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DIGITAL VIDEO PRESERVATION IN CONTEMPORARY ART MUSEUMS AND SMALL COLLECTIONS IN 2012

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ABSTRACT

From the mid-2000s museums and other institutions caring for video collections have seen a shift in the type of material coming into their care as the production and handling of media moves from tape-based to file-based systems and workflows. This shift has had a significant impact on the procedures needed to ensure the long-term preservation of video artworks, requiring institutions to adjust their practices to this new environment.

This paper discusses the results of a small-scale survey focusing on current practices for the preservation of file-based video art in cultural institutions. The survey was conducted over two months in early 2012, in the context of Matters in Media Art (www.tate.org.uk/about/projects/matters-media-art). Matters in Media Art is a multi-phase collaborative project—supported by the New Art Trust—between the Museum of Modern Art, New York; the San Francisco Museum of Modern Art; and Tate, London. The aim of the survey was to understand the main problems institutions face in the shift to file based artists' video and to identify common procedures, practice, training, and tools.

From interviews with staff actively involved in the preservation of media collections at twelve cultural institutions, four main challenges were identified:

- a lack of standards for technical metadata and file formats;
- the need for integration of different hardware and software components required for a seamless preservation workflow;
- the need for increased knowledge of digital video technologies, and
- the need for a greater understanding of general information technology infrastructure.

Looking back at the results it is clear that in three years the field has evolved and in 2015 there are more and better tools available, standards are being defined, and best practices are emerging.

INTRODUCTION

From the late 1990s, contemporary art museums and other cultural institutions started developing and communicating emerging practices for the preservation of video art. One of the first examples is the Playback conference in 1996, organized by the Bay Area Video Coalition (BAVC). Institutions like Independent Media Arts Preservation, Electronic Arts Intermix, the Netherlands Media Art Institute, and projects such as Matters in Media Art have worked to develop and publish information to support those engaged in the preservation of video art. Initially, practices associated with video preservation followed the standards developed by the video production industry, which at the time were tape-based.

Between 2000 and 2010, the move to tapeless production and delivery of video gathered pace. In 2004 Panasonic released P2, a professional digital recording solid state memory storage media format, and in 2008 the BBC launched its Digital Media Initiative in an attempt to introduce a completely tapeless production workflow. The shift from tape-based to file-based systems in the production industry, together with the development of affordable editing software and hardware means that video art is now mostly produced digitally. As a consequence museums are now receiving newly produced video art-

works as digital video files and need to adjust their preservation practices to accommodate these new formats.

Given that videotape was never designed for long-term preservation, most collections operated a migration policy to transfer their videotape onto new stock and new formats every seven to nine years. These collections now need to consider the migration from tape to file formats, given that tape formats are likely to become obsolete in the next few years (Tadic 2012). Although it is difficult to predict how long current common tape formats like Digital Betacam and HDCam will stay in use, it is clear that they are set to become obsolete. Tapes which are now due to be migrated should be moved to file-based formats. Therefore now is the time for museums and other collections to plan their migration from tape to file formats and define the strategies necessary to preserve these files.

For custodians of video collections, this means not only adapting to a completely different set of storage media, but also adjusting to software and hardware systems for recording, editing, and playback. Although there is much that can be learned from the broadcast industry, digital archives, and the IT domain about the conservation and management of these new technologies, the solutions being developed in these other contexts are not directly applicable to collections of video artworks. The difference in scale of museum collections compared to broadcast archives, differences in budgets, and the particular requisites of high value video artworks in museums mean that many of the solutions used in other fields must be adapted before they can be used in an art museum context. A museum's collection may be composed of less than a few hundred video artworks, but the value of each of these artworks can be very high. A broadcaster may have millions of hours of video, necessitating the creation of compressed files to reduce the amount of storage needed, while a museum may only have a few hundred hours of video, and will strive to preserve it at the highest quality, retaining original image quality and keeping the option to produce new, high quality formats.

It was against this background of rapid change that the Matters in Media Art project team agreed that it was important to create a snapshot of what those engaged with the preservation of video art were doing to preserve their video files. A survey was considered to be a good option for understanding the main problems institutions are facing and how they are solving them. The survey has helped identify common procedures and specific needs for training and tools.

Twelve cultural institutions with recognized experience in the conservation of video were contacted and staff members actively involved in the preservation of video and media collections were interviewed. All the institutions are involved in caring for video collections and all but one are actively involved in collecting video. Of the twelve institutions contacted, the Imperial War Museum (IWM), in London was the only institution chosen which did not have a focus on video artworks. It was chosen as a means of indicating whether there was a significant divergence in emerging practices and challenges faced by those working with video art collections and those working with other types of video collections.

