



# A Guide to Approaching Audiovisual Digitization for Artists and Arts and Culture Organizations

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# Executive Summary

In 2017 Bay Area Video Coalition (BAVC) received a generous grant from the Andrew W. Mellon Foundation which supported the continuation of our Preservation Access Program (PAP), which offers subsidized preservation services to artists and organizations with archival audiovisual holdings. As part of the grant, BAVC has written this paper meant to provide direction and guidance in the process of preserving audiovisual collections, particularly those owned or managed by individuals or smaller organizations. The paper provides information for both practitioners in the field of preservation as well as information for artists and organizations that will help them to prioritize digitization efforts, as well as better understand the issues they may encounter as they plan to preserve tapes of various types and brands, thereby, ideally, saving time and effort in the preservation process.

The paper discusses the preparation of a collection before digitization, the stewarding of files post-digitization, and which tasks are best left to a digitization vendor. The paper also discusses common errors found in all parts of digitization and preservation workflows, and methods for selecting a preservation file format. Finally, the paper discusses updates made to BAVC's tape preparation and digitization workflows which were enabled by the funding from Mellon. These workflow updates were informed by data collected by BAVC technicians throughout the digitization process, and are being shared to help advance the general expertise in the field of audiovisual preservation.

## Introduction

Established in 1994 in partnership with the Getty Research Center, BAVC's Preservation Department works with museums, artists, and cultural institutions around the world to reformat, archive, and make accessible seminal creative and historical works on video and audiotape, as well as community-based works that are broadly used in academia, research, and other project production. Today, BAVC's Preservation work represents one of the nation's longest-standing non-profit audiovisual preservation programs. From the beginning, BAVC Preservation implemented practices and services that helped define the field of video preservation. It continues that work today by pursuing a range of field-building initiatives and services.

In May 2013, with support from the National Endowment for the Arts (NEA), BAVC launched the *Preservation Access Program (PAP)*, offering subsidized preservation services to artists and smaller arts organizations that might not otherwise have the resources to pursue preservation work for their collections. This program has forged closer alignment between BAVC's preservation activities, with its other programs to inspire social change by empowering media makers to develop and share diverse stories through art, education and technology.

In 2017, funding for PAP was renewed through a generous grant from the Andrew W. Mellon Foundation (the “Mellon Foundation”). This grant from Mellon allowed BAVC to continue offering PAP, which is now in its 12th round. The funding also gave BAVC an opportunity to update our workflows and data collection processes in an effort to identify and alleviate common issues and roadblocks in preservation workflows. BAVC has written this white paper in order to provide direction for the field regarding audiovisual collections owned by artists and small arts organizations. The paper provides an analysis for both practitioners in the field of preservation as well as information for artists and arts and cultural organizations that will help them to prioritize digitization efforts as well as better understand the issues they may encounter.

This paper begins by describing the work that collection holders must do before and after sending their materials to a digitization vendor, as well as the kind of work and tasks that digitization vendors should be expected to perform. This is meant to give organizations an idea of how to prioritize and delegate the tasks involved in moving towards the digital preservation of their materials. Next, there is a discussion about digital deliverables formats. This is meant to provide a framework that organizations can use to select their digital file formats, rather than a discussion of individual formats. Next, there is a discussion about errors common to analog and digital preservation workflows, with the purpose of helping organizations identify and mitigate these errors in their own collections. And finally, there is a discussion about BAVC’s own findings and workflow enhancement over the past two years. This discussion is more technical than the previous sections, and is meant to enhance the state of preservation so that others in the field do not need to retread the same ground or reinvent the wheel.

The archiving and preservation field is lucky to have excellent thinkers and writers, many of whom have made their own research and documentation available to the public. As a result, many of the technical topics mentioned in this report have been discussed at length by scholars and practitioners in the field. With that in mind, we provide links to pre-existing documentation. Links to these documents are provided within the narrative, and are also collected at the end of this document in the “Additional Resources” section.

# Approaching Digitization as an Individual or Small Organization

This document is meant to prepare smaller organizations before they embark on digitization initiatives. It includes the discussion of important concepts, practices, tools, and equipment that will be necessary to understand while formulating a digitization and preservation plan. It's important to have a preservation plan in place before digitizing materials in order to avoid having to redo any work done if the digitization is not performed to spec, or if the files are lost or corrupted while plans or policies are being decided upon.

## What the collection holders can do

The Preservation Access program is designed to allow participants to use BAVC's skill and expertise to digitize their audiovisual collections. Much of the work that BAVC does is specialized, and requires expensive and difficult to find equipment. However, this specialized work is only a portion of the overall work that needs to be done in order to properly preserve content contained in audiovisual collections. In fact, there is a great deal that collection holders need to do before and after sending their materials to a digitization vendor to ensure that their materials are being properly preserved.

## Pre-Digitization

### Inspection, Inventory, and Description

In this segment we will discuss inspecting, inventorying, and describing tapes. Inspection, inventory and description can be done at the same time in order to reduce the amount of time spent handling the materials. However, if lack of resources causes you to be solely responsible for these activities, inspection should be prioritized. The proper inspection of your tapes can not only help determine where resources should be prioritized, it can also help identify contamination that can spread across entire collections if not properly handled.

### Inspection

Inspection is a service that BAVC provides to PAP participants. An experienced professional will be able to identify issues that an inexperienced person may not notice. Certain odors and visual cues can indicate specific levels of deterioration or contamination. While there is no substitute for experience, there are many resources available to guide people through the inspection of their materials.

A full copy of the [ISO 18933](#) standard approved by the International Organization for Standardization (ISO) can be purchased, at this writing, for about \$115. This document

describes the care and handling practices for magnetic media, and was written and informed by the work of many experienced people in the field. If this price exceeds your budget, much of this information is available in other resources that have been made available for free. One such document is [Magnetic Tape Storage and Handling A Guide for Libraries and Archives](#), written by the Commission on Preservation and Access and the National Media Laboratory. This document is extremely thorough, and discusses many aspects of the physical makeup of video tape, handling, and playback. A more succinct guide can be found in [Basic Inspection Techniques to Sample the Condition of Magnetic Tape](#) by Specs Brothers. This document can serve well as a reference manual for people performing intake, as it has images that illustrate specific types of tape deterioration and damage.

BAVC's inspection workflow is informed by a mix of the ISO 18933, the Specs Brothers document, and our experience as to what details about the condition of a tape are most relevant for future transfer processes.

Prior to our work with the Mellon Foundation, BAVC did not maintain standardized rules of entry for the severity of each inspection point. With the Mellon Foundation's grant, BAVC was able to improve our CRM (Salesforce) to better capture our inspection data. This data is used for internal data analysis, and is also delivered to collection holders. The following is a list of inspection points used by BAVC technicians when performing intake on a tape:

- Popped Strands
- Stepping
- Dirt
- Mold/Fungus
- Crystallization
- Cassette/Reel Damage
- Odor
- Container Damage
- Tape Distortion or Damage

This 9-point inspection is designed to capture the most salient information about the condition of the tapes. Each of these 9 points can have one of the following 6 values assigned to it:

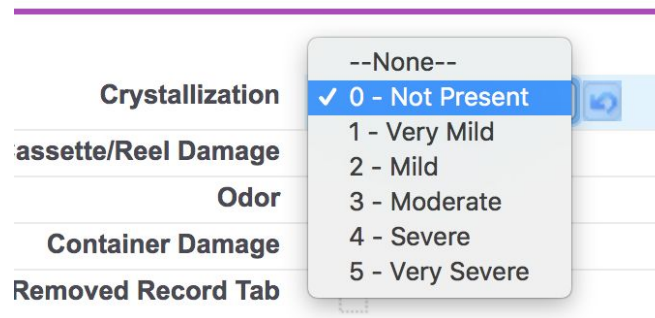
- 0 - Not Present
- 1 - Very Mild
- 2 - Mild
- 3 - Moderate
- 4 - Severe
- 5 - Very Severe

The data collection at this point will inform how we proceed with the care, handling, playback, and potential remediation of the tape.

