Identifying Endangered Media Formats

Julia Novakovic The Strong National Museum of Play Rochester, New York

June 30, 2021

the strong
NATIONAL MUSEUM OF PLAY



- Houses the world's most comprehensive collection of historical materials related to play
- Explores play and the way in which it encourages learning, creativity, and discovery, and illuminates cultural history
- Home to:
  - National Toy Hall of Fame
  - World Video Game Hall of Fame
  - *American Journal of Play*
  - International Center for the History of Electronic Games (ICHEG)
  - Brian Sutton-Smith Library & Archives of Play



- Mission changed in 2003, impacting exhibits, collections, research library







International Center for the History of Electronic Games (ICHEG)

- Collects, studies, and interprets video games and related materials, and the ways in which these games are changing how people play, learn, and connect with one another
- More than 60,000 items and growing, includes:
  - Games and their platforms
  - Packaging and advertising
  - Publications
  - Personal and business papers of key individuals and companies in the electronic games industry

Reaching Critical Mass



1982:
Margaret Woodbury Strong Museum opens to the public



2003:
Museum shifts to play mission

2014:
Atari Coin-Op collection arrives at museum





2009:
ICHEG established

2016:
Tipping point of media in archives





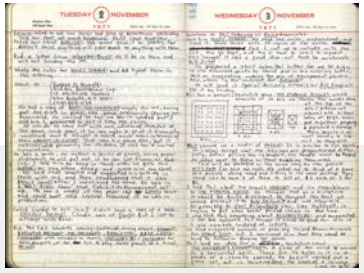
Digital Preservation Working Group

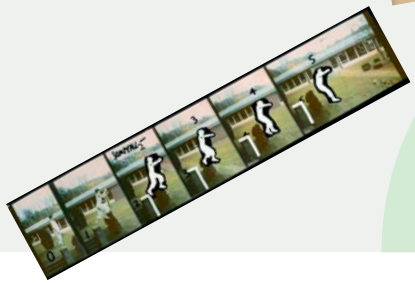
- Established in 2016
- Staff members from Collections, Conservation, Exhibits, IT teams
- Original plans: digitization for access, museum digital assets
- Shift to focus on digitization for preservation

Criteria for Digitization: **RAVE**

RARE

One-of-a-kind







AT-RISK

Items threatened by deterioration





R A V E

VALUABLE

Evidential or historical value







ENGAGING

Visually compelling, fun, recognizable, iconic

















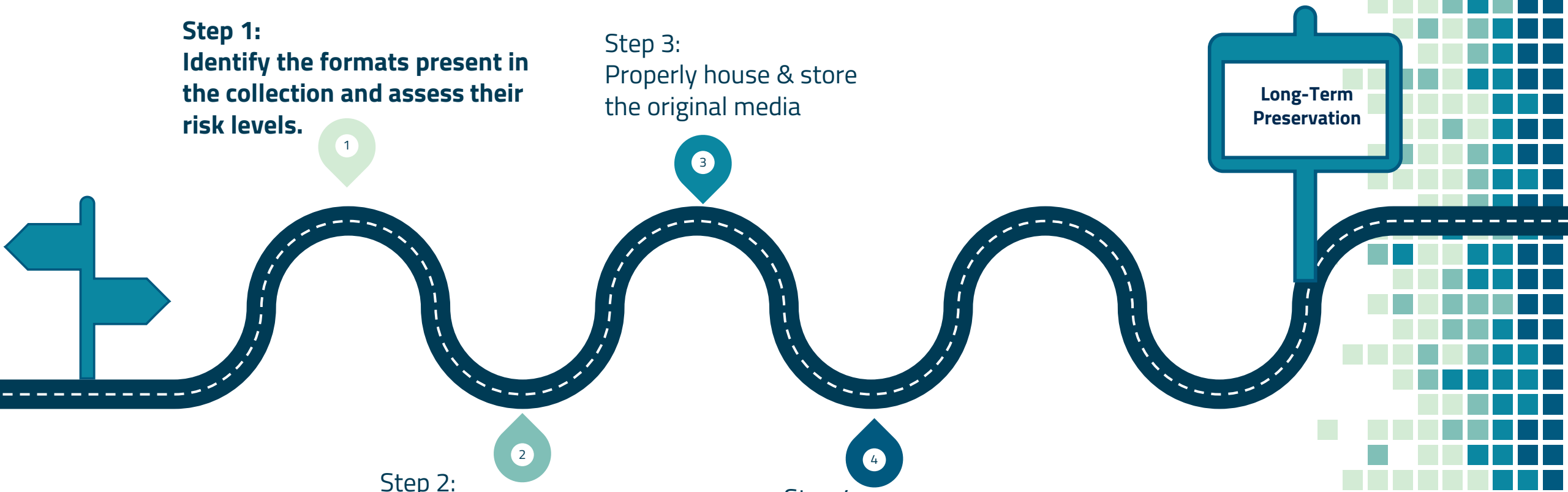
What comes next?

...AT-RISK materials

On the Road to Long-Term Digital Preservation

Step 1:
Identify the formats present in the collection and assess their risk levels.

Step 3:
Properly house & store the original media



Step 2:
Create disk images of the contents & extract metadata; a/v format migration

Step 4:
Access the content from disk images & migrated a/v formats

Survey Planning

- Identify categories of endangered media
- Review every processed archival collection to determine exact quantity of each endangered media format
- Which collections need immediate attention?
- Which collections are stable (for now)?
- Use survey results to inform next steps



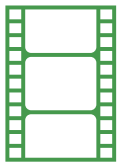


Identifying Categories of Endangered Media



Digital media

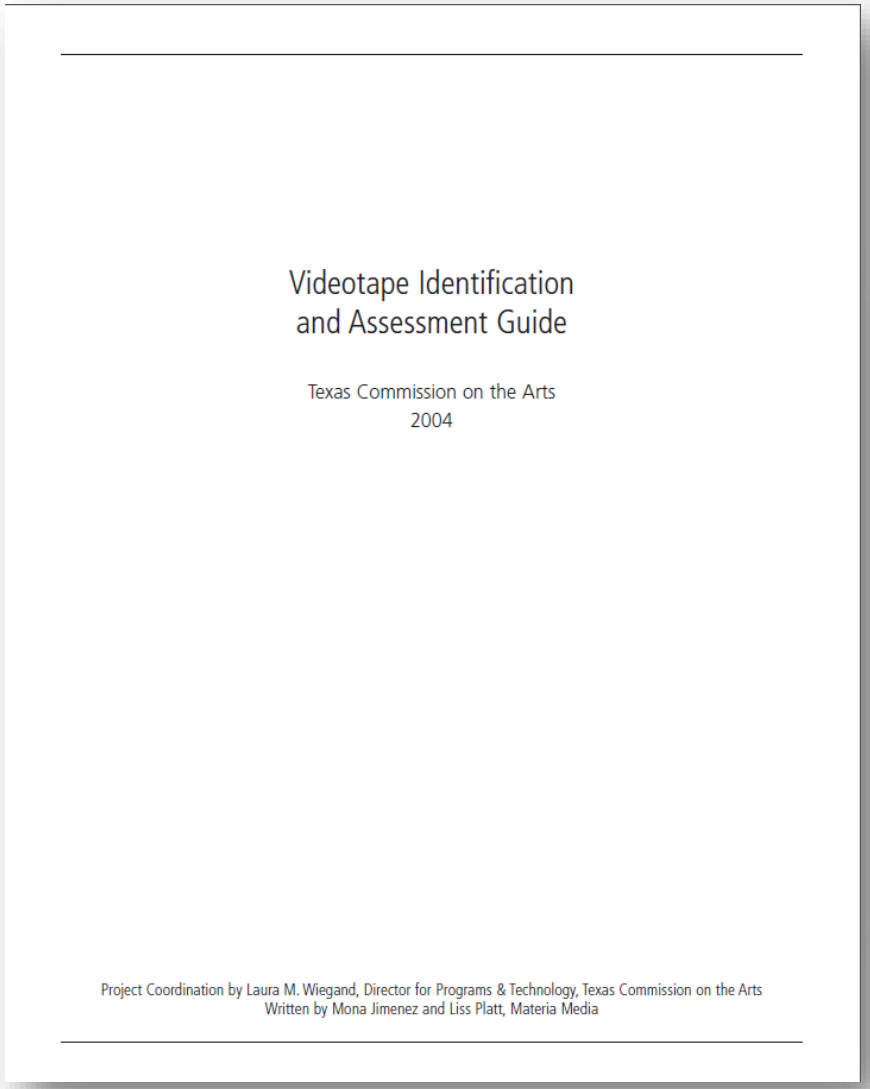
- Floppy disks [8", 5.25", 3.5"]
- CD-ROMs [also CD-R, CD-RW, etc.]
- DVDs [also DVD-R, DVD+R]
- Data tapes [DDS]
- Memory cards [SD cards]
- External hard drives
- Proprietary cartridges [Jaz, SyQuest, Iomega Zip, etc.]
- USB/flash drives
- Born-digital files
- "Other disk formats"



Audiovisual materials

- Audio cassettes
- Audio CDs
- Film (16mm, 8mm)
- DVD-Video, DVD-Audio
- Beta tapes [Betamax, Betacam, BetacamSP, DigitBeta]
- U-matic/U-matic SP tapes
- VHS tapes (also S-VHS, VHS-C)
- Open reel [2"quad, 1" type C, ½" open]
- Laser disks
- Video8/Hi8 cassettes
- MiniDVs
- DATs
- "Other magnetic a/v formats" [...D2, D3, etc.]

Reference on Formats



- "Videotape Identification and Assessment Guide," Texas Commission on the Arts, 2004



Reference on Formats

I. INTRODUCTION

PURPOSE

This handbook is intended to answer the questions of archivists, librarians, and others who have a collection of videotapes they wish to keep for many years. The guidelines offered touch briefly on each appropriate topic, but do not cover any topic in detail. (Refer to the appendix for sources of more detailed information.)

TAPE AS AN ARCHIVAL MEDIUM

Magnetic tape is not considered a good long-term storage medium for archival material. In fact, there is no good archival medium for the long-term storage of video. The archivist is therefore faced with the problems of maintaining obsolete equipment and having to migrate (copy or transfer) material to a newer tape format or a different type of medium.

Nothing is permanent, but properly made magnetic tape stored in reasonable archival conditions has lasted over 50 years. The main archival problems seen with magnetic tape are instability of the binder with some types of tapes, and the rapid obsolescence of the equipment (formats).

Even if there were a convenient and economical long-term storage medium available, it would still be imperative that archivists establish a long-range plan for care of the magnetic tape material in their facility until all of that tape is migrated to the new medium, or to a new tape format. Migration must be considered an element of all long-term archival plans. This handbook is intended to help the archivist in this endeavor.