In addition to the IWM, fine art museums, video art distributors, video transfer labs within larger institutions, and one private company that transfers video but also advises various museums on preservation, were contacted. The full list of interviewees can be found in the acknowledgements section. The interviews took place between March and April 2012. The information from the interviews was summarized in categories according to the questions asked with context or illuminating comments added. Video art and related media was the main focus of the discussions with the collecting institutions, with the exception of the IWM, where the bulk of the collection is documentary moving image and not just video. While preparing the survey, the team was aware that the IWM had experience in developing a digital preservation strategy.

The sizes of the video collection ranged between 300 and over 10,000 titles. The numbers varied depending on whether the institution was a fine art museum, a producer or distributor, or a documentary collection. Art museum collections ranged between 100 and 500 titles; the Museum of Modern Art (MoMA) was the outlier, with over 3000 titles. Distributors do not necessarily have ownership of the works they distribute, but still care for between 3,500 and 10,000 titles in total. Finally, the documentary collections, the IWM, and the Getty Research Institute (GRI), care for up to 50,000 titles.

Not all institutions were sure about the amount of data in their care. This was mostly due to the fact that often there were various copies of the same files, and also that these were kept in different storage media. The rough estimates are illustrated in Table 1 and 2.

It was clear from the interviews that most institutions were already developing new methods and procedures, and had started to address parts of the challenge presented by the move to file based formats. However, comprehensive preservation workflows have been slow to emerge. While it is always the case that the specific institutional context will determine many of the details, there were a number of shared challenges including the difficulty in sharing metadata over new and old platforms, the investment of time needed to establish new workflows, and the lack of easily accessible tools.

I have addressed the changing situation by adding current information and new tools and references where relevant, but, as was identified in the survey, the only way to stay up-to-date is by continuously talking to other experts and practitioners not only in the field of video conservation, but also in related fields.

CHALLENGES IDENTIFIED

The challenges identified were similar throughout the institutions and independent of the level of development of their preservation programs. Establishing or improv-

Storage space in terabytes (TB)	Number of Institutions
0-10TB	2
11-50TB	4
51-100TB	2
>100TB	1

Table 1.

Storage device	Number of Institutions
Institutional server	6
Hard-drives	4
Data tape (total of LTO (Linear Tape-Open) and DLT (Digital Linear Tape))	7
LTO (LTO-4 and unspecified generation)	6
LTO-4	3
DLT	1

Table 2.

ing digital preservation workflows was one of the main needs identified by respondents. Even institutions that already run automated digital asset management systems, like the IWM and GRI, felt that workflows needed to be improved.

An important finding was the level of agreement regarding the lack of a standard file format for preservation, with institutions agreeing that the formats they are currently using are not ideal, because they are proprietary and dependent on the production industry. This makes the need to monitor the developments in the industry critical. Metadata was explicitly named by six of the institutions as something needing development, particularly in terms of automation of extraction, but also in how the information is transferred between different modules of the preservation workflow. An example is the automatic extraction of technical metadata and its importation into a database. Another key point raised in relation to metadata was the lack of an agreed standard for technical metadata for video.

Respondents highlighted the lack of suitable tools for analyzing the integrity of video files, but also the need for better ways to carry out quality control for video files, in particular high definition (HD) video. They also identified the need to learn from different fields and work with different departments within the institutions, in particular working with internal information systems or technology departments. In the majority of interviews, respondents reported a need to know more about information technology and also digital preservation.

Each of these six key points will be developed in the following sections of this paper:

1. Systems and workflows
2. Archival storage and ingest
3. Media and standard file formats for preservation
4. Metadata
5. Quality assessment
6. Knowledge, skills, and tools

SYSTEMS AND WORKFLOWS

The institutions contacted have different collections and structures in terms of departmental organization and team members. However, they share a number of key functions performed as part of the mission to preserve their collections. These functions can be closely mapped to what is defined by the Open Archival Information System (OAIS) reference model as the set of functions that an archival information system must perform: ingest, archival storage, data management, preservation planning, access, and administration.

Therefore, although in the interviews many institutions did not identify themselves as digital repositories, they are effectively performing this role. It is important to bear in mind that the OAIS model does not necessarily refer to an automated digital repository, nor must the information or metadata be in a digital format.

