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# Motion Picture Film and Magnetic Tape: A Short Premier

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# Mixed Media: Working with Audio and Visual Materials—

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## Motion Picture Film and Magnetic Tape: A Short Primer

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### Writers Wanted!

Do you work with or have an interest in photographs, moving images, or sound recordings? Mixed Media wants to hear from you! Article-length (1,000–1,500 words) explorations of formats, preservation, use, special collections, or innovative projects—any take on audiovisuals—are welcome. Pitch ideas to Assistant Editor Paul Eisloeffel at paul.eisloeffel@nebraska.gov.

Sound recordings and moving images (audiovisuals) come in many varieties and require all manner of machines to record and replay them. This short primer focuses on a few of the audiovisual formats common to archival holdings: motion picture film and magnetic tape. While they share certain physical, mechanical, and environmental characteristics, they are distinctive enough to justify this brief exploration. Our hope is to familiarize the reader with some general points about these unique materials.

### Historical Background

The nineteenth century saw the convergence of technology and ingenuity that laid the path for the creation of what we now call audiovisuals. Starting with the innovation of still photography in the first half of the century, the race to create sound and motion recordings of some permanence was under way. It wasn't until the last decades of the 1800s that both were achieved. Devices crude to our modern standards enabled capture and playback, the two functions essential to audiovisuals, for unlike other documents—even photographs—these audiovisuals relied on machines for both their creation and access to their content.

In the end, moving images provided the vehicle for the convergence of both sound and motion pictures. In 1913, Edison introduced a device to synchronize sound with moving pictures. By 1929, the means for adding sound to the physical film itself was launched, and soon thereafter the two coexisted ubiquitously. The motion picture thus became the quintessential audiovisual document, combining sound, image, and motion in a single medium.

While changes in format and physical characteristics continued with sound recording and motion picture technology, these were relatively minor when compared to the advent of magnetic tape in the mid-twentieth century. This significantly and irrevocably changed the way many sound and moving images were captured and replayed.

### Shared Characteristics

*Machine Obsolescence*

Later parts of this section will deal with the physical structure of both motion picture film and magnetic tape. But first, it is worth noting a common vulnerability shared by these and virtually all vintage audiovisuals: machine obsolescence. As advances took place in both capturing and replaying recordings of sight and sound, the machines that made these advances possible evolved and became more complex. Consequently, one of the principal problems archives face is not just appraising and preserving audiovisual materials, but finding (and possibly maintaining) the machines that can safely replay the wide variety of formats they may house for appraisal, reformatting, and access.

The rapid—some may say exponential—evolution of audiovisual formats, especially since the mid-twentieth century, has fed this machine obsolescence. Equipment once common has become rare, as have replacement parts and the engineering knowledge needed to service them. Like some electronic records, any fear we may harbor that the loss of the technology will spell the loss of access to the recordings themselves is not unfounded for these machine-dependant documents.

*Physical Construction*

A large part of this evolving obsolescence is tied in with the physical characteristics of the differing formats, although in their basic construction, motion picture film and magnetic tape are remarkably similar. In their simplest construct, both include a base, or substrate, layer and a top layer. Base layers, the majority of which are the plastics acetate or polyester, provide a strong foundation for the more pliable top layer. The top layer carries the actual recorded "information" of the audiovisual item, made either of an emulsion containing light-sensitive silver particles or dyes (in the case of film) or metal-laced gelatin (for magnetic tape). Sometimes a protective coating layer is present as well. These shared physical properties do imply a similarity in the preservation issues faced by both

film and tape audiovisuals, and to some degree that is the case. But as we will see later, the two are varied enough to exhibit their own concerns.

## Common Motion Picture Film and Magnetic Tape Formats

What follows are brief descriptions of the audiovisual formats most commonly found in archival collections.

*16 mm, 8 mm, and Super 8 Motion Picture Film*

Introduced in 1923, 16 mm film was the first consumer-grade motion picture film, dubbed "safety film" because it lacked the incendiary qualities of professional 35 mm film. The smaller 8 mm film, available in the early 1930s, became popular with hobbyists and amateurs, while 16 mm gravitated toward more professional and commercial use. Super 8, launched in the mid-1960s, increased the image size of 8 mm film by reducing the sprocket hole (perforation) margin of the film. Soundtracks (both optical and magnetic) were predominantly added to 16 mm film, as befit its commercial use, but eventually all three formats were capable of holding added sound.


