Digital Statement Part V

Survey on Long-term Digital Storage and Preservation

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I.   Introduction: Existing references and resources

The sustainability of digital files and formats for long-term preservation has been a major concern in our field for almost two decades now. The FIAF Technical Commission published the Digital Preservation Principles in 2016, taking as its reference the OAIS (Open Archival Information System) Model, which is available online.[1]

Increasingly, film archives are publishing their own technical specifications online for the deposit of digital elements, such as the Swedish Film Institute.[2] *The Digital Dilemma*, published in 2007 by the Academy Film Archive of the Academy of Motion Picture Arts and Sciences[3], also contains valuable information and recommendations for the transition from analog to digital, including recording data on film, which is still a sustainable way to preserve the files and save films. Currently a European project on digital preservation is being written in German.[4]

The FIAF website additionally contains valuable links and resources about digital preservation.[5]

The present text intends to provide an overview of the different practices of digital preservation, according to the results of a small survey sent by the Technical Commission to FIAF members and correspondents in January 2019.

Through institutional examples (bigger archives and smaller archives) this text intends to draw a landscape of digital preservation in different locations. Also we have to notice that a few archives, such as the Cinemateca Portuguesa, Cinémathèque française, Cinemateca Brasileira, CNC, Cinémathèque suisse, Swedish Film Institute and EYE, are still practicing "emergency photochemical duplications" in order to make one duplication of unique film elements in a state of advanced deterioration[6] or regular 35mm prints for film elements. These archives, including the BFI, also consider that it is still possible to make restorations purely on film.[7]

This survey is naturally not exhaustive, since it is not representative of the entire community of archives. Different archives will also have different choices according to clear preservation

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[1] Resource available on the TC page, FIAF website. Link: https://www.fiafnet.org/images/tinyUpload/E-Resources/Commission-And-PIP-Resources/TC_resources/Digital%20Preservation%20Principles%20v2%200.pdf

[2] Swedish Film Institute online specifications: https://www.filminstitutet.se/globalassets/1.-sok-stod/filminstitutets-stod/produktionsstods-dokument/technical-specifications-for-contractual-deposit-of-digital-film-elements-oct-2015.pdf

[3] *The Digital Dilemma* can be downloaded on this link: https://www.oscars.org/science-technology/sci-tech-projects/digital-dilemma

[4] DIN SPEC 15587: German recommendation for the digitization of film. There is a current project group to develop a CEN standard for the preservation of digital cinema.

[5] https://www.fiafnet.org/pages/E-Resources/FIAF-Summer-School-Resources.html

[6] The Cinemateca Brasileira lab still processes photochemically, mainly via wet-gate 35mm film duplication. 2018 processing statistics: photochemical duplication 93.303 metres; sound to digital files 86.696 metres; scanned images 37.574 metres. The financial perspectives of 2019 foresee an eminent reduction in film duplication due to limitations on buying raw stock.

[7] See the BFI Heritage 2022 print-making project (non-digital).

goals, access goals, and budget limitations for storage. Nevertheless, it provides a sense of the standards that have been applied by a sample set of institutions and commercial laboratories for the past few years.

Among the 17 non-profit institutions or private organizations that received the survey, 16 provided answers. We would like to thank the following archives and persons who took part in this survey:

Film Archives

- **British Film Institute (BFI)**, London, UK, Kieron Webb and Stephen MacConnachie
- **Bundesarchiv**, Berlin/Hoppegarten, Germany, Florian Wrobel
- **Centre national du cinéma et de l'image animée (CNC)**, Paris/Bois d'Arcy, France, Daniel Borenstein
- **Cinemateca Brasileira**, São Paolo, Brazil**,** Rodrigo Mercês
- **Cinemateca Portuguesa**, Lisbon, Portugal, Tiago Ganhão and Tiago Baptista
- **Cinémathèque française (CF)**, Paris/Saint-Cyr, France, Céline Ruivo and Yohann Dedy
- **Cinémathèque Royale de Belgique (CRB / Cinematek)**, Brussels, Belgium, Arianna Turci and Bruno Mestdagh
- **Cinémathèque suisse**, Lausanne, Switzerland, Caroline Fournier
- **EYE Filmmuseum**, Amsterdam, Netherlands, Anne Gant
- **Imperial War Museums (IWM)**, London, UK, David Walsh
- **Irish Film Archive (IFI)**, Dublin, Ireland, Kasandra O'Connell and Kieran O'Leary
- **Library of Congress (LoC)**, Washington, DC/Culpeper, Virginia, USA, Heather Linville
- **Svenska Filminstitutet / Swedish Film Institute (SFI)**, Stockholm, Sweden, Lars Karlsson
- **Taiwan Film Institute (TFI)**, Taipei, Taiwan, Teresa Huang

