**From Preservation Guide**

# Main: PreservationStrategy

## 4. Make a Preservation Strategy

| Develop a Strategy | |
|---|---|
| **Collection Strategy** | **Preservation Strategy** |
| • **Long-term purpose**<br>• **Access**<br>• **Required changes**<br>• **What preservation contributes** | • **Selection**<br>• **Conservation**<br>• **Restoration**<br>• **Digitisation**<br>• **Documentation** |

**4.1 Selection: which material goes first?** There is a lot of information about selection. Most managed collections already have considerable experience of selection, including:

- Selection of the material coming into the collection
- Review of material at regular intervals, to decide about further retention

For a preservation process, the issue of selection begins with setting priorities. Generally there are the following major factors to consider:

- Value of the material
- Obsolescence of the format
- Condition and life expectancy

Fortunately, you've already made a map of the collection – so these factors have already been assessed, and the collection has been divided into broad categories. The work that remains is to make another sort of map: a preservation plan covering the entire time necessary to deal with all your preservation needs. This can range from a 6-month plan to transfer a small amount of material from an old to a new format, to a 400-year plan for the storage, restoration and re-mastering (onto film) of an entire film collection **[1]**.

A preservation strategy is not a full preservation plan. For the strategy, the issue is sequence and timescale. All the elements in the preservation map that need attention are put in a priority sequence – and time information is added according to how long you want the work to last, or how long the funding lasts, or how long the material itself will last.

As a brief example, here's a possible strategy for the B&W plus Ektachrome film collection introduced in the section on **Getting Started: Cartography** GettingStarted

**Preservation Strategy: BBC film**

| Type of material | Condition | Action needed | Timescale | In-house or contracted? |
|---|---|---|---|---|
| 16m mag sound track - masters | vinegar syndrome! | digitisation to file formats; destruction of originals | 2 years starting immediately | Contracted; checking in-house |
| 16m mag sound track - duplicates | vinegar syndrome! | destruction (after respective masters are transferred and checked) | 2 years starting immediately | In house |
| 16mm Ektachrome | some colour fade | Access copies made on digibeta and DVD | Starting when budget allows: in 2 years | Preparation and checking in-house; telecine contracted out |
| 16mm B&W film negatives | good | Maintain in appropriate storage conditions; review condition at intervals | Review plan and condition every five years | Review is done in-house |
| 16mm B&W | fair: have | Maintain in appropriate | Keep until | |

| | | | | |
|---|---|---|---|---|
| film prints | been circulated | storage conditions | preservation actions taken on negatives | Storage is in-house |

As another example, used with permission from the audiovisual collection of the library of the University of Maryland -- here is their preservation strategy table from 2002:
**http://lib.umd.edu/TSD/PRES/priorav02.html**

**Audiovisual Preservation Priorities FY 2002**

| Unit | Collection | Quantity | Action | Score |
|---|---|---|---|---|
| Broadcasting Archives | Men of Crisis | 1 | Conservation | 11 |
| Performing Arts Library | IPAM audio collection | 1000 discs and tapes | Conserve, duplicate | 11 |
| Archives | LAB Vox Pop Collection | 400 audio discs | Conserve, duplicate | 11 |
| Archives | AIAW & UBC | 350 items | Conserve, duplicate | 10.5 |
| Broadcasting Archives | Arthur Godfrey Audio Collection | 5,000 items | Conserve, duplicate | 10.5 |
| Archives | Arthur Godfrey Film & Video Collection | 300 items | Conserve, duplicate | 10.5 |
| Nonprint Services | Critics Place Films | 454 films | Conserve, duplicate | 10.5 |
| Archives | Athletic Legacy | 3,500 items | Conserve, duplicate | 10.5 |
| Broadcasting Archives | WETA Videotape Collection | 1,000 items | Conserve, duplicate | 10 |
| Nonprint Services | Beta recorders and players | 2 pieces of equipment | Purchase | Unranked |
| Archives | Cold Storage | 1 or 2 rooms in Hornbake | Build | Unranked |
| Archives | Preservation facility/lab for AV preservation & duplication | 1 space in Hornbake | Build | Unranked |

**references on selection: INA, B&G**?

Top **4.2 Conservation: how to keep what you have**

Conservation was defined in Section 1.3, and is a vital part of all preservation strategies. Even if the next step in a preservation plan is a transfer to new media, there has to be something left – ideally in pristine condition – to be transferred. Digitisation and transfer processes actual occupy a tiny proportion of the lifetime of an object. For the majority of the time, the main issue is conservation.

