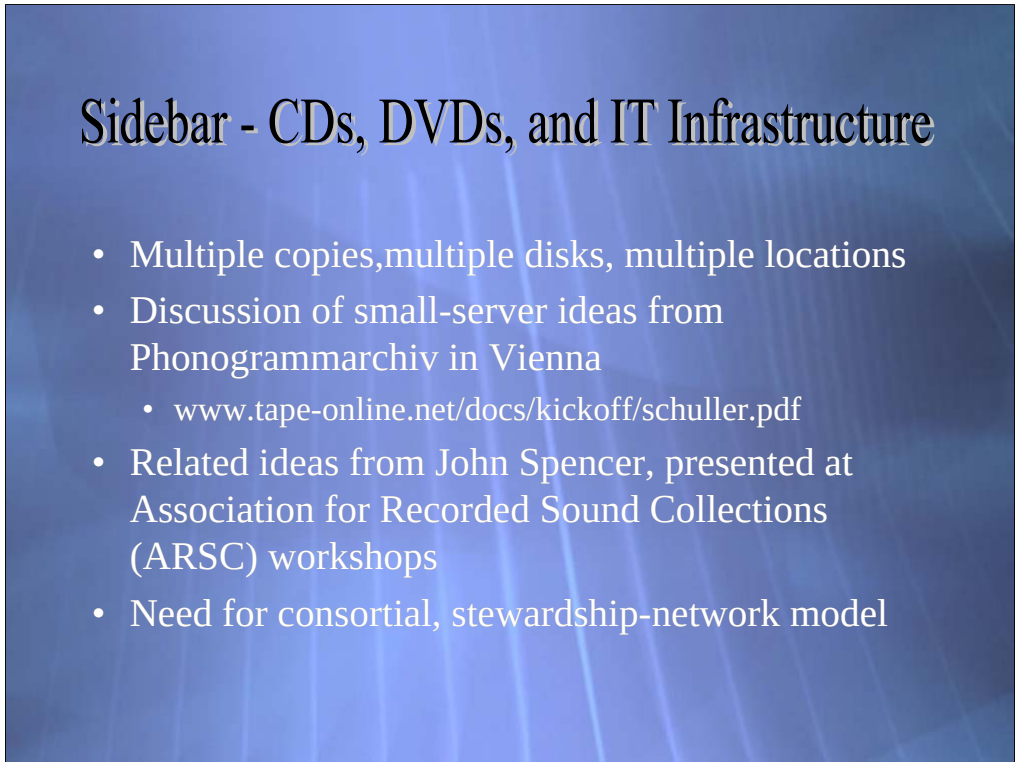
Sound Directions packages its content using METS, with subsidiary use of AES31-3 from the Audio Engineering Society to bind (or virtually bind) segments into a single, continuous recording.



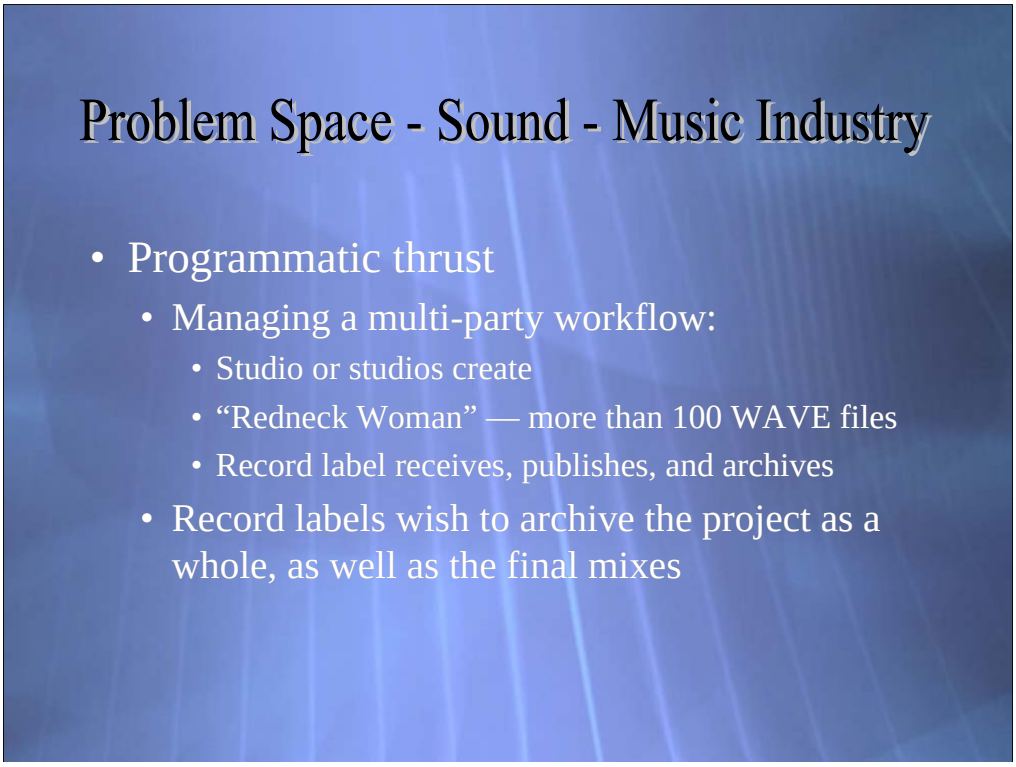
AES metadata is also in play. Sound Directions, like the prototyping effort I directed a few years ago, makes use of two draft AES standards for administrative metadata: *audio object* and *process history*, what METS calls *digital provenance*. These specifications owe a great debt to Dave Ackerman from Harvard, also on the Sound Directions team.



These big projects put content onto servers in a robust information technology infrastructure. But not everyone has this, and some archives have put their audio masters on compact disks or DVDs. But writeable CDs and DVDs have a relatively short life expectancy and future migrations will be labor intensive. Audio CDs have a second drawback: they only support moderate levels of resolution.



What's a small archive to do? Careful use and storage of redundant disks is always wise. Meanwhile, Dietrich Schüller of the Phonogrammarchiv in Vienna has written about what he calls "personal" Digital Mass Storage Systems. There is clearly a need for consortial networked support for preservation, a topic being investigated by NDIIPP at the Library of Congress.



For the music industry, the problem space is a little different. For one thing, there are multiple parties in the production process. To create a CD, an independent producer may record and then mix the tracks, building a *project* that may include hundreds of files. The project is delivered to the label that publishes and archives the content.