Other organizations

- **AV Preservation by reto.ch**, Ecublens, Switzerland, Reto Kromer
- **San Francisco Silent Film Festival (SFSFF)**, San Francisco, USA, Robert Byrne

II.   "Raw uncompressed files" or "Raw scans"

As mentioned in Part II of the Digital Statement, digitizing a film includes not only archiving a final result (the master), but also archiving what are commonly called the "raw files" (image and sound),[8] which are uncompressed. 14 of the archives that answered the survey use an overscan for the image during digitization, which includes part of the edges and the frameline. According to the possibilities of the scanner, the Cinémathèque française (CF) and the CNC, for instance, are practicing the full overscan, which includes the entire film edge information with the manufacturer's signature and edge codes, or the entire perforation shape.
The Cinémathèque Royale de Belgique (CRB / Cinematek) has chosen not to keep the raw scans, and mostly archives the master files.

1) Image / Output Format: DPX or TIFF[9]

- DPX is the main format used for preservation: 14 archives

- TIFF is used as a second preservation format: 4 archives (CNC, Bundesarchiv, IFI, Cinémathèque suisse).

4 archives in the survey (Cinémathèque suisse, IFI, CNC, Bundesarchiv) are using both native formats,[10] depending also on the source material (DPX for negative or TIFF for positive stock).

2) Logarithmic vs. Linear / bit depth

10 bit Log DPXs are used in most cases, although in single cases, 12 bit Log and 24 bit Log. TIFF only supports linear color space, and is used in most cases in 16 bit.

For DPX formats:
- RGB 10 bit Log: 10 archives
- RGB 12 bit Log: 2 facilities (AV Preservation, Cinemateca Portuguesa)
- RGB 16 bit Lin: 1 archive (Bundesarchiv)
- RGB 16 bit Log: 1 archive (BFI)
- 24 bit Log: 1 facility (AV Preservation)
- Single-channel 10/12 bit Log: 1 archive (BFI)

For TIFF formats:

- 16 bit Lin: 4 archives (Bundesarchiv, CNC, IFI, Cinémathèque suisse)

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[8] Digital Statement Part II: "Raw Scans".
[9] For further information on DPX and TIFF, or questions associated with Log, Lin, and bit rate, please visit the following website, which provides a useful and simple glossary of terms:
https://www.gammaraydigital.com/resources/guides/what-file-format-should-i-scan-my-film
[10] Since DPX can be converted into TIFF during post-production.

The IFI mentions that using 16 bit Lin TIFF goes with their scanners' settings and output. The CNC and Cinémathèque suisse use 16 bit Lin TIFF for scanning 35mm positive prints with high contrast, but 10 bit Log for 35mm negatives.
Depending on their 3 scanners, the Cinemateca Portuguesa won't do the same native output: Cineric scanner: DPX, 4K wet-gate, 12 bit Log; Blackmagic scanner: DPX, ultraHD, dry, 10 bit; MWA scanner: ProRes 422 HQ, HD. Two scanners are being used for collection access, and not for preservation.
The Bundesarchiv also uses 16 bit Lin DPX because they are scanning films not only for access but also for preservation, and opted for higher quality (or a higher amount of data).
Depending on the project, the BFI uses 10/12/16 bit Log. For black & white films they set the scanner to a single channel (monochrome), which helps to reduce the overall size of the raw scans.

3) Resolution

2K and 4K are the main resolutions used today for scanning. Depending on the film stock, gauge, material, type of scanner, or the final result (preservation or access), a choice of resolution can be applied.

2K: 8 archives
3K: 1 archive (Cinemateca Brasileira)
4K: 8 archives
6K: 1 facility (AV Preservation)
8K: 2 facilities/archives (AV Preservation, CF).

For instance, 2K resolution is applied by 6 institutions[11] when they scan a 35mm positive or 16mm film or even smaller formats (CNC, CF, LoC, EYE, SFI, Bundesarchiv).