- It can inform any immediate action that needs to be taken to quarantine or remediate the tape

- It can inform the transfer technician of any special handling or considerations when beginning to handle or transfer the tape.
- It provides the collection owners of the condition of the tape upon arrival at our facility, if they were unable to do so before we received it.

| ▼ Intake Quality           |  |                           |                                     |
|----------------------------|--|---------------------------|-------------------------------------|
| Popped Strands             | 2 - Mild   | Crystallization           | 0 - Not Present                     |
| Stepping                   | 4 - Severe   | Cassette/Reel Damage      | 2 - Mild                            |
| Dirt                       | 1 - Very Mild  | Odor                      | 3 - Moderate                        |
| Mold/Fungus                | 0 - Not Present  | Container Damage          | 1 - Very Mild                       |
|                            |  | Tape Damage or Distortion | 2 - Mild                            |
|                            |  | Removed Record Tab        | <input checked="" type="checkbox"/> |
| Inspection/Condition Notes | Tape smells like candle wax. Head of tape is slightly damaged. |                           |                                     |
| Notes From Client          |  |                           |                                     |



If upon inspection you notice possible mold contamination you should take immediate action. Mold and fungus can grow on either the case, cassette, reel, or the tape itself. If mold is found in any of these places the tape should be quarantined immediately, as the possibility of cross-contamination can put the entire collection at risk. Quarantining the tape involves sealing the tape by using any type of non-reactive airtight storage. If the case or container is the only portion that is contaminated it should be discarded. If the case or container has artifactual value and cannot be discarded it can be cleaned with Isopropyl ([70% concentration is best suited to kill bacteria and mold, but 99% is best suited to use as a solvent to clean water-sensitive equipment](#)). If any of your tapes have mold contamination than all of them could have been exposed to mold spores at some point. Inhibit mold growth on the rest of your collection by storing your tapes in a location that has an ideal climate. 65°F and 40% Relative Humidity.

Signs of damage and oxide shedding, or signs of [soft binder syndrome](#) are also important to note if they can be properly identified. These conditions will greatly affect the process taken to make the tapes playable for digitization, and indicate that previous storage and handling techniques may have been inadequate.

The Association of Moving Image Archivists (AMIA) Community Archiving Workshop has developed an [Inventory and Condition Form](#) that can be used for audio, video, and film objects. This document is just one of [many documents](#) that the workshop has developed than be used for the administration of audiovisual archiving projects.

### Inventory and Description

The inventory and description of your collection will enable you to focus resources on what is most important. An adage that rings true throughout the many realms of the cultural heritage community is “Content is king, but context is the kingdom.” In the case of item inventory and description, collecting information about the items in your collection can help to build the context that you’ll need to make decisions about processing and preserving your content.

When describing your objects consider collecting information about the content, creators, physical properties, and signal properties. If information about the content and creators is not known already known, it will have to be gleaned from the label or any paper ephemera inside of, or attached to the tape or container. The total run time (often written as TRT or duration) is an important datum to collect, as it can help your digitization vendor create an accurate quote for digitization costs, and it can help you estimate how much digital storage you’ll need for digitized video files.

The task of collecting information about the physical properties of media objects is more specialized, however a number of resources are available to aid in the identification of videotape formats. In 2004 the Texas Commission of the Arts created a thorough [Videotape Identification and Assessment Guide](#). DC Video, a video digitization vendor, also has a guide on [their website](#) which goes so far as to include possible stock brands and models. Ashley Blewer has created a [Magnetic Media Formats Chart](#) that can easily be printed and placed next to a workstation

Information about the signal properties refers to whether the video content is in black & white, color, or both, or whether the audio is in mono or stereo. Most of the time you’ll need to playback the tape in order to know this information, and in most cases you’ll need to wait until the tape is played or digitized to gather this information. However, in some cases this information is noted on the label or in other documentation.

### Tools: AV Compass

[AV Compass](#) is a tool developed by BAVC to educate collection holders about their AV objects, and help them inventory those objects. AV Compass is split into the following five sections:



1. Learn
2. Identify
3. Plan
4. Preserve
5. Inventory

The first four sections (Learn, Identify, Plan, and Preserve) contain videos to help users understand core preservation concepts. The videos are short, under three minutes each, in order to demonstrate the concepts in a clear and succinct manner.

The fifth section (Inventory) is a web app that allows users to inventory and describe AV objects, and organize those objects into collections. The inventory interface is split into three sections per object: *Item Basics*, *Item Properties*, and *Item Condition*.

The *Item Basics* section asks for basic descriptive information related to the content on the item. This section could be filled by someone with only a cursory understanding of analog media.

- Collection
- Item Title
- Original Creator(s)
- Rights Summary
- Creation Date

The *Item Properties* section includes more detailed questions about the object and the information/data on the object. Filling out this information would require an intermediate understanding of media handling.

- Media Type
- ID
- Parts
- Sound
- Color
- Generation
- Importance/Priority
- Duration

In the *Item Condition* section AV Compass provides a checklist for important inspection items. This checklist does not allow users to enter severity levels into their systems, partially because it is geared towards less experienced users, who may not have the context necessary to judge the level of severity of any present issues.

- Broken
- Bugs / Pests
- Crystallization
- Damage to case or can
- Dirty / Dusty
- Improperly Wound
- Mold
- Odor / Smell

- Scratched
- Shrunken
- Sticky
- Vinegar syndrome
- Warped / Curled

AV Compass can provide a compact tool for organizations that don't have the resources to build or purchase a bespoke asset management system. While we would like to include more features in the future, the current state of AV Compass is simple and easy to use. Organizations looking to inventory and describe their media object should consider AV Compass as a starting point for describing their collections. In the case that these organizations outgrow AV Compass there are a number of more complex and feature-rich collection management tools such as ArchivesSpace or The Museum System.

Inspection is also an ideal time to record any *record tabs* on your tapes. A record tab is a feature found on cassette tapes that inhibits users from recording over the material on the tape. The physical properties of the record tabs differ across different formats, some are plastic flaps that need to be ripped off, some are plastic buttons that can be removed, and some are plastic sliders that can be moved from side-to-side. Regardless of the form factor, all record tabs should be removed during inspection in order to mitigate potential erasure during digitization or playback.

### Selection

Selection is an important task in a digitization initiative as it will define where resources are allocated. Even in a situation wherein an organization has enough resources to digitize their entire audiovisual holdings, selection policy plays an important role in deciding which tapes, formats, and or collections will take priority. Many organizations cannot afford to digitize their entire holdings, and it is critical for these organizations to define a selection policy to guide their priorities and resource allocation.

A number of resources are available to aid collections holders in the development of a selection policy. Organizations like the [Northeast Document Conservation Center](#), and publications such as [The Magazine of Digital Library Research](#) host articles written on the topic of developing a digitization selection policy. Institutions such as [Dartmouth](#) and [FIT SUNY](#) have made their digitization selection policies public. The [Instruction Manual for the Audio/Moving Image Survey Instrument](#) created by Columbia University Libraries contains a formula used for assessing the priority of a particular object based off of the object's exposure to risk, overall condition, obsolescence, and the value of the contained content.

The processes of inspection and description are valuable in providing information about the priority of a particular object or collection. Information as basic as the tape format can be critical in defining the tape's priority. More granular information about the tape, such as its condition, the year it was recorded, or the content held therein are examples of information gathered during inspection or description that would be useful in defining a tape's priority.

What follows is a ranking of audiovisual media formats by risk of data loss. This list is neither exhaustive nor authoritative, but is rather a reflection of BAVC's experience. A format's ranking is determined through a combination of the average physical condition and robustness of the format, along with the accessibility and condition of extant playback equipment. This list does not consider the importance of the content held on the tapes.

- **Extremely high risk**
  - 1/2" Open Reel Video
  - 2" Open Reel Video
- **High risk**
  - U-matic
  - MiniDV
  - DAT
  - DVD
  - CD
- **Moderate Risk**
  - 1/4" Open Reel Audio
  - 1" Open Reel Video
  - Video8 / Hi8 / Digital8
  - Betamax
  - MiniDisc
- **Low risk**
  - VHS
  - Audiocassette
  - Betacam / Betacam SP / Digital Betacam

BAVC recommends against sending multiple copies or generations of a single program with the intention that your digitization vendor only digitize the best quality tape. Many vendors will refuse to do this due to the amount of time and effort it takes to prepare any given tape for digitization. Some vendors may offer the service, but charge a fee for each tape that was wasn't transferred to make-up for the preparation time. Even if the vendor agrees, there are still a number of potential complications. It is common for tapes that are labeled identically have very different content. If the tapes do have the same content, the decision about quality must be made by a technician with next to no experience with the content of the collection. That is to say, selections about what content should be digitized or preserved should be made by collection holders, so that digitization technicians can focus their efforts on performing the best possible transfers. The best practice in this situation would be to either select a single version for digitization based off the available documentation, or to have the vendor digitize both versions and have your own staff make the decision about which copy has better quality.