PRESERVATION FUNCTIONS

Preservation

Preservation broadly encompasses those activities and functions designed to produce a suitable and safe environment that extends the useful life of collections. It includes securing the funds for preservation activities, security, and disaster preparedness, as well as conservation, restoration, examination, documentation, and a long-range plan.

Conservation

Conservation is generally considered to be but one aspect of an overall preservation program. Conservation allows a tape to realize a full life by implementing proper maintenance, handling and storage procedures. This entails suitable storage in proper temperature/humidity conditions, sequestering from use as a service copy, monitoring staff handling procedures, and restoration.

Restoration

a. Physical Restoration

Restoration involves actions to stabilize and return a deteriorated or damaged tape as nearly as possible to its original condition. This means treating a failing tape in a manner that enables the recording to be played at the same level of quality it held when first laid down.

It is assumed that there is intrinsic value in the recorded information or content and little, or no, intrinsic value in the original physical item itself. Thus it is appropriate, for example, to transfer material from an obsolete tape format to a newer format of equal or better quality.

- "Videotape Preservation Handbook," Jim Wheeler, 2002

Figure One:

ANALOG VIDEOTAPE FORMATS

Year *	Tape Width	Cassette/ Open Reel	Use **	Obsolecence Rating ***	Originating Company	Comments ****
1956	2"	OR	P	CE	Ampex	2" Quad
1962	2"	OR	IE	CE	Ampex	First popular helical
1963	2"	OR	IE	Ext	Sony	2" Helical
1964	1"	OR	IE	Ext	Sony	
1965	1"	OR	IE	CE	Ampex	SMPTE Type A
1965	1"	OR	IE	Ext	PI	Precision Instruments
1965	1/2"	OR	IE	CE	Sony	CV--First low cost VTR
1968	1"	OR	IE	EXT	IVC	
1968	1/2"	OR	IE	Ext	Sony	
1969	1/2"	OR	IE	End		EIAJ-1
1969	1/4"	OR	IE	Ext	Akai	Small portable
1970	1/2"	C	IE	Ext	Phillips	First Cassette VTR
1971	3/4"	C	IE	T	Sony	3/4" U-Matic
1972	1/2"	C	C	Ext	Cartravision	Consumer VTR
1972	1/2"	C	IE	Ext	Sanyo	V-Cord
1973	2"	OR	IE	Ext	IVC	2" Helical
1975	1"	OR	P & IE	End	Bosch	SMPTE_B
1975	1/2"	C	C	CE	Sony	Betamax--First consumer
1976	1"	OR	IE	Ext	Sony	
1976	1"	OR	P & IE	CE	Ampex	SMPTE A with Slo-Mo
1976	1/2"	C	C	ok	JVC	VHS
1978	1"	OR	P	End	Ampex/Sony	SMPTE_C
1983	1/2"	C	P & IE	Ext	Panasonic	SMPTE_M
1984	1/2"	C	P & IE	Ext	Sony	Betacam
1984	8 mm	C	IE & C	Ext		8 mm (.315")
1986	1/2"	C	P & IE	End	Panasonic	M-II
1987	1/2"	C	P & IE	T	Sony	Betacam-SP
1987	1/2"	C	IE & C	ok	JVC	S-VHS
1988	1/2"	C	P & IE	Ext	Sony	ED-Beta
1989	8 mm	C	IE & C	T		Hi-8 (.315"

Figure Two:

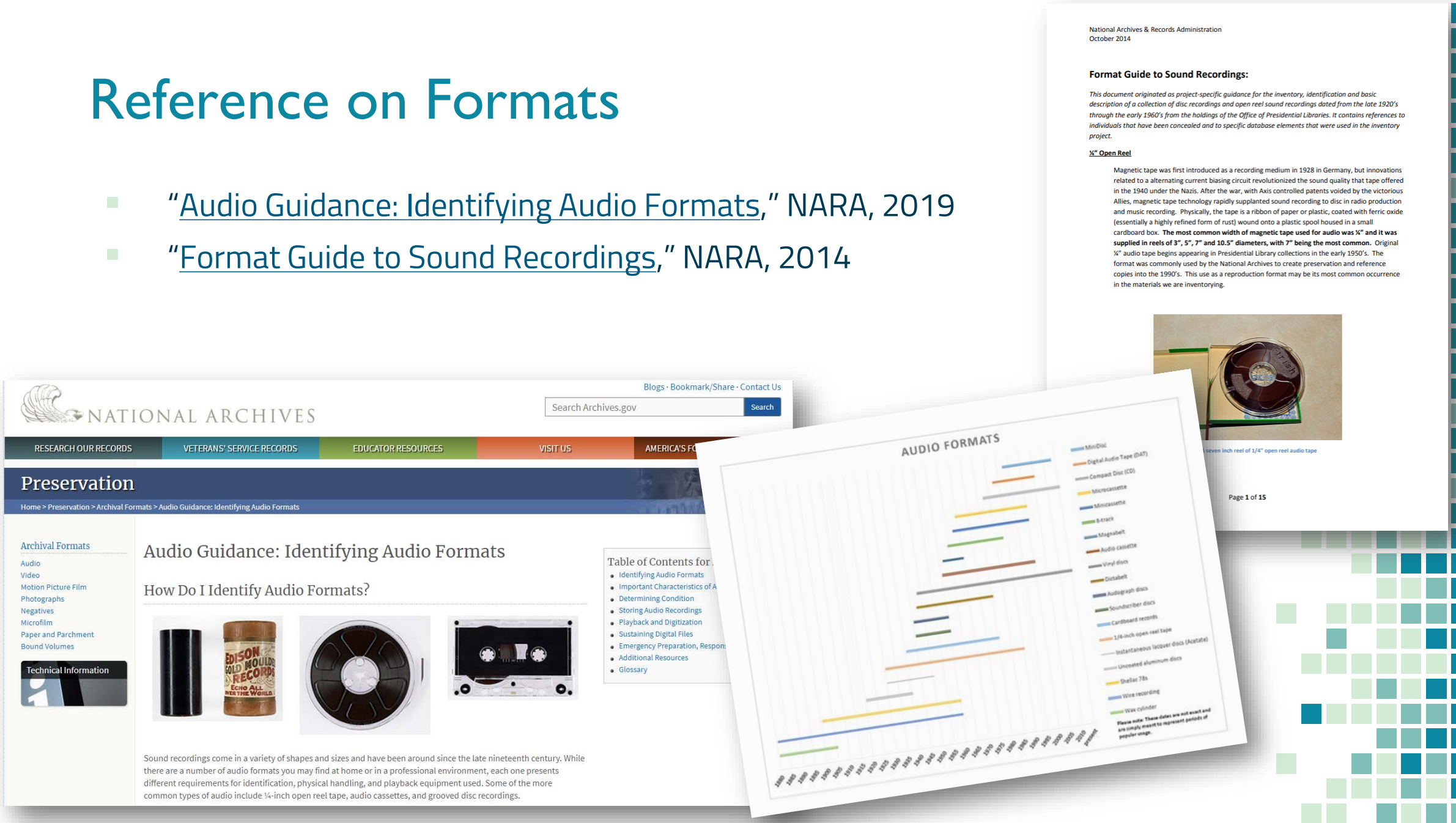
DIGITAL VIDEOTAPE FORMATS

Name	Year *	Makers	Tape Width	Tape Thick-ness	Hours per Cassette	Tape Type	Comp-ression	Bits	Quantiza-tion
D1	1986	Sony BTS	.75"	13 µm	Medium=1/2 Large=1 1/2	Iron	No	8	4:2:2
D2	1988	Sony Ampex Hitachi	.75"	13 µm	1/2, 1, 3	MP	No	8	Composite
D3	1992	Panasonic	.5"	11 µm	4	MP	No	8	Composite
DCT	1992	Ampex	.75"	13 µm	2	"	"	"	
Digital Betacam	1993	Sony	.5"	13 µm	1/2, 1, 3	MP	2:1	8	Composite
D5	1994	Panasonic	.5"	13 µm	Small=1 Large=3	MP	2:3:1	8	4:2:2
HD-D5	1999	Panasonic	.5"	11 µm	4	MP	No	10	4:2:2
D9 - Digital-S	1995	JVC	.5"	13 µm	2	"	"	10	4:2:2
Digital Beta SX	1995	Sony	.5"	13 µm	1 1/2	MP	5:1	10	
D6	1996	Toshiba	.25"	8-9 µm	Medium=1 Large=2	MP	3:1	8	4:2:2
D7 - DVCPRO	1996	Panasonic	.25"	7 µm	4	MP	10:1	10	4:2:2
DV/ Mini-DV	1996	Consortium				MP	5:1	8	4:1:1
						ME	5:1		4:1:1

* Indicates when the product was first introduced.

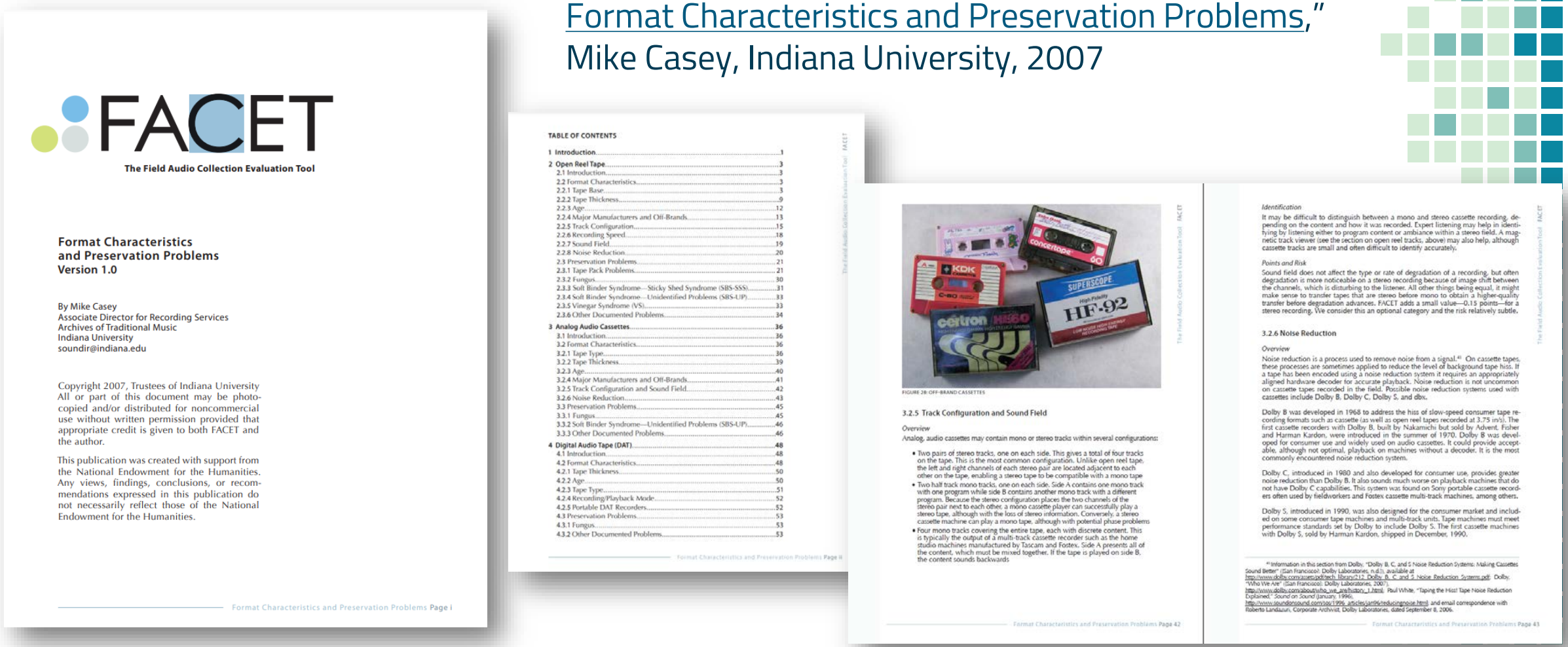
Reference on Formats

- "Audio Guidance: Identifying Audio Formats," NARA, 2019
- "Format Guide to Sound Recordings," NARA, 2014