*This illustration shows some of the common motion picture film formats and housings likely to inhabit archival collections. Films in cans, on reels and cores (hubs without reels), and in original boxes are the most likely finds. The two loop cartridge films in front, housed for presentation, are rarer. The film in the upper left is a 35 mm film on a core.*

*U-Matic Videotape*

So named for the U-shaped winding of the tape during recording and playback, U-Matic videotape was introduced by Sony in 1969. It is also commonly known also as ¾" due to the width of the raw tape. U-Matic was one of the first videotapes to use a cassette-style enclosed housing. Meant for professional use, it was both cumbersome and had relatively short play times. Nevertheless, its image quality and cassette format made it a staple of professional use (especially in broadcasting and education) from the 1970s well into the 1990s.

*Betamax Videotape*

Betamax (or Home Beta) was introduced by Sony in 1975. Its target was consumer home use, and along with VHS quickly replaced 8 mm film as the home movie format of choice in the consumer market. Though the quality of Betamax was superior, Sony's refusal to share its technology with competitors spelled its demise in favor of VHS. Turning this defeat to its advantage, Sony evolved Betamax into Betacam, a format that rivaled U-Matic in the professional market. Betamax's ½" wide magnetic tape in its cassette enclosure uses the same transport system as U-Matic, though Betamax cassettes are significantly smaller than U-Matic cassettes.

*VHS Videotape*

As noted above, the history of the consumer-based VHS (Video Home System) cassette is intertwined with that of Betamax. While VHS was not superior in quality to Betamax, the machines available to the public were more prevalent, included more desirable features, and offered longer playing time. VHS cassettes are larger than those of Betamax, and although it comes in various lengths (as do other cassette-housed magnetic tapes), the common VHS tape is longer than Betamax.

*Reel-to-Reel Audiotape and Videotape*

Reel-to-reel (RTR) tape is also known as open reel tape due to its lack of enclosure. The tape is housed on a supply reel, and then threaded through a deck's mechanism onto a take-up reel. This is the basic mechanics of all open-reel audiovisuals, from 16 mm film to 2" videotape.

Audio RTR tape was used as early as the 1930s, but became a staple of sound capture and playback starting in the 1950s. Audio RTR recording was practiced by both amateurs and professionals in the home, in the recording studio, and in the

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*Familiar videotape formats found in archives holdings show two reel-to-reel (open reel) tapes at the top of the picture. The ¾" U-Matic tape cassette in the center is flanked by a Betacam tape to the left and a VHS tape to the right. An 8 mm videotape cassette is in the lower left. The remaining small tapes in front are two common formats of digital videocassettes: Mini-DV (left) and DVCPro.*

field. Its consumer use declined with the introduction of the inferior audiocassette, but its professional use continued until digital formats became available, and even then it was trusted more than digital technologies until recently. Audio RTR tape typically comes in ¼" and (less frequently) ½" widths.

The first magnetic videotapes came into use in the mid-1950s. These first video RTRs were 2" wide, and although 1" and ½" tape followed, the 2" (or Quad tapes) remained a staple of commercial use for years. Reel-to-reel videotape was never considered a consumer format.

Because there is no housing with RTR audio- and videotape, it was routinely spliced for editing purposes. Besides the usual maladies seen in other magnetic tapes, these splices add a preservation concern as they can dry and disengage from the tape. Storing reels flat will shift the tape to one side and cause friction during playback, damaging the tape. Poor forward and rewind habits will also cause the tape to become unlevel and damaged over time.

## General Vulnerabilities

*Film: Acetate Base Layer*

Acetate-based films, the variety most commonly found in archives, are first and foremost vulnerable to what is commonly known as vinegar syndrome. This is a chemical breakdown of the cellulose base, exuding acetic acid (vinegar) and causing the base to shrink while the emulsion does not. Prolonged exposure to humidity and heat is usually to blame. Warping and cupping are also common results, as is separation of the emulsion from the base. There are ways to detect the levels of this kind of deterioration, but the unmistakable smell remains the best indication that a film is affected. Acetate degradation is also a danger to early acetate magnetic tape. Prolonged high humidity can cause the film to stick to itself and can promote the growth of biological agents like mold and mildew. Extended exposure to high heat can cause the base to distort and become wavy.

