



GUIDELINES FOR THE CREATION OF DIGITAL COLLECTIONS

Digitization Best Practices for Moving Images

CARLI Digital Collections Users' Group
Standards Subcommittee

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Scope:

This document sets forth guidelines for digitizing moving image materials for CARLI Digital Collections. It provides a set of recommendations for technical specifications that digital objects should adhere to, as well as a discussion of digital video concepts, file formats, web delivery, and digitization workflow. Examples of video content in CONTENTdm systems, links to digital video hardware, software, and vendor services, a sample workflow, and further readings are also provided

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For questions about this document, please contact CARLI at support@carli.illinois.edu.

1. Introduction

Libraries seeking to preserve and provide access to moving image content such as films, video recordings, and television broadcasts in digital format face a number of daunting obstacles. Digital video formats and specifications abound, server space to store the massive amounts of data generated must be allotted, and mature, clearly established best practices for creating preservation-worthy digital objects have yet to fully evolve. This document will seek to provide a gentle introduction to the fundamental concepts and challenges of video digitization, and offer recommendations for creating archival files for long-term preservation as well as derivatives that can be disseminated over the Internet.

Perhaps the primary concern in working with digital video material is the large amount of storage space and computer processing power needed to digitize and store moving image material. Digital video production results in much larger files than those created by the digitization of static images or audio, and the ability to store massive amounts of data is often an issue for many institutions. However, as with all digitization projects, the initial digitization of the material should occur at the highest resolution possible, without the use of lossy compression which may compromise the integrity of the material during subsequent copying and regeneration. The balance between the ideal of uncompromised preservation and the realities of file management storage costs will need to be weighed carefully before undertaking a video digitization project.

Depending on an institution's storage capacity, the "best practices" recommendations below may not be appropriate for every digitization project. Project managers should evaluate the importance of the long-term preservation of the material when deviating from these guidelines. The "acceptable practice" recommendations offer a sound alternative for compressed master files when sufficient storage space is a concern.

2. Recommendations & Best Practices

2.1 *For Digitizing Analog Moving Image Material*

The following recommendations are for the digitization of analog video material such as films, videos, or television broadcasts. Digital objects created should have the following characteristics for sampling, sample size, resolution, data rate, and file format (see Section 3 for a detailed discussion of these specifications):

2.1.1 Archival Preservation:

Best practice:

For each program of moving image material, the initial digitization should strive to create an uncompressed, high-quality archival master wherever possible. Uncompressed video requires an enormous amount of storage space, but an uncompressed master is crucial to preserving the integrity of the content over the long term.

- Uncompressed YCbCr or JPEG2000 lossless encoding (codec)
- 640 x 480 resolution (assuming 4:3 original aspect ratio)
- 30 bit sample size
- progressive scanning
- 30 MBps data rate
- MXF (.mxf) file format

Acceptable practice:

Archival masters created using lossy compression are not ideal, but may be used when sufficient storage space is unavailable or the material is deemed of less historical importance.

- MPEG-4 AVC (H.264) or DV encoding (codec)
- 640 x 480 resolution (assuming 4:3 original aspect ratio)
- 30 bit sample size
- progressive scanning
- 30 MBps data rate
- AVI (.avi) or QuickTime (.mov) file format

2.1.2 Derivative Copies:

Derivative copies for online access can be created from the master file – these derivatives must use compression in order to reduce the file size to make online access feasible.

Adobe Flash is recommended for streaming video, while MPEG-4 is recommended for files that will be downloaded by users.

- MPEG-4 AVC (H.264) encoding (codec)
- 320 x 240 resolution (assuming 4:3 original aspect ratio)
- 256-600 kbps data rate
- Adobe Flash (.flv) or MPEG-4 (.mp4) file format

2.2 For Born-Digital Moving Image Material

Libraries are increasingly assuming the responsibility for archiving and providing access to born-digital video material. The integrity of the file formats submitted should be evaluated and the material should be migrated to a more preservation-friendly format if appropriate. Since the material has already been digitized, there is no benefit to upsampling (increasing the resolution, sample size, or data rate).

2.2.1 Archival Preservation:

When creating archival copies from born-digital video content, maintain the same frame rate, resolution, data rate, and sampling scheme as the original.

Best practice:

Use these recommendations for the best prospects for longevity.

- progressive scanning
- MXF (.mxf) file format

Acceptable practice:

Use these recommendations when historical preservation is less important.

- progressive scanning
- AVI (.avi) or QuickTime (.mov) file format

2.2.2 Derivative Copies:

Derivative copies for online end-user access can be created from an archival master using lossy compression. Adobe Flash is recommended for streaming video, while MPEG-4 is recommended for files that will be downloaded.

- MPEG-4 AVC (H.264) encoding
- 320 x 240 resolution (assuming 4:3 original aspect ratio)
- 256-600 kbps data rate
- Adobe Flash (.flv) or MPEG-4 (.mp4) file format

3. Understanding Digital Video

Fundamentally, all moving image formats (film, analog video, digital video) consist of a sequence of still images (referred to as “frames”), which, displayed in rapid succession at a constant rate, produce the illusion of movement. The image sequence may also be coupled with an audio stream consisting of one (mono) or two (stereo) channels. In digital video, frames consist of bitmapped digital images, and the audio stream consists of a digital audio file.