Reference on Formats

- "FACET – The Field Audio Collection Evaluation Tool – Format Characteristics and Preservation Problems," Mike Casey, Indiana University, 2007



FACET

The Field Audio Collection Evaluation Tool

Format Characteristics and Preservation Problems
Version 1.0

By Mike Casey
Associate Director for Recording Services
Archives of Traditional Music
Indiana University
soundir@indiana.edu

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FIGURE 28: OFF-BRAND CASSETTES

3.2.5 Track Configuration and Sound Field

Overview

Analog audio cassettes may contain mono or stereo tracks within several configurations:

- Two pairs of stereo tracks, one on each side. This gives a total of four tracks on the tape. This is the most common configuration. Unlike open reel tape, the left and right channels of each stereo pair are located adjacent to each other on the tape, enabling a stereo tape to be compatible with a mono tape
- Two half track mono tracks, one on each side. Side A contains one mono track with one program while side B contains another mono track with a different program. Because the stereo configuration places the two channels of the stereo pair next to each other, a mono cassette player can successfully play a stereo tape, although with the loss of stereo information. Conversely, a stereo cassette machine can play a mono tape, although with potential phase problems
- Four mono tracks covering the entire tape, each with discrete content. This is typically the output of a multi-track cassette recorder such as the home studio machines manufactured by Tascam and Fostex. Side A presents all of the content, which must be mixed together. If the tape is played on side B, the content sounds backwards

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Identification

It may be difficult to distinguish between a mono and stereo cassette recording, depending on the content and how it was recorded. Expert listening may help in identifying by listening either to program content or ambiance within a stereo field. A magnetic track viewer (see the section on open reel tracks, above) may also help, although cassette tracks are small and often difficult to identify accurately.

Points and Risk

Sound field does not affect the type or rate of degradation of a recording, but often degradation is more noticeable on a stereo recording because of image shift between the channels, which is disturbing to the listener. All other things being equal, it might make sense to transfer tapes that are stereo before mono to obtain a higher-quality transfer before degradation advances. FACET adds a small value—0.15 points—for a stereo recording. We consider this an optional category and the risk relatively subtle.

3.2.6 Noise Reduction

Overview

Noise reduction is a process used to remove noise from a signal.[41] On cassette tapes, these processes are sometimes applied to reduce the level of background tape hiss. If a tape has been encoded using a noise reduction system it requires an appropriately aligned hardware decoder for accurate playback. Noise reduction is not uncommon on cassette tapes recorded in the field. Possible noise reduction systems used with cassettes include Dolby B, Dolby C, Dolby S, and dbx.

Dolby B was developed in 1968 to address the hiss of slow-speed consumer tape recording formats such as cassette (as well as open reel tapes recorded at 3.75 in/s). The first cassette recorders with Dolby B, built by Nakamichi but sold by Advent, Fisher and Harman Kardon, were introduced in the summer of 1970. Dolby B was developed for consumer use and widely used on audio cassettes. It could provide acceptable, although not optimal, playback on machines without a decoder. It is the most commonly encountered noise reduction system.

Dolby C, introduced in 1980 and also developed for consumer use, provides greater noise reduction than Dolby B. It also sounds much worse on playback machines that do not have Dolby C capabilities. This system was found on Sony portable cassette recorders often used by fieldworkers and Fostex cassette multi-track machines, among others.

Dolby S, introduced in 1990, was also designed for the consumer market and included on some consumer tape machines and multi-track units. Tape machines must meet performance standards set by Dolby to include Dolby S. The first cassette machines with Dolby S, sold by Harman Kardon, shipped in December, 1990.

[41] Information in this section from Dolby, "Dolby B, C, and S Noise Reduction Systems: Making Cassettes Sound Better" (San Francisco): Dolby Laboratories, n.d.), available at http://www.dolby.com/assets/pdf/tech_library/212_Dolby_B_C_and_S_Noise_Reduction_Systems.pdf; Dolby, "Who We Are" (San Francisco): Dolby Laboratories, 2007), http://www.dolby.com/about/who_we_are/history_1.html; Paul White, "Taping the Hiss! Tape Noise Reduction Explained," *Sound on Sound* (January, 1996), http://www.soundonsound.com/sos/1996_articles/jan96/reducingnoise.html; and email correspondence with Roberto Landazuri, Corporate Archivist, Dolby Laboratories, dated September 8, 2006.

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Reference on Formats

- "Data Media Timeline," Museum of Obsolete Media

Museum of Obsolete Media

Search ... Search

About | All Media | Audio Media | Video Media | Data Media | Film Media | Media Preservation

Data Media Timeline

From Jacquard Loom cards to PlayStation Vita memory cards, the history of data storage on removable media with a list of media in the Museum in chronological order of introduction. Comprising disks/discs, tape, solid-state media, ROM cartridges, and punched media.



1780s
Catalogue card (1780s – 2015)

1800s
Jacquard Loom card (1801 – 1990s)

1840s
Punched tape (1846 – 1980s)

1850s
Wheatstone tape (1857 – 1980s)

1890s
Herman Hollerith's punched card design is used in the 1890 US census (1890)

Punched card (1890 – 1980s)

1900s
Macrame lace embroidery punched roll (1906 –)

Media Timelines
Audio Media Timeline
Video Media Timeline
Data Media Timeline
Film Media Timeline
Media by Decade of Obsolescence

Data Media by Type
Disks / Discs
ROM Cartridges and Cards
Magnetic Tape
Solid State Media
Punched Media and Other
Video Game Console Media

Punched card (1890 – 1980s)



Punched cards (also known as IBM cards or Hollerith cards) were used to control automated machinery or for data processing and consisted of stiff card with holes in predefined positions to represent data or commands.

Prior to their first use for data processing in the 1890 US census using cards designed by Herman Hollerith, forms of punched cards were used to control Jacquard textile looms and mechanical organs.

The cards used in the 1890 US census had round holes, 12 rows and 24 columns. In 1928, IBM developed the 80 column card, using rectangular holes, and this doubled the data that could be stored on a card. The 80 column card became the dominant type, but other formats were available.

IBM and its competitors developed a variety of machines for creating, sorting, and tabulating punched cards and by the 1950s the punched card had become ubiquitous in industry and government. They were the primary medium for data entry, data storage, and processing even before the advent of the digital computer, and millions were created every day. They were a write-once medium, and groups or 'decks' of cards formed programs or collections of data. Users could create cards using a desk-sized keypunch with a typewriter-like keyboard. A typing error generally necessitated repunching an entire card.

During the 1960s however, magnetic tape began to replace punched cards as the primary means for data storage. Even so, punched cards were still commonly used for data entry and programming until the mid-1980s.

The first punched cards were blank, but subsequent cards usually had printing such that the row and column position of a hole could be identified, and cards could also carry other printed information such as logos. Some cards had one upper corner cut so that cards not oriented correctly, or cards with different corner cuts, could be easily identified.

A standard 80 column punched card contains 80 bytes, so 99,961 boxes of 2,000 cards would be required to contain the same amount of data as a single 16 GB microSD card.

Similar Media
Jacquard Loom card (1801 – 1990s)
Catalogue card (1780s – 2015)
Wheatstone tape (1857 – 1980s)
Punched tape (1846 – 1980s)
Macrame lace embroidery punched roll (1906 –)

1960s
DEC releases the PDP-1, the first minicomputer (1961
LEO III tape (1962 – 1981)
IBM introduces first word processor, the MT/ST (Magn
IBM MT/ST (1964 – late 1970s)
DECtape (1964 – 1980s)
IBM releases the System/360 range of commercial mainframe computers (1964)
9-track tape (1964 – 2003)
Magnetic stripe card (1964 –)
Olivetti introduces what is sometimes called the first desktop computer, the Programma 101 programmable calculator (1965)
Olivetti Programma magnetic card (1965 – early 1970s)
Tri-Data CartriFile (1968 – mid 1970s)
Knitting machine punched card (late 1960s – 2000s)
96-column punched card (1969 – late 1970s)

1970s
Intel introduces Erasable Programmable Read-Only Me
The Kenbak-I, the first personal computer, is introduce
IBM introduces the 8-inch floppy disk, initially in read-o
8-inch floppy disk (1971 – early 1980s)
Magnavox launches the first-generation of home video generation were simple 'pong'-style consoles that playe printed circuit boards to select the chosen game (1972
Magnavox Odyssey (1972 – 1975)
QIC Data Cartridge (1972 – 2000s)
IBM introduces a read/write capable 8-inch floppy disk
IBM 3850 Mass Storage System (1974 – 1986)
Control Data Corporation 9877 (1974 – 1990s)
Bill Gates and Paul Allen found Microsoft (1975)
DC100 (1975 – 1987)

Blu-ray Disc Recordable Erasable (BD-RE) (2006 –)



Blu-ray Disc Recordable Erasable (BD-RE) is a high-capacity optical disc that can be erased and re-recorded multiple times, and is a type of Blu-ray Disc that can be read in all Blu-ray Disc drives. The similar BD-R discs can only be written to once.