## Storage

It is important to consider how to implement long-term storage before you even have your materials digitized. As technology continues to advance, storage continues to become cheaper by volume. Three main storage platforms are available for consumer-level storage: Hard Disk Drives (HDD), Solid State Drives (SSD) and Cloud Based Storage Solutions. This paper will not discuss enterprise level storage solutions.

### HDD Options

In 2007 Google published a [study](#) on the lifespan of HDDs using data about drive failures collected from their own web-hosting facilities. The study found that temperature and activity levels were less related to drive failure than was previously believed. Additionally, it was noted that drives failed the most in the first 3 to 6 months, and after the third year. This suggests that if a drive survives for six months, it will likely last for three years. It also suggests that at three years a new drive should be considered.

Storing files in duplicate or triplicate across multiple hard drives is a suitable low-budget method for long-term storage. Drives should be tested every six months, and if they show signs of failure they should be replaced. Storing the drives in separate locations will guard your data against localized natural or environmental disasters.

This method can be made more robust by using a hard drive enclosure that has 2 drive bays and supports RAID 0. RAID stands for Redundant Array of Independent Disks, and RAID 0 is a configuration in which two drives have the same exact data on them. This means that one drive can fail, and no data will be lost. This advantage in data redundancy comes at the cost of slower read/write speeds, and more expensive hardware.

Yet another layer of robustness can be added by purchasing a Network Attached Storage (NAS) unit with built-in monitoring tools. A NAS can use more complex RAID configurations to allow for drive failures without data loss, and can be configured to send email updates when a drive fails, or when other hardware failures are detected. This is a more expensive option, as NAS enclosures themselves can be expensive, and require larger arrays of drives. Additionally, in order to guard your data against localized natural or environmental disasters two NAS units should be placed in different locations, adding more cost to the storage system.

### SSD Options

SSD drives have no moving parts, and as such are much faster and less prone to data loss via physical damage than HDD drives. SSD storage is currently much more expensive than HDD storage, but it is steadily becoming less expensive as the technology advances. SSD storage is not considered a good option for long-term storage due to the idiosyncrasies of the technology.

SSD memory can only be written a limited number of times before the drive wears out. However, SSD memory can be read without causing any wear to the device. With this in mind, even a low-endurance SSD can have relatively long life-span in a context where data is written to the drive as few times as possible, but read from the drive regularly, which is a valid operating procedure for archival storage. A 2018 [white paper](#) released by Western Digital references that the new QLC NAND chips have been “envisioned for write-once-read-many (WORM) type archive applications.” At this point it may be unwise to invest in SSD storage for small-scale archival needs, but the future of this technology appears to be promising.

### Cloud Storage Options

Cloud storage is a subscription service wherein the customer pays a monthly fee for a specific amount of space on the provider’s storage server. Different services provide different feature sets in order to target specific client needs. Companies like DropBox, Box, and Google provide cloud storage that is geared towards simple file storage with minimal feature sets. Other companies like Acronis, IDrive, and Zoolz are geared towards small business backups, providing extra services such as encryption, compression, and user management. The pricing can range from \$2 per TB per year to \$199 per TB per year depending on the provider and available features.

One significant downside of working with cloud storage as an individual or small organization is the limited bandwidth available for uploading and downloading. Without access to enterprise level internet connections it could take up to 8 hours to upload a single 100GB video file. However, if the cloud is only being used for long-term storage, the files should only have to be uploaded once.

Cloud storage provides a simple solution to delegate the storage management to a third-party, and thus the question of whether it is right for your comes down to resources allocation. Consider whether the price of cloud storage may offset the time and resources necessary to manage a storage system locally.

### Post-Digitization

Once you have received your materials back from your digitization vendor you’ll want to make sure that the files you received are as expected, and that you take the proper steps to ensure their long-term preservation.


### Quality Control

Whenever audiovisual specialists review digitized files a major concern is the quality of the video signal. Often the question comes up: Is the transfer “good quality?”

BAVC has developed a Quality Control checklist that is used to check every single tape we digitize. The technician performing quality control is asked to step through every item in the checklist and assure that the video file being checked passes the following tests:

- **Metadata**
  - Does the metadata created by the transfer technician match the file?
- **Derivatives**
  - Digital files created from the digital Preservation Master file are referred to as “derivative” files. Do these files play back properly, and match the content of the Master?
- **Trimming**
  - Is any content cut-off? Is there more than 10 seconds of static at the beginning or end of the file?
- **Time Code**
  - Does the timecode in the file match the timecode on the tape?
- **Audio Sync**
  - Is the audio in sync with the video?
- **Notes**
  - Are any video errors in the video file properly and clearly notated?
- **QCTools Report**
  - Is the QCTools report for the master file free of any major errors (see the following section for more details on what QCTools is and how it is used)
- **MediaConch**
  - Does the file pass the standard MediaConch profile tests? (see the following section for more details on what MediaConch is and how it is used)

---

| ▼ Quality Control Elements  |                          |
|---|--------------------------|
| Metadata  | <input type="checkbox"/> |
| Derivatives  | <input type="checkbox"/> |
| Trimming  | <input type="checkbox"/> |
| Time Code   | <input type="checkbox"/> |
| Audio Sync  | <input type="checkbox"/> |
| Notes   | <input type="checkbox"/> |
| QCTools Report  | <input type="checkbox"/> |
| MediaConch  | <input type="checkbox"/> |

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These checklist items were developed over years of data collection about what problems occurring during the digitization progress. Each item was added in order to check for specific

commonly occurring error. In doing this, BAVC has created our own internal definition of *quality*. It's worth noting that the video signal of a file that passes this checklist test may contain errors, so long as those errors are properly noted and not caused by improper playback or digitization practices.

Your organization should likewise create a systematic way to perform quality control on each file received from your digitization vendor, regardless of how you define quality. Institutions such as [UCLA Library](#) and [Carnegie Hall](#) have made their quality control workflows publically available.

Most digitization vendors have a standard time window in which they will hold onto backup copies of your digital files before deleting them. This window is generally the amount of time that you'll have to check your files for errors caused by digitization. If you know that you'll need longer than the allotted time to perform quality control on you files you will need to make adjustments to the agreement or contract you have with your digitization vendor.

Tools: MediaConch

[MediaConch](#) is an Open-Source Media Conformance Checker tool. This means that MediaConch can help to make sure that digital files meet the specifications that you or your organization define as being *correct*.

Every digital file contains metadata inside of it that describes different aspects about the file. This metadata includes information like frame size, frame rate, language, and digital encoding. When testing files that you've received from a digitization vendor you'll want to make sure that the files match the specifications that you've decided on (more information about selecting deliverable formats can be found in the *Digitization Formats* section of this paper). MediaConch can do this very quickly, by comparing the metadata inside of the files being checked against a policy, or set of policies. Policies contain a set of tests that a file must pass. Any detail of the file that does not match the tests defined by the policy is said to "fail" the policy check. MediaConch can perform batch processing, meaning that hundreds of files can be checked against a single policy all at once. This provides a time efficient way to perform basic quality control checks.

Users can create their own policies, or choose a *Public Policy* in the MediaConch interface. Public Policies are policies that have been created and curated by members of then archival community and uploaded to the [Policy Editor Page](#) on the MediaArea homepage. This feature is crucial in allowing organizations to share and build off each other's work in the field, and is an example of the collaborative ethos of the audiovisual preservation community.

If you have strict specifications for your digital files, the best way to make sure your vendor adheres to the specifications is to use MediaConch to make your own profile based off of a sample file and provide your vendor with the profile. This will allow the vendor to check the files on their end before sending them to you. If you do not have any specific needs BAVC suggests

requesting files that conform to the *CAVPP Preservation Master* profile that comes default with MediaConch.