The fundamental concepts of digital video technology include:

- size and shape of the individual images (frames)
- resolution at which the images are captured
- compression processes used to encode the information (codecs)
- speed at which the images follow each other during playback
- overall length of the program
- accompanying audio
- size of the files created

These factors are discussed in order below. The recommendations for archival preservation are highlighted wherever appropriate.

3.1 *The Size and Shape of the Individual Images (Frames)*

3.1.1 **Image Size (Resolution)**

Similar to digital images, the size of the video stream is expressed as the number of horizontal pixels (width) multiplied by the number of vertical pixels (height). The horizontal measurement is sometimes referred to as the number of “samples,” and the vertical measurement is sometimes called the number of “lines.” The larger the image size, the better clarity and fidelity the images will have.

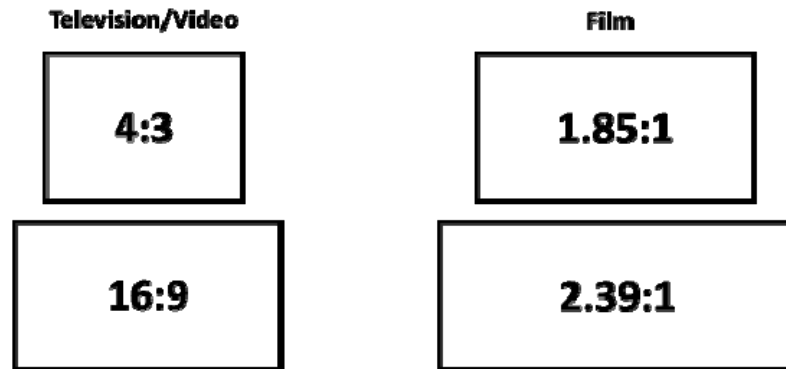
For example, an image size of 320 x 240 means that the video stream is 320 pixels/samples in width by 240 pixels/lines in height. 320 x 240 resolution is often referred to as “quarter-screen” size, while 640 x 480 is “full screen.” Standard-definition (SD) television uses 640 x 480, while high-definition (HD) formats may be in larger sizes such as 1280 x 720 or 1920 x 1080.

✓ *Recommendation: 640 x 480 resolution (assuming 4:3 original aspect ratio)*

3.1.2 **Aspect Ratio**

This value represents the width of the video stream divided by its height. Most analog television and video material has a 4:3 aspect ratio, which is used in SD television, while 16:9 is used for HD television and European digital television. Most commercial films appearing in theatres have an aspect ratio of 1.85:1 or 2.39:1.

Commonly used aspect ratios:



✓ *Recommendation: maintain original aspect ratio*

3.2 The Resolution at Which the Images Are Captured

3.2.1 Sampling

For each pixel in an image within a digital video stream, three elements are recorded: a “luma” element, corresponding to the brightness level; and two “chroma” elements, corresponding to the color levels for red and blue. The more precise the measurement of these elements is, the higher the resolution will be.

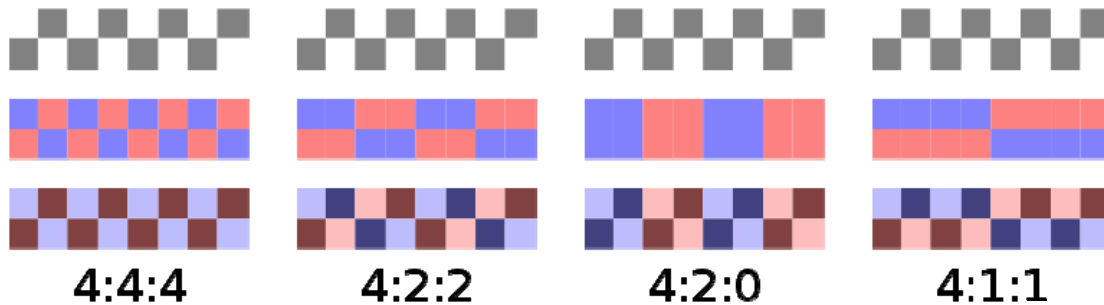
To reduce the size of digital video files, some chroma subsampling is almost always used. Humans are generally more sensitive to changes in brightness than changes in color, so in principle video formats can be made more efficient by sampling the chroma elements at a lower rate.

Below are some common sampling schemes:

- **4:4:4** – Luma and chroma elements are sampled at every pixel
- **4:2:2** – Luma is sampled at every pixel; chroma at every other pixel (basically, the chroma resolution is halved)
- **4:2:0** – Luma is sampled at every pixel; chroma at every other pixel, and red and blue values are sampled alternately on every other line
- **4:1:1** – Luma is sampled at every pixel; chroma at every 4th pixel

4:2:2 is a commonly used format in high-end digital video equipment, while 4:2:0 is used in almost all MPEG-based formats, including DVDs. It should be noted that 4:4:4 is the only true “lossless” sampling scheme.

The image below helps illustrate the differences between sampling schemes:



(image adapted from <http://en.wikipedia.org/wiki/Chroma_subsampling>)

The type of subsampling used when the material is digitized is directly related to the type of codec used to encode the file (see section 3.3 below).