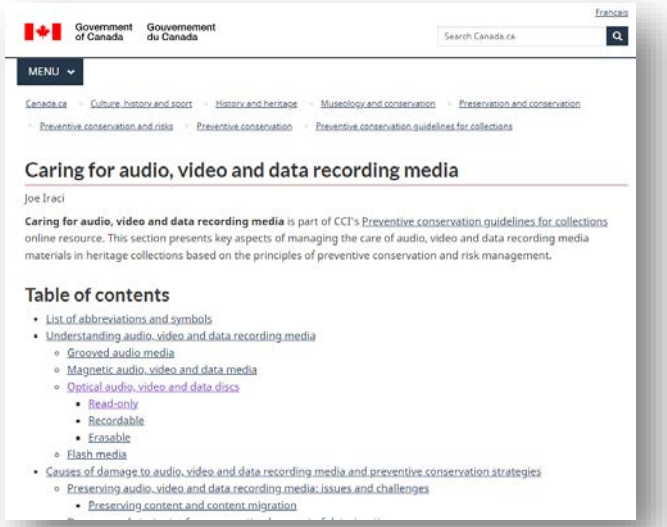
BD-RE drives can be found in computers and personal video recorders (PVRs).

Disc capacities are 25 GB for single-layer discs, 50 GB for double-layer discs, 100 GB for triple-layer, and 128 GB for quadruple-layer.

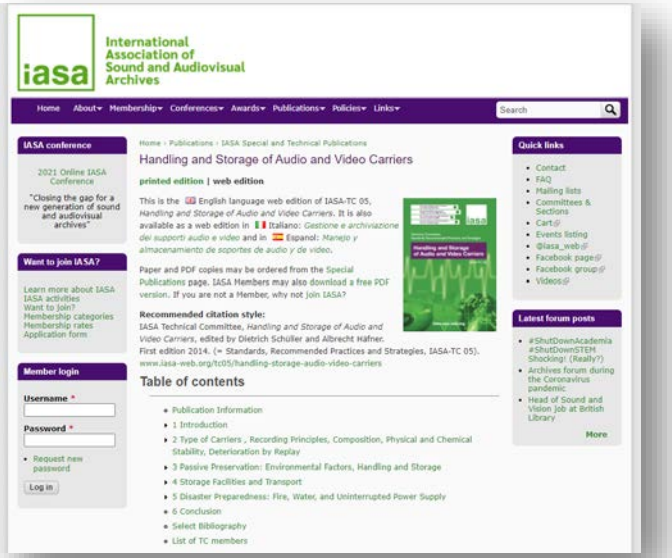
Similar Media
Blu-ray Disc Recordable (BD-R) (2006 –)
Blu-ray Disc (2006 –)
Sony PlayStation 4 Blu-ray (2013 –)
4K Ultra HD Blu-ray Disc (2016 –)
Sony PlayStation 3 Blu-ray (2006 – 2017)

Reference on Formats

- Resource handout also includes information on:
  - Magnetic tape storage and handling
  - Caring for audio, video, and data recording media
  - Handling and storage of audio and video carriers
  - Motion picture film
  - Digital media identification



From https://www.canada.ca/en/conservation-institute/services/preventive-conservation/guidelines-collections/caring-audio-video-data-recording-media.html.



From https://www.iasa-web.org/tc05/handling-storage-audio-video-carriers.



From https://www.archives.gov/preservation/formats/motion-picture-film-identify-formats.html.

Survey Process

- Create spreadsheet with columns for formats, rows for collections
- Pull identified collection
- Time to count!



41% of collections contained endangered media formats

1,079 VHS tapes

1,348 5¼” floppy disks

770 U-matic tapes

5 Collections with more than 100 individual components in need of attention

4,006 in Atari Coin-Op records



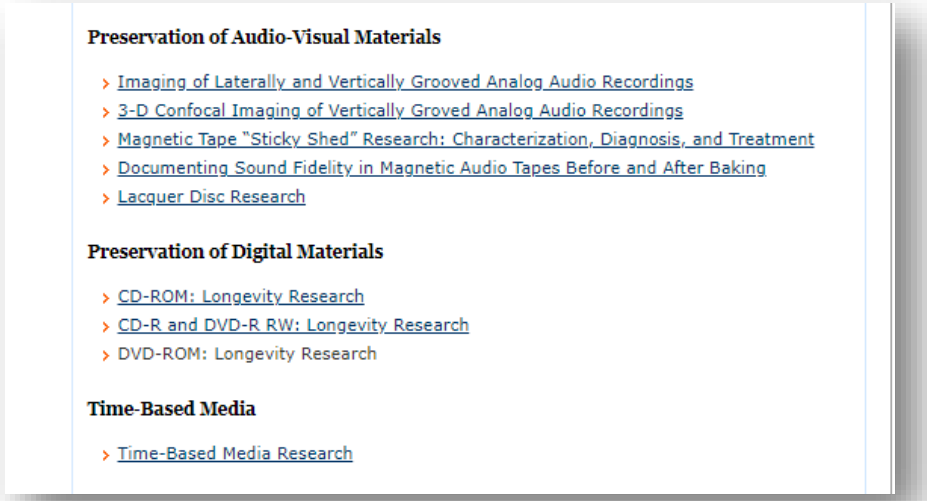
Now what?

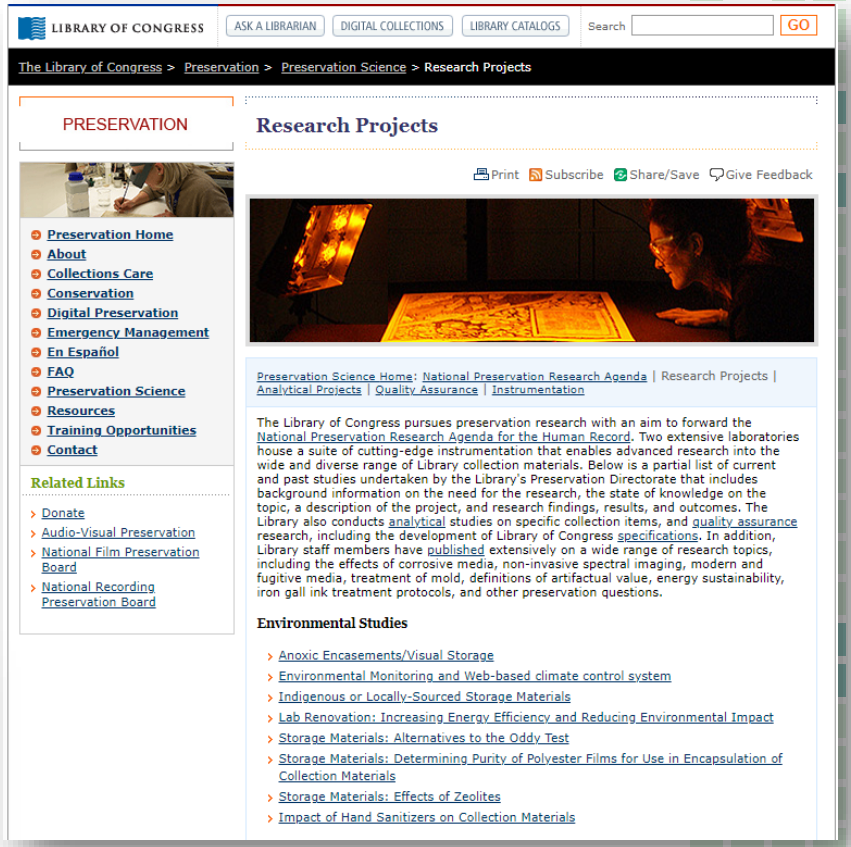
Research life expectancy of these media types to prioritize our next steps.



Resources for Estimating Life Expectancy

- Library of Congress – Research Projects
  - Environmental Studies
  - Preservation of Traditional Materials
  - Preservation of Audio-Visual Materials
  - Preservation of Digital Materials
  - Time-Based Media
  - Technology Transfer

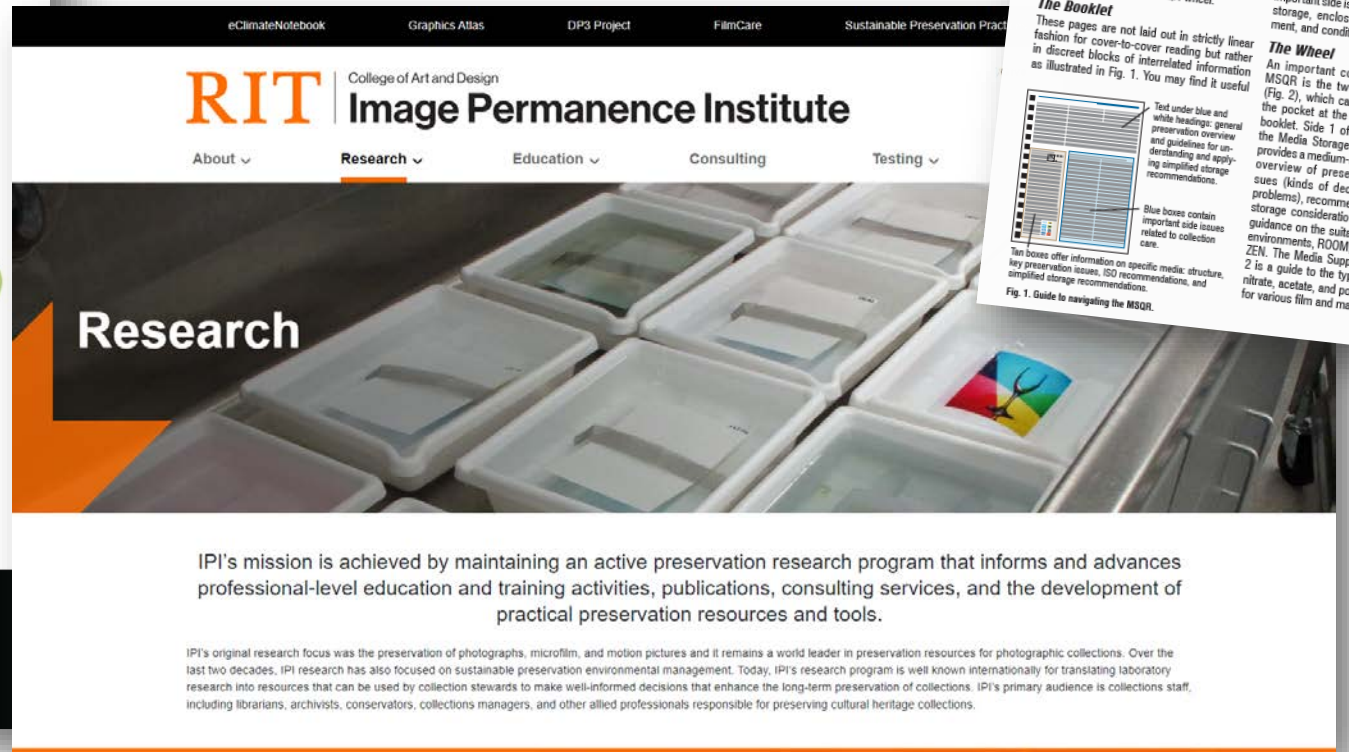




Resources for Estimating Life Expectancy

- Image Permanence Institute (IPI)
  - Preservation metrics and risk assessment
  - Sustainable preservation practices