There are four main factors in a programme of conservation:

**1. Handling, packaging and shelving** This area is about the immediate environment of a physical item: what encloses it, what it sits on and how – and how humans manipulate it.

- **Handling:** items should have protective packaging, and the item should be kept inside the packaging except when actually being used (played). Only trained staff should handle material when it is out of the packaging. Obviously, materials out of the archive should never be left exposed to the sun or chemical pollution, or to physical damage. This is easier said than done, which is why master copies

should never leave the controlled area. There are detailed guides to the handling of wax cylinders, disc recordings (shellac and vinyl), open reel materials, audio and video cassettes – and of course film.

- **Packaging:** Every item should be in a package, for prevention of physical damage and for environmental protection (from water damage and dust, and possibly also for humidity control. There are rather exotic techniques for putting material into sealed bags in a dry environment – to provide a low-humidity microenvironment. Such measures are not universally accepted (a sealed bag may accelerate vinegar syndrome, for instance). There are also standards for packaging, and so proper, approved packaging should be used – for ALL items in the collection. Packaging should be replaced when damaged (or when it goes rusty, as in film cans). The newer film storage packaging is plastic and cannot rust.
- **Shelving:** Shelving doesn't have to be expensive and fancy, but it does have to of the right size for the material, and there needs to be enough of it! One of the major problems with shelving is when too much material is packed too tightly, and so items are damaged when pulled out or wedged in. Material should also be placed properly on the shelves. Usually this means upright, not flat – except for film – and oriented so that the packaging will not admit water coming from above (the usual direction to worry about, because if water comes from below that means the whole building is flooded and it doesn't matter which way up the cases are stacked).

**2. Environmental conditions** – and again there are three main factors

- **Temperature control:** In general, audiotape and videotape should be stored below 20° C, and the humidity should not exceed 40% relative humidity; detailed recommendations and standards on environmental conditions are in the **Where to get more information on conservation section**, just below.

Film has more specialised requirements:

- Nitrate film is flammable, and subject to special rules. Most countries have fire safety laws governing the handling and storage of nitrate film.
- Film that is susceptible to colour fade needs to be kept at a very low temperature, around 0° C.
- Film that is beginning to show vinegar syndrome needs to be kept away from other materials, as the acetic acid will damage everything in the collection if not stopped. It also needs storage a very low temperature, around 0° C, to slow down the chemical change until some remedial action can be taken (like making new masters, or digitising at very high quality).

- **Humidity control:** Dry is better than wet, as long as it isn't too dry. The recommendations suggest 30 to 40% relative humidity, for materials being stored at temperatures between roughly 10 and 20° C. At very low temperatures humidity is less an issue, and it is very difficult to maintain 40% relative humidity as temperature goes down toward zero, because the air's ability to hold water goes down as temperature goes down. So: as the temperature goes down, relative humidity goes up. This is why we get dew in the cool morning. What nobody should get, if at all possible, is dew in the archive! If material is kept cold, then some care must be taken when material goes into or out of 'cold storage', to minimise thermal stress and also to prevent formation of dew inside the packaging.
- **Stability** of the environmental controls. Temperature and humidity are important, but a stable environment is equally important. When temperature changes, materials expand or shrink. Thick films of acetate, wound hundreds of layers deep on a reel or cassette, can generate immense pressures which can distort and permanently damage the materials. The international standards for temperature and pressure also include standards for stability.

Stability has two components: the sophistication of the environmental controls (the cooling and drying equipment) – and the time constant for change of the storage area. A big area, well insulated and with a lot of material in it will change temperature slowly, and so be easier to stabilise. A small room or a nearly empty room – with thin walls -- will heat up quickly once the air conditioning fails. It may be far more cost effective to improve insulation than to invest in sophisticated controls for the chiller and dehumidifier.