Most of the survey archives use 4K resolution when they scan 35mm negatives, even though some archives have chosen to scan both 35mm negatives or original nitrate positives in 4K for preservation purposes. 16mm can also be scanned at 4K at the Cinémathèque suisse, depending on the source. 8K resolution has been applied at the CF to wide formats or obsolete gauges such as 90mm. The CNC has scanned 75mm Lumière films at 7500 pixels.

The Cinemateca Brasileira uses a certain type of resolution, depending on the original material; the geometry varies, from "full aperture" (for silent films) or "Academy" (for sound films). 35mm film is mainly scanned at the Arriscan "native" 3K resolution (silent 3072 x 2106, sound 2730 x 2075) and framed so that the perforations can be used as a future reference for image stabilization. 16mm film is only scanned using the Cintel Ditto at 1728 x 1232. No "super 16mm" was scanned last year.

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[11] For those who provided a precision.

III. Master Files

Master files are commonly a second version of the raw scans, which have been graded and restored (see Part III of the Digital Statement). Usually Master files are also cropped, compared to raw files, which are made in overscan to keep the edge information and for restoration treatment purposes.[12] Cropping makes them suitable for projection with the proper aspect ratio. They can be converted (DPX to TIFF, or Log to Lin) depending on needs and final output.

In some cases, such as at the IWM, digitization is mostly done for access, research, and TV use. Most of the films are not graded or restored, and are already cropped. In this case the raw scans and master files are the same version; they are also regarded as access files by the institution.

The Cinemateca Brasileira, for instance, has been preserving three versions of the master: the restored files and the graded files are stored separately, with the final result, including both, being the third version.

1) The Color Space

The CNC, BFI, and Swedish Film Archive and EYE mentioned that the color space of the digital master is set usually at DCI-P3[13] or Rec. 709.

2) Resolution, bit rate

Most of the responding archives use the same resolution or formats as the raw scans in order to create a master.

The CNC converts 4K files to 2K in order to create a master.

3) Mezzanine

8 archives have implemented a Mezzanine format. This compressed file is made from the master files, and is useful and flexible enough to generate access files for streaming or VoD, for instance. But it is not yet considered a long-term preservation format. This survey demonstrates that the responding institutions do not use a format according to any specific standards.

"Mezzanine" seems to be an unclear terminology in archival practice, since in some cases, lossless compression for long-term storage (see the section below dedicated to storage) and the notion of Mezzanine in the industry world appear to be the same thing. One example is the IMF format, which is a lossless JPEG 2000 compression (reversible) and an SMPTE standard recommended to produce a Mezzanine file.[14]

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[12] The overscan also helps the work on stabilization made on softwares. The perforations can be a reference for proper stabilization work that respects the original movement of the film.
[13] DCI-P3 is a common RGB color space set for digital movie projection.
[14] The French cinematographers association (CST) recommends the use of IMF, SMPTE ST 2067-40, as mezzanine format: https://www.cst.fr/publications-et-documentation/rt021-imf/

CRB/Cinematek: ProRes
IWM: ProRes HD422
IFI: ProRes HQ or ProRes XQ
LoC: ProRes 442 HQ, MPEG-4
Cinémathèque suisse: ProRes 422/444 or DNX HD
BFI: ProRes. The majority are 1080p, but they will increasingly make them in original project resolution (i.e., 2K or 4K)
Swedish Film Archive: ProRes 422 for b&w, 444 for color
CNC: ProRes 422 for b&w, 444 for color, 2K
Cinemateca Portuguesa: ProRes 4:4:4 or 4:4:2

IV.   Projection, Access, Distribution

1) DCP and other formats

- The JPEG 2000 compression called the DCP (Digital Cinema Package) is used by all the survey archives, in 2K or 4K.

- The IWM, LoC, and Cinémathèque suisse produce ProRes files for projection on demand.

- The Cinemateca Brasileira can project HDCAM, Digital Betacam, HDV, DVCam, Blu-ray, and DVDs, or different domestic video formats (VHS, VHS-C, Video 8, Digital 8, etc.).

⇒ **Specific DCP formats**

- The BFI specifies that DCPs for silent films are retimed with repeat frames in a 24 fps package. One exception has been their recent 68mm restorations, which are in higher frame rate 30 fps packages.

- The CF also experimented to recreate silent film projections in 16 fps using a 48 fps (3D encoding) frame rate. Unfortunately these high frame rate DCPs were too complicated to manage for loans, since they would require the resetting of digital projectors.