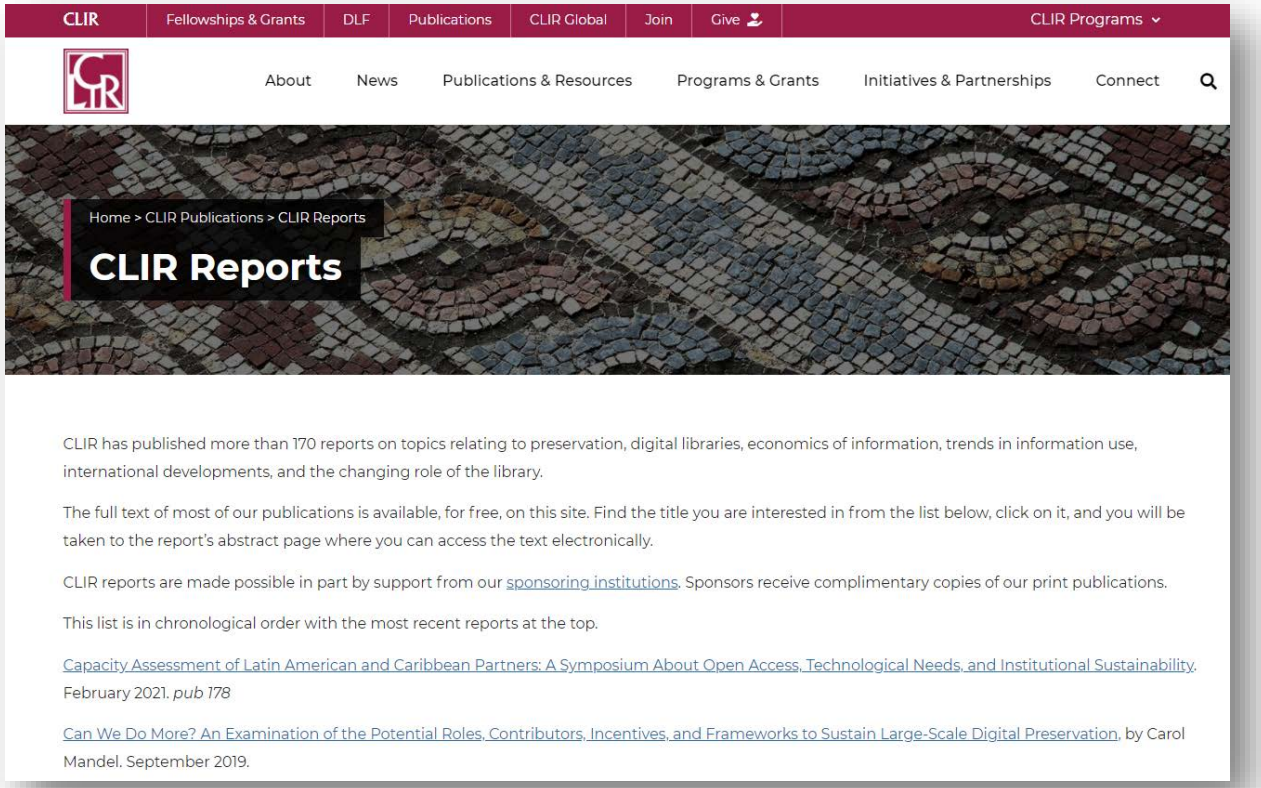






Resources for Estimating Life Expectancy

- Council for Library and Information Resources (CLIR)

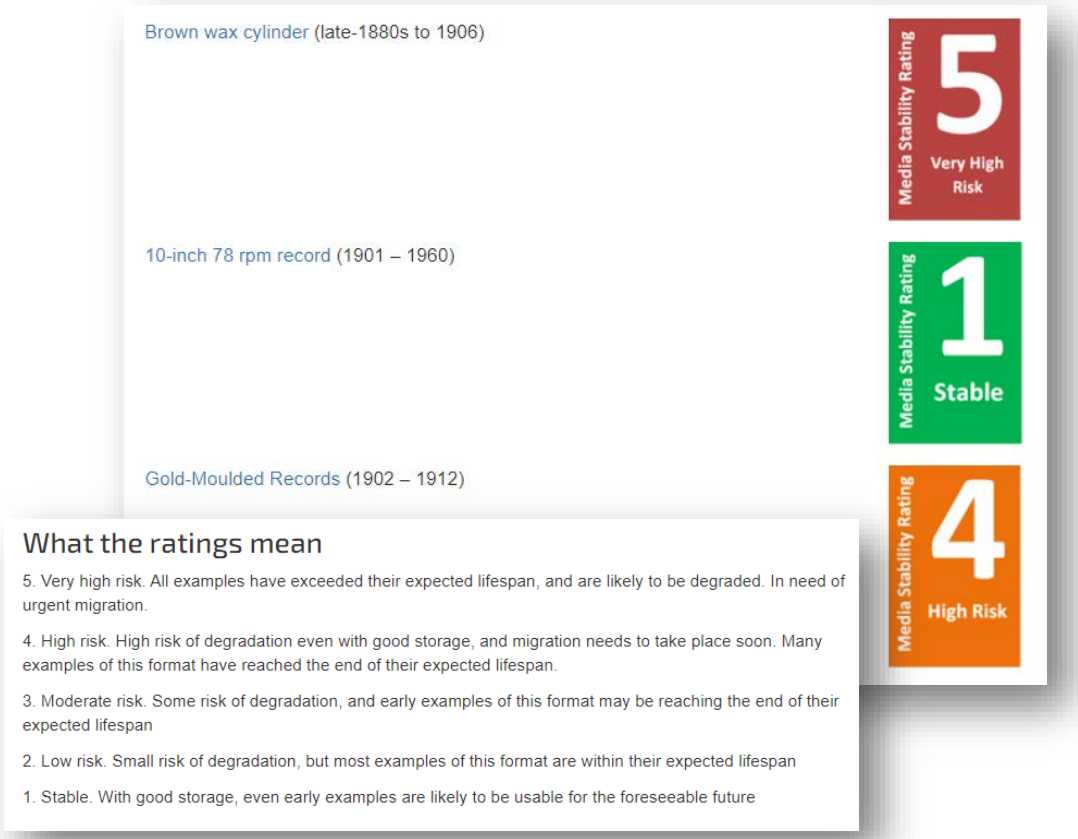


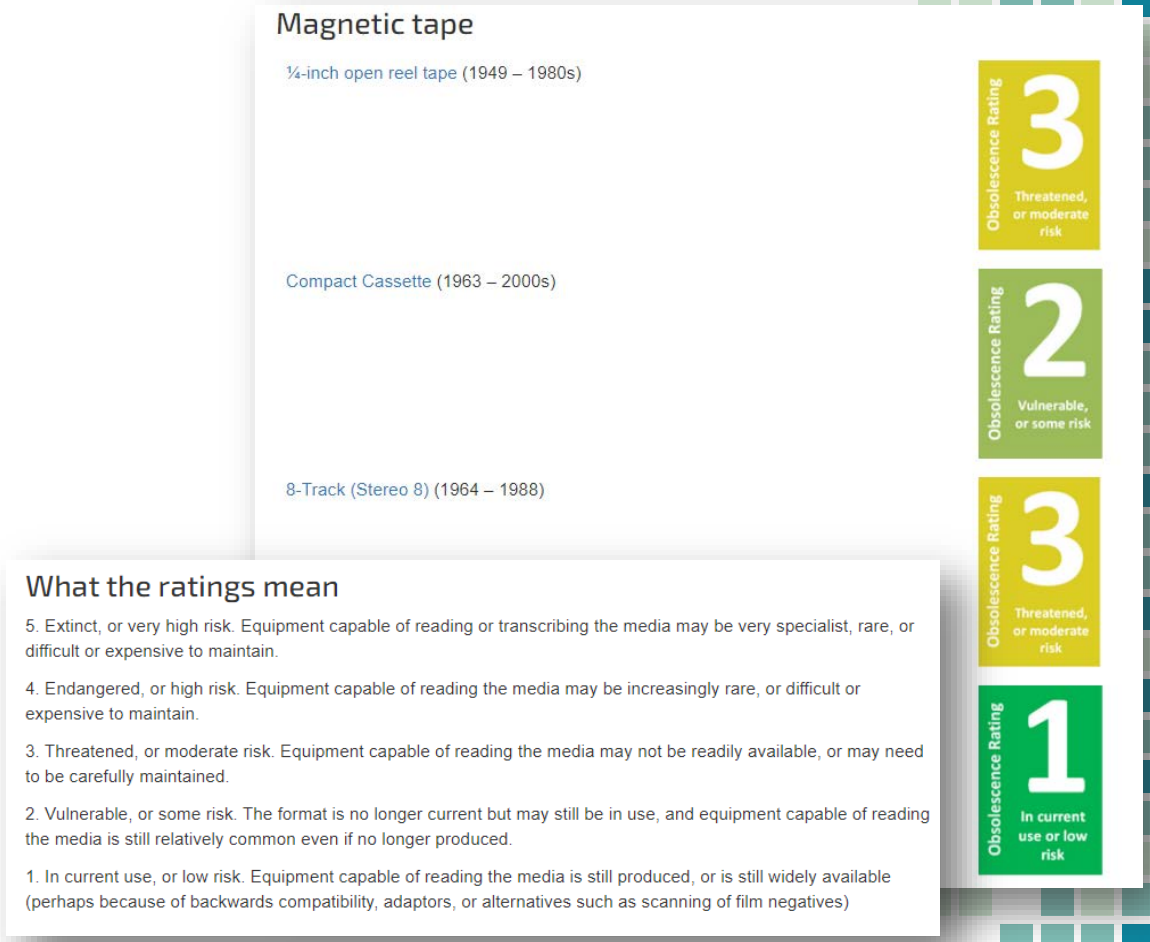


From https://www.clir.org/wp-content/uploads/sites/6/pub164.pdf.

