

Basic Concepts and Principles of Audiovisual Preservation

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October 16, 2013
Connection to Collections Online Community
Webinar Series: Caring for Audiovisual Material

Audiovisual Material: Slow Fires, part II

The nearly worldwide adoption of alkaline-buffered paper is cause for much optimism about the prospects for greatly extended life expectancies of the published record in the future.

In contrast to the clear successes of paper preservation, it is now obvious that magnetic audiotape and videotape and acetate-based films are the great preservation challenges of the twenty-first century.

---Paul Conway, "Preservation in the Age of Google: Digitization, Digital Preservation, and Dilemmas," *Library Quarterly* (2010)

Challenges of Maintaining Obsolete Audiovisual Media

- Noncurrent or niche formats
- Paucity of players
- Increasingly limited options for reformatting
 - Digital reformatting is often the best solution for most materials (audio and video)
 - Film-to-film copying is often cost-prohibitive and may be difficult to do soon in the wake of decreasing availability of film stock
- Reliance on vendors for conservation and reformatting for many institutions
- Are these heritage objects with intrinsic values or just "containers" for content? It depends ...

Outline for Today's Webinar

- Physical Composition and Vulnerability of Audiovisual Materials
 - Motion picture film
 - Analog audio formats
 - Wax cylinders and discs
 - Magnetic media (open reel tapes and cassettes)
 - Analog video formats (magnetic media)
 - Open reel tapes
 - Cassettes
- Controlling Deterioration and Damage through Appropriate Storage Environments and Handling
 - Enclosures
 - Environmental conditions
 - Particulate matter (dust), fingerprints, foreign matter
 - Control of magnetic fields (for magnetic carriers) and light sources to limit damage to materials
 - The importance of using well-maintained inspection and replay equipment

Physical Composition and Vulnerabilities of Audiovisual Media

Vulnerabilities of Audiovisual Media

- Chemical deterioration ("natural aging")
 - e.g. Hydrolysis of film base (nitrate and acetate)
 - e.g., Hydrolysis of magnetic media (sticky shed syndrome)
 - e.g., Acetate disc deterioration (hydrolysis of coating, made of nitrocellulose lacquer plasticized with castor oil)
- Mechanical deterioration
 - Stresses from temperature and relative humidity fluctuations
 - e.g. Warping of vinyl discs in high temperatures
- Biological deterioration (mold, mildew, and pests)
 - e.g., Wax cylinders susceptible to mold due to organic material used in manufacture

Physical Composition and Vulnerabilities

Motion Picture Film

Four Common Film Gauges



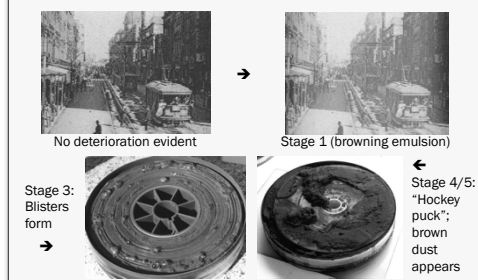
Common Motion Picture Film Gauges and Bases

- Film in the United States is usually one of these varieties:
 - 35 mm (pre-1951) = cellulose nitrate
 - 35 mm (1951-present) = cellulose triacetate
 - 35 mm (1980's-present) = polyester
 - 16 mm, 8 mm, Super 8 = triacetate (some early 16mm on cellulose diacetate)
- You may also find these other less common smaller gauge films
 - 28 mm (1912, nitrate)
 - 9.5 mm (1922, diacetate), 17.5 mm (1917, nitrate), 22 mm (1911, diacetate)

Chemical Deterioration: Motion Picture Film (Nitrate)

- Stage 1 = Fading of silver image, brownish discoloration of the emulsion, "rotten egg" smell.
- Stage 2 = Base becomes sticky
- Stage 3 = Film becomes soft and blisters, "honey" appears at the top of the roll.
- Stage 4 = Film congeals into a solid mass (or "hockey puck").
- Stage 5 = Base disintegrates into a pungent reddish brown dust.
- In stages 1, 2, and 3, some parts of the roll may still be salvageable.