*Tape: Polyester Base Layer*

Although some early audiotape used acetate as a base, magnetic tape for audio and video used a polyester base from the 1960s to the present. Polyester is relatively stable, chemically speaking, but poor machine transport can damage the tape such that the sound or picture becomes distorted. The polyester can stick to itself if the humidity is too high and can melt in extreme heat, while too little heat and humidity can cause the base to become brittle.

*Film: Emulsion Top Layer*

Prolonged exposure to light can fade the image on the emulsion layer of motion picture stock, whether it contains the light-sensitive silver of black-and-white film or the dyes of color film. High levels of light, heat, and humidity are especially dangerous to color film. These can fade the dyes (magenta, green, and cyan), causing the loss of significant detail contained in each dye layer. Magenta is the most resilient and the last to fade, accounting for the common pink quality of affected films.

*Tape: Magnetic Top Layer*

Like the emulsion of film, the top layer of magnetic audio- and videotape holds the all-important information. A common malady suffered by this top layer is known as sticky shed syndrome, and, like so many other vulnerabilities we've seen so far, it is caused by high humidity. In short, the top layer reverts to a gelatinous state and sticks not only to itself when wound in storage but also to machine parts during playback. Also like film's emulsion, prolonged exposure to light can negatively affect the magnetic layer. Finally, because of the magnetic nature of tape, storage near sources of strong magnetic fields, such

as air handling machinery, can erase or partially degrade the information on the medium.

These are all some of the ills that make film and magnetic tape vulnerable—most, but not all. Vermin, mold, floods, and dust are also common dangers. But as complicated as all these threats may seem, most can be traced back to poor environment, the chief enemy of any archival material.

But the preservation liability that is unique to motion picture film and magnetic tape lies directly in their nature as machine-dependent documents. The machines themselves—those that create but, more important, those that are typically used for playback—subject these items to physical rigors virtually unequalled in the document world. Motion picture film is wound around a series of spindles and toothed gears to be systematically tugged through a projection gate through which a hot light passes. Magnetic tape is similarly curled around capstans and guide wheels to wipe in direct contact with the playback head. Videotapes housed in cassettes are pulled out from their casings into the inner workings of the playback deck. And if the films or tapes are already compromised, playback can damage them further and in some cases the machines as well.

But all is not lost. There are ways to examine motion picture film safely, and there are many well-equipped labs that can work with magnetic tape unharmed. In any case, it is prudent for an archivist to be aware of the formats and vulnerabilities of these moving image films and magnetic tapes most likely to exist in a repository's holdings.

## Resources

There are many resources on the nature, construction, and care of motion picture film and magnetic tape. Below is an annotated list of resources the authors have found to be particularly helpful.

Jerry Bruck, Al Grundy, and Irv Joel, "Audio Timeline," Audio Engineering Society, 2009, http://www.aes.org/aeshc/docs/audio.history.timeline.html (accessed February 15, 2010). If you have any doubt that the history of audiovisual technology is complicated, take a look at this detailed list.

Canada's AV Preservation Trust (formerly known as the Alliance for Canada's Audio-Visual Heritage) is a charitable nonprofit organization dedicated to promoting the preservation of Canada's audiovisual heritage and to facilitating access to and the usage of regional and national collections through partnerships with members of the audiovisual community. Its 1995 report, *Fading Away: Strategic Options to Ensure the Protection of and Access to Our Audio-Visual Memory*, is available on-line as a PDF file at http://www.collectionscanada.ca/04/041701_e.html (accessed February 15, 2010).

Mona Jimenez et al., *Videotape Identification and Assessment Guide* (Austin: Texas Commission on the Arts, 2004), http://www.arts.state.tx.us/video/pdf/video.pdf (accessed February 15, 2010). This publication is a must-have for archives with videotape. Highly illustrated and accessibly written, it speaks to the nonexpert.

National Film and Sound Archive, "Care for Audiovisual Materials" (Canberra, Australia: National Film and Sound Archive, 2007), http://www.nfsa.gov.au/preservation/care_audiovisual/ (accessed February 15, 2010). Short FAQs make this a valuable first-look guide to the nature and preservation of the most common formats.

National Film Preservation Foundation, *The Film Preservation Guide: The Basics for Archives, Libraries, and Museums* (San Francisco: National Film Preservation Foundation, 2004), http://www.filmpreservation.org/preservation/film_guide.html (accessed February 15, 2010). Designed as both a basic guide and a more detailed reference, this publication is a must-have for anyone who works with motion picture film or wants to understand more about it.

