KEEPING AUDIOVISUAL CONTENT ALIVE

PRESTO CENTRE

Digest: Film scanning considerations

Version 1.1

2011 Published by PrestoCentre, http://www.prestocentre.eu

Introduction

This PrestoCentre digest summarises the considerations and decisions made in the context of a large-scale film scanning operation by the Netherlands Institute for Sound and Vision.

Sound and Vision guarantees the sustainable preservation of the Dutch national audiovisual heritage and makes it accessible to professionals, educational institutes and the general public.

The considerations presented by the authors (Tom de Smet and Harm Jan Triemstra) are of most relevance to institutions or companies with large quantities of (16mm) film material to be digitised and that face time and budget constraints.

Context

The Images for the Future programme is run by the Netherlands Institute for Sound and Vision and is set to digitise about 17.500 hours of material from film collections within 5,5 years. On average this amounts to a production of 3.000 hours a year.

The physical carriers selected for the Images for the Future programme receive conservation treatment, either through basic repair as a preparation for scanning or extensive conservation if source material properties deem necessary. As a minimum requirement the digital format must be an accurate copy of the original carrier suitable for repurposing in professional (post-)production and support digital sustainability.

The main challenge Sound and Vision faced was to find the so-called sweet spot for the approach of this mass digitisation process. The sweet spot is the optimal balance between production volume, available budget, time constraints, quality and archival requirements, which will always be a trade-off between these factors. Also the availability of standards and capabilities of market solutions were taken into account.
This digest describes the context of the collections, the considerations and choices made by Sound and Vision regarding this sweet spot and the current and future digitisation approach.

Current and past film digitisation cycles have shown that preparing and scanning archival film is complicated due to the characteristics of the collections.

1. Film Collection

Sound and Vision archives and offers access to a huge collection of film material that can be divided into two distinct parts.

- Broadcast collection: covers a period from roughly 1955 to 1989 with a total volume estimated at 25.000 hours. The majority of this material originates from broadcasters and is made of 16 mm positive reversal.

- Non-broadcast collection: Sound and Vision has over 10.000 hours of film materials that weren't produced for broadcast purposes. This collection is very heterogeneous and consists of numerous film collections that came from a wide range of Dutch institutes, companies, private collectors, and professional as well as amateur film makers.

1.1 Film characteristics impacting digitisation

Current and past film digitisation cycles have shown that preparing and scanning archival film is complicated due to the characteristics of the collections. At the same time, it is important to respect the material in its diversity and flaws.

Size estimates

Film length is estimated for suppliers using the 'film can' size, but 'film can' contents vary widely, resulting in film length being considerably lower.

Deterioration and damage

- Various amounts and degrees of shrinkage and/or brittleness are present;
- Cement splices can potentially cause instability in the scan results from data scanners;
- Glue residue from tape splices must be cleaned manually before scanning;
- The consistency of earlier preparations quality cannot be guaranteed.

Mixed materials

- It may occur that direct negative shots are edited in positive materials;
- A-Wind and B-Wind may have been edited together, causing focusing issues.

Multiple reels

- Multiple sound mixing recordings may be present (Music & Effects);
- Multiple editing reels may be present, without a final edit.

Picture quality and emulsion

Material from Sound and Vision's broadcast collection is on reversal film stock, which sometimes shows sharp contrasts, with underexposed indoor shots, noise, and density levels that are too high. The collections also contain a certain number of discoloured films.

1.2 Film registration and metadata

Films and accompanying audio carriers are registered in the Sound and Vision cataloguing system 'iMMix' along with their material properties and relationship to cans and programme metadata. Completeness and accuracy of registration is not always on par with digitisation requirements. This requires preparation effort and old databases need to be converted.

2. Film digitisation process until 2010

Mass film digitisation within the scope of the Images for the Future programme started in 2008. The digitisation process until the end of 2010 was based on Telecine transfer in standard resolution (SD) to Digital Betacam (Digi). After registration of the new carrier in the 'iMMix' cataloguing system, each item on the Digi was encoded to an MXF D10-50 hi-res file (the SD video standard for both Sound and Vision and the Dutch Public Broadcasters) for digital access and transcoded to an MPEG-1 proxy for browsing.

It is the experience of Sound and Vision that SD resolution sufficiently captured the actual details in the 16 mm and 8 mm films within the sub-collections that were selected for SD-digitisation. However, Sound and Vision identified numerous sub-collections that require higher resolution digitisation to capture all the information on film. An archive master would ideally be a lossless data format to suit digital sustainability and preservation.

3. A roadmap for HD film digitisation

3.1 Quest for the sweet spot

During 2008 and 2009 Sound and Vision investigated several approaches and solutions to overcome the limitations of the SD approach and determine the best trade-offs for its future mass film digitisation.

The decision was taken to select a data format and implement a tapeless solution. Being the default standard for film postproduction, the DPX format became the best candidate for the digital master

of the film image. The sheer size of a DPX digital master soon posed the problems of DPX storage volume costs and manageability. Therefore, the potential of JPEG2000 as a visually or even mathematically lossless compressed intermediate digital archive master was investigated during two consecutive pilots.

