

# Basic Concepts and Principles of Audiovisual Preservation

Karen F. Gracy

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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

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

## Outline for Today's Webinar

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

## Physical Composition and Vulnerabilities of Audiovisual Media

### Vulnerabilities of Audiovisual Media

- o Chemical deterioration (“natural aging”)
  - o e.g. Hydrolysis of film base (nitrate and acetate)
  - o e.g., Hydrolysis of magnetic media (sticky shed syndrome)
  - o e.g., Acetate disc deterioration (hydrolysis of coating, made of nitrocellulose lacquer plasticized with castor oil)
- o Mechanical deterioration
  - o Stresses from temperature and relative humidity fluctuations
    - o e.g. Warping of vinyl discs in high temperatures
- o Biological deterioration (mold, mildew, and pests)
  - o 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



35 mm (1893)

16 mm (1923)

Super8 8mm  
(1965) (1932)

## Common Motion Picture Film Gauges and Bases

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

## Chemical Deterioration: Motion Picture Film (Nitrate)

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



## 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)

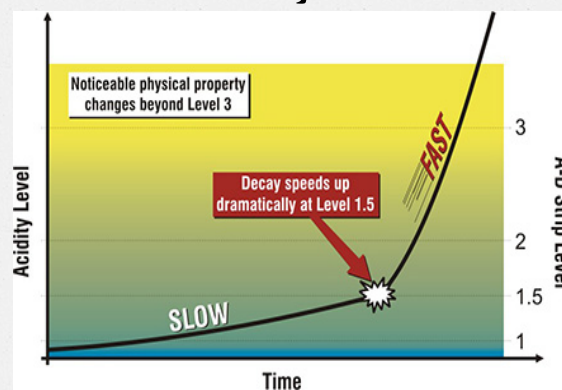


Bottom photo:

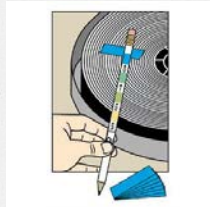
Late stage of vinegar syndrome (film shatters)



## Acetate Deterioration and the Autocatalytic Point



## Two Ways to Monitor Acetate Deterioration



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



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

## Inspection: Motion Picture Film

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



## Inspection: Motion Picture Film

- o Damage
  - o Scratches (emulsion or base)
  - o Perforation damage
  - o Projector oil and dirt
  - o Shrinkage
  - o Color fading
- o Number of splices
- o Type of perforations
- o Deterioration
- o 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