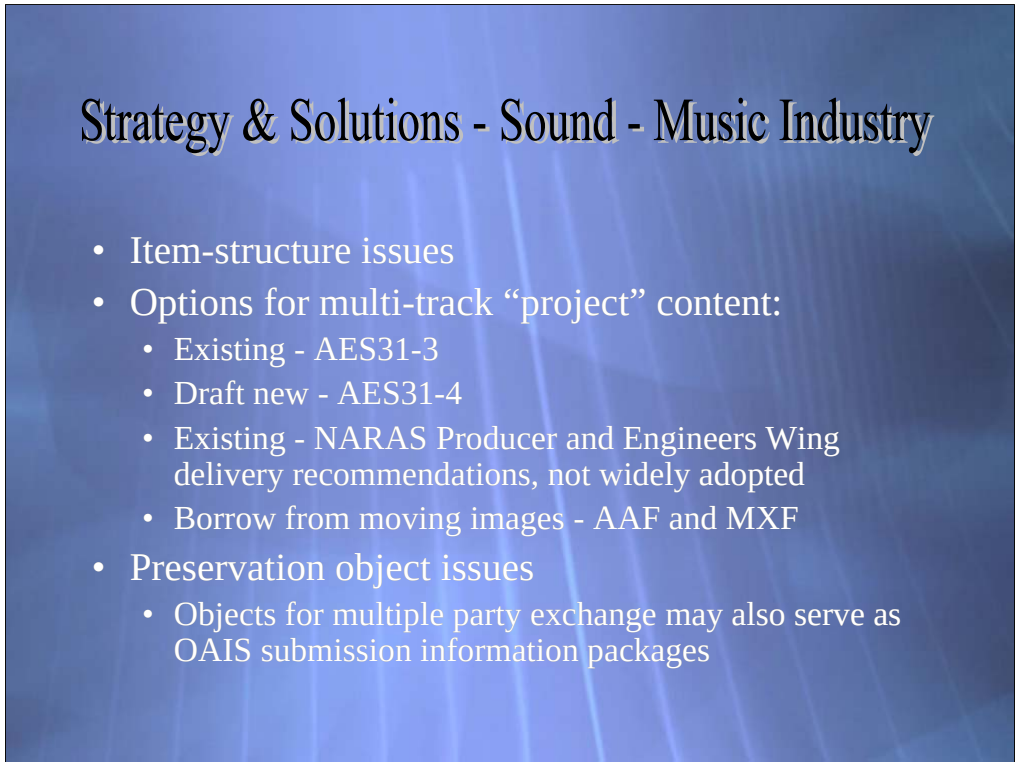
Strategies for the music industry? They archive the digital content as created, joining memory institutions in embracing high resolution LPCM encoding, wrapped in WAVE or Broadcast WAVE. However, there is also some use of DSD encoding.

Strategy & Solutions - Sound - Music Industry

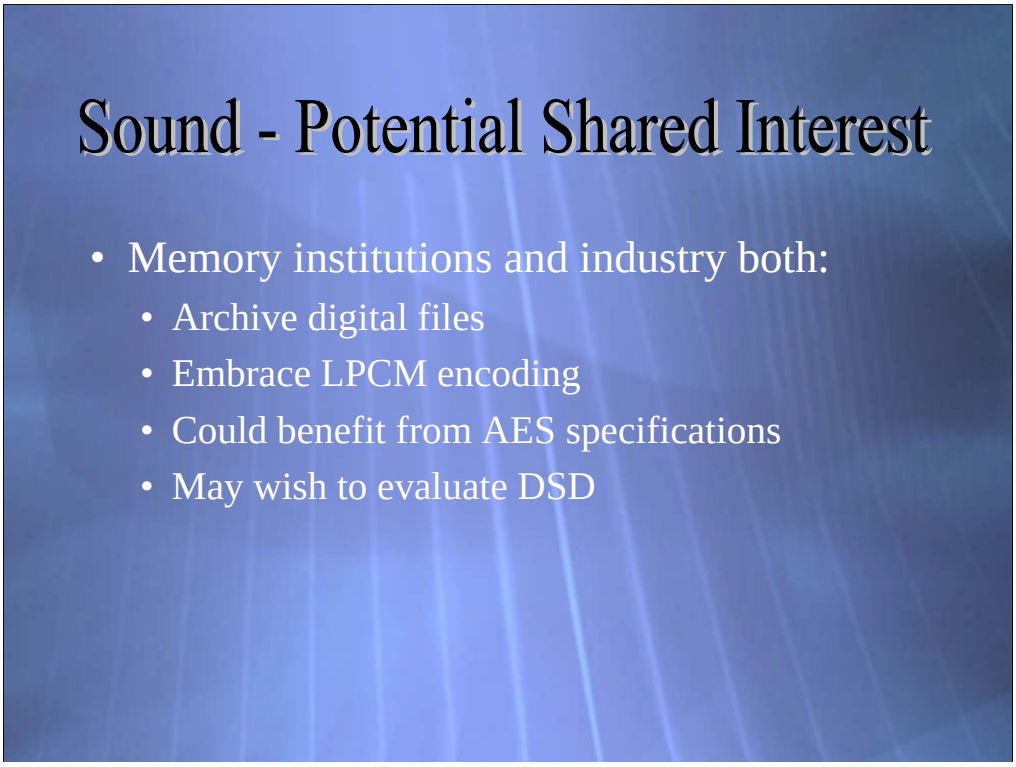
- Identifiers for commerce:
  - GRid for "releases"

  - ISRC for "tracks" (individual recordings); iTunes requires ISRC

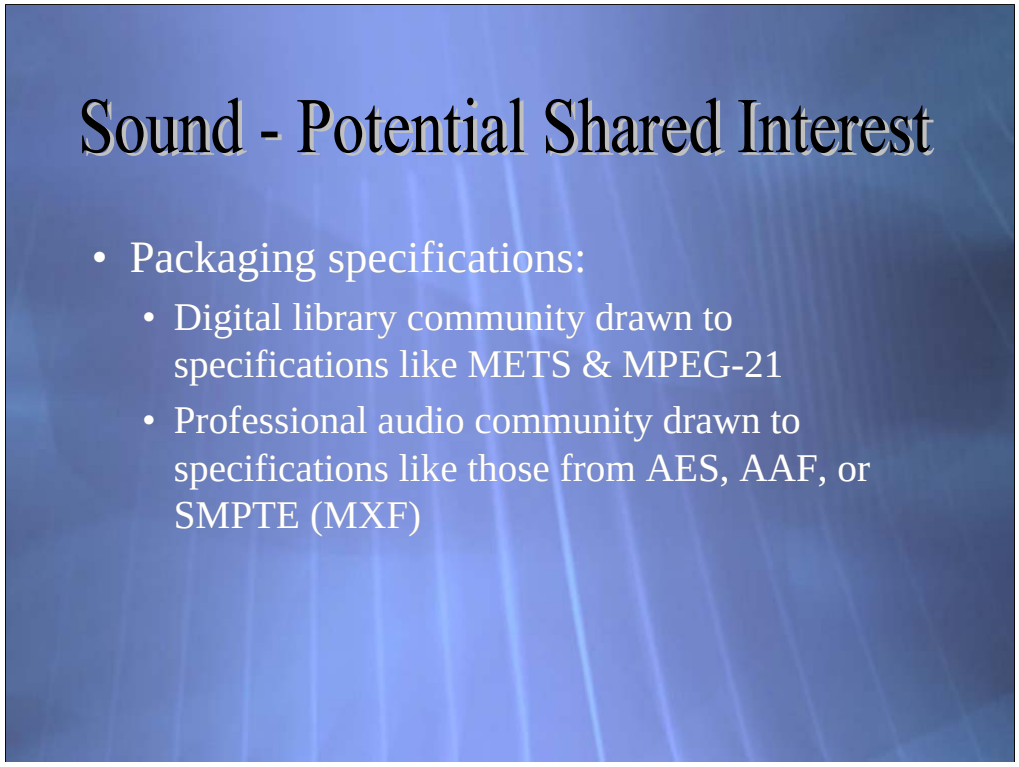
The industry also has identifier schemes to support commerce and to track licensing. These specifications are new, however, and may not be widely implemented.