✓ *Recommendation: 4:4:4 sampling scheme (best practice); or 4:2:2 (acceptable practice)*

3.2.2 Video Sample Size (Bit Depth)

This value, represented in bits, indicates how detailed the measurement of the luma and chroma elements is. The higher the number, the more detailed the measurement. The value is expressed as the sum of the bit depth for the 3 sampled elements (1 luma, 2 chroma). Individual elements are usually sampled at a depth of 8 or 10 bits, meaning that most digital video files have a 24 or 30 bit sample size.

✓ *Recommendation: 30 bit sample size*

3.2.3 Scanning: Progressive vs. Interlaced

“Scanning” in this context refers to the means in which the frame image is captured. There are two main types of scanning used in digital video: *interlaced* and *progressive*. Each has advantages and disadvantages.

- **Interlaced:** Two fields or “exposures,” each containing one-half of the image information, are captured about 1/60th of a second apart. One field consists of the odd-numbered lines, the other the even-numbered lines. Due to subject movement between the capture of the two fields, some blurring is possible when the two fields are combined in a single frame, which often occurs when transferring analog video to digital. Most existing analog video is in interlaced format.
- **Progressive:** The entire image is captured in a single exposure. This allows for increased clarity, but requires more processing power to render. Most born-digital video uses progressive scanning.

During playback, progressive and interlaced video will be presented to the viewer in the same format in which they were scanned.

✓ *Recommendation: progressive scanning*

3.3 Compression Processes Used to Encode the Information (Codecs)

Given the need for reducing the size of digital video files for both long-term storage and web dissemination, substantial effort has gone into the creation of algorithms and programs to compress the digital information within the file at the time of creation and de-compress it at the time of playback. These programs are commonly referred to as “codecs” (**compressor-decompressor**). The codec used during file creation is directly related to the type of chroma subsampling (see section 3.2.1 above) used when the file is encoded. (Codecs and encoding standards are often referred to interchangeably.)

Codecs may be lossless (no information is discarded during the encoding process), but most involve lossy compression, meaning that some information is discarded at the time of encoding. Depending on the importance of the digital video file being created, the purpose of the collection, and the storage capabilities of your institution, using a lossy codec may be an acceptable practice. (In reality, the vast majority of digital video file formats and collections in existence use lossy compression.)

There are only a few lossless codecs/encodings available:

- **Huffyuv** – An open, fast, lossless Win32 video codec
- **JPEG2000 (Lossless)** -- An image compression standard which can be both lossless or lossy, depending on how it is implemented
- **Lagarith** – A more recent version of Huffyuv
- **Uncompressed YCbCr** – This captures the full luma (Y) and chroma (CbCr) information for every pixel. (In reality, this is not a codec, since there is no compression.)

Some commonly used lossy codecs/encodings include:

- **DV** – The codec used by many digital video cameras.
- **H.263** – Used to encode Flash video or other formats intended for low-bandwidth online or mobile dissemination
- **MPEG-2 Part 2** – Also known as **H.262**. This codec is used for all DVD video.
- **MPEG-4** – This standard has a wide range of applications, from low-end web-disseminated files to high-quality files used for digital television. There are two especially relevant encoding schemes specified by the MPEG-4 standard:
 - **MPEG-4 Part 2** – this encoding has 2 different profiles: Simple Profile, for low-quality files, and Advanced Simple Profile (ASP), which forms the basis for other commonly used codecs such as DivX and Xvid
 - **MPEG-4 Part 10** – Also known as **H.264** or **MPEG-4 AVC**. This is becoming one of the most widely used encoding schemes, due to its ability to create smaller file sizes while retaining image quality. It is used in Blu-ray, HD DVD, and digital television, and is compatible with a wide variety of media players and software platforms.

- **QuickTime H.264** – Apple’s proprietary encoding standard based on H.264.
- **VC-1** – A Microsoft-developed alternative to the H.264 codec, which has since been adopted as a standard by the Society of Motion Picture and Television Engineers (SMPTE). Also part of the Blu-ray and HD DVD standard.
- **WMV** – Microsoft’s proprietary Windows Media Video codec
- **Xvid, DivX, FFmpeg, 3ivx** – These codecs are all based on MPEG-4 ASP. Xvid is an open standard.

One important thing to understand is that *the codec is not included in the digital video file itself*. The user’s playback software must include a codec which, if it is not the same as, must at least be compatible with the codec used to create the file. If the user does not have the proper codec installed on his/her computer, the video may not be viewable.

- ✓ *Recommendation: Uncompressed YCbCr or JPEG2000 lossless codec (best practice); or MPEG-4 AVC (H.264) or DV encoding (acceptable practice)*

3.4 The Speed at Which the Images Follow Each Other During Playback

3.4.1 Frame Rate & Field Rate

“Frame rate” refers to the number of frames displayed per second during playback. 30 frames/second is the standard for almost all non-film video and television material, whether it is analog or digital. (Film has a rate of 24 frames/second.) “Field rate” refers to the number of fields displayed per second during playback. For progressive-scanned video, the field rate and frame rate are the same. However, for interlaced video, the field rate is actually 2x the frame rate (because it takes two fields to make a complete frame).