Resources for Estimating Life Expectancy

- Museum of Obsolete Media - Media Stability Ratings
- Museum of Obsolete Media - Obsolescence Ratings



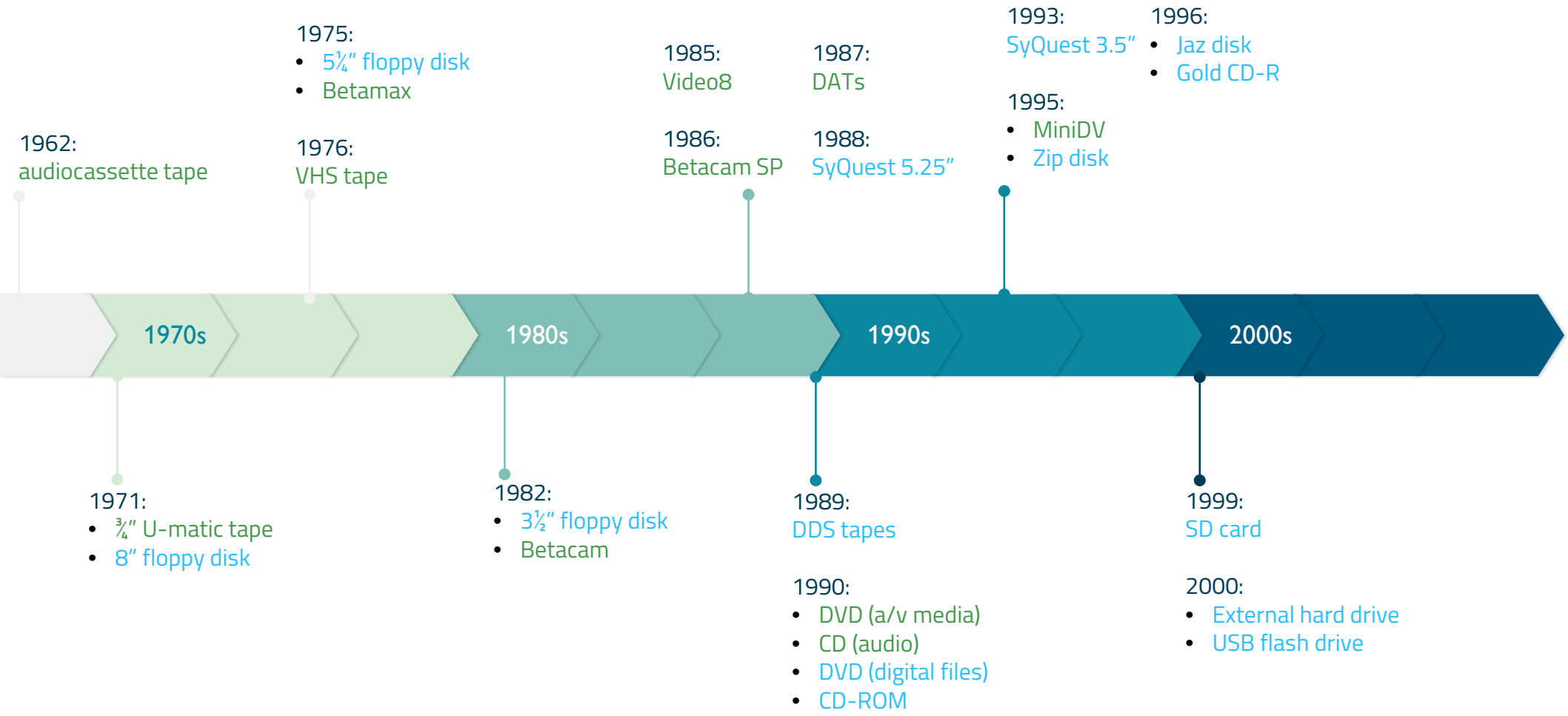


What About Definitive Numbers?



- … It depends …
- Consider:
  - Medium
  - Support material
  - Format
  - Storage conditions
  - Handling and use

Intro Dates of Media Formats in the Archives



Determining Life Expectancy

- Format
- Medium
- Support material
- Introductory date

Example :

- Format: audiocassette tape
- Medium: magnetic audio tape
- Support: polyester
- Intro date: 1962
- Life expectancy: 20 years
- Part of collection: Jordan Mechner papers
- Earliest possible date in collection: 1984
- Quantity in collection: 3
- Equipped for playback: yes

Magnetic Tape

Magnetic audio tape consists of a base layer, a binding layer, and sometimes a back coat.

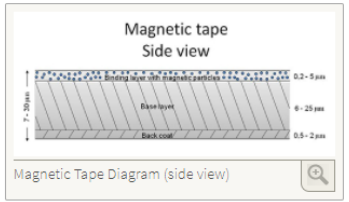
The base layer is either paper, PVC, acetate, or polyester. It functions as a substrate to support the recording as it travels through the playback equipment. Most are either acetate or polyester.

The binding layer supports the magnetic particles used for recording. Manufacturers experimented with various formulations of these binding elements and sometimes consider detailed information about the exact components to be trade secrets. Often it is the binder which breaks down or changes over time and causes a tape to degrade or become sticky and difficult to play (see Condition Assessment) for additional information.

The back coat layer, if present, is carbon based and is meant to reduce friction and static electricity.

More information on plastic tape bases:

- Acetate (1930s-1970s): a tape base that deteriorates over time by drying out. The tape will be very brittle and may have a distinct smell of vinegar; the breakdown of acetate is often referred to as "*vinegar syndrome*" (see Condition Assessment) for additional information.
- PVC (1940s-early 1970s): this was an inexpensive plastic tape base that was not widely used (see Condition Assessment) for additional information.
- Polyester (early 1950s-present): also referred to as Mylar, PE, or PET. Durable and chemically stable tape base that became the norm for audio tape manufacturing by the 1970s. Depending on the time period when they were manufactured some tapes with polyester base may exhibit signs of sticky shed syndrome.

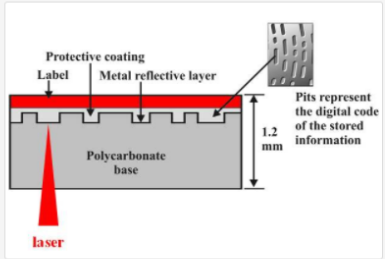


Magnetic Tape Diagram (side view)

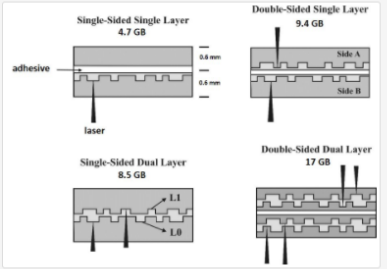
From https://www.archives.gov/preservation/formats/audio-important-characteristics.html

Read-only

- The information is placed on the disc at the same time that the disc is manufactured and is stored in the form of "pits" that are imbedded into the polycarbonate plastic base (Figures 9a, 9b and 9c).
- A series of pits of different sizes make up the binary code (0s and 1s) that represent the digital content.
- All optical discs contain a metal reflective layer that is imperative to the functioning of the disc.
- Examples of read-only discs include:
  - laserdisc
  - CD-audio
  - CD-ROM
  - CD-video
  - DVD-video
  - DVD-audio
  - DVD-ROM
  - Blu-ray Disc-video
  - Blu-ray Disc-ROM



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Figure 9a. Cross-section of a read-only CD.

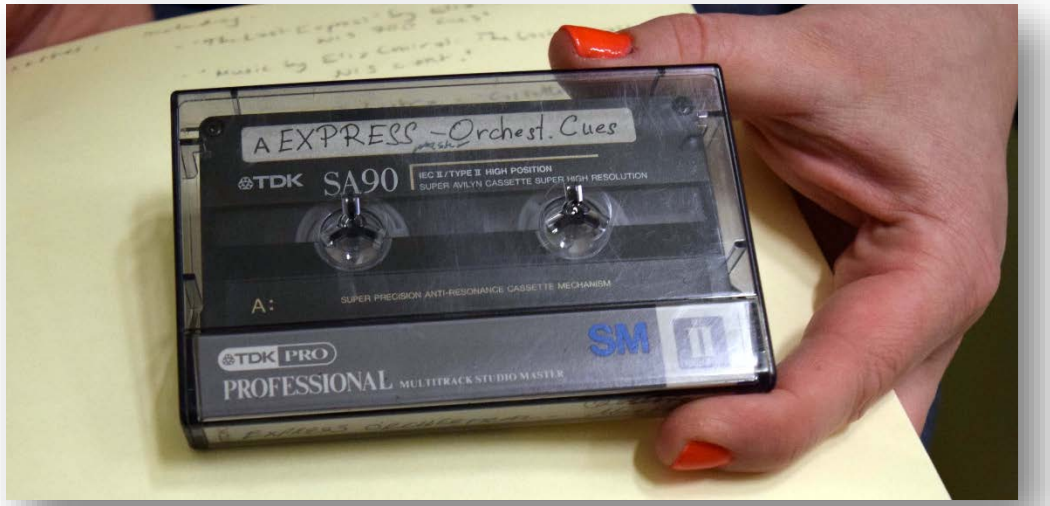


© Government of Canada, Canadian Conservation Institute. CCI 125773-0167
Figure 9b. Cross-sections of a read-only DVD. Two

From https://www.canada.ca/en/conservation-institute/services/preventive-conservation/guidelines-collections/caring-audio-video-data-recording-media.html

Formula

Earliest born date + Life expectancy = Earliest extinction date



1962 + 20 years = 1982

Well, that was 39 years ago… we might have an unreadable piece of media!

Accessing Media Formats

- Do we currently have ability to read this in-house?
- Is original media currently the only access copy?