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

## Analog discs

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



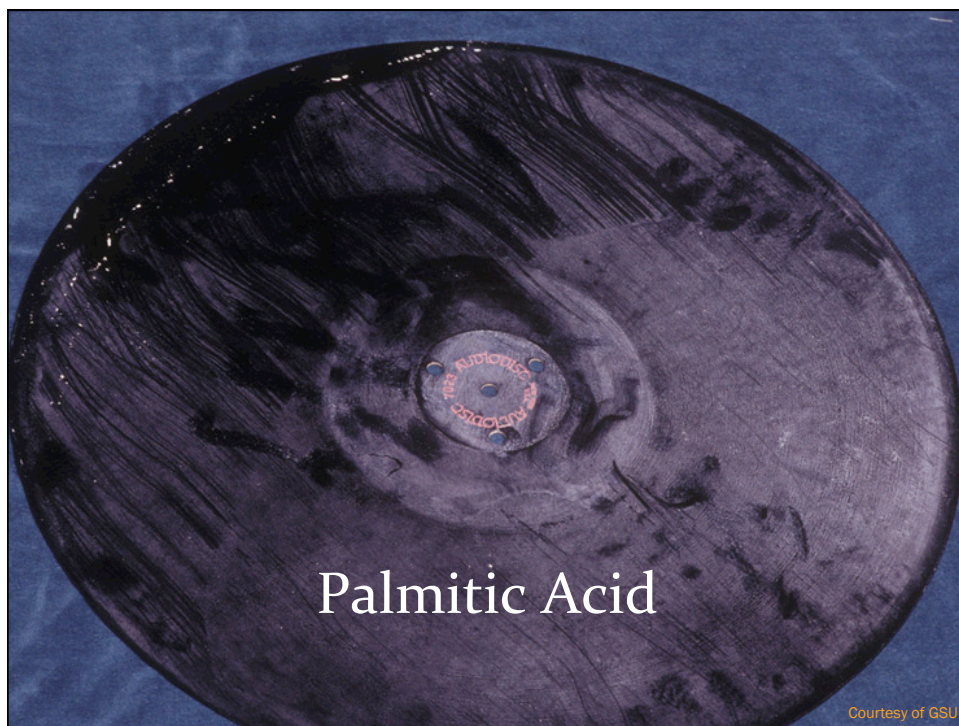
Courtesy of GSU



## Deterioration: Discs

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





## 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

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

## Inspection: Sound Recordings

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



## Physical Composition and Vulnerabilities

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

### Analog Tape

- Comes in many sizes
- How long does it play?
  - Tape speed
  - Reel size
  - Tape thickness
  - Track format





## 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





## Analog Tape: What's it Made from?

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



- 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



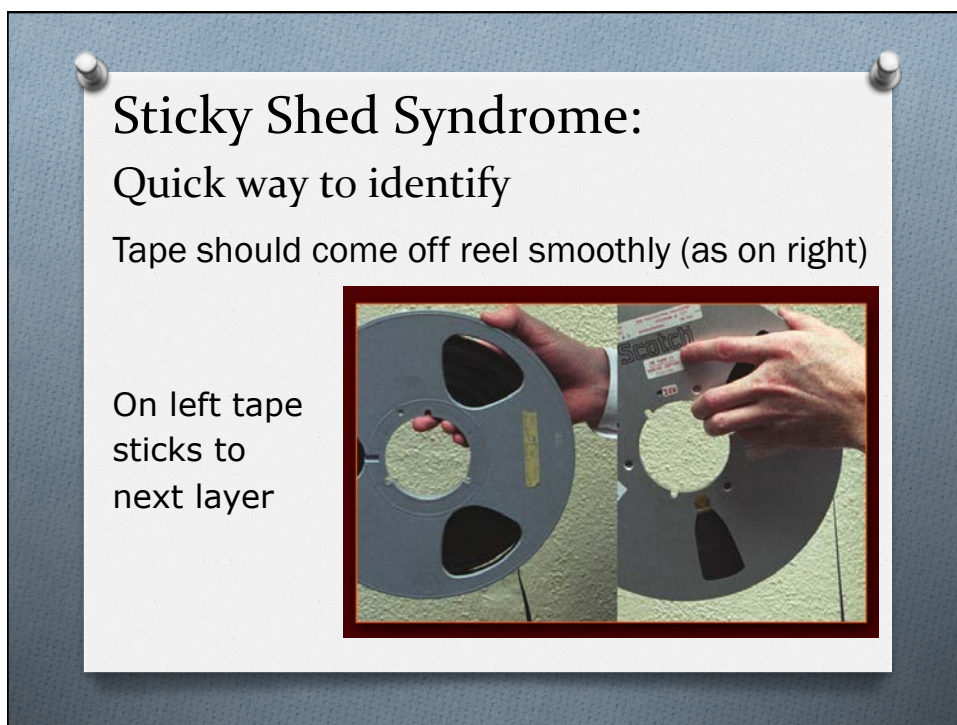
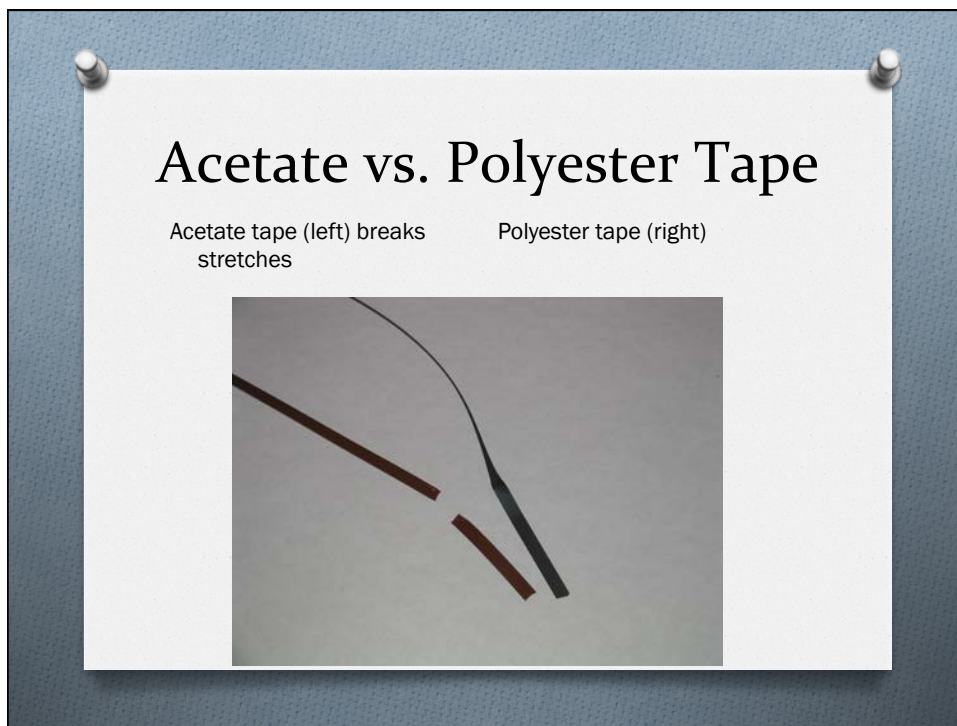
## Acetate Tape: Common Ailments