Stages of Nitrate Deterioration



Chemical Deterioration: Motion Picture Film (Acetate)

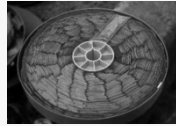
Diacetate or Triacetate

- "Vinegar syndrome" —hydrolysis reaction
 - Embrittlement (loss of flexibility)
 - Shrinkage (as much as 10%), leading to "channeling," where the emulsion separates from the base
 - Autocatalytic point = 1.5 (measure of the amount of "free acidity" in the film base); film deterioration accelerates rapidly once it reaches this point
- Loss of plasticizers

Vinegar Syndrome Attacks!

Top photo:

Early signs of vinegar syndrome = spoking (evidence of channeling)

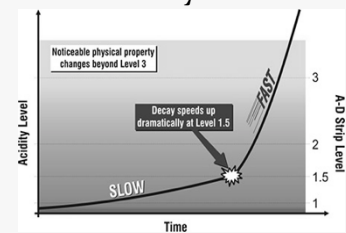


Bottom photo:

Late stage of vinegar syndrome (film shatters)



Acetate Deterioration and the Autocatalytic Point



Two Ways to Monitor Acetate Deterioration



- A-D Strips
 - Made by Image Permanence Institute
 - Allow you to rate levels of acid vapor present in the can



- Molecular sieves
 - Made by Kodak and others
 - When placed in cans, they absorb and reduce acid vapor, thus keeping film from reaching the autocatalytic point.

Inspection: Motion Picture Film

- Identifying information
- Length
- Film stock manufacturer and date of manufacture
- B&W or Color (if color, what type?)
- Silent or Sound (if sound, what system?)
- Gauge
- Nitrate, Diacetate, Triacetate, or Polyester
- Generation
- Language of Soundtrack or Titles

Inspection: Motion Picture Film

- Damage
 - Scratches (emulsion or base)
 - Perforation damage
 - Projector oil and dirt
 - Shrinkage
 - Color fading
- Number of splices
- Type of perforations
- Deterioration
- Any other information about the film that is important

Questions?

Physical Composition and Vulnerabilities

Analog Audio Formats
(Wax Cylinders and Discs)

Identification: Sound Recordings

- o Cylinders and discs
 - o Wax cylinders
 - o 78's
 - o LP's
 - o 33 1/3 rpm
 - o 45 rpm

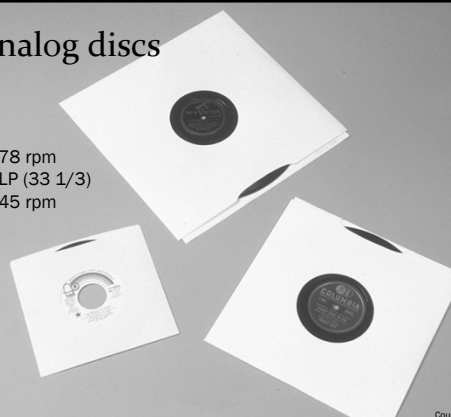
Identification (Sound): Wax Cylinders



- o Very fragile, cracks easily;
- o Should be rehoused (original container, as shown here, is notorious for promoting growth of mold).