The adoption of packaging options for multi-track content is less settled. I gather that AES31-3 is not sufficient in and of itself, so there is talk of AES31-4. There is also talk about the AAF and MXF formats initiated by moving image folks. However it gets done, objects packaged for industry exchange are likely to be suitable as preservation packages.

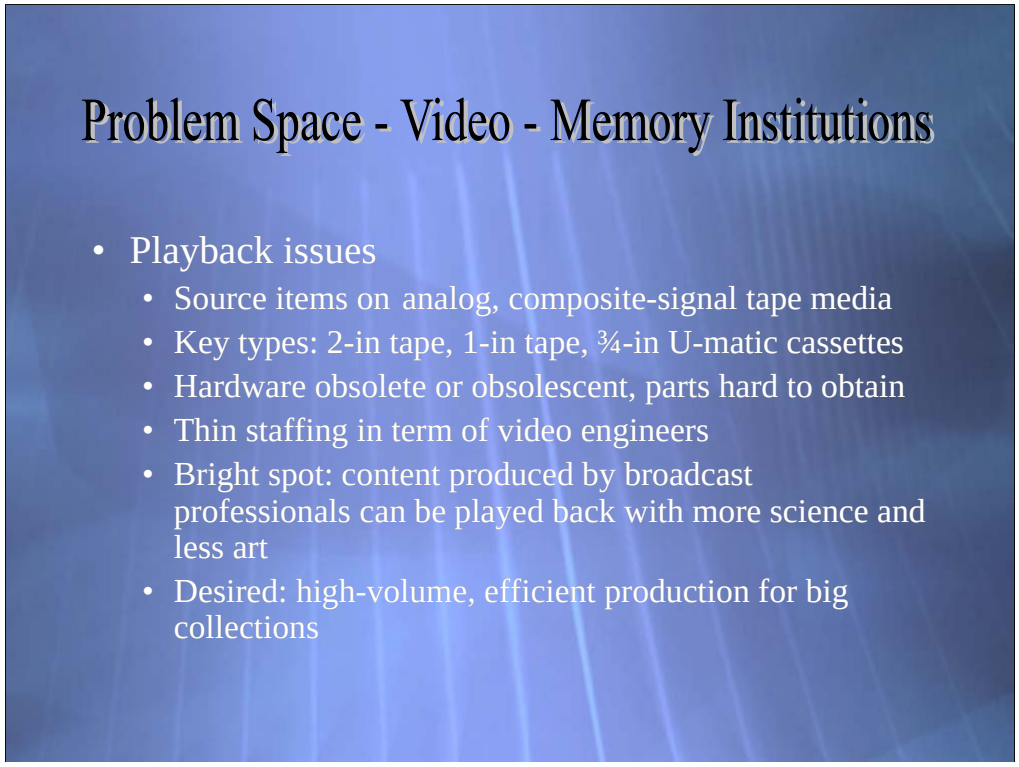


I have mentioned some synergies between memory institutions and industry: digital-files that contain LPCM encoding, a potential role for metadata standards from AES, curiosity about DSD encoding.



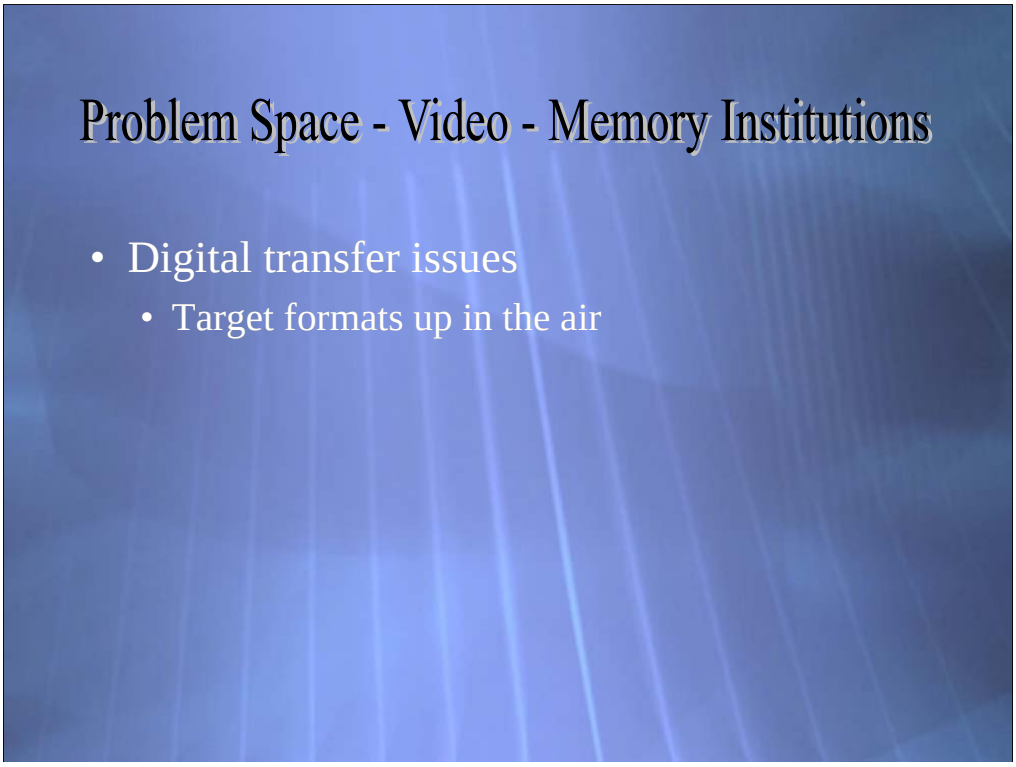
Should we work together on packaging? The digital library community is drawn to METS or MPEG-21, while the professional audio community is drawn to specifications like those from AES, AAF, or SMPTE. These are not exactly in conflict . . . but neither are they "the same." What the recording industry does is a matter of considerable interest for libraries and archives that receive content from outside, as LC does through copyright deposit.