Dietrich Schuller, *Audio and Video Carriers* (Amsterdam: Training for Audiovisual Preservation in Europe [TAPE], 2008), http://www.tape-online.net/docs/audio_and_video_carriers.pdf (accessed February 15, 2010). Perhaps a bit technical for the neophyte, it's still one of the best texts on audio and video media, including optical formats.

The Web site of Specs Bros., http://www.specsbros.com, a video- and audiotape restoration company, includes some good basic magnetic media FAQs, some tips on what to do in a disaster, and a white paper, "Basic Inspection Techniques to Sample the Condition of Magnetic Tape."

John W. C. Van Bogart, "Magnetic Tape Storage and Handling," National Media Laboratory, 1995, http://www.clir.org/pubs/reports/pub54/1introduction.html (accessed January 2010). This may appear dated, but it still offers good solid information, particularly on the vulnerabilities of audiotape.

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### Oral History in the Mid-Atlantic Region

The spring conference "'Catching Lightning in a Bottle': Documenting Science, Technology & Innovation through Oral History" will be held April 28–29 at the Charles Sumner School Museum and Archives in Washington, D.C. The emphasis of the conference will be on how oral history is being utilized to capture information lacking in other forms of documentation, such as the thoughts and inspirations surrounding the "Eureka" moment in a scientist's research or the struggles endured by different population groups as they endeavored to establish themselves in fields previously closed to them. http://www.ohmar.org/confercurrent.html

### Reference and User Services Association (RUSA)

"Behind the Genealogy Reference Desk: Our Capital's Hidden Genealogy Gems" is the theme of the RUSA History Section preconference to be held June 25 at the Daughters of the American Revolution Library in Washington, D.C. This full-day event is a valuable professional development opportunity for new reference librarians, who will benefit from the fundamental tools presented, as well as for experienced genealogy librarians looking for a refresher course. Personal family history researchers are also invited to attend. http://www.ala.org/ala/newspresscenter/news/pressreleases2010/january2010/genealogy_rusa.cfm

### Society of Southwest Archivists

The annual meeting "Archives at the Crossroads" will take place April 28–May 1 at the Inn and Spa at Loretto in Santa Fe, New Mexico. The meeting starts with timely workshops on preservation of photographic materials, fund-raising, and caring for Native American collections. It continues with a keynote address, "I Was a Teenage Packrat for the FBI," from well-known author John Nichols. Two and a half days of sessions cover everything from preserving the history of the Route 66 corridor, academic archives, and archival training and funding opportunities to Jewish archives in the Southwest, small press archives, and initiatives and projects in tribal archives and collections. http://southwestarchivists.org/HTML/Meeting.htm

### Texas A&M University

The ninth annual Book History Workshop is scheduled for May 23–28 at the Cushing Memorial Library in College Station, Texas. This five-day workshop provides an intensive, hands-on introduction to the history of books and printing, with a focus on the hand press era. The workshop is intended for librarians, archivists, students, teachers, collectors, and private individuals who have an interest in the first three and a half centuries of the printed book. The course consists of a unique combination of labs and seminars designed to provide students with practical experience, as well as a broad historical survey of the field. http://cushing.library.tamu.edu/events/book-history-workshop/

### Western Roundup 2010

This super-regional meeting of archivists across the western United States will take place April 28–May 1 at the Renaissance Seattle Hotel in downtown Seattle, Washington. The meeting is sponsored by Northwest Archivists, the Conference of Inter-Mountain Archivists, the Society of California Archivists, and the Society of Rocky Mountain Archivists. Preconference workshops include emergency preparedness and response, grant writing, and implementing "More Product, Less Process." Session topics range from interlibrary loan of archives and special collections materials, grant agencies, and on-line exhibits using open source software to memory and meaning in archives and connecting with your community. http://northwestarchivistsinc.wildapricot.org/WesternRoundup2010/

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*Washington State Film Preservation Manual: Low-Cost & No-Cost Suggestions to Care for Your Film*. This manual, available on-line at http://www.lib.washington.edu/specialcoll/film/preservationmanual.pdf, is intended to address the film identification and preservation needs of museums, historical societies, libraries, and other smaller institutions.

Jim Wheeler's *Video Preservation Handbook*, http://www.media-matters.net/docs/resources/Traditional%20Audiovisual%20Preservation/WheelerVideo.pdf, is a comprehensive guide designed for archivists and librarians who are responsible for the care of moving images on tape.