Tools: QCTools

[QCTools](#) (Quality Control Tools for Video Preservation) is free, open source software developed by BAVC in collaboration with [Dave Rice](#) and the [Dance Heritage Coalition](#). It offers conservators and archivists new tools to enable the inspection of video signal characteristics for batches of digital media, in order to prioritize archival quality control, detect common errors in digitization, facilitate targeted response, and thus increase trust in video digitization efforts.

QCTools is a powerful and complex program, and as a result it has a rather steep learning curve. A number of archivists and preservationists have published tutorials, guides, and resources for using QCTools:

- [Drop Video File\(s\) Here: The Emergence of Free Quality Control Tools for Video Preservation](#) by Benjamin Turkus
- [QCTools Manual](#) by Moving Image Preservation of Puget Sound
- [QCSchool: Embedding QCTools in an automated digitization workflow](#) by Peter Bubestinger
- [QCSchool: All About TOUT](#) by BAVC
- [QCSchool: Mean Square Error and Peak Signal to Noise Ratio Filters](#) by BAVC

One of the main drawbacks of QCTools is that it can take a very long time for the program to analyze your files. BAVC attempts to mitigate this by providing collection holders with pre-populated QCTools reports as a standard file deliverable. We suggest that you request QCTools reports from your vendor, however it is possible to generate reports yourself using the free and open source command line tool [qcli](#).

Tools: Fixity

[Fixity](#) is a freely available tool developed by AVP. The tool can be used to scan a directory and create a checksum of every file. These scans can be set on an automated schedule, and can send email notifications if errors are found.

The purpose of this tool is to make sure that files remain unchanged at a bit-level while in storage. Fixity will throw an error if any file in the selected directory has even a single bit changed. However, Fixity will not tell you how or why a file was changed.

Fixity is lightweight, and simple, making it a great tool for small organizations to use for scheduled fixity checks.



## What to delegate to your vendor

### Tape Preparation

Depending on the format, age and condition of your tapes many will need to be baked and cleaned before they can be properly transferred. Tapes that are not properly prepared before playback can have very poor quality, can damage playback equipment, and can be permanently damaged themselves. This preparation often includes packing/retensioning, baking, and cleaning tapes, though the process varies between tape formats, brands, and models. The benefits of baking a tape can expire in a few days, even when the tapes are kept in climate-controlled storage, and thus baking should only be performed immediately before digitization.

BAVC records any preparatory action performed on a tape, along with the date that action was performed and the user that performed it. If you have any concerns about your vendor's tape preparation workflows be sure to ask for an explanation of their workflows beforehand.

### Transfer

While it may seem obvious, it's worth noting that your digitization vendor should specialize in digitizing and reformatting audiovisual media. If you trust your vendor then you will want to defer to them for any decisions being made about transfer workflows or processes. However, if you have doubts, concerns, or questions about your vendor you can ask if their processes adhere to the following guidelines:

- Transfer technicians should try multiple signal chains to assure the best possible quality
- Recording levels should be set to avoid waveform clipping or information loss
- Preservation transfers should best represent the material on the original object, and not include any unnecessary intervention, edits, or changes to the original content. If any changes must be made, they should be noted.
- Time Base Correctors should be used when digitizing analog videotape media.
- Preservation formats for analog media should be uncompressed
- Preservation formats for born digital media should match the native source

### Derivative Video Files

Many digitization vendors offer derivatives created from the Preservation Master free of charge. If you are unsure what kind of derivative files you want, opting to receive derivatives from your vendor can save you both the administrative resources it takes to make the decision, and the computational resources it takes to create the files. If you do plan to use your vendor's derivatives try to get a sample file from them up-front in order to make sure that their files are compatible with your playback and editing systems.

If you want a specific derivative file type that isn't offered by your vendor you should consider creating it yourself if possible. You may be charged extra for the creation of a custom deliverable. Additionally, requests for customized deliverables may put additional strain on your vendor's workflow, which can result in longer turnaround time, and increased potential for errors.

## Metadata Deliverables

Many digitization vendors can provide boilerplate metadata exports containing information about the transfer process, the equipment used, and technical metadata about the digital files. Request a sample of the metadata that a vendor can provide you to see if it contains all of the information you want about your files. As with the derivative video files, opting to use your vendor's standard metadata export will often be the quickest and least error-prone solution.

# Digitization Formats

## Identifying Use Cases

Deciding on digitization formats can be difficult to do. There are a number of formats available, and even more opinions about which are best and which are worse. A method that Information Professionals often use to drive institutional decisions of this type is the creation of *use cases*. This involves creating a list potential uses for the digitized content. The following is an example list of what an organization would want to do with their digital files, and is not meant to be prescriptive or exhaustive.

*Digital files in this example repository will be used to:*

- Preserve the content on the tapes with the highest possible quality
- Contain descriptive information about the tape's content
- Provide the content to filmmakers working with archival content
- Recut the footage into a new project
- Stream the files over the internet
- Screen the content at festivals
- Display the content in a museum or exhibit

## Identifying Use Types

Once a list of possible uses can be determined, the next step is to determine *use types* that can serve these needs. Use types are not a technical distinction like a format, but rather an abstract classification. The previous list of use cases can be broken into three file use types:

- File Use Type: **Preservation**
  - Preserve the content on the tapes with the highest possible quality
  - Contain descriptive information about the tape's content
- File Use Type: **Production / Mezzanine**
  - Provide the content to filmmakers working with archival content
  - Recut the footage into a new project
- File Use Type: **Access**
  - Stream the files over the internet
  - Screen the content at festivals
  - Display the content in a museum or exhibit

In this example we've determined three distinct use types: Preservation, Production, and Access. Rather than trying to find a single digital file format that satisfies all potential use cases, we can now try to find digital file formats that satisfy only a single use type. This is a preferred

approach, as there is no single file format that can satisfy all possible use cases. Each format comes with its own strengths and weaknesses, each of which can be leveraged to best satisfy potential use cases.

## Identifying File Formats

The following Format Matrices describe the salient details of popular file formats.

### Format Matrix for **Preservation** Use Type

| <b>Format</b> | <b>Compression</b> | <b>File Size</b> | <b>Open Source</b> | <b>QuickTime Support</b> |
|---------------|--------------------|------------------|--------------------|--------------------------|
| v210 / MOV    | No                 | 100 GB / hr      | No                 | Yes                      |
| V210 / AVI    | No                 | 100 GB / hr      | No                 | Yes                      |
| FFV1 / MKV    | Lossless           | 40 - 60 GB / hr  | Yes                | No                       |
| JPEG200 / MXF | Lossless           | 40 - 60 GB / hr  | No                 | No                       |
| ProRes 422 HQ | Lossy              | 30 GB / hr       | No                 | Yes                      |
| DV            | Lossy              | 11 GB / hr       | No                 | Yes                      |

### Format Matrix for **Production / Mezzanine** Use Type

| <b>Format</b>  | <b>Premier Support</b> | <b>FFmpeg Support</b> | <b>Highest Bitrate</b> |
|----------------|------------------------|-----------------------|------------------------|
| ProRes 422 HQ  | Yes                    | Yes                   | 63 Mbps                |
| DV             | Yes                    | Yes                   | 25 Mbps                |
| DV50           | Yes                    | Problematic           | 50 Mbps                |
| D10 / Sony IMX | Yes                    | PAL Only              | 50 Mbps                |

### Format Matrix for **Access** Use Type

| <b>Format</b> | <b>Streaming Support</b> | <b>Chrome Support</b> | <b>Subtitle Support</b> | <b>Easy To Copy</b> |
|---------------|--------------------------|-----------------------|-------------------------|---------------------|
| H.264 / MP4   | Yes                      | Yes                   | Yes                     | Yes                 |
| WMV           | Yes                      | No                    | Yes                     | Yes                 |
| DVD           | No                       | No                    | Yes                     | No                  |

The following list represents BAVC’s typical deliverable package

- **Preservation:** v210 / MOV
- **Production / Mezzanine:** ProRes 422 HQ / MOV
- **Access:** H.264 / MP4

This particular configuration is designed to support individuals and small organizations with collections totalling less than 70 hours. Each hour of original material will result in approximately 130GB of digital content. 70 hours will be just enough to fill a 10TB drive, which presents a sweet spot for value (At the time writing this paper the cost of a 10TB G-Drive on from B&H is \$300, while the cost of a 12TB G-Drive from B&H is \$600). This deliverable configuration is meant to meet a wide range of use cases, and the formats are generally well supported across popular operating systems.