Video. The memory institution problem space for video also features reformatting older content.

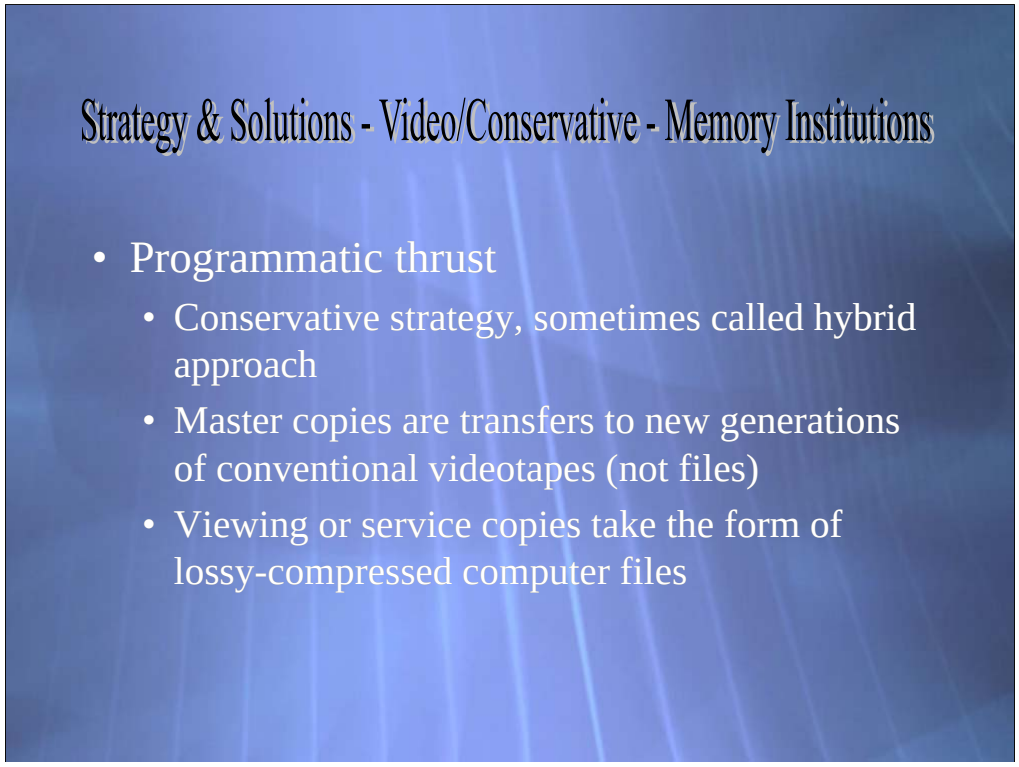


Most holdings consist of analog *composite* videotapes. Many types of tape players are no longer manufactured and parts are hard to find. Specialized engineering knowledge is needed to maintain equipment.

One bright spot for archives with holdings of broadcast content is the legacy of FCC engineering rules; these tapes play back with a bit more science and a bit less art.



But what to copy to? Target formats--whether a new generation of videotape or a digital file--are somewhat up in the air.



On the solution side, there are two strategies afoot in memory institutions. At the Library of Congress, the American Folklife Center recently acted out the conservative solution for a collection of half-inch PortaPak videotapes from the 1970s. The master copy was made on videotape, while the viewing copy took the form of a computer file: a hybrid approach.

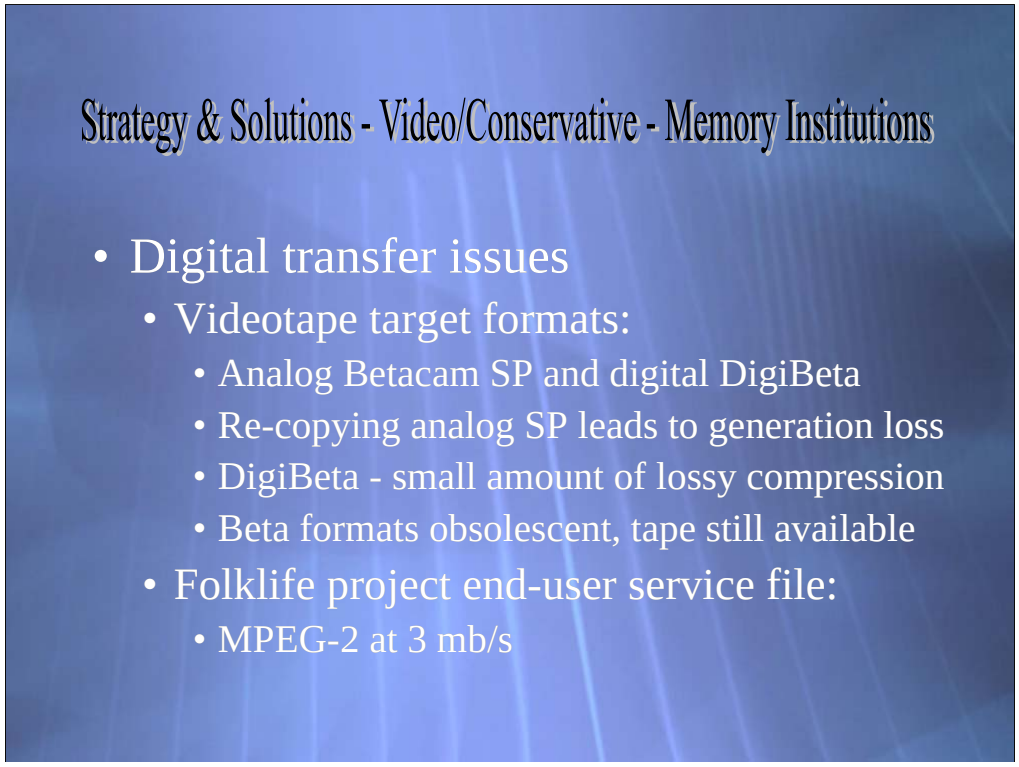
Strategy & Solutions - Video/Conservative - Memory Institutions

- Playback issues
  - Compared to audio, more frequent use of outsourcing
  - Some archives purchase and maintain old hardware