Analog discs

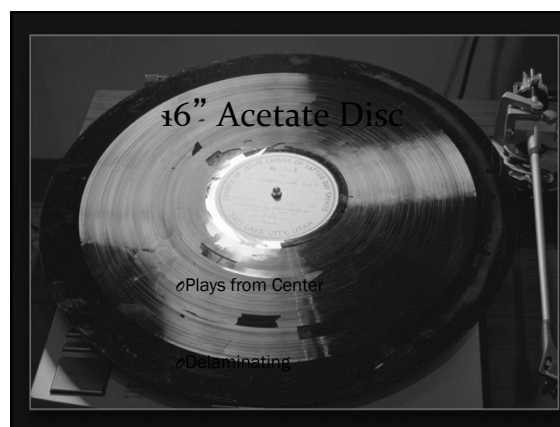
- 78 rpm
- LP (33 1/3)
- 45 rpm



Courtesy of GSU

Deterioration: Discs

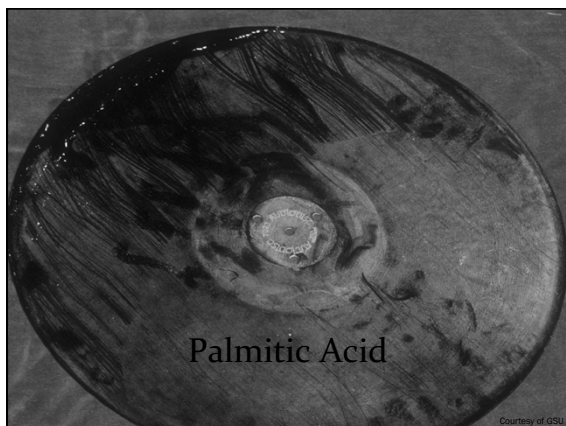
- o Acetate or lacquer discs (a.k.a., "instantaneous" discs)
 - o Least stable type of sound recording, due to plasticizer leaching from acetate coating
 - o Powder residue
 - o White specks or small, pasty (moist) mounds on the groove surface
 - o Palmitic acid
 - o Similar to powder residue
 - o Crystallized (dry) white specks or small mounds on the groove surface



16" Acetate Disc

o Plays from Center

o Delaminating



Deterioration: Discs

- Shellac discs (78's)
 - Discs become embrittled over time (resulting in a powder residue)
 - Filler is susceptible to mold.
- Vinyl LP's
 - Most stable material used for disc sound recordings
 - But ... made from PVC which degrades when exposed to high temperatures.
- Compact Discs
 - Susceptible to "laser rot" and delamination of the inner layers of the disc.

Inspection: Sound Recordings

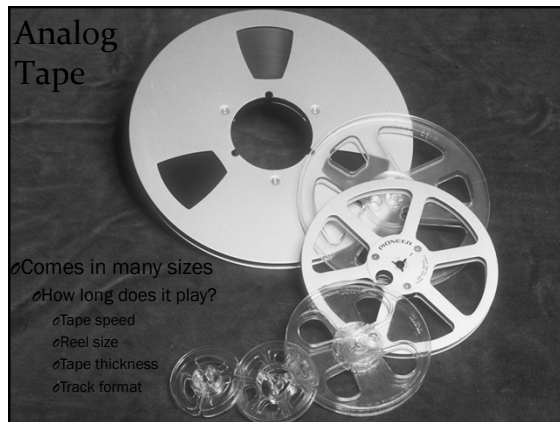
- Cylinders and Discs
 - Title/Content
 - Size
 - Disc, cylinder, film?
 - Monaural or stereo?
 - Vertical or lateral grooves?
 - Speed?
 - Running time (minutes)
 - Tin foil, lacquer, aluminum, copper, silver, gelatine, paper, wax, bitumen, vinyl?

Inspection: Sound Recordings

- Cylinders and Discs
 - Over-recorded or under-recorded?
 - Worn?
 - Warped?
 - Grooves: broken or shallow?
 - Scratched, cracked, or broken?

Physical Composition and Vulnerabilities

Analog Audio Formats
Magnetic Media
(Open Reel Tapes and Cassettes)





Philips Compact Audio Cassette

- Most problems solvable by changing shell
 - 5-screw shells are easy to disassemble
 - Sonic-welded shells are very difficult to disassemble



Courtesy of GSU

Analog Tape: What's it Made from?

- Oxide Layer Emulsion
 - Iron Oxide (rust)
 - Binder (glue)

Iron Oxide (rust) in Binder (glue)

Base: Acetate or Polyester

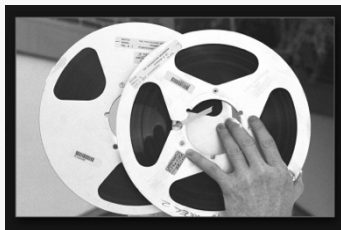
- Base
 - Paper (very rare)
 - Acetate (translucent)
 - Polyester (=Mylar™)

Deterioration: Magnetic Media

- Audiotape (and videotape as well)
 - "Sticky shed" (hydrolysis of the binder)
 - Affects both open reel tape and cassettes
 - High-pitched squealing on playback
 - Significant loss of oxide material over area played
- "Vinegar syndrome"
 - Affects cellulose acetate tape (open reel audiotape only)
 - Pungent vinegar odor (acetic acid)
 - Buckling, shrinking of material
- Mold
 - White/green/yellow/blue fuzzy specks
 - Mold/mildew smell

Identification of Acetate Tape

- Acetate Tape is Translucent
- Polyester Tape is Opaque



Common Mistake: handling 1/4" tape on hub

Do Not handle tapes without reel flanges (sides)!