**3. Protecting the masters** – the basic idea for protecting masters is to minimise their use. Ideally, once in a great while, like 20 years, a master will be taken from storage and used to make a new sub-master. That doesn't mean that masters should be ignored for 20 years – condition checking should be done every year, but on a sampling basis.

Audio and videotape collections have an advantage here, as they can make new sub-masters in-house for a relatively low cost – so they have no excuses for subjecting master material to risk by using it for regular playback, or loaning it out.

A proxy is just a copy. A plan for protecting masters by the use of proxies should have several layers

- Master material, used only to make sub-masters – at very long time intervals (like 20 years)
- Sub-masters, used to make distribution or access copies.
- Distribution and access copies – the daily working copies of the collection. These are replenished as needed by making new copies from the sub-master.

A sub-master should last 20 years – meaning it has to be able to make 20-years' worth of access copies before it is worn out. If the collection requires so many access copies that the sub-master wears out too soon, then a fourth layer could be added (something like Distribution Master) – so only distribution masters are made from sub-masters, and access copies (by now fourth generation) are made from the distribution master.

Many archives cheat – and once they have an access copy, they make another copy of that when it starts to wear out. This is clearly unsatisfactory, as the quality will go down and down and bring the collection into disrepute. Other archives regularly use master material for ordinary access. This practice should be avoided. It amounts to throwing the archive out the window – piece by piece. It is an unfortunate fact of life for analogue media that every use of an item causes at least a small degradation – and every use has a risk of very large degradation and damage. The digital world has solutions to this problem, but in the analogue world **the master copy should be protected as the absolute priority of the collection**.

**4. Condition monitoring** – Life-expectancy can be predicted, but predictions are generalities, and there is no substitute for direct examination of media. Unfortunately the only aspect of audiovisual media that is well developed for automatic monitoring is measurement of acetic acid level, for which there is a wealth of information and various forms of test materials [IPI references]. There are test strips that can be used on materials once they've been removed from their containers – and there are containers which incorporate indicators, for continuous monitoring. For large collections where use of such tests and containers would be very time consuming and expensive, it is perfectly feasible and (usually) satisfactory to use a sampling approach, and apply the test strip evaluation and the special containers to a statistically representative sample of the collection.

There has been research on other methods of condition monitoring, and PrestoSpace is active in this area. One action is the report:

**D6.1 Report on video and audio tape degradation mechanisms**
[**http://www.prestospace.org/project/public.en.html**].

> Video tapes (and to a lesser extent audio tapes) are prone to a considerable number of degradations, which have a direct impact on the playability, on the risk incurred by the playback machine, and on the urgency for transfer. The two main types of degradation are the tendency to head-clogging, and the 'sticky-shed syndrome', which tends to block the tape in the VTR. The causes of such degradation are currently unknown, even if hypothesis such as polymer hydrolysis and lubricant migration are the most advanced causes. A real study on what actually take place is required before trying to 1) detect and 2) correct the problem. This report will clearly demonstrate the different mechanisms that cause a tape to be unplayable, and propose ways for measuring the advance of these processes, and for curing these.

Additional PrestoSpace information about condition includes:

- **D6.2 Manual tape condition assessment tool**
  There is currently no way of assessing the tape condition, other than attempting to play them, with the risk of damaging the VTR. Such tools exist for film (AD Strips). This Deliverable will be a tool for assessing the tape condition in the view of assessing, before transfer, the urgency, the difficulties to be expected, and selecting the tapes to be transferred first. This tool will be either be a handheld optical or chemical measurement tool, or passive sensitive detectors such as the ones used for film, that will measure the concentration of the chemical degradation markers.

- **D6.3 Automatic tape condition measurement tool**
  In addition to the manual tape condition assessment tool, an automatic tool that can be installed in a robot, or in a cleaning machine, will measure precisely the level and type of degradation of a video or audio tape, and recommend specific process such as baking if required. This tool will measure the status of the tape using physical methods (friction, residues measurements after cleaning), and/or measuring the concentration of chemical markers.