From 1961: Ampex VR-1000-B 2-inch quadruplex VTR

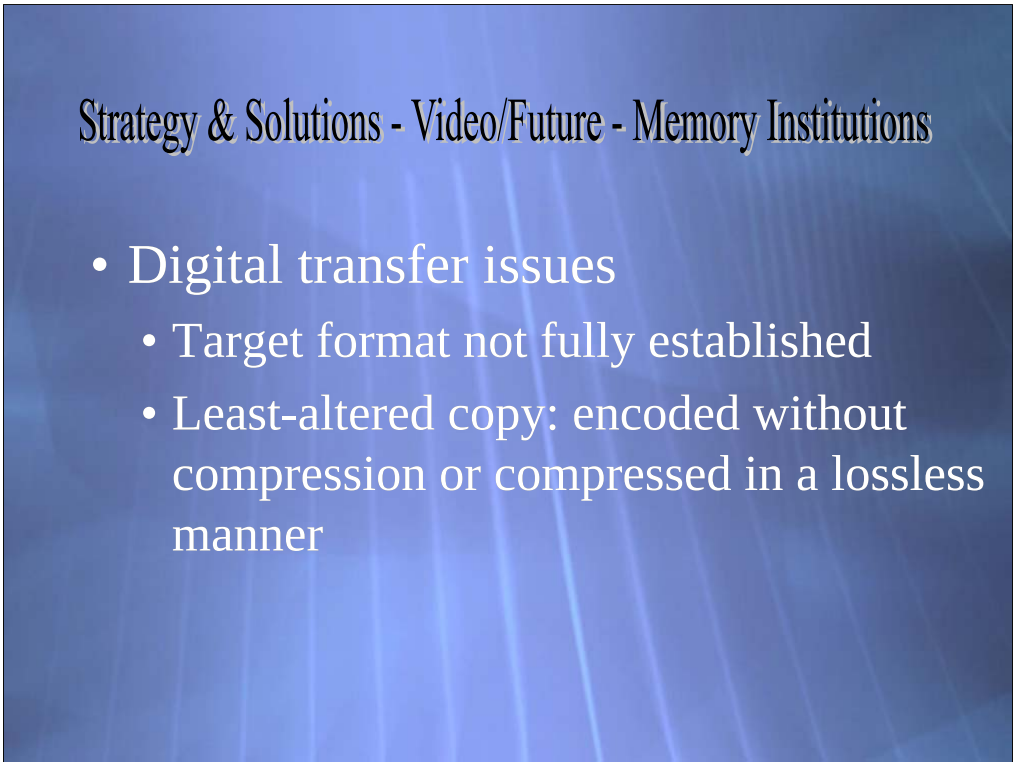
Image from Wikipedia

To address the problem of obsolete equipment and missing engineers, the Folklife Center outsourced their job.

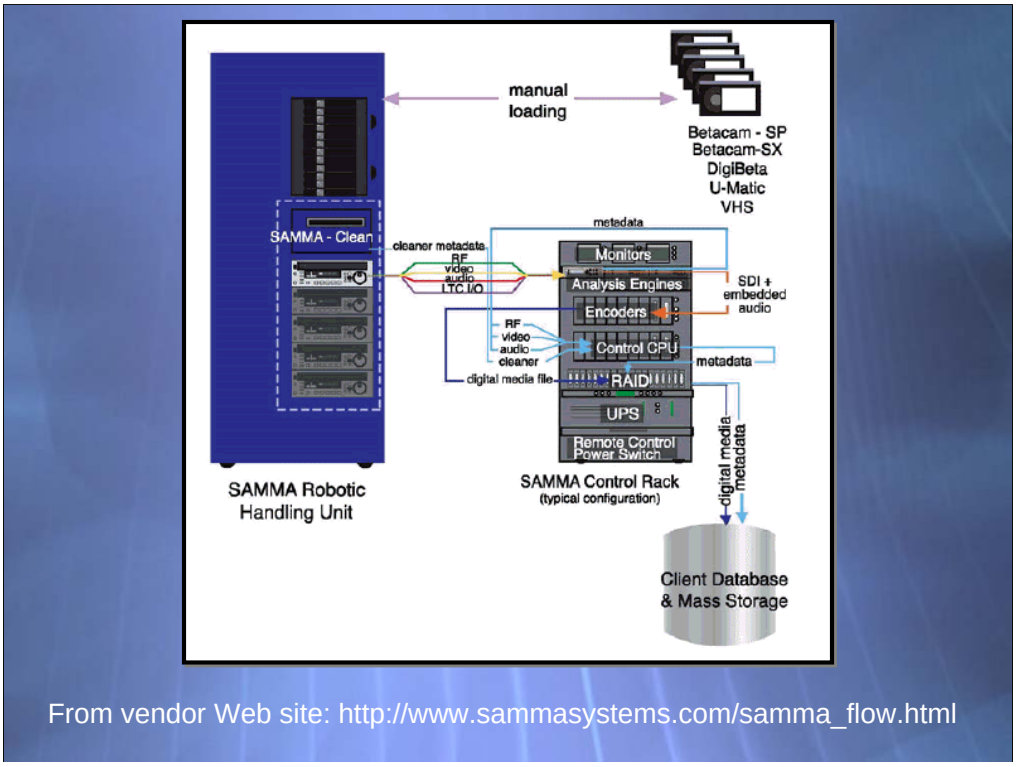


The target videotapes for most hybrid projects are analog Betacam SP or digital DigiBeta. Neither is perfect; Beta SP is analog (you get generation loss in future migrations) and DigiBeta includes a small amount of lossy compression. The Folklife Center hedged their bets by making copies on both types.

Making a videotape as the preservation master is today's conservative approach but memory institutions also foresee a future in which they produce an exceedingly high quality digital file as a preservation master.



Ideally, the target format ought to contain uncompressed or losslessly compressed data. The leading advocate for this approach is Jim Lindner.



From vendor Web site: http://www.sammasystems.com/samma_flow.html

His company, Media Matters, is developing a system called SAMMA that can be configured to produce preservation *tapes* in a hybrid mode or to make *files* as the master copy.