- The Swedish Film Archive produces 30 fps DCP for all silent films with a frame rate lower than 24 fps and mentioned that they had unreliable performance with 48fps playback on some projectors.

⇒ **Encrypted DCPs**

Most of the survey archives do not encrypt their DCPs (created from their own collections, or deposits from the outside) for long-term storage purposes.

Some archives have already agreed to send non-encrypted DPCs from their collections within the FIAF members network, to facilitate their projection.
The CRB/Cinematek says that all versions and subtitles are available, non-encrypted.
Meanwhile, for loans and distribution, 5 archives encrypt them.

- The IWM and the SFI encrypt DCPs for films that are commercially distributed: a distributor or a paid service takes care of the KDM and the delivery to movie theatres.

- The BFI usually encrypts for distribution, unless specific rights-holder approval is received for non-encrypted projection.

- The Taiwan Film Institute (TFI) encrypts all their DCPs, for commercial and non-commercial projections, including the FIAF network.

- The CF encrypts DCPs when a loan is done out of a FIAF network, for commercial theatres. DCPs can also be encrypted for any type of loan (commercial and non-commercial) at the request of the right-holders.

2) Web and VoD platforms

9 archives – the IWM, Bundesarchiv, EYE, IFI, BFI, CRB/Cinematek, TFI, LoC, and Cinemateca Brasileira – use platforms either on their own website, or a public online platform with free access (YouTube, EFG) for their films.
The CF and TFI use private VoD systems.

HD H264/AAC MPEG-4: 10 archives
SD MPEG-2: 1 archive (TFI)
MKV: 1 archive (Cinemateca Portuguesa)

V. New films, new acquisitions

Few archives have written internally or published online technical specifications for the deposit of new digital acquisitions or for legal deposit. Most of the time these elements are born-digital films.[15]

In many cases, the archives (BFI, IFI, EYE, CRB/Cinematek, Cinemateca Brasileira, CF, SFI, Bundesarchiv) that ask for the deposit of masters, such as DCDM, DPX, or TIFF, also ask for a non-encrypted DCP. The DCDM is also required by a few national archives for legal or mandatory deposit. Only two archives (CNC, LoC) ask for the deposit of a Mezzanine format.

DCDM: 7 archives
DPX: 4 archives
TIFF: 3 archives
Lossless JPEG 2000: 1 archive (Cinemateca Portuguesa)

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[15] In some rare cases today, a film can be shot with a 35mm negative and digitized afterwards.

Unencrypted DCP: 9 archives
Encrypted DCP: 2 archives (Cinemateca Portuguesa, CF)
ProRres: 7 archives
MPEG-4: 2 archives
HDCAM SR: 1 archive (TFI)
UK DPP AS-11[16]: 2 archives (IFI, BFI)
JPEG 2000 MXF: 1 archive (LoC)

The CF has received deposits of encrypted DCPs in many cases, despite asking right-holders not to encrypt them.
The Cinemateca Portuguesa specifies that deposits are in general RGB Rec. 709 (full range), to be viewed with Gamma 2.4, the aspect ratio of post-production. It also specifies the use of MD5 checksum for deposits.
The Cinemateca Brasileira *mentions* the storage of external hard drives that are received as legal deposit, usually USB 3.0 5400 rpm portable hard drives, with no solution at the moment to archive the content elsewhere.

1) Conversion and transcoding before long-term storage (raw scans, master, and distribution files)

Some archives have chosen to use lossless compression for long-term preservation of a master, in order to reduce the amount of space used for storage. This means that the process of compression is reversible, with theoretically no information loss.

- AV Preservation stores "Delta Files", which allows the regenration of the raw scans when needed.
- The CF and IFI convert their uncompressed files into FFV1 format.
- IFI uses RAWcooked software, which is launched via a custom Python script that verifies losslessness/reversibility (seq2ffv1py).[17]
- The IWM uses the ZIP protocol for wrapping up files in a single "zipped" file, which allows for different types of compression, or no compression at all. "DEFLATE" is simply a name for one of the most commonly used types, offering mild and lossless compression.
- The SFI uses the MAP package that uses JPEG2000 lossless to encode the image. The package doesn't have the same constraints on framerate, resolution etc like a DCP. This conversion creates a playable object (sound and image) and reduces the file size to at least 50%.

Two archives (Bundesarchiv and IWM) are considering implementing the FFV1 format this year, either for storing video formats or for uncompressed files.

The CF mentions that a checksum called framemd5 is integrated with the files MKV/FFV1.