There are reasons to deviate from this configuration, even for small organizations. In the case that a collection holder has no editing capabilities and the individual materials represent atomic or completed works the production files could be omitted and only the preservation files and access files would be delivered. Conversely, if the collection contains raw material for a film which would not be ready for screenings, then access files could be omitted. Keeping in mind that access is one of the key tenants of the Preservation Access Program we rarely omit access files from the delivery package for collections participating in the program. Under no circumstances would we not deliver a preservation file, as the production and access files are not sufficient to provide long-term preservation.

# Common Errors

Digitization workflows are both labor intensive and reliant on various mechanical and technical systems. As a result these workflows are prone to many types of errors, ranging from human error, to failures in the equipment or software used. The first step in avoiding or solving these problems is to be able to identify them.

## Errors inherent to analog tape and workflows

The [AV Artifact Atlas](#) (AVAA) is an open-source guide used to define and identify common technical issues and anomalies that can afflict audio and video signals during playback and digitization. The AVAA contains many years of work performed by the audiovisual preservation community to document, describe and collect examples of common errors. Rather than retread that ground, this report will discuss general groupings of errors, and link to AVAA articles associated with those groupings.

## Errors caused by physical deterioration

Poor storage and aging tape can lead to a particular set of errors. In the case of tape damage, warping, or deformation the video playback heads and sync heads are unable to properly read the information off the tape. If this happens only for an instant it may cause a video dropout. If this happens for an extended period of time it can cause a total loss of picture.

Physical deterioration can manifest in a number of ways. The oxide can become damaged or fall off the tape, or the tape can become too sticky to properly playback. BAVC has developed methods of baking and cleaning tapes in order to stabilize physical deterioration and minimize the video errors it may cause. However, the best way to reduce deterioration errors is to store your tapes in optimal conditions and to handle them properly. Information about tape handling and storage can be found in the aforementioned report written by the [Council on Library and Information Resources](#).

BAVC was able to use data collected during our intake, cleaning, and digitization processes to identify particular tape stocks that are regularly problematic. This is a list of those tapes stocks, along with a short summary of the intervention taken to help with the common problems experienced when dealing with the tapes:

- **Karex Silverchrome**
  - **Format:** ½" EIAJ
  - **Issues:** Soft binder syndrome. Oxide shedding. Dirt accumulation.
  - **Intervention:** Longer baking times and extra time spent cleaning
- **Ampex 198**

- **Format:** Betacam
- **Issues:** Soft binder syndrome.
- **Intervention:** Baking and cleaning. Requires access to a betacam cleaner
- **Ampex 197**
  - **Format:** U-matic
  - **Issues:** Soft binder syndrome.
  - **Intervention:** Baking and cleaning. Requires access to a betacam cleaner
- **Ampex 176**
  - **Format:** ½" EIAJ
  - **Issues:** Soft binder syndrome. Swelling upon baking
  - **Intervention:** Cold desiccation and extensive cleaning
- **Sony V-30 and V-32**
  - **Format:** ½" EIAJ
  - **Issues:** Black residue builds up on tape and cleaning cloth while cleaning
  - **Intervention:** Further baking is required

The following AVAA articles describe errors that may be caused by tape deterioration.

- [Damage, scratches and tape wear](#)
- [Skew Error](#)
- [Tape deformation](#)
- [Video dropout](#)
- [Stiction or Sticky Shed Syndrome](#)

## Errors caused by poor playback equipment

Due to the idiosyncrasies and instabilities of analog video playback systems, the ideal equipment to use when digitizing analog videotape is the exact same equipment that the tape was recorded with. This is often not possible, since many of the decks used to record the tapes have been broken, lost, or thrown away. Video recording and playback decks can be calibrated, which can impact how the signal is recorded onto the tape. Additionally, equipment such as Time Base Correctors and Processing Amplifiers are used to set the video signal levels to be both as close to the original recording as possible, and also within the allowed ranges for digital capture. The best playback is had when decks are calibrated to match the signal on the tape, and the video signal levels are within range. A video signal path may be perfectly calibrated in regard to one tape, but completely uncalibrated in regards to another, even within the same collection.

BAVC technicians will often test a tape multiple decks to ensure the best possible quality. If any serious errors occur during playback, or the image quality falls below a certain threshold, the technician will attempt playback using different equipment to be sure that no errors are being introduced by the playback equipment.

Poorly maintained equipment can also introduce errors into the video signal. If the machines are plugged into dirty or unconditioned power sources, noise can leak into the signal. Skilled technicians are familiar with how these types of errors manifest, and will try to avoid introducing any of these errors into preservation transfers. However, it is important to become familiar with these types of errors which can be avoided with properly maintained and calibrated equipment, and properly trained technicians

The following AVAA articles describe errors that may be caused by poor playback equipment.

- [Electrical ground loop interference](#)
- [Clipped Video Signal](#)
- [Dirty Head Drum](#)
- [Head Clog](#)

## Errors inherent to the tape or recording

It is important to understand that some errors cannot be fixed during the preservation process. These types of errors are inherent to the recording, and are sometimes referred to as being native or “baked in”. These errors can be caused by poor quality or improperly maintained recording equipment. Errors may have been introduced by editing mistakes or bad equipment during analog post-production workflows. Generational loss, which occurs with analog tape when copies are made from copies across multiple generations, is also common in audiovisual collections.

In a preservation environment, these errors are considered as part of the original video content, and thus are not reduced or mitigated by means of intervention or digital manipulation. While this may seem bleak, it is not hopeless. Many of these errors can be mitigated during digital production workflows after the preservation process, and having a properly transferred high-quality preservation transfer of the original can enable this future remediation.

BAVC technicians are trained to make specific notes about the occurrence, persistence, and severity of these errors, despite knowing that nothing can be done to fully fix them during the preservation process. Your digitization vendor should communicate any occurrence of these errors so that you know they were not introduced by faulty digitization equipment.

The following AVAA articles describe errors that may be inherent to videotape recordings.

- [Head switch noise](#)
- [Carrier Leak](#)
- [Bearding](#)
- [Crash Record](#)



- [Chrominance Noise](#)

## Errors inherent to digital workflows

The digitization workflow does not end once the file has been digitized. There are still a number of steps that technicians must perform before the digital files are ready to be preserved. The steps taken between digitization and long-term storage are necessary, but can also provide opportunities for errors. This segment will discuss errors common in file-based workflows and how they can be mitigated.

### Transcoding Errors

What they are and how they happen

Transcoding errors are introduced to digital video files by problems encoding, decoding or otherwise manipulating the digital video file. In an archival environment these errors can generally be avoided by selecting a robust preservation master file format, and by not using the preservation files for editing, manipulation, or access.

That being said, there is a distinct possibility of compromising the integrity of the preservation files during the digitization workflow. Many digitization vendors, BAVC included, will trim preservation files if there is an inordinate amount of static or black before or after the desired content. We have found that two popular video editing tools introduce errors to the video content during the trimming process. Both *QuickTime Player 7*, and *Adobe Premiere Pro CC 2018* will improperly re-encode the v210 video format. The error appears in QuickTime Player 7 when the “Export” option is used, rather than the preferred “Save As” option. There is no way to avoid the issue with Adobe Premiere CS 2018, and we suggest using an earlier version of this software for editing v210 files.

How to test for them

Both of the aforementioned tools truncate the 9th and 10th bit of each video channel, rendering a 10 bit file effectively an 8 bit file. This error is next to impossible to see with the naked eye. However, BAVC technicians were able to identify the issues by viewing the files with the [QCTools](#) software. The *Waveform* and *Bit Plane (10 Slices)* filters were useful in this particular error.

### Transmission Errors

What they are and how they happen

Transmission errors refer to problems that occur when a digital file is moved across storage volumes. The typical method of dragging and dropping a file using the standard Mac Finder, Windows Explorer, or similar file navigation tools is often not sufficient when working with large

video files. An interruption in the connection, which can be in the form of a cable coming loose, a loss in network connectivity, or a hiccup in an electrical power system can cause bits to be lost and files to become corrupted.