Determining Media Viability

- Add more columns to spreadsheet…
- Order media by earliest possible extinction dates
- Identified formats with no in-house readers (inaccessible to researchers and for digitization)
- Easily identified three formats based on qty. & chronology:
  - U-matic tapes
  - 8" floppy disks
  - 5¼" floppy disks

Format	Medium	Support	Intro	LE (years)	Strong Archives	Earliest born	Quantity	Earliest extinction	Equipped
Cassette Tape	Magnetic Audio Tape	Polyester	1962	20	Brian Fargo papers	1962	1	1982	yes
Cassette Tape	Magnetic Audio Tape	Polyester	1962	20	John Szczepaniak	1962	1	1982	yes
Cassette Tape	Magnetic Audio Tape	Polyester	1962	20	Jordan Mechner	1963	3	1983	yes
Reel-to-reel	Magnetic Audio Tape	Polyester	1963	20	Atari Coin-Op records	1969	96	1989	
Cassette Tape	Magnetic Audio Tape	Polyester	1962	20	Atari Coin-Op records	1969	20	1989	yes
3/4" U-Matic	Magnetic Video Tape	Polyester	1971	20	Atari Coin-Op records	1971	763	1991	
3/4" U-Matic	Magnetic Video Tape	Polyester	1971	20	Jordan Mechner	1971	7	1991	
Data Tapes	?	?	?	20	Jordan Mechner	1971	58	1991	
8" floppy	Computer disk	Polyester	1971	20	Atari Coin-Op records	1971	248	1991	
Syqvest	Hard Drive	Zip	1986-1998	5	Atari Coin-Op records	1986	295	1991	
DVD - A/V media	Computer disk	Optical	1990	5	Ron Dubren	1990	1	1995	yes
DVD - A/V media	Computer disk	Optical	1990	5	Anne D Williams	1990	4	1995	yes
DVD - A/V media	Computer disk	Optical	1990	5	CJ Rogers	1990	32	1995	yes
CD - Audio	Computer disk	Optical	1990	5	CJ Rogers	1990	3	1995	yes
5.25" floppy	Computer disk	Polyester	1975	20	Atari Coin-Op records	1975	930	1995	
5.25" floppy	Computer disk	Polyester	1975	20	Penguin Software	1975	252	1995	

5¼” and 3½” Floppy Disks

- *Interior* : polyester “cookie” coated with iron oxide particles, magnetized into the ones and zeroes that make up the data
- *Exterior* : flexible plastic sleeve housing, sealed at outside edges, with hole in center that exposes a small amount of “cookie”

Potential issues :

-Magnetic media can shed from cookie on disk
-Disks are sensitive to magnetic fields
-Floppy disk drive can cause physical damage to disk







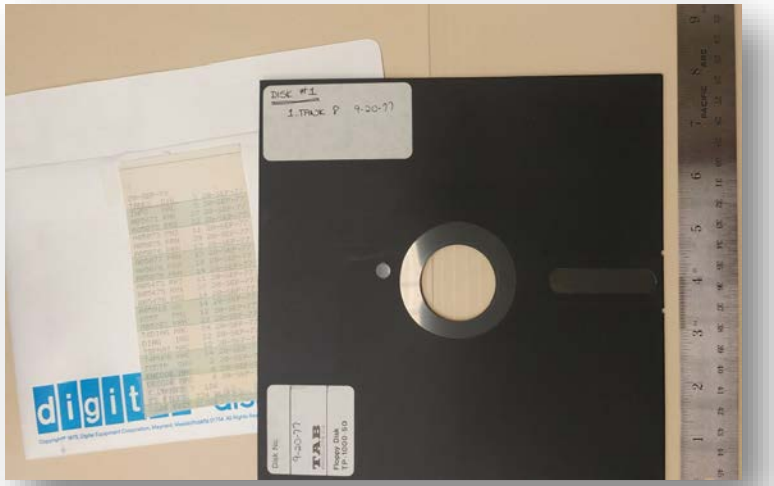


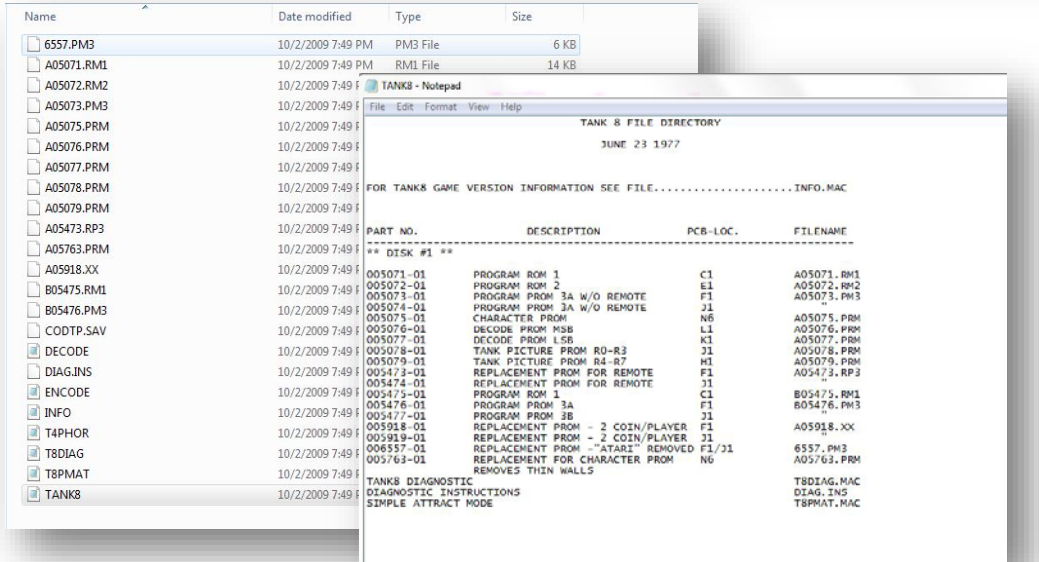
8” Floppy Disks

- Older than their 5¼” disk cousins and with less storage capacity
- Also vulnerable to damage by handling/use
- …where do we get a drive to read this?!
- Digitization = likely “final use” of physical object









Obsolescence Rating 5 Extinct, or very high risk

https://obsoletemedia.org/media-preservation/obsolescence-ratings

U-matic Tapes





- *Interior* : magnetic media supported by polyester;
  unlike other magnetic a/v formats, reels turn in opposite directions
  (and tape exits cassette to enter player)
- *Exterior* : two possible sizes, plastic cassette with clear window
  which shows interior reels

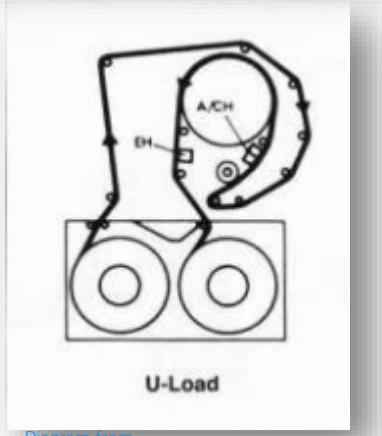


Diagram from
https://cool.culturalheritage.org/videopreservation/vid_guide/11/11.html

Potential issues :

-"Sticky shed"
-Signal loss due to problems with physical object
-Damage to tape from spinning video drumhead
-Digitization = likely final use of physical object





https://obsoletemedia.org/media-preservation/obsolescence-ratings/.

Additional Common Examples



16mm film

- Acetate safety film
- Originally moving images only; sound added c. 1930 and color introduced with Kodachrome (1935)

Potential issues:
-vinegar syndrome
-may want to digitize for access

But check your 35mm to ensure it's not nitrate film stock…!

Additional Common Examples

Audio cassettes



- *Interior* : two spools between which magnetically-coated polyester film is passed and wound; may be two stereo pairs of tracks or two monaural audio tracks
- *Exterior* : protective plastic shell (4" x 2.5" x 0.5")

Potential issues :

-tension failure on take-up spool
-variance in tape speed/playback sounds
-may want to digitize for access

Additional Common Examples



Data tapes (DAT, DDS)

- *Interior* : digital recording on magnetic tape; can only be recorded/played in one direction. Technology based on video recorders (rotating head, helical scan), not like an analog cassette deck
- *Exterior* : Looks like a standard audio cassette, but roughly half the size (usually about 2.87” x 2.13” x 0.41”)

Potential issues :

-sticky shed
-need special data tape drive, associated software/emulators
-not always backwards compatible

Additional Common Examples



VHS tapes

- *Interior* : Mylar ½" magnetic tape wound on two spools, contains anti-despoiling mechanism
- *Exterior* : plastic shell(7⅜" × 4 1/16" × 1") held together with five screws; flip-up cover allows players and recorders to access the tape

Potential issues :

-deterioration of recording
-formatting of tape: NTSC, SECAM, PAL
-S-VHS will not play in standard VHS deck

Additional Common Examples

Betamax/Betacam tapes



- *Interior* : ½" magnetic tape wound on two spools
- *Exterior* : plastic shell[sizes can vary based on camera/player]

Potential issues :

-difficult to find parts or people to repair Betamax tape decks

-risk for signal loss due to deterioration

-extensive inspection is difficult without playback

Additional Common Examples



Compact discs

- Digital optical disc data storage format, originally designed to store digital audio recordings (later adapted for data storage)
- 4.7" diameter, designed to hold up to 74 min of uncompressed audio or 650 MB of data
- Polycarbonate plastic with thin layer of aluminum (or gold) applied to surface, protected by film of lacquer
- Data is represented as pits encoded on spiral track into top of plastic layer, read by focusing a laser through bottom of plastic

Potential issues :

-susceptible to damage from handling and environmental exposure
-rewritten media = possible data errors
-CD-Rs = dye-based and degrade quickly

Additional Common Examples

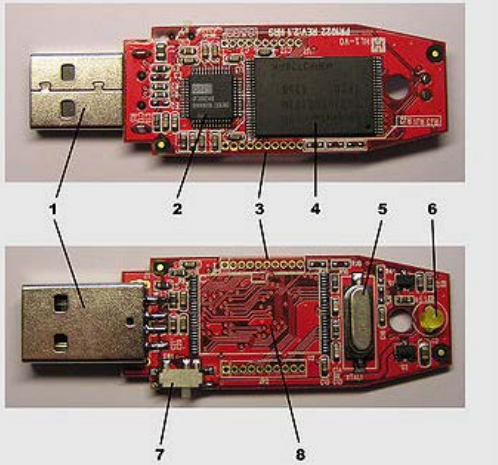
USB flash drives

- *Interior* : printed circuit board with integrated circuits; one IC is interface between USB connector and onboard memory, other IC is flash memory
- *Exterior* : cover made of plastic or metal to protect electronics from mechanical stress

Potential issues :

-data rot
-limit on write/erase cycles
-limit on insert-removal cycles
-physical damage
-password-protection?





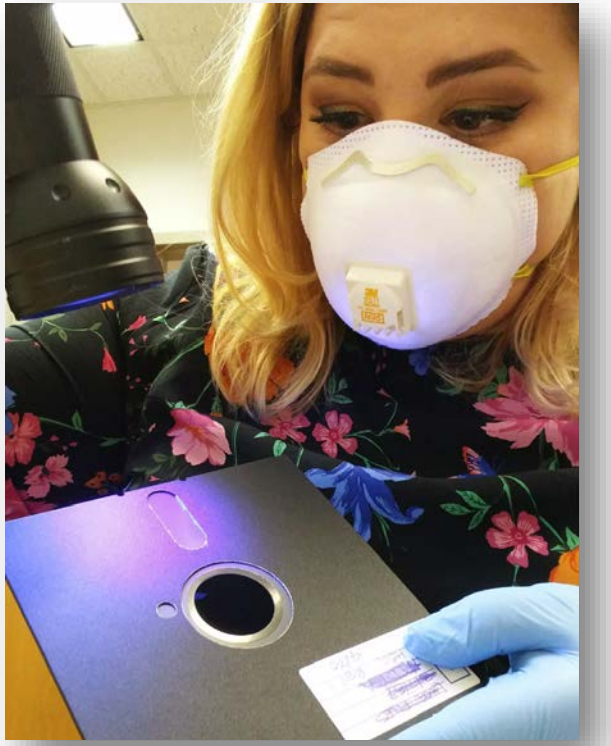
Internals of a typical USB flash drive

1	USB Standard-A, "male" plug
2	USB mass storage controller device
3	Test point
4	Flash memory chip
5	Crystal oscillator
6	LED (Optional)
7	Write-protect switch (Optional)
8	Space for second flash memory chip

Diagram from https://en.wikipedia.org/wiki/USB_flash_drive.