3.4.2 Data Rate (Bit Rate)

This value is a measurement of the amount of information delivered over a given period of time. It is usually expressed in kilobytes per second (kB/s or kBps) or megabytes per second (MB/s or MBps). The larger the data rate, the higher the quality of the video stream will be, but higher data rates also require more bandwidth and processing power to render the video stream during playback.

- ✓ *Recommendation: 30 MBps data rate*

3.5 The Overall Length of the Program

3.5.1 Duration

This value represents the length of time of the entire video stream. It is expressed in hours:minutes:seconds. For example a video with a length of 1 hour, 5 minutes, and 26 seconds would be written as “01:05:26”.

3.6 The Accompanying Audio

For a complete discussion of digital audio principles and practices, please see the Guidelines for the Creation of Digital Collections: Digitization Best Practices for Audio available here: http://www.carli.illinois.edu/mem-prod/contentdm/guidelines_for_audio.pdf.

3.7 The Size of the Files Created

Digital video production results in much larger files than those created by the digitization of static images or audio. While server space seems to come ever more cheaply these days, the ability to store massive amounts of data will continue to be an issue for most libraries. Thus, almost all of the underlying technological concepts of digital video need to be understood in the context of the acute need for compression and reducing file sizes.

File sizes for 1 hour of SD digital video material:

Uncompressed:	70-100 GB
Lossless compressed:	25-50 GB
Lossy compressed:	10-20 GB

4. Metadata

For a detailed discussion of descriptive metadata practices for digital objects, please see the Guidelines for the Creation of Digital Collections: Best Practices for Descriptive Metadata available here: http://www.carli.illinois.edu/mem-prod/contentdm/guidelines_for_metadata.pdf.

5. File Formats

Digital video file formats are best understood as wrappers or containers which hold the individual frame images, information on how they are to be played back, any audio files associated with the video stream, and metadata about the contents of the file. The type of file format used does not necessarily dictate the quality of the video (which is more of a function of the encoding used, see section 3.3 above), though some file formats do not support uncompressed or lossless encoded image data.

Unlike digitizing images, text, or audio, **there is no file format that has been definitively established as the standard for preservation-quality digital objects.** However, some file formats have greater prospects for longevity and stability than others – as with any digital object, a file format that is open (*i.e.*, non-proprietary), well-

documented, widely-used, and that has the backing of some sort of standards-endorsing organization is preferred.

Here are some commonly used file formats and their extensions, and an indication of whether they are suitable for archival preservation and/or web dissemination:

File Format	Extension	Archival?	Web?	Notes
AVI	.avi	✓	✓	Audio Video Interleave. This is the standard Windows multimedia container. Semi-open, well-documented, and widely used.
Flash	.flv		✓	Used to deliver MPEG-encoded video via a Flash player. Widely used for web dissemination.
Motion JPEG 2000	.mj2, .mjp2	✓		Well-documented, open standard supporting uncompressed or lossless-encoded image data. Not widely adopted as of this writing.
MPEG-1, MPEG-2	.mpg, .mpeg		✓	Although open, stable, and widely-used, this format has been eclipsed by MPEG-4.
MPEG-4	.mp4		✓	Open and widely used, but inherently lossy. This format is used mostly for end-user dissemination.
MXF	.mxf	✓		Material eXchange Format container. Open, capable of encompassing uncompressed or lossless-encoded image data.
QuickTime	.mov	✓	✓	Apple's proprietary container format. Semi-open, well-documented, and widely used.
Real Video	.ram		✓	RealMedia's proprietary container for delivering streaming media online.
Windows Media Video	.wmv		✓	Microsoft's proprietary container for digital video.

✓ *Recommendation: MXF (.mxf) file format (best practice); or AVI (.avi) or QuickTime (.mov) file format (acceptable practice)*

6. Delivering Video on the Web

As with file format, many issues can come into play when choosing how to deliver digitized video over the web. Concerns such as budget and internal technical support, scope of project, and intended audience can guide choices on download method and file player. Decisions on the formats, presentation, and method of access will be shaped by the goals of the project and the technical capabilities of both your institution and users.

For example, if the sole purpose of a project is archival, then high quality video files can be stored on media at a local level and simply retrieved manually when needed. In this case a high quality, lossless video file may be created, without worrying about file size or

the technical needs of the end user. However, if that video needs to be viewed remotely, whether by a small local community or a larger public community, then access over the web can provide a better solution. A smaller, more compressed file can be created to provide quick and easy access to the content of the file over the web.

No matter what file format is chosen for the project, decisions will have to be made on how that video will be distributed over the web (either as a download or through video streaming) and what video player options will be made available.

6.1 Download: Direct & Progressive

6.1.1 Direct Download

The simplest and quickest method for distributing video over the web is through direct download. In this instance, the video file is placed on a server and access is provided through a simple hyperlink on a website. The file is then downloaded by the user and saved to their computer. Playback will occur when the file has been completely downloaded. Any required media players will need to be installed on the user's computer.