Our preferred method of moving any file from our storage server to a delivery hard drive is the following command

```
rsync -av --progress /source/directory /destination/directory
```

Rsync is a command-line tool that ensures that files are moved without any data loss due to connectivity issues. It will also avoid overwriting existing files on the source directory with the same name, unless the existing file is deemed to be out of date.

### How to test for them

The most robust way to ensure that transmission errors have not corrupted or otherwise changed your files is to perform fixity checks on the files using checksums. Using checksums to ensure fixity of digital collections is a tried and true digital preservation technique, and more on the subject can be read on the [Digital Preservation Coalition website](#).

## Metadata Errors

The previously mentioned errors concern undesired changes to the digital files. However, there is potential to encounter issues with the metadata that describes the files. Metadata, put simply, is data about data. In this context, metadata refers to technical details that describe the salient details about a digital file. A video file's format, frame size, and frame rate are all examples of metadata. This data can be very useful to archivists who work with digital collections, and can help enable both preservation and access within digital repositories.

### What they are and how they happen

Inaccuracies and inconsistencies in metadata can quickly inhibit its utility. Metadata can be inaccurate if it is missing, misspelled, or out of date. However, even accurate metadata can be inconsistent. It is important to use rules of entry and controlled vocabularies to avoid possible inconsistencies.

# Important Findings And Workflow Improvements

Funding provided by the Andrew W. Mellon Foundation allowed BAVC to make a number of improvements to our documentation and workflows. This portion of the paper describes the updates that were made, as well as any findings that were made as a result of research and data collection. The information in this section is geared towards an audience specifically interested in the procedural details of the handling and preparation of audiovisual materials for digitization. It is intended to increase the knowledge and awareness of digitization workflows across the audiovisual preservation field.

## Improved Baking and Cleaning Techniques and Workflows

Much has been written about the process of baking tapes, including a [comprehensive history of tape baking written by Crystal Sanchez](#). The most salient detail about what has been written is that nobody seems to agree entirely on a process. Temperatures range between 122° F to 140° F, and baking times range from 4 hours to 48 hours. BAVC's approach to baking has been to develop best practices based off of the research, as well as gather data about what methods have and haven't worked. Rather than argue with existing research on the topic, we will focus on our findings about what worked best with the tapes that we needed to bake.

### Baking and cleaning procedures by format

We found that method that yielded the best results for sticky and dirty ½" Open Reel EIAJ and ¾" U-matic tapes was baking tapes for 48 hours at 125.6°F (52°C). The following is the program that BAVC uses for our *SalvisLab Thermocenter* scientific oven:

|                      |                              |
|----------------------|------------------------------|
| <i>Program Name:</i> | <i>P02</i>                   |
| <i>Set Temp:</i>     | <i>52°C</i>                  |
| <i>Gradient:</i>     | <i>4,0°C/min</i>             |
| <i>Hold Time:</i>    | <i>48:00 [48-hour cycle]</i> |
| <i>Fan Speed:</i>    | <i>60%</i>                   |

Other baking programs with lower temperatures and less time did far less to impact the results of soft binder syndrome. These other programs did not fully cure the symptoms of soft binder syndrome, and we found ourselves baking tapes multiple times before they could be successfully cleaned and played back.

This baking program yielded good results across all videotape formats. However, the steps necessary to prepare a tape for baking vary according to the format.

## ½" Open Reel

All ½" open reel tapes are packed, baked and cleaned before being played back. The decision to bake all ½" open reel tapes was made at BAVC many years ago, and our experience in recent years has only supported the need for this.

The process of packing, also known as exercising and retensioning, involves running the tape from the original source reel to a pickup reel, then rewinding it back to the original source reel. This process serves multiple functions: Many of these tapes have not been unspooled in decades, and may have a number of popped strands, uneven tape packs, or uneven pressure within the tape pack. The process of packing, exercising, or retensioning the tape smooths out the pressure, and often smooths out the popped strands. It's ideal to have as few popped strands as possible during the baking process, as the tape will expand and contract when baked and popped strands can be damaged during the process. Packing the tapes also gives the transfer technician insight into the condition of the tape. Scratches or shedding in the oxide or backing, and even soft binder syndrome can be seen and noted during this process if they are severe enough.

All packing and cleaning at BAVC is performed on a modified Sony AV-3600 deck. The modifications made to the deck include defeating fail-safe mechanism and removing the video heads. The fail-safe mechanism is designed to stop the deck's motor if there is no tape in the path, but this is not necessary for packing or cleaning since the tape never travels along the typical tape path. Previously, a business card or small piece of cardboard was used to keep the fail-safe mechanism from activating, but we found it much simpler for general use to open the deck and bend the fail-safe mechanism behind a non-moving part inside the deck to keep it permanently in the "on" state. Removing the video heads is done mostly to salvage the heads and avoid damaging them further. Video head removal is best done by an experienced tech, but can be performed by an ambitious novice as long as there are no plans to use the deck for playback in the future.

The final step in making the AV-3600 a proper cleaning deck is to get the source and pickup reels at the same height. The helical scan across the videotape on these decks is achieved by having the pickup reel physically lower than the source reel. However, for cleaning it's best that the reels are the same height. In order to achieve this, we place a ¼" audio reel on the pickup reel position on the deck. The ½" pickup reel can be placed on top of the ¼" reel, and the ¼" reel provides enough height to properly align the take-up and pickup ½" reels. Gaffers tape is adhered to the top of the ¼" audio reel, and to the bottom of the of whichever reel is the designated pickup reel for packing and cleaning. The contact between the gaffers tape on the two reels allows for more friction, which adds more consistent torque to the forward packing process.

½” open reel tapes can be placed lying flat directly in the oven. Previously BAVC avoided placing tapes on top of each other in order to make sure of optimal airflow and even heating. In general, this practice is maintained, but we will stack tapes if necessary. However, when the tapes are stacked, we use plastic ¼” NAB reel cores between tapes to promote even airflow. Tapes are allowed to cool in the oven, which typically takes about 4 hours.

Once cooled, the tapes can be cleaned. The processes must be performed manually, since BAVC does not have an automated ½” tape cleaner. Tapes are always cleaned in rewind mode, from the pickup reel to the source reel. This is because the three teeth on the reel spindle do not make contact with the pickup reel, but do make contact with the source reel. These teeth provide enough torque to rewind a tape that is very sticky or dirty.

The tape is cleaned with TexWipe TX304 wipers. The technician rewinds the tape while using their thumb and forefinger to apply even pressure across the tape. A new wiper should be used once dirt buildup is visible to avoid scratching the oxide on the tape. The time it takes for dirt to visibly build up can vary from 5 seconds to 60 seconds of fast-forwarding depending on the condition of the tape. One common issue found commonly with Sony brand ½” tape is that sticky residue builds up on the wiper. In this case, the technician may notice that the wiper needs to be *peeled* off the tape, and leaves behind some black residue. This residue is very hard to remove without damaging the tape, and can clog the heads of a playback device. This residue buildup is a symptom of soft binder syndrome, and can be ameliorated by subjecting the tape to further baking. The buildup of the residue on the tape can cause headclogs and damage to the playback video heads, even if the tape otherwise plays without a problem. We suggest any tape that exhibits this issue be baked further to avoid potential headclogs.

### ¾” U-matic

Our methods of selecting and preparing U-matic tape for baking have changed drastically throughout the process of testing our procedures. Previously, we would clean all of our U-matic tape in an RTI tape cleaner upon intake, with the understanding that if the tape cleaner stopped (producing a *BIND* message on its simple display) that we would be certain the tape needed baking. Additionally, U-matic tapes would have their cassette shells opened in order to provide more even heating and airflow to the tape.

We found that cleaning the tapes before baking only worsened the condition of tapes suffering from soft binder and deterioration. In the case of a deteriorating tape, the sticky particles would rub off onto the metal rollers housed inside of the cassette while the tape was being cleaned. The buildup would eventually seize the tape, making it unplayable. This problem could be addressed after the fact by continuing with baking as normal and cleaning the metal rollers with a cotton swab and isopropyl alcohol. However, we found that it was best to avoid this problem altogether and simply bake all U-matic tapes before cleaning them. If the tapes are baked before being cleaned, the sticky particles never get a chance to build up on the rollers, as they

are dried and loosened by the baking process. The previous policy decision to pack all U-matic tapes was made at a time when the majority of U-matic tapes were not experiencing moderate to severe deterioration. However, in our experience the tipping point has now been reached, and the majority of U-matic tapes suffer from moderate to severe soft binder syndrome or other deterioration.