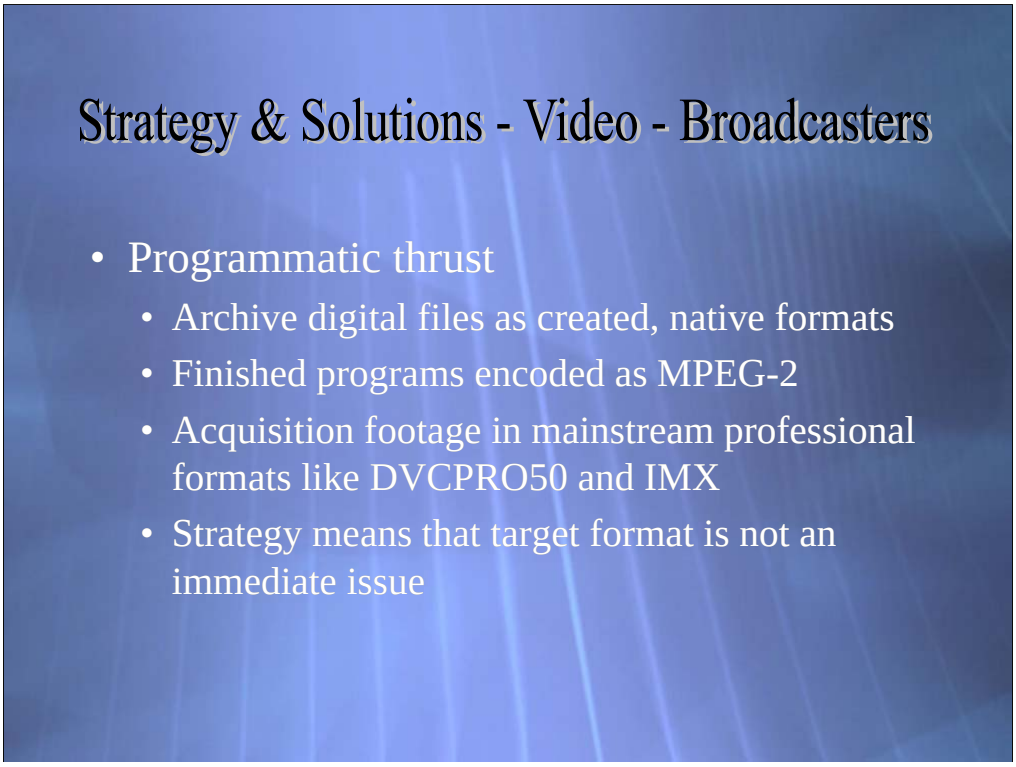
In the file-making configuration, the system applies lossless JPEG 2000 compression to each frame of video. These frame images and an accompanying soundtrack object are then wrapped in MXF or Motion JPEG 2000. Each hour of video comes to something like 25 GB.

This technology will soon be field tested by the Library's planning team for the National Audio-Video Conservation Center. One virtue of the copying system is that it can play back three or four tapes in parallel, thereby increasing throughput.

What is the problem space for broadcasters? My insights come from my work with the public television team in an NDIIPP partnership project.

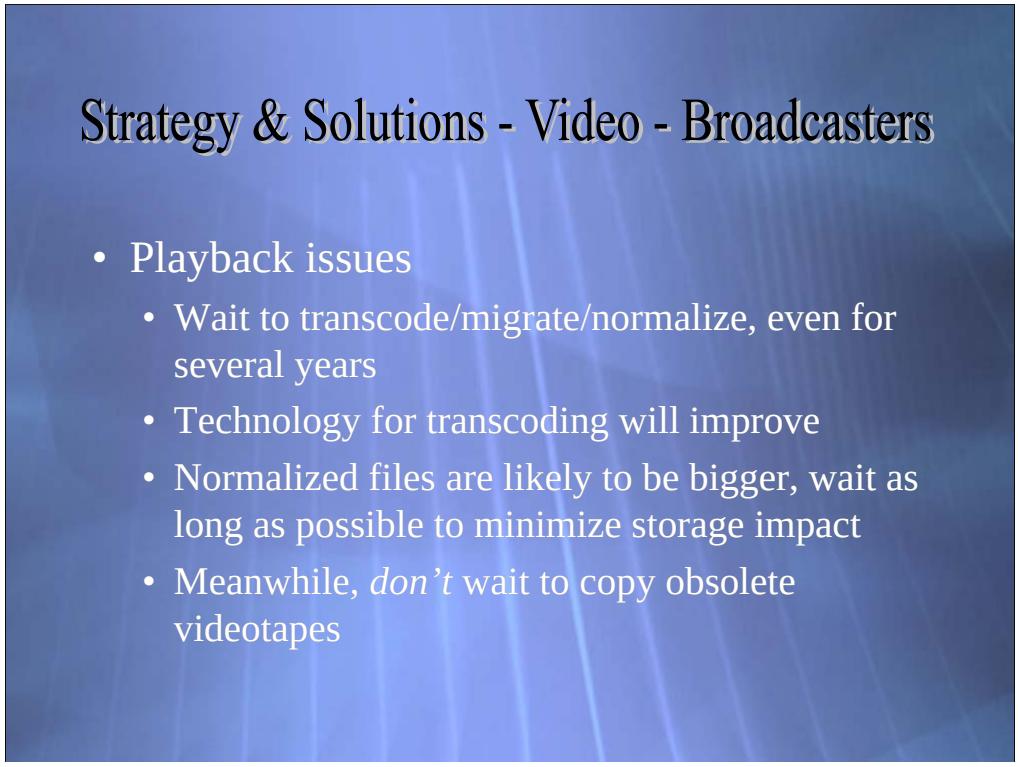
For broadcasters, slowly but surely, cameras move into a no-tape mode for the *acquisition* of footage. And the *post-production environment* is now largely file based. Producers wish to archive both the finished programs and the acquisition footage, which has stock shot value.

There are no particular playback problems: the formats and playback systems are both of the here and now.



Solution strategy? The public television broadcasters articulate a file-based approach, but one that differs from the future file-oriented strategy for memory institutions. The public television project team plans to hold their content in native formats.

Finished programs generally end up with MPEG-2 encoding, which is specified for broadcast under the new digital television rules. Acquisition formats vary but, for broadcasters, generally fall into professional categories.



It is not that transcoding will never be needed: their position is that it is not needed now. If files are normalized to, say, an uncompressed video bitstream or a set of compressed JPEG 2000 frames, the size increases significantly. Why transcode now, they ask, when the native compressed formats are good for a few more years? Then we will have better transcoding tools and storage will be cheaper.

Regarding older videotapes, however, these experts agree with memory institutions: obsolete tape formats need to be copied (and thus transcoded) now.

In the NDIIPP-funded project, wrapper and packaging formats are a focus. Industry-wide, the AAF and MXF formats are beginning to be adopted, and some vendor systems include them.

AAF and MXF are flexible and variable--you might compare them to PDF; you can make a lot of subtypes. The smart move is to develop profiles--what MXF calls an *application specification* or *AS*--a set of rules that governs the specifics for your implementation.