Sound and Vision researched the most important and least known aspects of the film digitisation process, for which it delivered another pilot, performed a hands-on market survey and asked Fraunhofer IIS to perform extensive research and testing.

3.2 JPEG2000 systems, film quality and scanning resolution

3.2.1 JPEG2000

JPEG2000 production systems were tested hands-on with DPX files from Sound and Vision film material. The overall conclusion of the pilot and research was that important functionality was not yet available and that the market would need more time to embrace the JPEG2000 compression as an archival standard for film material.

3.2.2 Film quality and scanning resolution

Selecting the right scanning resolution is more complex than simply trying to capture grain detail. The technical quality of the digitised film is determined by more parameters than scanning resolution alone. And another important factor in the equation is the technical quality of the film itself, which is a result of multiple factors.

One could take a look at the commonly used quality measurement method 'Modulation Transfer Function' (MTF) that depicts how contrast information in a system degrades with respect to the increased spatial frequency, and how the total MTF can be determined by multiplying the individual MTF-curves of each system function. For the purpose of allocating the right spatial resolution Sound and Vision identified and mapped different types of stock based on cinematographical quality and historical importance within its collection.

3.3 Research results

3.3.1 Film scanning

The first step in digitising film is scanning. In this step, proper parameters and quality control is essential since it strongly influences the quality of the final product. The Fraunhofer research extensively covered this area and lead to the following conclusions:

- Regardless the resolution of the scanner, the output images should be stored in the native resolution of the scanner;
- Since the scanned images also serve to digitally preserve the content, the images should be scanned at a resolution high enough to capture all the detail available in the source material;
- Images scanned with 10-bit logarithmic colour components provide enough dynamic range to capture the usable range of densities. The 10-bit logarithmic transfer curve is widely used in the film industry and provides the best opportunity for software and hardware compatibility when processing these images;
- When colour faded material is scanned, the scanner should take care of the first step in colour-correcting the images. The black and white levels of the scanner should be adjusted per colour component to make maximum use of the available bit depth;
- The most convenient choice of colour space is to keep the RGB colour space provided by the scanner and have it documented by the scanning party.

For the Sound and Vision collection, it appeared that the full 2K resolution is enough to

capture even the highest quality film. In most cases, however, the image quality is considerably lower and lower scanning resolutions can be used without compromising the captured detail. As a result, the following differentiation is made:

- Full 2K resolution (2048x1556) scanning for premium content: all 35 mm film as well as super-16mm, 16 mm film containing premium content or 16 mm material of exceptional cinematographical beauty and skill;

- HD resolution (1440x1080, picture area due to 4:3 aspect ratio) scanning for all other 16 mm material.

3.3.2 Image Compression

Sound and Vision considered two ways to store pictures from film digitally as the 'archive master': uncompressed DPX files or the mathematically lossless JPEG2000 compression algorithm. Both formats allow the film pictures to be stored in their original aspect ratio and, since the pictures are stored as individual images, there exist no frame rate issues.

Subjective quality assessment

JPEG2000 seems the ideal compression algorithm for storing a visually lossless digital copy of the original film. The biggest problem with JPEG2000, however, is industry support for archiving applications and tools for checking, controlling and validating the quality of the JPEG2000 code stream as well as performance issues.

Objective quality assessment

The objective quality assessment performed during the Fraunhofer research showed that mathematical quality indicators currently available are of little use in determining the absolute quality degradation of an image due to compression. The two models used (PSNR and MTF) showed that the quality degradation is strongly dependent on the image content.

3.4 Roadmap for HD film digitisation

Of pivotal importance in the film digitisation roadmap are the decisions to use DPX as the digital archival format and XDCAM HD422 as the digital access format. This means that even though the (subjective) compression quality assessment showed that it is possible to use JPEG2000 at attractive bit rates, the gain in storage requirements was not high enough to counterbalance the added complexity, lack of industry support and necessary computing power.

All film material suitable for 2K scanning is being scanned at the premises of the Netherlands Institute for Sound and Vision. Approximately two thirds of the entire HD digitisation will be done by external suppliers that are carefully selected through European public tender procedures. The preparation of the film material will in such case also be performed by the supplier according to Sound and Vision's instructions. The following output will be expected from the supplier on LTO4 tapes:

- DPX (TAR) 1440*1080, 10 bit log, RGB;
- BWAV (24 bit PCM @ 48kHz) for sound, that has been synchronised to the image by means of a 1kHz tone in the digital domain;
- XML file containing all the necessary metadata to ensure all relevant information goes back into the Sound and Vision database. The XML files are also crucial to support and facilitate extended processing.

The remaining 4000 hours of film material are being scanned at Sound and Vision on its DFT Scanity to HD (1440*1080) for 16mm film material and full aperture 2K (2048*1556), for 35mm material as well as a selection of 16mm material.
This in-house scanning facility is also equipped with an NLE set to check and adjust the synchronisation of the sound and image. The facility also enables Sound and Vision to perform a quality check on the DPX and WAV files produced by the external supplier before encoding all scanned material into XDCAM HD422 (with embedded sound).


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