As mentioned in the discussion on ½” Open Reel, tapes are typically packed before being baked. Our method of baking them first certainly goes against the common practice in this regard, however there is sound reasoning to support our practice. Popped strands, which can be damaged during the baking process, are far less common in U-matic than they are in open reel formats because the cassette helps to stabilize the tape as it winds onto the reel. Also, unlike other video-cassette formats, U-matic has no reel locks. Magnetic tape expands when exposed to heat, which can cause the reels to shift position slightly. If a cassette has reel locks the natural shifting of the tape as it heats up will be inhibited, causing the tape to stretch. However, this potential issue will not affect U-matic tapes, as they lack reel locks and can move freely during the baking process.

We also found that the process of opening the cassette shells had no noticeable advantage, and in fact only served to cause damage to the tape label in the case that the label was placed over the cassette seam. By leaving the cassettes intact while baking we were able to drastically decrease the handling of the fragile tape reels, as well as the amount of time spent preparing tapes to be baked. In lieu of opening the tapes, transfer technicians ensure optimal airflow make sure that none of openings in the cassette are obstructed. The critical openings are those below the metal flap that protects the exposed tape.

## VHS

Unlike U-matic tapes, the majority of VHS tapes do not suffer from soft binder syndrome or severe deterioration, and in turn BAVC does not generally bake VHS tapes unless it is determined to be necessary. Because BAVC has an RTI TapeCheck VHS cleaner we are able to easily clean all of our VHS tapes as part of our intake process. Cleaning upon intake ensures that any buildup of dust or dirt will be removed before transferring. VHS tapes are only baked in the case that soft binder symptoms manifest during cleaning or playback. BAVC’s transfer technicians are adept in determining whether image errors during transfer may be related to stickiness, and will bake the tape accordingly.

## Cleaning Workflow Updates Summary

- Baking ½” Open Reel and ¾” U-matic tapes at 48 hours at 125.6°F (52°C) yielded optimal results.
- Creating multiple ½” cleaning decks from Sony AV-3600 decks allowed for more efficient packing and cleaning workflows

- Adding gaffers tape to the bottom of the pickup reel increased friction and helped create a smoother pack.
- Cleaning ½” tapes in the reverse mode was much more efficient, but we had to repack tapes if they were going to be baked again
- Packing and cleaning U-matic tapes before baking could potentially worsen the playability.
- Baking all U-matic tapes before cleaning almost entirely eliminated instances where the tape would bind in the cleaner
- Opening U-matic tapes before baking was found to be unnecessary

## Some tapes cannot be baked

There are limitations to what can be baked. One purpose of BAVC's documentation of process data is to identify limitations to the baking process. There have been instances in which the baking process was either ineffectual or damaging, and with sufficient data collection a profile of unbakeable tapes could eventually be created.

Since the implementation of our data collection processes only one instance in which baking damaged tape has been noted: Multiple Ampex 174 tapes from a single collection expanded in size after being baked. The expansion was not noticeable until the tapes were packed onto a new reel for cleaning, at which point it was clear that the tape had expanded beyond the point of fitting on the reel. The tapes suffered advanced binder and oxide shedding, and were unable to be transferred. Our initial assumption was that any tape made of Ampex 174 stock would be damaged by baking. However, this assumption was challenged by anecdotal evidence from colleagues about their positive experiences baking this stock. Unfortunately BAVC has no accessible archive of data related to baking Ampex 174 tape, so it's currently not possible to make a data-based determination.

## Improved Metadata Extraction Workflows

Mellon funding allowed us to update a number of Salesforce interactions, notably: we were able to develop workflows which push metadata collected from files directly into Salesforce records. For years, BAVC has collected essential information about the digital video files created during digitization and delivered it along with the video files. The data can be used by the collection holders to describe and maintain their digital collections in accordance with accepted digital preservation practices. This metadata was previously entered by hand into Salesforce, which was both time consuming and error prone. The updates to the workflow include automation both to extract and normalize metadata directly from the files and to push that metadata directly to Salesforce.

| ▼ Digital Object Elements  |                            |                                  |                                  |
|----------------------------|----------------------------|----------------------------------|----------------------------------|
| Digital File Name          | BAVC1007859_Z4             | Digital Video Data Rate          | 224 Mbps                         |
| Digital File Duration      | 00:33:04:26                | Digital Video Color Matrix       | BT.601                           |
| Digital File Size          | 52.23 GiB                  | Digital Video Color Space        | YUV                              |
| Digital File Format        | MOV                        | Digital Video Chroma Subsampling | 4:2:2                            |
| Digital Video Codec        | Uncompressed 10-bit (v210) | Digital Audio Data Rate          | 2304 Kbps                        |
| Digital Video Bit Depth    | 10                         | Digital Audio Bit Depth          | 24                               |
| Digital Compression Mode   | Lossless                   | Digital Audio Sampling Rate      | 48 KHz                           |
| Digital Video Scan Type    | Interlaced                 | Digital Audio Codec              | Linear PCM                       |
| Digital Video Frame Rate   | 29.97                      | Digital Audio Channel Positions  | L R                              |
| Digital Video Frame Size   | 720 x 486                  | Digital Audio Channel (s)        | 2 Channels                       |
| Digital Video Aspect Ratio | 4:3                        | Checksum Generator               | MD5                              |
|                            |                            | Checksum                         | 345c625542c85d9ad7f61d82e885ab02 |

The extraction and normalization scripting can be found on BAVC's [GitHub account](#). The automation to push the metadata directly into Salesforce is built into a free [Skyvia](#) app. By automating these processes we've significantly decreased the possibility of incorrect metadata being delivered to collections holders.

## Mold Remediation Workflows

Over the past two years BAVC has sent over 60 tapes to Specs Brothers to be remediated for mold. We cannot transfer or treat moldy tapes at our lab because we do not have the equipment or facilities to do so. Our initial approach for dealing with moldy tapes was to request that the collection holder send Specs Brothers their moldy tapes directly. However, this proved somewhat problematic, especially when dealing with individual artists or collection holders lacking strong archival or project management foundations. We found that the best way to simplify the projects was to have the collection holders send us all of their materials, and then to send the moldy materials to the mold subcontractor ourselves. This gave us a chance to inspect the tapes, affix our barcodes to the moldy tapes, associate the tapes with statements of work for the subcontractor, and create a shipping manifests of the tapes being sent to the subcontractor. While the additional work on the management end and increased contact with moldy materials is generally undesirable, the tradeoff was increased control over the process and improved communication with the subcontractor.

Along with moldy tapes, BAVC also received a collection that had minor mold contamination on the cases, but not on the tapes themselves. After speaking with the collection holder we agreed to send back the cases so they could be cleaned by the collection holder. This decision was made because the cases had no original identifying marks, and could be cleaned easily without any possibility of causing damage. In other instances, collection holders have discovered potential mold contamination on the cases but not the tapes and have elected to send only the tapes. When this is done the tapes can be housed in ziplock bags with desiccants or wrapped in bubble wrap to avoid potential damage.



When moldy tapes are returned to BAVC by the subcontractor we do our best to prioritize the digitization above any other materials currently being processed. This is done because there is a possibility of the mold growing back if too much time passes between the cleaning and the transfer. The mold remediation process kills all living mold, and cleans off any growth living on the tape. However, mold spores are resilient and mold colonies can potentially grow back. We did experience one instance in which tapes were not transferred within 30 days of receiving them from the mold remediation subcontractor, and regrowth had already begun. It is unclear from our experience whether every tape that has been remediated for mold will eventually have the mold grow back, but it is certainly a possibility to consider when storing the tapes in the long-term.

The following are three important considerations when dealing with moldy materials.

- If possible, adhere barcodes or identifiers to the case and the tape before sending to a subcontractor.
- If only the cases are moldy, consider sending only the tape to your digitization vendor.
- Mold may grow back after remediation. Transfer the tapes as quickly as possible after mold remediation, keep tapes with mold issues quarantined even after remediation.