Item-Level Inspection

- Identifying problems
  - Dirt and dust?
  - Mold?
  - Magnetic media iron oxide shed?



- Equipment used
  - Personal protective equipment
  - UV light
  - Conservation-approved cleaning tools (melamine foam, swabs, isopropyl alcohol)

Examples of Damaged Media





From http://www.chromaservices.ca/repair_services/repair_vhs_beta_tapes.html





From http://www.little-archives.net/guide/content/about_commonproblems.html



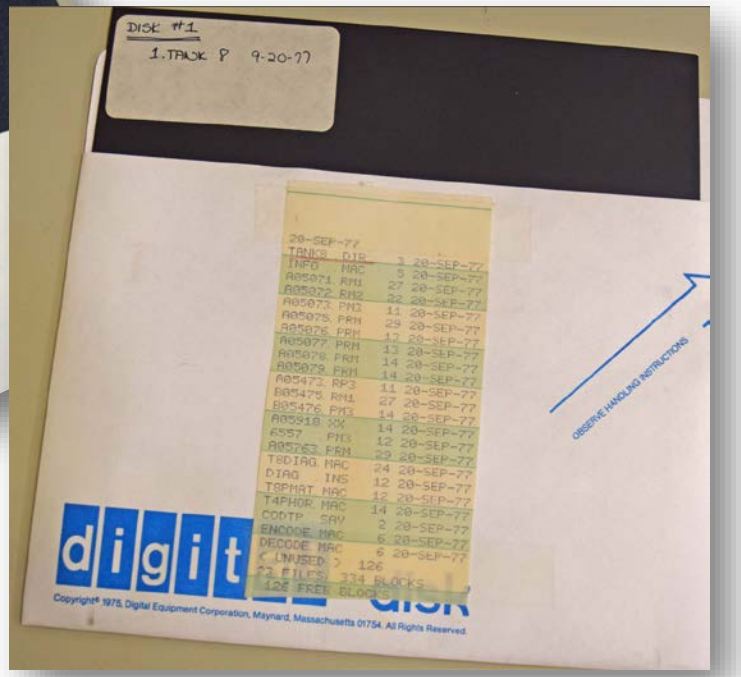
From http://stanleyvideos.com/is-it-possible-to-clean-the-fungus-in-the-video-film-cassette.aspx

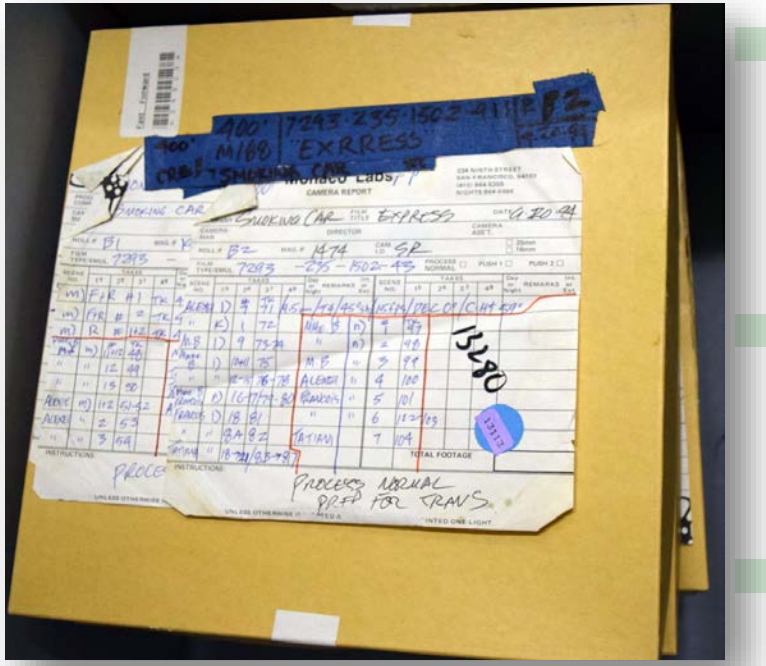
Use Available Physical Metadata for Making Decisions

- Directory printouts?
- Recognizable handwriting?
- Labels?
- Enclosures?
- Signs of damage/improper storage?









Storage Environments and Effect on Life Expectancy

- Life expectancy (LE) calculated at ambient temp. (68°F) and rH (50%)
- Fine conditions in existing museum storage areas, but cooler and drier conditions may prolong LE





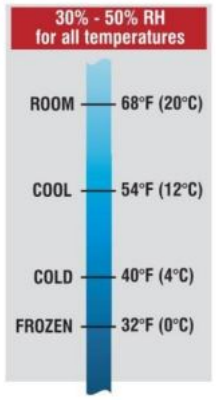


Ideal Storage Temps for Audiovisual Materials

Suitability of environments for storage of various media types.

Storage Conditions	Glass Plates	Nitrate	Acetate		Polyester		Photo Prints		Ink Jet Prints	Magnetic Tape		CDs DVDs
			B&W	Color	B&W	Color	B&W	Color		Acetate	Polyester	
ROOM	Fair	No	No	No	Good	No	Good	No	Fair	No	No	Fair
COOL	Good	No	No	No	Good	No	Good	No	Fair	Fair	Good	Good
COLD	Very Good	Good	Good	Good	Very Good	Good	Very Good	Good	Good	Good	Good	Good
FROZEN	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Good	Good	No

NOTE: Degrading acetate and nitrate should be frozen. The ratings for ink jet prints reflect their susceptibility to pollutants and contaminants.



QUALITATIVE RATING SYSTEM	
NO	Likely to cause significant damage.
FAIR	Does not meet ISO recommendations but may be satisfactory for extended periods.
GOOD	Comparable to ISO recommendations.[12]
VERY GOOD	Will provide an extended lifetime.

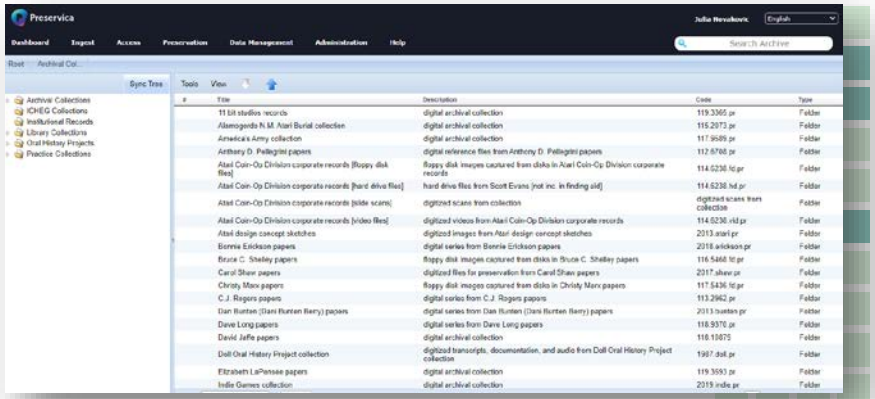
From *IPI [Image Permanence Institute] Media Storage Quick Reference, 2nd Edition*

From https://sustainableheritagenetwork.org/system/files/atoms/file/IdealStorageTemperatures.pdf

Next Steps…

Considerations :

- Time and skill set
- Using vendors vs. digitizing in-house
- Acquisition of hardware and software
- Digital asset management system (DAMS)

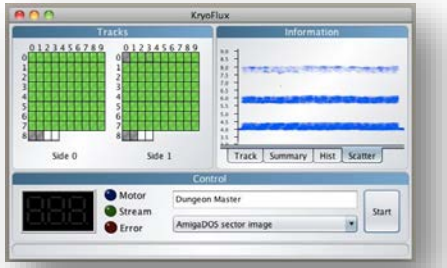


Inventory and assess endangered media in archival collections

Disk imaging, a/v migration; properly house and store media

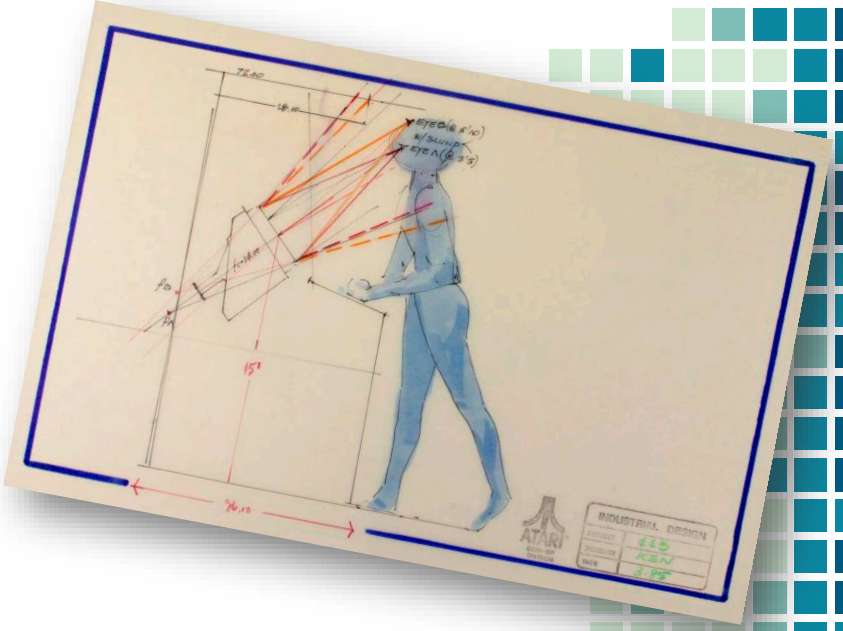
Access content from disk images and migrated a/v formats

End goal: Long-term preservation





Deep Breaths!



- Start thinking about media formats when they are part of incoming acquisitions; capture descriptive information up front
- Consider moving away from reliance of physical object as access copy
- Discuss your institution's digitization goals and capabilities
- Research media format composition/life expectancy for your collections
- Keep good notes and data
- Plan and execute an item-level survey of formats in your collections



THANKS!

Any questions?

Julia Novakovic

jnovakovic@museumofplay.org

Twitter: @archivesjulia