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[16] The UK DPP AS-11 is a broadcasting format.
[17] The FFV1 format was discussed during the 2018 FIAF Congress in Prague. See Reto Kromer's article, "Matroska and FFV1: One File Format for Film and Video Archiving?" (*JFP* 96, 04.2017).

VI. Sound preservation

In terms of sound, digital formats are more variable than image formats, depending upon their final distribution (cinema or TV broadcast). RAW formats are usually the same as the restored files.

WAV (unspecified): Cinémathèque suisse, CF
WAV (48 or 96 kHz): IFI, CRB/Cinematek
WAV (48kHz / 16 bit): CRB/Cinematek
WAV (48kHz / 24 bit): IWM, EYE
WAV (96kHz / 24 bit): IWM, BFI, TFI, LoC, Cinemateca Brasileira
BWF - Broadcast Wave File (48 kHz / 24 bit): SFI, Cinemateca Brasileira
BWF - Broadcast Wave File (96 kHz / 24 bit): SFI, Bundesarchiv, Cinemateca Portuguesa

The IFI specifies that restored files are often Broadcast WAVE Format (BWF), due to the presence of the bext [Broadcast Extension] chunk. The IFI often writes coding history in the bext chunk[18] via BWF MetaEdit software.

1) Conversion of new deposits

Despite the standardized formats that are required for deposit, some archives are receiving different types of files for productions. In such cases, archives need to transcode these files in order to standardize their long-term storage.

- The Cinémathèque suisse makes a Mezzanine format (ProRes).
- The CF can convert into either JPEG 2000 or ProRes.
- The LoC converts new deposits into JPEG 2000 MXF.
- The SFI uses MAP for image and sound.
- The Bundesarchiv stores the files as they are.

VII. Long-term Storage

1) Tape system

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[18] The Bext chunk is a part of the header in a Broadcast WAV container. For instance, the IFI performs some remastering of the audio and documents the coding history in the bext chunk with BWF MetaEdit software, as per the European Broadcasting Union's EBU Technical Recommendation R98-1999 : https://hes32-ctp.trendmicro.com:443/wis/clicktime/v1/query?url=https%3a%2f%2ftech.ebu.ch%2fdocs%2fr%2fr098.pdf&umid=6c4f8e8a-03b4-4589-850e-15b8a9c1cabf&auth=2fa48df6780db62279b54055f9bd56b254df76c4-59199a5a824f9c33184415c174f5133fbdd1c016 / https://tech.ebu.ch/docs/r/r098.pdf

Most of the survey archives use a tape system for long-term conservation. They have also performed regular migration of their LTO (Linear Tape-Open) magnetic tape data storage. The archives that still have older generations of LTO tapes are in the process of migrating them. Some archives also admit that they generally wait for 2 generations to migrate their data, in order to reduce the cost (the price of tape drops every time a new generation is introduced).

Below are the generations that are currently used for storage, or which have not yet been migrated.

LTO-3: 2 archives
LTO-4: 2 archives
LTO-5: 3 archives
LTO-6: 7 archives
LTO-7: 5 archives
LTO-8: 5 archives
IBM 3592 drives and tapes:[19] 1 archive (BFI)

The BFI notes that IBM tapes (TS-1150 – gen 5 – equivalent to LTO-6) are denser than LTO (10 TB per cartridge), and faster. The next generation of IBM will contain 20 TB per cartridge. The BFI will continue to run one data tape library with LTO and one with IBM.

The CF, BFI, EYE, and Cinemateca Brasileira use the TAR format for LTO storage. The other survey archives didn't specify.

2) **LTO Tape Library**

11 archives have adopted the LTO library system. This is an active, automatic storage system, able to check, read, record, and migrate the content of tapes.

The other 6 survey archives or organizations can play their LTO tapes and record them, but the tapes are physically stored on shelves.

Below are the names of the LTO robot, with the specified storage capacity depending on the institution.

Spectra

- BFI: Spectra Logic T-950 x 2, each with 4 drives (one with LTO drives, one with IBM drives), managed by a Spectra Logic BlackPearl REST API gateway, stocked with LTO-6.
- IFI: Spectra Logic T50e, connected to a Strongbox T10 HSM.