Different processes that form elements of the workflow associated with the long term preservation of video artworks are run in different parts of the institution, and newly added components such as a new storage system, are required to integrate with other systems already in place, like a central collection management system. The main issues appear in the interfaces between those different systems and particularly in sharing information between them. Depending on an institution's organization, different departments or experts will be responsible for different parts of the OAIS processes.

All the institutions were aware of the need to adapt their preservation plans for digital files, and most institutions were (and still are) actively developing their systems and workflows. Even the larger institutions, like the IWM and the GRI, who have systems already in place, felt that a lot of development still needed to happen.

ARCHIVAL STORAGE AND INGEST PROCESSES

As expected respondents reported a rapid increase in the number and size of digital files, and discussed the chal-

lenges associated with the need to locate, manage, and store these files appropriately. This was also reflected in the need identified by those interviewed for more specialized IT knowledge. In Tate's case, time-based media conservation had begun a much closer collaboration with the IT department. For smaller institutions, one highly specialized member of staff was engaged or an outside specialist was contracted to deal with the IT specific tasks associated with the bit preservation of digital files. In all cases there was a clear distinction between those maintaining the IT infrastructure—servers, back-ups, and networks—and those people managing the data. People felt the need for specialists to ensure the IT infrastructure was adequate, but felt strongly about keeping control of the data and of how the data is organized and migrated. The line may also be drawn between bit preservation and long-term access and use.

A significant increase in in-house expertise around video technologies was reported, particularly in the museums. Museums are now hiring time-based media conservation experts. These experts are checking and migrating video in-house, activities that were traditionally done using external video facilities. Tate, MoMA, and the Solomon R. Guggenheim Museum now have in-house video suites. This is in part due to the decrease in cost of the video systems. For example, it is now possible to buy used professional Digital Betacam video decks for less than £5,000 (\$8,500 USD), which would cost over £30,000 (\$50,000 USD) if bought new. This means that it becomes more cost effective to have this equipment in-house, rather than using an external facility.

THE MEDIA

The hardware and software required for video editing have become simpler to use and more affordable. While in the past, producing video required the access to production houses with professional quality equipment and qualified video engineers, the advent of Apple Final Cut Pro and faster laptops means anyone can create their own videos at home. Furthermore, collections are

actively acquiring works from young and emerging artists, meaning that works may have been produced on extremely low budgets. This influences the type of video materials being supplied to museums.

The cameras and editing systems used in file-based production allow for a greater variety of file formats, and so, instead of the three common tape formats—Betacam SP, Digital Betacam, and DV or DVCAM— institutions now receive files using various combinations of containers and codecs (see Table 3).

On the other hand, there is a shift away from making a distinction between formats used as archival masters and those used for display. Artists are increasingly specifying that the high quality necessary for archiving also be achieved for the playback in the galleries. This has been made possible by recent developments in computer technology, enabling large uncompressed video files to be streamed.

FILE FORMAT PRESERVATION STANDARDS

Currently there is a lack of consensus regarding a file format for long-term preservation of high value video. The formats being used in 2012 were: Quicktime 10-bit uncompressed (four institutions), SAMMA MXF, JPEG2000 (two institutions) and AVI with uncompressed video (V210) (one institution). The other four institutions had no specific format for the preservation of video as files, either for standard definition or high definition.

Decisions about a suitable archival format were based on the file format being sustainable, mostly in terms of its adoption, disclosure, and transparency as defined by the Library of Congress (www.digitalpreservation.gov/formats/sustain/sustain.shtml).

There is a preference for uncompressed and widely supported formats with good documentation, such as Quicktime. The main drawback of Quicktime and the uncompressed codecs associated (Blackmagic uncom-

Wrapper and codec (compression)	Number of institutions who referred them
Quicktime, DV	5
Quicktime, H.264 (as display format)	5
Quicktime, 10-bit uncompressed	4
Quicktime, Pro Res	4
MPEG-2 (as display format)	3
MXF, JPEG2000	2
MPEG-4 (as display format)	2
Flash	2
REDCODE RAW	1
AVI, V210	1
2K	1
DPX	1
Amateur	1
AVC Intra 100	1
Quicktime, Pro Res HQ422 (HD)	1
Quicktime, TIF files	1

Table 3.

pressed, for example) is the fact they are proprietary (JISC 2014), but given their wide user base, documentation and support in various platforms it becomes an acceptable risk.

However, all institutions noted that they were not happy with the formats they currently use; expressing the view that these were only temporary choices and that alternatives were badly needed. This situation has not changed since the survey was conducted.