One benefit of direct download is reduced set-up time and costs. Existing web server infrastructure can be used for the storing of files, and no special coding is needed to provide access, making it attractive for projects with little technical support. Once a file is downloaded, the user can choose their preferred media player for playback of the file, putting a higher onus on the user but also allowing them more freedom when viewing the files.

6.1.2 Progressive Download

One step up from direct download is progressive download. Progressive download also uses a standard web server for storage and access. Unlike direct download, progressive does not need the entire file to download before it can be played. Once the first portion of the file has been downloaded, or buffered, by the media player the file will begin to play, providing almost continuous playback. This allows for a user experience that is similar to streaming, without set-up or support requirements which are quite so advanced.

In both cases the entire video file will eventually be downloaded to the local user's machine, which means the file can be copied and distributed without your control (a problem if there are security or copyright concerns with the material). Also, the user cannot move around the chronological timeline of the video until the entire file has been downloaded, even with a progressive download.

6.2 Streaming Video

In contrast to direct or progressive downloads, streaming video allows quicker access to video content and does not require files to be downloaded onto the user's computer. Streaming video begins playing almost immediately, providing much quicker access to content. No files are actually downloaded by the user, helping to prevent unauthorized distribution of content. While a specialized streaming video server will be needed, this added hardware cost is offset by reduced bandwidth needs, increased playback options, and greater information on the use of material.

6.2.1 Streaming Media Servers

Streaming media (or streaming video) servers are specifically designed to be used for transmitting video or audio over the web. These servers can be set-up locally or through a hosted solution provider. A streaming server will take into account the format, size, and structure of a video file, as well as the capabilities of the user's connection and media player, and feed only those portions of the file that are needed for viewing at a given time. This decreases the amount of bandwidth that needed to view the file, reduces the load on the server, and maximizes playback quality. Administrative functionality allows for closer examination of the frequency, time, and conditions of video viewing.

A major benefit of streaming video is greater control over the playback of the file for the user. Because the streaming server is only distributing the portion of the file needed for viewing, the user can move forward and backward along the timeline. Streaming servers can also better handle larger traffic loads, and manage multiple users accessing files simultaneously. Because no file is downloaded to the user's computer, it cannot easily be saved locally and copied without permission. While software programs that can capture streaming video do exist, the fact that no file exists locally adds a level of security not available with downloaded files.

(See Appendix A for a list of video streaming servers.)

6.3 File Formats & Players for Dissemination

Most standard video file formats can be used for both download and streaming purposes, and file size and quality is also fairly consistent across formats. Therefore, compatibility and consistency of playback across platforms become the major factors in deciding what format to use.

Popular File Formats: Player & Operating System Compatibility

File type	Flash (Win/Mac)	Windows Media Player 11 (Windows)	Windows Media Player 9 (Mac)	QuickTime (Win/Mac)	Real Player 8 (Win/Mac)
.fla	X				
.swf	X				X
.wmv		X	X		
.avi		X			X
.mov				X	
.mpg		X		X	X
.mp4				X	
.ram					X

Third party software programs can increase the compatibility of some file formats across platforms, but these programs often require advanced skills by users. It is best to provide an option that will reach the widest possible audience, while retaining the look and feel required by your project.

(See Appendix B for examples of different media players and formats in digital library collections, including CONTENTdm-based collections.)

No matter what the format, video files can be presented to the user through either a direct link or an embedded player. A direct link is the simplest method, leading to a direct download or perhaps a progressive download in a new window, but offers little control over how the user will experience the video. Embedding a file places the link to the file and the player directly onto the web page, which not only allows for immediate playback of the file within the context of the site, page, or metadata, but also gives a certain amount of control on the size of the player, what controls are made available, if the file will automatically start playing, and if it will repeat on a loop. While the code for embedding a file on a page will include information needed to control the playback of the file, the player must still be installed on the user’s computer for playback to work. A combination of these methods can be used to provide both the immediate embedded playback, as well as options to download the file in alternative formats.

For widest support across platforms, Flash is a popular choice. It comes preinstalled on most systems, the player is embedded on the page (so that playback is not dependent on the local machine), and offers more options for playback and display. File size is slightly larger than similar quality from other formats. Files must also be converted to Flash from other formats, adding a step to the process. Files are designed for online playback, rather than direct download. Also some newer smart phones and tablet computers will not play Flash video.

Flash has two basic file formats: the .flv file which is the Flash video file, and the .swf which is the web version that is presented to the end user. The .swf file serves as a container, which includes the information needed to present and play the .flv file. The .swf file is the one that will actually be linked to or embedded on your web page.

The next most compatible format is MPEG (.mpg), which can be viewed in players native to Windows and Macintosh computers, including Windows Media Player, QuickTime, and RealPlayer. The newer MPEG-4 (.mp4) format, however, is not supported on Windows Media Player.

Windows Media files (.wmv) can be played using Windows Media Player, which comes installed on all Windows computers. However, Microsoft has ceased development of the Media Player for Macintosh, so the only player available for that platform is two versions old and not actively supported. Use of this format could therefore effectively exclude a large user base.

QuickTime files (.mov) can be played using QuickTime, which is natively installed for Macintosh computers and available for download on Windows and other systems.