Oracle

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[19] https://en.wikipedia.org/wiki/IBM_3592

- EYE: Oracle SL 150 robot with 2x2 drives with LTO-7 and LTO-8.
- SFI: 2 x Oracle StorageTek SL 3000 . One library is equipped with LTO-8 and the other with Oracle T10K-D tape drives.
- Bundesarchiv: Oracle SL 4000 – LTO-7 – 12 PB. It will be replaced by an Oracle SL 8500 with LTO-8 in 2019.

IBM

- Bundesarchiv: IBM TS 3500- LTO-6 – 2 PB. They keep copies of the tapes offline, on the shelf.
- Cinémathèque suisse: IBM TS 4500 – LTO-6 – 5 PB (2 identical libraries of these characteristics).
- IWM: IBM TS1150.

Quantum

- TFI.
- CRB/Cinematek: Quantum Scalar i80. Only used for actively writing tapes.

Unspecified

LoC: robotic data tape libraries using Enterprise T10000 (T10K) data tapes (currently the 8.5 TB per tape generation)
CRB/Cinematek: 2 tape buffers are used for writing LTO tapes and storing proxies. Total storage on tape buffers, capacity 150 TB.

VIII. Access Storage

Access storage in this case means a server that allows direct access to the files. Depending on daily activities and goals, this storage system can have different functions. It can be either short-term storage or longer-term storage; it can also be used for storing uncompressed files for post-production work (grading, editing, etc.). Most of the time it is used for compressed files that are suitable for different types of local and online access or projection.

Below are the solutions used by different archives, with the precision of the storage capacity:

1) **Servers and capacity**

Bundesarchiv: IBM Storwize, 250 TB

EYE: Netapp (SAN/NAS) 75 TB.
Temporary storage QNAP and DVS (for film digitization) preparing for ingest.

Cinémathèque suisse: 2 SAN, one on full flash disks, the other on SAS disk 10,000 RPM or 7200 RPM
-Temporary storage : 190 TB (on full flash), for ingest, daily lab work.

-Longer-term storage on SAN: 250 TB, mainly on SAS disk, for diffusion, usual projection, or for stills.

Swedish Film Institute (SFI): Rohde & Schwarz (former DVS). Fibrechannel. 200 TB useable storage. This is now 6 years old, and their aim is to make a tender for a new one this year, looking to get around 800 TB of useable storage.

IWM: Various NAS and SAN (capacity at least 100 TB).

Cinemateca Brasileira: 5 servers, capacity 90 TB and hard drives.

BFI: Isilon NAS cluster from Dell EMC, 1.5 PB capacity for instant access / delivery to web applications, including BFI Southbank Mediatheque.
Two 144 TB G-Rack NAS devices from G-Technology, for video digitization workflow specifically.
-Temporary storage: A portable HDD for delivery of born-digital files from acquisition sources. Use of file-transfer applications such as AFrame and Aspera to acquire digital media into the BFI preservation network, for example, from TV broadcasters.

IFI: 80 TB Synology Rackstation and 16 TB of AVID ISIS storage.
-Temporary storage: a combination of external hard drives and their NAS for pre-accession material. Occasionally they have used LTO for temporary storage, but they try to avoid this when possible.

Taiwan Film Institute (TFI): SAN Quantum 270 TB, where the raw scan files are stored before restoration and for post-production work. 100 TB capacity.

Cinémathèque Royale de Belgique (CRB / Cinematek): Scale Logic HyperFS, 150+ TB, Mezzanine files and Web proxies.
- Temporary storage: DPX files for grading and digital cleanup, high-speed NAS, 200 TB. Redundancy, file vault.

Library of Congress (LoC): DVS SAN, 512 TB capacity. Used for short- and medium-term storage for grading, image restoration, and active project file storage.
-Temporary storage: DPX, ProRes files for temporary storage for in-house projects are in process. They are stored on the SAN, external hard drives, or RAIDs.

San Francisco Silent Film Festival (SFSFF): Hard drives.

Cinemateca Portuguesa: 1 server for DCPs, video masters, 50 TB; possible to increase to 1 PB.

Cinémathèque française (CF): SONNET Fusion RX1600 RAID, 50TB, temporary storage dedicated to new acquisitions, used for the conversion of DPX files into FFV1.

CNC: Tiger 300 TB.

AV Preservation: 96 TB of SSD.

2) Storage facility: in-house vs. external

Most of the survey archives store and manage their files in their own facility.

CRB/Cinematek has an "in-house" and an "external facility", which have a duplicate of the files, with other Belgian cultural institutions as disaster recovery.