In 2014 there is a growing interest in the use of open source formats, such as FFV1 within Matroska containers. This format is currently part of the Preforma project (<http://www.preforma-project.eu>) and is also linked to tools supporting the long-term preservation of video. For example, Archivematica, an open source tool for producing Archival Information Packages draws on the FFMPEG tool set and supports FFV1 as a normalization codec for archival video. The Austrian Mediathek has also been using FFV1 in an AVI container within their DVA Profession digitization tool, which they started developing in 2009.

Ten institutions mentioned the need to understand the production process to define what files they want to receive for preservation. Five institutions mentioned they prefer to transcode any files themselves, so as to control the quality of the transcoding. The requirements for production diverge from the requirements for archiving and it was widely recognized that there is often a need to support non-expert artists (or producers in the case of the IWM) to ensure the best possible masters could be supplied to a collecting institution.

The following quotes highlight a number of important points related to video preservation practice:

Normally we will ask for the original master or a clone of the original (if something is made on Apple Pro Res that is what we want). We feel we ought to be more com-

petent at choosing the archival format than any donor. (Walsh 2014)

We sometimes need to reformat, for instance when codecs and containers are proprietary. As an example, an artist couple gave me an MTS file (MTS is a Sony format for consumer cameras, similar to a Handycam Digital8. It is a highly proprietary format that in 2012 needed the particular Sony software to open the file- that has since changed). I suggested that they save this file in a different file format, as this would be less harmful in the long-term. Many artists use video for documentation purposes and are not video artists as such; the mentioned artists just bought a camera, recorded and then needed to install the software that came with the camera. (Jarczyk 2014)

Transparency of the production process, documentation, openness of the codec and wrapper and archival best practices drive our acquisition policy. Whatever the artist considers the master should persist and we want to change nothing about the original file. Of course, sometimes we need to make changes such as when obsolescence requires us to transcode the file so that it will persist, but we still maintain the original. (Oleksik 2014)

These quotes address the importance of understanding and recording the production history of video artwork, specifically the master as supplied by the artist, which is widely viewed as significant in understanding the history of a work. It is also important for making key decisions regarding the choice of normalized formats and identifying any artifacts that might be visible in the video material. Creating a normalized format alongside the format supplied by the artist is not uncommon, but identifying a good option that supports all the characteristics of the original files, like color space or chroma subsampling can be challenging.

It is important to retain the files supplied by an artist or their representative in their original format, even if there is a policy to also produce a normalized version for preservation purposes. This is because it allows the possibility

of returning to the original files if any problems are detected in the normalized files at a later date, and it may also help to identify different versions of the same work.

METADATA

Metadata is one of the key issues for collection management and digital preservation. Metadata is essential to accomplish the basic functions of a repository, find the files needed, manage their storage, and plan for migration. There have been many developments in this field, mostly coming from the archive world, and three main standards are widely used by the archives community: Dublin Core, Preservation Metadata Implementation Strategies (PREMIS), and Metadata Encoding and Transmitting Standard (METS). These refer to descriptive, administrative, structural, and preservation metadata and METS refers specifically to the encoding of that metadata. For many types of digital files there are also standards for the technical metadata, but when asked in the interviews whether they had adopted a standard for the technical metadata of video files, none of the interviewees was doing so. Seven of the interviewees referred to using tools like Videospec, Mediainfo, or the media info tool in Streamclip to extract the metadata available within the files (see references for links to the tools).

At about the same time as the survey was taking place, one set of recommendations was published by the project Digitizing Contemporary Art (DCA), which expands the recommendations set forth in the Metadata Standards Framework from the National Library of New Zealand (2002). The DCA seems to be the first to attempt listing technical metadata required in the context of video art and digital preservation (Henriksen 2012).

Since 2011, when the second version of the Public Broadcasting Metadata Dictionary (PBCore) was released, the interest around this technical metadata schema has been growing. For example, compliancy with PBCore is mandatory for records in the American Archive (Rubin 2011). More problematic than extracting

the technical metadata is to input it to collection management systems, a laborious manual process for all but two of the institutions. Given the number of files being created and copied it very quickly becomes impractical to manually input all the information recommended for the digital preservation of all the files. This is a core issue for all institutions, and a priority problem to be resolved, particularly in connection to developing a digital repository that takes advantage of greater automation. The solution will depend on the institutions' pre-existing systems, and so it is likely that it will always have to be tailored to each individual institution.