RealMedia files (.ram) can be played using RealMedia Player, which is available across platforms.

7. Digitization Workflow

7.1 Digitizing Video Yourself vs. Using a Vendor

In most video digitization projects you will probably face the choice of digitizing the materials yourself or sending them out to a vendor. There are pros and cons for each choice, and a number of factors will influence your decision.

Cost may likely be the driving factor. It can be incredibly expensive to acquire and set up the proper equipment for a video digitization workstation, (see section 7.2 below). Furthermore, there will be costs in terms of staff training to use the equipment, and costs in terms of staff time. Digitizing analog video is largely a real-time process, not to mention memory-intensive, so the workstation used will be unavailable for other tasks while digitization is in progress. Similarly, staff may not be able to multitask during video digitization, as they will probably need to monitor the equipment and make sure everything is running smoothly. However, if your library plans to digitize a significant amount of video, it may make more sense to invest in the equipment and training necessary to do so in-house. Vendor services are not inexpensive, as you are paying for access to someone else's expertise and (usually) higher-end equipment.

Quality of the finished product may also factor into your decision. There are a number of vendors who work regularly with libraries, archives and other cultural institutions to digitize video and other multimedia sources. Vendors can usually offer professional-level equipment and software that may be beyond the reach of your local resources, and can digitize more types of media than most libraries can afford to work with in-house. They can often also make repairs to damaged tapes and correct color and audio problems. If high-quality uncompressed archival files are needed, you may prefer the results you can

get from a vendor. If, on the other hand, you are digitizing video that you do not intend to save for the long term, the quality available from a local workstation may be sufficient.

7.2 *Doing it Yourself*

If you decide to digitize your analog video collections yourself, there are four main areas to consider: workflow; hardware; software; and file storage.

7.2.1 **Workflow**

While the specifics will vary based on your selections for hardware and software, the general workflow for digitizing video will look something like this:

1. Make sure that playback device (VCR, camcorder, etc.) is connected to the analog-to-digital converter device and that the converter device is properly hooked up to computer.
2. Turn on the playback device.
3. Launch the capture software.
4. Create a new project. You may need to alter the software settings to work with your type of source video; some software can detect video type and adjust settings automatically.
5. Determine where project files will be saved during capture (i.e.: select a hard drive). Make sure you have adequate available space for your project.
6. Cue up the video on the playback device. Depending on software and hardware, you may be able to control the playback device through the software interface.
7. Start the import function in the software and play the video to be captured.
8. When capture is complete, stop software import. Save the project.
9. Create derivative files as needed, using your software's export features or other software designed to compress and/or stream digital video.
10. Transfer your files to appropriate storage and delivery platforms.

7.2.2 **Hardware**

There are many factors to consider in setting up a workstation for digitizing video. First is the workstation itself. Whether using Windows or Mac hardware, a video workstation needs more RAM and storage and a faster processor than most library computers. How much is dependent upon the type of video you will be working with. For Standard Definition (SD) video, the workstation should have at least 2 GB of RAM, and at least 4 GB when working with High Definition (HD) video. When considering processor speed, keep in mind that digitizing video requires moving large amounts of data at a fairly rapid pace. The faster the processor, the more likely that the workstation can handle the video files without significant lag or dropping frames. The technical specifications for your capture software and conversion card or device can provide guidance as to the minimum processor speed needed for adequate performance and recommended configuration for optimum performance.

Also needed for your video workstation is a way to convert analog signals from VHS and other older formats to a digital signal that the computer can capture. You will need not only a functioning playback device, such as a VCR or camcorder, but also a video capture device that sits between the playback machine and the computer. These types of devices generally fall into two categories: video capture cards that reside in the PCI slot of your CPU; and external conversion units that connect to the computer via FireWire or USB. Each type of device comes in many varieties, so it is important to select a card or conversion unit that provides the capabilities you need, such as support for the type of analog output from your playback device (composite video, component video or S-video). It is also important to consider how the device handles audio and what type of digital output it supports. A number of higher end cards and conversion boxes can support both analog input and output as well as digital input and output, and may be a good choice if you expect to work with different types of video sources in the future. It is also important to note what type of video compression the card or conversion box supports. Many lower end external conversion devices on the market automatically compress video and do not give you a choice of compression level. Especially when digitizing video for preservation, master files should be compressed as little as possible (ideally they should be completely uncompressed) so it is crucial that the device you choose allows for the amount of compression called for in your local specifications.

(See Appendix A for a list of video capture hardware device vendors.)

7.2.3 Software

In addition to these hardware considerations, digitizing video also requires the use of capture software to import and edit the digital video stream. Most commercial video editing applications also offer video capture and are generally considered all-in-one solutions. Some examples at the high end are Apple's Final Cut Pro, Adobe Premiere Pro, Sony's Vegas Pro, and Grass Valley's EDIUS. All capture video from a variety of sources and can convert using a variety of codecs. In addition, they offer sophisticated editing tools and special effects. Depending on the type and amount of video you will be digitizing and whether you are digitizing only for preservation purposes or will be editing and organizing clips, these packages may provide more features than you really need. They are also relatively expensive, ranging from about \$400 to \$1000. Lower-end or more limited packages may provide the amount of functionality needed for some projects. Some of these include Adobe Premiere Elements, Apple's iMovie, and Windows Movie Maker.