The LoC has, in addition to their Packard Campus digital archive in Culpeper, second copies of all preservation and access files, which are stored in a remote location at another Library of Congress data center.

The CNC will contract a commercial company to manage the files. The CF (which is a co-dependent of the CNC's storage) and the Bundesarchiv are also contemplating this solution.

IX. Collection Management

1) Digital Asset Management (DAM)

4 archives (IWM, Bundesarchiv, EYE,I BFI) use Digital Asset Management software to provide public access to their digital collections.

The **SFI** uses a system called DIVArchive for maintaining the libraries. All metadata on the films are kept in Adlib.[20] Since they are two separate networks there is no live connection between them.

The **Bundesarchiv** is planning a completely new long-term storage system that will go with a new DAM, which will be interoperable with their database.

The **BFI** uses an Imagen media asset management system, integrated with an Adlib collections management system (Imagen is the master system for media ingest / transcode / retrieval / delivery).

2) OAIS Model[21]

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[20] Adlib is the master system for documentation of the collection, physical and digital. This database is used by few FIAF archives. The CF and CNC are about to migrate to Adlib as well.

[21] The OAIS Reference Model, as the name implies, is a very general and open framework designed originally for storing data from space missions, but has since been widely adopted for other forms of digital preservation. It contains a simple way to envision and organize an archive's processes, including how it receives material and what is received (SIP / Submission Information Package), how it stores material, and what it stores (AIP / Archive Information Package), and how it gives out material (DIP / Distribution Information Package). The OAIS Reference Model also has separate modules for Preservation Planning and Administration. As a very basic theoretical framework, it is a widely adopted way to sketch a broad overview of archival activities, and can be especially useful when speaking with management or other archives.

2 archives (EYE and IWM) refer actively to the OAIS Model, while 3 archives (BFI, IFI, and Cinemateca Brasileira) refer to this model without necessarily using the same terminology. The Cinémathèque suisse is planning to implement it with a new database.
The Bundesarchiv is creating a new DAM which will refer to the OAIS Model, while their database for film metadata will be interoperable but remain a separate system.

X.   Recording restorations back to film

The recording back to film of restorations is applied by 8 archives (SFSFF, BFI, LoC, Cinemateca Brasileira, Cinémathèque suisse, Cinemateca Portuguesa, CF, CNC).
The CNC, SFSFF, and CF try to do it systematically.

The other survey archives make a new dupe negative, depending on the project, original source (if it is unique), or resources.

The BFI notes that they make a distinction between restoration and remastering. They record back to negative and make prints of restorations, but do not remaster (because there are multiple, suitable film elements still existing).

XI. Conclusion

In this initial survey of the current digital landscape, the conclusion could be drawn that it is rocky terrain. There is much more work to be done to get a global view of digital film archiving, to hear from more archives at all stages in the development of digital workflows. For instance, some of the larger and more streamlined workflows coming from major production studios, as well as very small regional archives, are not represented here, and that may shift the results towards presenting a more homogenized view. However, there are some conclusions that can be drawn from the current set of responses:

1) There is a **stabilization in language and a conceptual clarity** emerging about the stages of a digital workflow within archives. The speed at which the respondents were able to clearly answer the questions in the survey meant that the archives, generally speaking, are using the same concepts and language. When archives speak of master files, digitization, digital storage, and mezzanine files, these terms are becoming clear among them, and are recognized as necessary parts of daily archival practice. This is a big development, because it will allow for better information exchange and better comparison of workflows.
2) There are **some choices which seem to be predominant**: Reading through the responses will certainly indicate majority choices, in 10 bit Log DPX, for example, or the use of ProRes, LTO, .wav files, etc. Further work should be done to investigate the variations, which likely have excellent reasons behind them, most likely to do with efficiency, cost, or quality. In order to help archives without digital workflows in making decisions, it would be helpful to detail the reasons why certain archives chose uncommon formats or processes.
3) **This is a developing situation.** For the TC, this survey was necessary and fruitful. There are reasons behind each archive's choices, which make sense at the given moment. But these decisions are made against a background of competing technologies and manufacturers, who are not working purely for the archive market in most cases, as well as quickly changing digital standards, the shifting desires of stakeholders and management, and the technical knowledge of staff at institutions. All of these dynamic factors suggest that it would be useful to revisit this survey in 5-10 years (or sooner), and see how everyone, and every choice, has fared over time.

The TC looks forward to further investigations into digital film practices and archiving.