Acetate Tape: Common Ailments

- Dimensionally unstable
- Grows/shrinks with humidity



Aged Acetate Cupping and skewing



Acetate Tape: Common Ailments

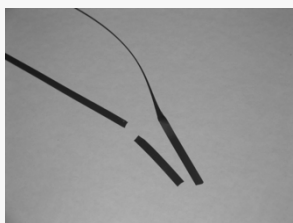
- Dimensionally unstable
 - Grows/shrinks with humidity
- Brittle
 - Breaks easily
- Vinegar Syndrome
 - Breakdown causes vinegar-like odor
 - Gets worse faster and faster
 - Contaminates surrounding media
 - Ultimately makes tapes too sticky to play
- Lubricant failure
 - No known cure

Polyester Tape: Basic Traits

- Opaque
- Handles nicely
 - "Flows" nicely in machine
 - Easily cut & spliced
- Dimensionally stable in environment
- Lubricants rarely fail
- Much higher fidelity than acetates
- Does not break (it stretches!)

Acetate vs. Polyester Tape

Acetate tape (left) breaks
stretches Polyester tape (right)

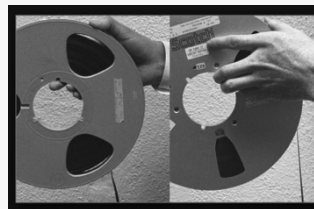


Sticky Shed Syndrome:

Quick way to identify

Tape should come off reel smoothly (as on right)

On left tape
sticks to
next layer



Results of Playing Tapes Afflicted with Sticky Shed



Inspection: Sound Recordings

- o Tape
 - o Title/Content
 - o Reel size
 - o Footage
 - o Running time?
 - o Full, half, or dual track?
 - o Original, master, or duplicate?
 - o Speed (ips= inches per second)
 - o Monaural or stereo?
 - o Tape width
 - o Polyester, acetate, or paper?

Inspection: Sound Recordings

- o Tape
 - o Over-recorded or under-recorded?
 - o Print-through?
 - o Oxide peeling?
 - o Warped?
 - o Splices?
 - o Dirty?

Physical Composition and Vulnerabilities

Analog Video Formats
(Open Reel Tapes and Cassettes)

Videos Come in Many Flavors!



Identification: Video Recordings

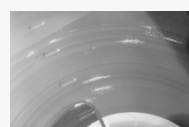
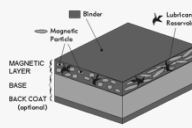
- o There have been over one hundred types of videotape formats in the last sixty years!
- o Many formats look very similar and can only be differentiated by:
 - o Width of tape
 - o Clues found on the housing
- o Check this site to familiarize yourself with the most common formats:
o <http://www.arts.state.tx.us/video/identify.asp>

Identification: Video Formats



- Left: Two Betacam sizes (both are professional format) compared to VHS—which is the VHS? (lower right!)
- Right: Four different consumer formats used in camcorders

Videotape Problems



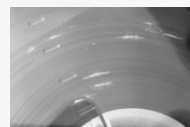
Inspection: Videotape

- Title/Content
- Tape width
- Cassette or open reel?
- Manufacturer of tape

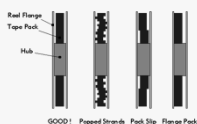


Inspection: Video Recordings

- Physical container (check for breakage)
- Odor?
 - Musty? = fungal infection
 - "Dirty socks" or "Waxy" = breakdown of the binder
- Visual evidence of fungal growth



Inspection: Video Recordings



- Tape pack
 - Popped strands, stepped pack, flange pack, pack slip, edge damage, cinching, and gaps in the pack
- Liquid or particulate contamination
- Tape degradation (white or crystalline powder, black or brown oxide)

Questions?

Controlling Deterioration and Damage

Appropriate Storage Environments and
Handling

Choosing the Right Enclosures and Shelving for Your Motion Picture Film

Containers

o Inert material preferred, such as:

o Polypropylene or polyethylene

o Non-reactive metal

o Acid-free cardboard (but be aware that it is not as sturdy as polypropylene or metal, and is not recommended for 16mm or 35mm gauges)

Shelving

o Metal, not wood!