(See Appendix B for a list of video digitization and editing software tools.)

7.2.4 Storage

Uncompressed digital video files are massive, so to work with digitized video you will need access to a large amount of storage. A single frame of uncompressed SD video (640 x 480 resolution, in color) equals about 1 MB. That adds up to about 30 MB per second and over 1.5 GB per minute. HD files are even larger. Fortunately, large capacity hard

drives are readily available and relatively inexpensive; 2 Terabytes (TB) drives can be found for only a few hundred dollars. However, you may want to consider a RAID or network-based storage for digitized video files. These options allow for even greater capacity and often include redundancy for back-ups in case of data loss.

7.3 Using a Vendor

There are a number of things to keep in mind when selecting a vendor for your project. While a formal Request for Proposal may or may not be necessary given the size of the collection you are working with and the purchasing rules of your institution, it is a good idea to provide a potential vendor with as much information as you can. You should include the number, type and condition of the videos to be digitized, and specify what type of digital files you want back and how they should be delivered, such as on an external hard drive. If you are able to determine the playback time or duration of the tapes to be digitized, you should also include this information as many vendors set their prices based on the number of minutes of video digitized. However, if tapes are fragile and repair is required before they can be digitized, a best guess of duration will help the vendor determine an estimated price range. You will also want to specify what kind of metadata you can provide with the collection and what type of metadata you expect back with the digitized files. If possible, try to solicit bids from more than one vendor because prices can vary widely. Finally, it is also a good idea to request references from vendors you may work with and follow up by talking with people who have done similar projects with them. Other customers' candor can be very informative and may influence your final decision.

Once you have received responses from one or more vendors, the process of negotiation begins. There are a number of details that you will need to work out. For instance, how are the tapes to be delivered to the vendor's facility? How should they be packed? Shipped? What kind of insurance is needed? Who is responsible for these charges? You will want to set deadlines for various steps in the project and work out what recourse each side has if those deadlines are not met. In addition, you should determine with the vendor what, if any, additional information the vendor needs to complete the job, such as how the digital files should be named. After you have finalized these details, make sure that both you and the vendor have them in writing. This will likely take the form of a contract or service agreement (usually supplied by the vendor) that you can submit to your institution's business and/or legal office once you have made your final selection.

When you receive your digitized video files back from the vendor, it will be important to verify that you received exactly what you expected to receive. Have all the videos you sent to the vendor been digitized? Have the tapes been returned, if this was part of your agreement? You will need to set up a process for quality checking each file to determine if video and audio (when applicable) are present and the files are usable. It may not be necessary to view every video in its entirety, but spot-checking every few minutes may be sufficient. If there is any problem with a digital file, be sure to report it to your vendor

promptly. A reputable vendor will want to correct problems quickly and to your satisfaction because they rely on good references from their customers when seeking new business.

(See Appendix C for a selected list of commercial video digitization services.)

Appendix A: Hardware & Software for Video Digitization, Editing, and Distribution

(Disclaimer: References below to specific products, resources, or services does not necessarily constitute or imply its endorsement or recommendation by CARLI.)

Hardware: Video Capture Devices

Blackmagic Design

<http://www.blackmagic-design.com/>

Grass Valley (formerly Canopus)

<http://www.grassvalley.com/>

AJA Video Systems

<http://www.aja.com/>

Hardware: Video Streaming Servers

Flash Media Server

<http://www.adobe.com/products/flashmediaserver/>

QuickTime Media Server

<http://www.apple.com/quicktime/streamingserver/>

RealNetwork's Helix Server

<http://www.realnetworks.com/products-services/helix-server-proxy.aspx>

Windows Media Server

<http://www.microsoft.com/windows/windowsmedia/forpros/server/server.aspx>

Software: Digitization & Editing

Adobe Premiere Elements

<http://www.adobe.com/products/premiereel/>

Adobe Premiere Pro

<http://www.adobe.com/products/premiere/>

Avid

<http://www.avid.com/video/>



Consortium of Academic and
Research Libraries in Illinois

EDIUS

http://www.grassvalley.com/products/edius_5

Final Cut Pro

<http://www.apple.com/finalcutstudio/finalcutpro/>

iMovie

<http://www.apple.com/ilife/imovie/>

Vegas Pro

<http://www.sonycreativesoftware.com/vegaspro>

Windows Movie Maker

<http://windows.microsoft.com/en-US/windows-vista/Getting-started-with-Windows-Movie-Makerh>

Appendix B: Examples of Video Dissemination Formats in Digital Collections

(Disclaimer: References below to specific products, resources, or services does not necessarily constitute or imply its endorsement or recommendation by CARLI.)