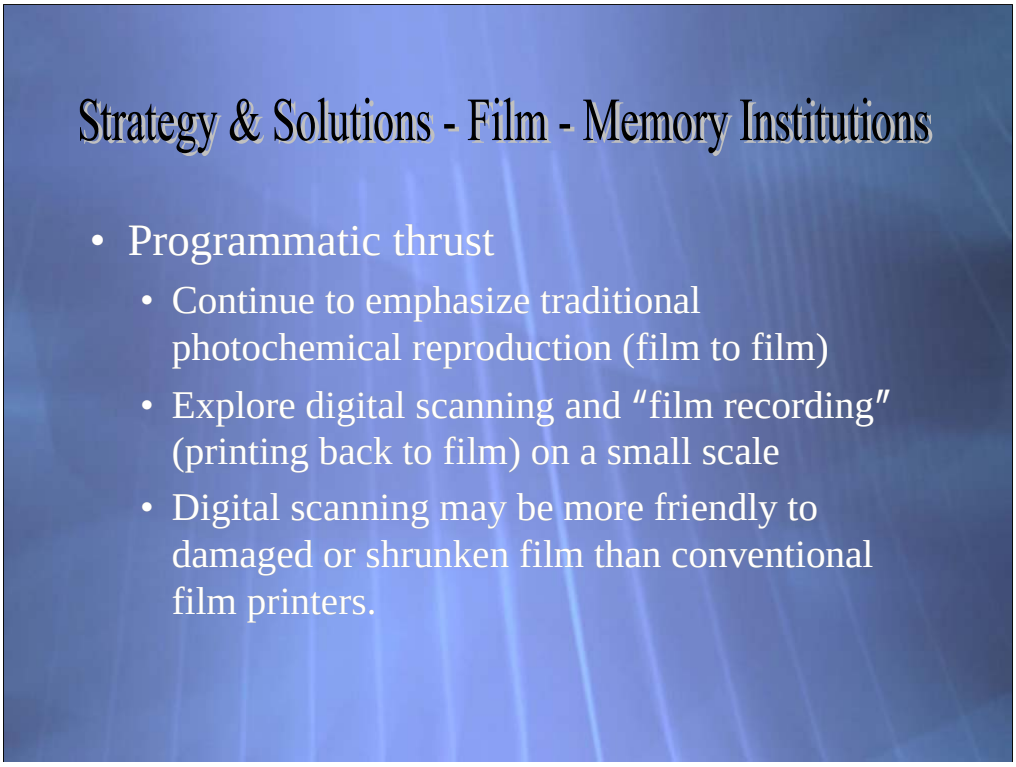
PBS is developing application specifications; one of these could define a package for submission to a repository.

Public television descriptive and administrative metadata is defined in the PBCore schema, now in the early throes of implementation. Meanwhile, in the commercial broadcast sector, SMPTE has provided a *registry* of metadata terms, but no discrete schema comparable to the AES specifications mentioned earlier.

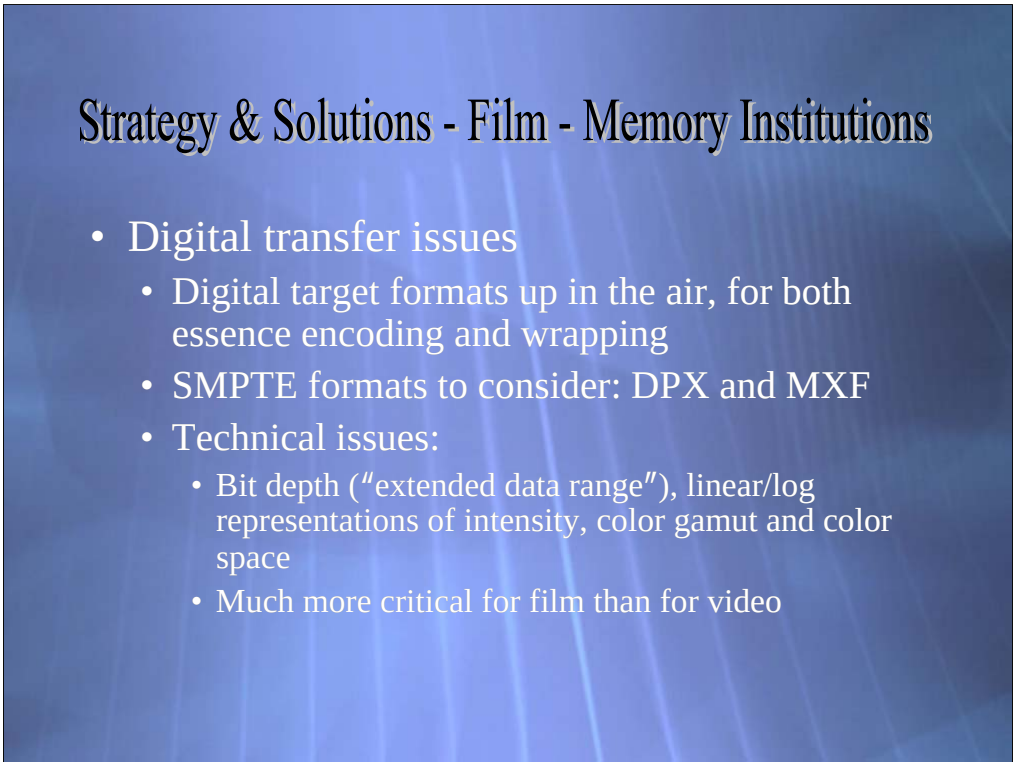
Where might memory institutions and industry make common cause? Perhaps wrapping and packaging. Broadcasters see AAF and MXF as exchange objects that are reasonably complete. At the same time, digital library folks may see these objects as filling the niche occupied by TIFF for images or WAVE for sound recordings: as parts of larger digital objects further defined by METS or MPEG-21.

Meanwhile, another common concern is administrative metadata, certainly the techy sub-category.

Now, regarding film. For memory institutions, we again have older historical content that can be difficult to play back; for example, nitrate originals.



At the Library of Congress--like other memory institutions--photochemical film-to-film reformatting continues to carry the day: film stock and equipment can still be purchased. In the background, there is a modest exploration of digital reformatting.