- 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!)





## 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

### ◊ Tape

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

## Physical Composition and Vulnerabilities

Analog Video Formats  
(Open Reel Tapes and Cassettes)



## Videos Come in Many Flavors!



## Identification: Video Recordings

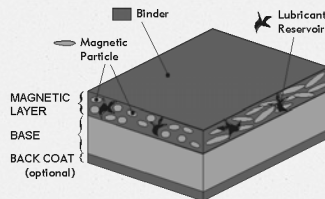
- o There have been over one hundred types of videotape formats in the last sixty years!
- o Many formats look very similar and can only be differentiated by:
  - o Width of tape
  - o Clues found on the housing
- o Check this site to familiarize yourself with the most common formats:
  - o <http://www.arts.state.tx.us/video/identify.asp>

## 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

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



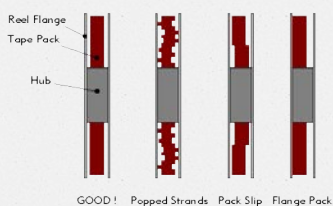
## Inspection: Video Recordings

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





## Inspection: Video Recordings



- o Tape pack
  - o Popped strands, stepped pack, flange pack, pack slip, edge damage, cinching, and gaps in the pack
- o Liquid or particulate contamination
- o 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

### o 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)

### o Shelving

o Metal, not wood!

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



- Left photo:
  - Vertical storage saves space but will warp your film over time!
- Right photo:
  - Horizontal stacks will reduce stress on film.

## Choosing the Right Enclosures and Shelving for Your Magnetic Media

- Containers
  - Polypropylene cases, if they can be found for your format.
  - Acid-free cardboard containers may be used for obsolete formats when polypropylene is unavailable.
  - Don't use those cardboard cases that often come with the tape!
- Shelving
  - Metal, not wood!



## Do's and Don'ts for Videotape Storage



*proper storage*



*improper storage*

## Audio Storage Do's



## Temperature and RH Guidelines: Film

<u>Type of Film</u>	<u>Type of Storage</u>	<u>Temperature</u>	<u>Relative Humidity</u>
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

<u>Format</u>	<u>Physical</u>	<u>Climate</u>	<u>Handling</u>
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

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

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

## Magnetic Fields and Light Sources

- o Keep all magnetic tape away from magnetic fields. Don't stack tapes on top of equipment.
- o Never leave open reel or cassette tapes exposed to the sun.
- o 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!