AV/AR Collection

Central Arkansas Library System

(Direct Download; Direct Link; QuickTime)

http://www.digital.butlercenter.org/cdm-p1532coll1/index_p1532coll1.php?CISOROOT=/p1532coll1

Voices of Freedom Collection

Virginia Commonwealth University

(Streaming, Direct Link, Real Media)

http://dig.library.vcu.edu/cdm4/index_voices.php?CISOROOT=/voices

Image & Video Library

American Society For Cell Biology

(Progressive Download; Direct Link; QuickTime)

<http://cellimages.ascb.org/> [select “Browse All Videos”]

Sulphur Springs Collection of Pre-Nickelodeon Films

Southern Methodist University

(Streaming; Embedded Player; QuickTime)

<http://digitalcollections.smu.edu/all/cul/ssm/>

American Democracy Project

Mike Downs Center for Indiana Politics, Indiana University/Purdue University Ft. Wayne

(Streaming; Embedded; Flash)

<http://mdon.lib.ipfw.edu/72.html>

Chuck Olin Digital Film Archive

University of Illinois at Urbana-Champaign

(Streaming; Embedded; Direct Link; Real Media; Windows Media)

<http://www.library.illinois.edu/hpnl/Olin/>

Promotional & News Videos*

Carleton College

(Progressive Download; Embedded & Direct Link; QuickTime & Flash)

https://apps.carleton.edu/athletics/audio_video/video/?item_id=611602

https://apps.carleton.edu/campus/library/about/orientation/?item_id=234868

* non-CONTENTdm collection

US Fish & Wildlife Service

National Digital Library

(Streaming; Embedded; Flash)

<http://www.fws.gov/digitalmedia>

Appendix C: Selected List of Commercial Video Digitization Services

(Disclaimer: References below to specific products, resources, or services does not necessarily constitute or imply its endorsement or recommendation by CARLI.)

DC Video

177 W. Magnolia Blvd
Burbank, CA 91502
(818) 563-1073

<http://dcvideo.com/>

Media Matters LLC

450 West 31st Street, 4th floor
New York, NY 10001
(212) 268-5528

<http://www.media-matters.net/>

The Media Preserve

A division of Preservation Technologies,
L.P.

111 Thomson Park Drive
Cranberry Township, PA 16066
(800) 416-2665

<http://themediapreserve.com/>

Preserving The Past

(street address not found; corporate
offices in Los Angeles and Rochester,
NY)

(818) 317-7147 (Los Angeles, CA)
(585) 271-4721 (Rochester, NY)

<http://www.preservethepast.com>

Safe Sound Archive

21 West Highland Avenue
Philadelphia, PA 19118-3309
(215) 248-2100

<http://www.safesoundarchive.com/>

Scene Savers

424 Scott Street
Covington, KY 41011
(800) 978-3445

<http://www.scenesavers.com/>

Spec Brothers

P.O. Box 195
Lodi, NJ 07644
(800) 852-7732

<http://www.specsbros.com/>

Appendix D: Links and Further Reading

Other Standards Documents

Audio-Visual Working Group. *Federal Agencies Digitization Guidelines Initiative*. Last updated 22 February, 2010. Available from

<http://www.digitizationguidelines.gov/audio-visual/>

Beard, I., Bogus, I., Gorder, E., & Gonzaga, N. *RUcore and NJDH Standards Analysis for Moving Image Objects*. Last updated 2007, April. Available from

http://www.njdigitalhighway.org/documents/dos_avwg_video_obj_standard.pdfh

Coyne, Mike and Mike Stapleton. *JISC - Study on the Significant Properties of Moving Images*. 26 March, 2008. Available from

http://www.jisc.ac.uk/media/documents/programmes/preservation/spmovimages_report.pdf

Video Preservation

Fleischhauer, Carl. *Video Formatting and Preservation*. 6 November, 2007. Available from

http://www.digitalpreservation.gov/library/resources/pubs/docs/Fleischhauer_DLF20071106.pdf

Knight, G., & McHugh, J. *AHDS Preservation Handbook: Moving Image*. 27 July 2005.

Available from <http://ahds.ac.uk/preservation/video-preservation-handbook.pdf>

McDonough, J. *Preservation-Worthy Digital Video, or How to Drive Your Library into Chapter 11*. Electronic Media Group Annual Meeting of the American Institute for Conservation of Historic and Artistic Works, Portland, Oregon, June 13, 2004.

Available from <http://www.media-matters.net/docs/resources/Digital%20Preservation/Preservation%20Worthy%20Digital%20Video.pdf>

“Preservation of Audiovisual Collections: Moving Images”. *International Preservation News*. No. 47, May 2009. Available from

http://www.ifla.org/files/pac/IPN_47_web.pdfh

Sustainability of Digital Formats: Planning for Library of Congress Collections. Last updated 21 May, 2007. Available from

<http://www.digitalpreservation.gov/formats/index.shtml>

Vitale, Tim and Paul Messier. *Video Preservation Website*. Available from

<http://videopreservation.conservation-us.org/>

Metadata

JISC Digital Media. *Metadata and Digital Video*. Last updated 7 January, 2010.
Available from <http://www.jiscdigitalmedia.ac.uk/movingimages/advice/metadata-and-digital-video/>

File Formats

JPEG 2000 - Wikipedia, the free encyclopedia. Retrieved October 15, 2009, from
http://en.wikipedia.org/wiki/JPEG_2000

Material Exchange Format - Wikipedia, the free encyclopedia. Retrieved October 15,
2009, from http://en.wikipedia.org/wiki/Material_Exchange_Format