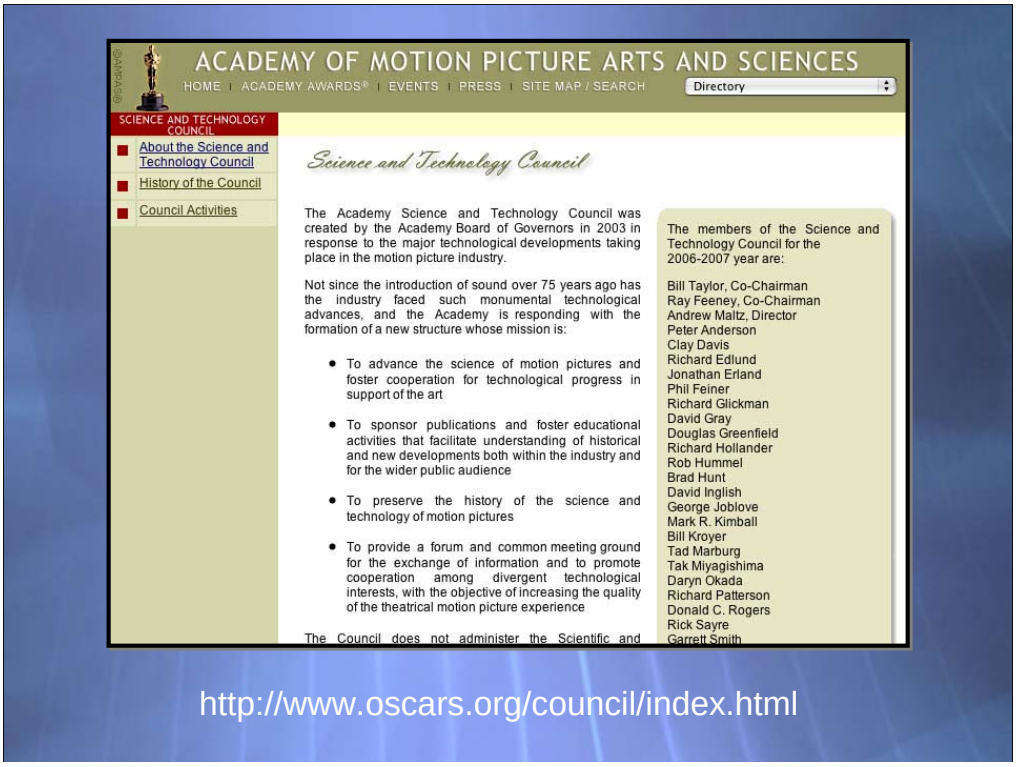
But there are uncertainties about the essence bitstreams and the file wrapper, and about the representation of density and color. The result is that public-sector film archives play a waiting game for now.

The contrast with Hollywood is striking, where some production processes and virtually all post-production are digital. Even if film goes through the camera, it is scanned once back in the lab. No longer is camera negative lovingly spliced to produce film printing masters. Today’s film printing masters emerge at the end of a digital production line.

Soon, even film printing masters will no longer be required. Distribution to theaters is moving to high resolution digital. The development of the DCI specification included sophisticated analyses of resolution and color space, necessary for successful theatrical projection.

The move to digital has produced anxieties for industry archivists: the formats used in post-production digital mastering are proprietary and obsolescent. And production outputs are extensive: the digital harvest from *Superman Returns* came to 200 TB.

Looking at the strategy and solution side, the most fully realized packaging scheme is the digital cinema distribution specification, developed by the DCI industry group and now being standardized by SMPTE.

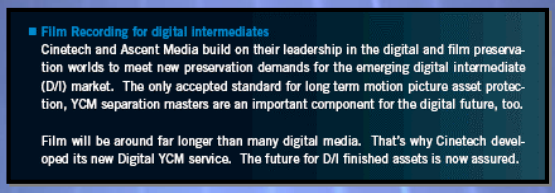


http://www.oscars.org/council/index.html

Meanwhile, the Academy of Motion Picture Arts and Sciences is examining the preservation of production and mastering materials.

Strategy & Solutions - Film - Commercial Producers

- Digital transfer issues
  - Uncertain about long-term accessibility of the digital master, studios or other producers print back to YCM separations on film



Advertising brochure from Cinetech: "*new Digital YCM service*"

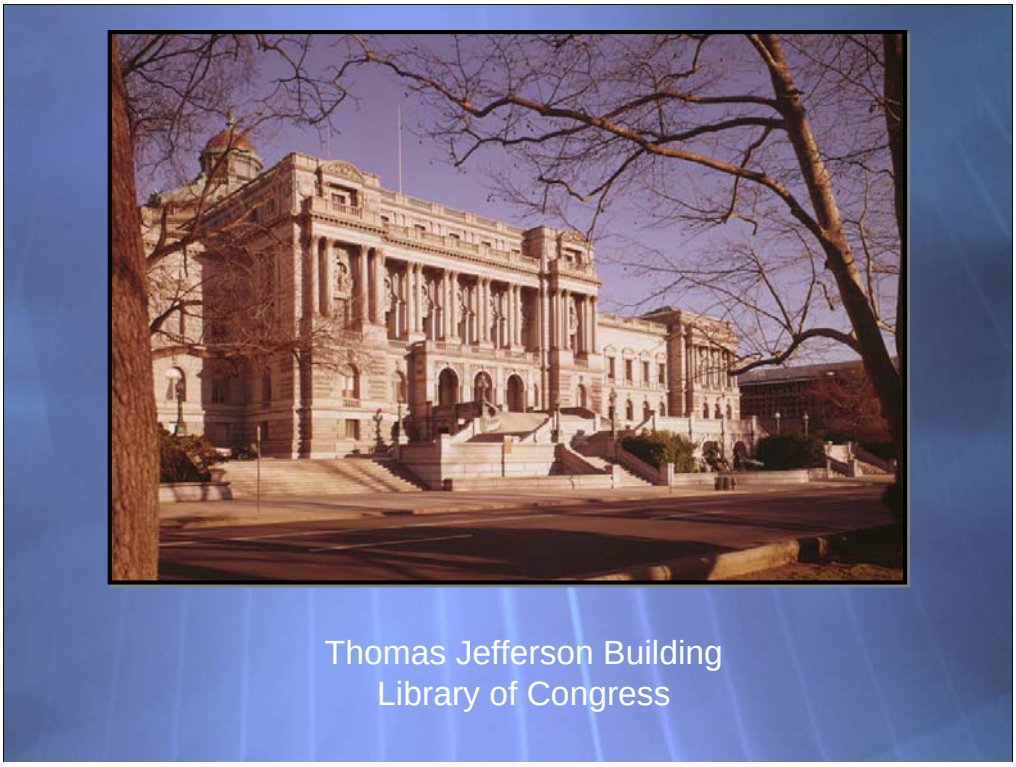
www.ascentmedia.com/solutions/onesheets/Cinetech%20restoration-F.pdf

Given the uncertainties, most studios output their digital masters not only as film printing elements but also as a trio of on-film color separations that can be archived in the conventional manner--a hybrid approach, if you will.

Shared topics? I believe that the industry's investigation of digital technologies in general has been and will continue to be instructive to memory institutions.

Will standardized encoding formats emerge in the industry for mastering elements or for camera footage? Will such encodings be appropriate for memory institutions? What can be learned from the industry's investigation of resolution and color?

Are the packaging concepts applied to digital cinema distribution more widely applicable?



For film, as for sound and video, I think archives and industry have common interests. Making the inter-community connections, however, may not be easy--and that's a topic for another day. Thanks for listening today!