## What Can Collection Holders Do Immediately?

The process of digitizing and preserving audiovisual media is complex and consumes resources, time, and labor. We understand that individuals or organizations that are under-resourced may not be able to undertake an initiative to completely digitize their entire collections. However, a well-planned roadmap towards digitization can help guide the allocation of funds and resources when they become available. With this understanding, we'd like to present a list of what collection holders can do immediately, by order of priority:

- Inspect materials for mold contamination, placing any potentially contaminated materials in quarantine.
- Inventory and describe all materials using the tools that best suit your collection.
- Use the collection inventory to define prioritization and selection policies.
- Develop use cases for file-based media assets, and select target digital formats that meet these needs.
- Consider options for long-term digital storage and purchase the necessary hardware or services.
- Develop a long-term preservation plan that is congruent with your digital file formats and storage platforms.
- Find a digitization vendor that can meet your desired specifications and needs.

Preservation is not an action that can be performed once and completed, but rather a collection of tasks and policies that must be regularly enacted upon materials to keep them stable and accessible. BAVC hopes that with the sharing of information and best practices in this paper, that individuals and organizations will have the capacity to build strong preservation practices, environments, and long-term commitment to support the preservation of their collections.

## Works Cited

- BAVC. (2015). *QCSchool: All About TOUT*. Retrieved from <https://bavc.org/blog/qcschool-all-about-tout>
- BAVC. (2016). *QCSchool: Mean Square Error and Peak Signal to Noise Ratio Filters*. Retrieved from <https://bavc.org/blog/qcschool-mean-square-error-and-peak-signal-noise-ratio-filters>
- Blewer, Ashley. (2016). *Magnetic Media Formats Chart*. Retrieved from [https://raw.githubusercontent.com/ablwr/media-id-posters/master/tapes\\_table\\_white\\_web.jpg](https://raw.githubusercontent.com/ablwr/media-id-posters/master/tapes_table_white_web.jpg)
- Bubestinger, Peter. (2016). *QCSchool: Embedding QCTools in an automated digitization workflow*. Retrieved from <https://bavc.org/blog/qcschool-embedding-qctools-automated-digitization-workflow>
- Carnegie Hall. (2018) *Digitized Materials Quality Control Workflow*. Retrieved from <https://github.com/CarnegieHall/quality-control/blob/master/qc-workflow-overview.md>
- Commission on Preservation and Access and the National Media Laboratory. (1995). *Magnetic Tape Storage and Handling A Guide for Libraries and Archives*. Retrieved from <https://www.clir.org/wp-content/uploads/sites/6/pub54.pdf>
- Dartmouth College Library. *Selection Policy for Digitization Projects*. Retrieved from <https://www.dartmouth.edu/~library/digital/about/policies/selection.html>
- DC Video. *Find Your Videotape Here*. Retrieved from <https://www.dcvideo.com/videotape-identifier>
- Digital Preservation Coalition. *Fixity and Checksum*. Retrieved from <https://www.dpconline.org/handbook/technical-solutions-and-tools/fixity-and-checksums>
- Fit Library Special Collections & College Archives. *Digitization Policies and Procedures*. Retrieved from <http://www.fitnyc.edu/library/sparc/visit/research/rights-reproductions/policies.php>
- Gertz, Janet. *Preservation and Selection for Digitization*. Retrieved from <https://www.nedcc.org/free-resources/preservation-leaflets/6.-reformatting/6.6-preservation-and-selection-for-digitization>

- International Organization for Standardization. (2017). *Imaging materials -- Magnetic tape -- Care and handling practices for extended usage* (ISO Standard No. 18933:2012). Retrieved from <https://www.iso.org/standard/60960.htm>
- Moving Image Preservation of Puget Sound. (2015). *QCTools Manual*. Retrieved from [http://sustainableheritagenetwork.org/system/files/atoms/file/QCTools%20Manual%20\(Printable%20Version\).pdf](http://sustainableheritagenetwork.org/system/files/atoms/file/QCTools%20Manual%20(Printable%20Version).pdf)
- Ooghe, Bart & Moreels, Dries (2009) *Analysing Selection for Digitisation Current Practices and Common Incentives*. D-Lib Magazine, September/October 2009, Volume 15, Number 9/10. Retrieved from <http://www.dlib.org/dlib/september09/ooghe/09ooghe.html>
- Pinheiro, E., Weber, W. D., & Barroso, L. A. (2007). *Failure Trends in a Large Disk Drive Population*. In Proc. of the FAST '07 Conference on File and Storage Technologies. Retrieved from [https://static.googleusercontent.com/media/research.google.com/en//archive/disk\\_failure\\_s.pdf](https://static.googleusercontent.com/media/research.google.com/en//archive/disk_failure_s.pdf)
- Production Automation Corporation. (2017). *Why Is 70% Isopropyl Alcohol (IPA) a Better Disinfectant than 99% Isopropanol, and What Is IPA Used For?*. Retrieved from <https://blog.gotopac.com/2017/05/15/why-is-70-isopropyl-alcohol-ipa-a-better-disinfectant-than-99-isopropanol-and-what-is-ipa-used-for/>
- Sanchez, Crystal. (2010). *Heating Things Up: A History of Baking Tapes for Video Preservation*. Retrieved from [https://www.nyu.edu/tisch/preservation/program/student\\_work/2010fall/10f\\_2920\\_sanchez\\_a2a.pdf](https://www.nyu.edu/tisch/preservation/program/student_work/2010fall/10f_2920_sanchez_a2a.pdf)
- Specs Bros., LLC. (2008). *Magnetic Tape Preservation. Basic Inspection Techniques to Sample the Condition of Magnetic Tape*. Retrieved from [http://www.specsbros.com/uploads/7/1/9/0/71903471/white\\_pages-\\_basic\\_inspection\\_techniques9.pdf](http://www.specsbros.com/uploads/7/1/9/0/71903471/white_pages-_basic_inspection_techniques9.pdf)
- Specs Bros., LLC. (2009). *Common Signs of Problem Tapes*. Retrieved from [http://www.specsbros.com/uploads/7/1/9/0/71903471/digi\\_9\\_common\\_cassette\\_problems\\_rev\\_2.pdf](http://www.specsbros.com/uploads/7/1/9/0/71903471/digi_9_common_cassette_problems_rev_2.pdf)
- Sueiro, Marcos. (2008). *AVDb: Columbia University Libraries Audio and Moving Image Survey Tool Instruction Manual*. Retrieved from <https://library.columbia.edu/content/dam/libraryweb/services/preservation/AV%20Manual-final.pdf>

Texas Commission on the Arts. (2004). *Videotape Identification and Assessment Guide*. Retrieved from <http://www.arts.texas.gov/wp-content/uploads/2012/04/video.pdf>

Turkus, Benjamin. (2015). *Drop Video File(s) Here: The Emergence of Free Quality Control Tools for Video Preservation*. Retrieved from [https://www.bavc.org/sites/default/files/resource/QCTools\\_WhitePaper2.pdf](https://www.bavc.org/sites/default/files/resource/QCTools_WhitePaper2.pdf)

UCLA Library Special Collections. *Metadata Quality Control Guidelines*. Retrieved from [https://www.library.ucla.edu/sites/default/files/Guidelines\\_MetadataQualityControl.pdf](https://www.library.ucla.edu/sites/default/files/Guidelines_MetadataQualityControl.pdf)

Western Digital. (2018). *Top Considerations for Enterprise SSDs*. Retrieved from [https://documents.westerndigital.com/content/dam/doc-library/en\\_us/assets/public/western-digital/collateral/white-paper/white-paper-top-considerations-for-enterprise-ssds.pdf](https://documents.westerndigital.com/content/dam/doc-library/en_us/assets/public/western-digital/collateral/white-paper/white-paper-top-considerations-for-enterprise-ssds.pdf)

## Tools Referenced

**AV Compass:** <http://www.avcompass.bavc.org/>

**MediaConch:** <https://mediaarea.net/MediaConch>

**QCTools:** <https://github.com/bavc/qctools>

**AV Artifact Atlas:** <https://bavc.github.io/avaa/>

**Fixity:** <https://www.weareavp.com/products/fixity/>

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