Related to this is the question of how to ensure centralized access to metadata, with information coming from different parts of a workflow, be it from processes associated with ingest, or descriptive and tracking information from the collection management system or other databases. Even once metadata is entered into a database, it is still not easy to share it across different pre-existing components of the repositories.

KNOWLEDGE, SKILLS, AND TOOLS

A useful outcome of the survey was the identification of areas of knowledge interviewees felt they needed to deepen and skills they were lacking. The main knowledge gaps identified by most respondents related to the evolution of digital video technology, digital formats, digital preservation, and the digital systems that support all these strands. The particular areas referred to were:

- Migration and workflows
- Digital preservation
- Codecs, compression, and exhibition formats
- High Definition Video
- MXF
- Cloud storage
- Open source options
- Programming
- Conservation
- Copyright

This list reflects the work being done to establish new preservation workflows, the evolution in file formats, and changes in the production standards.

The interviewees were also asked to identify tools that they would like to have or see developed. Most tools were related to managing digital repositories, with requests for automated digital repositories, tools to handle metadata, automatic file quality control, and better tools to manage workflows. One point made by one respondent was that being able to find appropriate tools is as important as developing new tools. Institutions like the Library of Congress, projects like PrestoCentre or private companies like AVPreserve developed or are developing tools that are very useful, but it can be daunting to find, test, and implement all the different tools needed. Knowing who is using which tools and how they are being used would make the task easier. The creation of the centralized registry for preservation tools, Community Owned Digital Preservation Tool Registry (COPTR) is addressing this issue. The registry is the result of the collaboration between the Digital Curation Centre, Digital Curation Exchange, National Digital Stewardship Alliance, Open Planets Foundation and the Preserving Digital Objects with Restricted Resources project.

A good example of an institution's strategy for keeping abreast of the technology evolutions is described in the following quote:

What we also do is to keep a permanent tech watch, so we see what new technologies appear. Every 5 years we make a serious survey and re-assess if there is something new that could help us in preservation but also for display and online presentation. We would for instance check what are the standards at museums, research institutes, EAI or ZKM. (Wijers 2012)

In this quote, Gaby Wijers points to the importance of keeping up to date with developments, and reflects on the need to do a thorough re-assessment, with the input from other institutions in the field. Changing the work environments for preservation can mean just adding a new tool to a workflow, but in the move from tape to file the disruption has been far more significant and has meant creating a whole new set of workflows. Given the specificities of the community and its small size, it is often easiest to contact people or institutions, which are at the forefront of testing new tools and systems. This issue was addressed by the project Presto4U, which worked with different communities of practice, for instance Fine Art Museums or Film Archives, to share the knowledge and experience in preserving video within those specific communities. The project finished in December 2014, but the information about the communities of practice was still available on their website in June 2015.

CONCLUSION

The preservation of digital video is a rapidly evolving field. There is no single source of information and those who are developing preservation plans need to look into current practice from the broader digital preservation community, video production, quality assessment, and developments in IT infrastructure and bit preservation in order to find suitable tools and strategies. Matching tools to needs involves producing a clear idea of the requirements for the preservation of digital video within a specific organizational context. This requires significant effort and time, which smaller institutions may struggle to find.

The staff involved in preservation is aware of the shortcomings of their current strategies and workflows and are actively working on making improvements; this is something that is best supported by establishing simple ways of sharing information and experiences through initiatives such as the Presto4U project. However there is also room for targeted training for this community in the development of workflows and the use of existing tools,

as the Open Planets Foundation is already doing for digital preservation in Archives and Libraries.

The question of a standard video format for preservation was the most requested area of development asked for from the respondents. FFV1 may be promising, however, wide adoption will be important to ensure that it continues to be supported, and this is difficult to predict. Hence rather than wait for consensus around a format for video preservation, which may in itself be unachievable, spreading the risk over at least two different formats and keeping a watch on the obsolescence risks for the formats in use may in fact be the most appropriate strategy. The issues with metadata standards sound easier to solve by combining different standards like Dublin Core and PREMIS which are already widely adopted in the digital preservation community.

It is encouraging to see the steady increase over the past ten years in the number of permanent staff dedicated to video or time-based media conservation. This indicates that collections are growing and that institutions are recognizing the need for specific knowledge and skills. There is also an increasing recognition of the importance of complementing this specific knowledge and skills with those of different fields, both from the digital preservation, video production, and IT communities.

This survey has provided a snapshot of the situation in 2012 as institutions address the challenge of moving from videotape to file-based production, delivery, and preservation of video artworks. In an area of rapid change it remains a dynamic and significant area of activity within the wider arena of digital preservation.

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