Do's and Don't's of Motion Picture Storage



o Left photo:

o Vertical storage saves space but will warp your film over time!

o Right photo:

o Horizontal stacks will reduce stress on film.

Choosing the Right Enclosures and Shelving for Your Magnetic Media

Containers

o Polypropylene cases, if they can be found for your format.

o Acid-free cardboard containers may be used for obsolete formats when polypropylene is unavailable.

o Don't use those cardboard cases that often come with the tape!

Shelving

o Metal, not wood!

Do's and Don't's for Videotape Storage

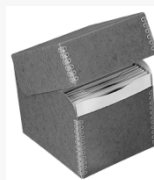


proper storage



improper storage

Audio Storage Do's



Temperature and RH Guidelines: Film

Type of Film	Type of Storage	Temperature	Relative Humidity
Nitrate	Medium-term Extended	40° F 32° F (frozen)	30-50% 20-30%
Acetate	Medium-term Extended	40° F 32° F (frozen)	30-50% 20-30%
Polyester (B/W)	Medium-term Extended	54° F 40° F	30-50% 20-30%
Polyester (color)	Medium-term Extended	40° F 32° F (frozen)	30-50% 20-30%

Temperature and RH Guidelines, Enclosure Recommendations for Audio Materials

Format	Physical	Climate	Handling
Grooved Discs	Stacked vertically in compartments	65-70° F 45-50% RH (+/- 10° F or 10% RH within 24 hour period)	By edges and labels only, gloves recommended
Wax Cylinders	In original containers, stored vertically	65-70° F 45-50% RH (+/- 10° F or 10% RH within 24 hour period)	By edges — avoid direct contact with playing surface.
Reel-to-Reel Tapes	Store vertically in sturdy dust-proof acid-free box, tape tail out (to avoid print through). Keep away from magnetic fields and heat sources.	65° F +/- 3° F 20-25% RH (+/- 5%)	By edges — avoid direct contact with playing surface.

Temperature and RH Guidelines: Videotape

Type of Storage	Maximum Temperature	Relative Humidity Range
Medium-Term	73° F	20%-50%
Long-Term	68° F 59° F 50° F	20%-30% 20%-40% 20%-50%

Do not freeze magnetic media!!

Acclimatization

- ◊ Avoid subjecting media types to rapid temperature changes.
- ◊ If storage and operating area temperatures differ by more than 15° F (8° C), allow an acclimatization time within the operating area of four hours for every 18° F (10° C) difference.

Particulate Matter and Other Contaminants

- ◊ Dust
 - ◊ Keep inspection and shelving areas clean, particularly when material is out of protective enclosures.
- ◊ Fingerprints
 - ◊ Cotton gloves can/should be used, particularly for motion picture film.
- ◊ Foreign matter (e.g., smoke, food/drink)
 - ◊ Needless to say, smoking is prohibited!
 - ◊ Past careless handling can leave such contaminants in collections, requiring a conservator's attention for proper cleaning and treatment.

Magnetic Fields and Light Sources

- ◊ Keep all magnetic tape away from magnetic fields. Don't stack tapes on top of equipment.
- ◊ Never leave open reel or cassette tapes exposed to the sun.
- ◊ Never leave motion picture film in the sun (particularly nitrate!).

Replay and Inspection Equipment

- All replay and inspection equipment should be clean and verified to be in working order/calibrated before attempting playback.
- Equipment should be cleaned frequently if material being inspected is actively deteriorating (e.g., sticky shed for magnetic media, deterioration of base for motion pictures, delamination of discs).
- Prefer gentle methods over more aggressive methods (seek out equipment that is known to be "easy" on materials).
- Professional quality equipment should be preferred over consumer-quality equipment when available.

Replay and Inspection (continued)

- Some inspection to identify materials can take place without playback equipment.
 - E.g., you don't need a projector to look at the first few feet of your film.
- Use physical evidence found on container and leaders whenever possible to identify and evaluate items without attempting playback.
- Full evaluation of material may require a conservator's expertise, depending upon the condition of the material.
- If material is actively deteriorating (strong smell, embrittlement, evidence of emulsion or oxide material flaking, delamination), is moldy, or has extensive damage (breakage, poor splices) ... call a conservator or vendor specializing in preservation of audiovisual media!

Questions?