**Where to get more information on conservation:**

**general references:**

- **http://www.clir.org/pubs/reports/pub54/** Van Bogart, Dr. John W.C. Magnetic Tape Storage and Handling: A Guide for Libraries and Archives. Washington, DC: The Commission on Preservation and Access and St. Paul, MN: National Media Laboratory, 1995.
- **Audiovisual Archiving: Philosophy and Principles** [PDF]. Ray Edmondson ; 2004. UNESCO
- **http://unesdoc.unesco.org/images/0010/001096/109612eo.pdf** "Audiovisual Archives: A Practical Reader" [PDF] Harrison, Helen P, 1997 ; UNESCO
- **http://palimpsest.stanford.edu/** Conservation OnLine, Preservation Department of Stanford University Libraries
- **http://www.ifla.org/VII/s35/pubs/avm-guidelines04.htm** IFLA
- **http://www.archives.gov/about/regulations/part-1232.html** NARA ; 1232.22=Nitrocellulose (nitrate) film. 1232.26=Storage conditions.

**National Film and Sound Archive, Australia**

- **"Managing the Collection"**
- **"How to Care for Your Video"**
- **"How to Care for Your Audio"**

**Wikipedia: http://en.wikipedia.org/wiki/Film_preservation**

**storage, handling and environmental conditions:**

- The Care and Handling of Recorded Sound Materials Gilles St-Laurent, Music Division'National Library Of Canada January 1996 **http://palimpsest.stanford.edu/byauth/st-laurent/care.html**
- AES22-1997 (Reaffirmed 2003) AES recommended practice for audio preservation and restoration -- Storage and handling -- Storage of polyester-base magnetic tape [1997-12-11 printing]; **"AES Standards in Print"**
- **http://palimpsest.stanford.edu/bytopic/environment/** Conservation OnLine, Preservation Department of Stanford University Libraries
- **http://www.rit.edu/~661www1/sub_pages/acetguid.pdf** IPI Storage Guide for Acetate Film
- **http://www.amianet.org/resources/guides/storage_standards.pdf** AMIA Preservation Committee Storage Standards and Guidelines for Film and Videotape -- a three-page summary quoting ANSI/ISO standards

**National Fire Protection Association http://www.nfpa.org/**

- Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film (NFPA 40)
- Standard for the Fire Protection of Storage (NFPA 230)

**Society of Motion Picture and Television Engineers (SMPTE)**
**http://www.smpte.org/smpte_store/standards/**

- RP 131-2002: Storage of Motion-Picture Films
- RP 103-1982 (Reaffirmed 1987), Care and Handling of Video Magnetic Recording Tape.

**International Association of Sound and Audiovisual Archives (IASA) http://www.iasa-web.org/**

- **"Safeguarding of the Audio Heritage: Ethics, Principles and Preservation Strategy"**, IASA-TC 03, version 2, 2001.

**International Standards Organization (ISO) http://www.iso.ch/iso/en/ISOOnline.frontpage**

- ISO 18902:2001 Imaging Materials - Processed Photographic Films, Plates, and Papers - Filing Enclosures and Storage Containers
- ISO 18920:2000 Imaging Materials - Processed photographic reflection prints - Storage practices
- ISO 18923:2000 Imaging materials -- Polyester-base magnetic tape -- Storage practices

**International Federation of Film Archives (FIAF)** **http://www.fiafnet.org/uk/**

- **Technical Manual of the FIAF Preservation Commission** - a user's manual on practical film and video preservation procedures containing articles in English and French. FIAF 1993, 192p., 66.93€ or incl."Physical Characteristics of Early Films as Aid to Identification", 91.72€

Top **4.3 Restoration**

**Restoration technology centre!**

Restoration has also already been defined, in **Restoration Overview**. Because audiovisual media are so easily damaged, restoration – which is usually an attempt to undo damage – is an important process in preservation. Restoration is a bit like a car body-shop: **a place to take something that's been banged up, where they can hammer out the dents and give it a respray**. The analogy is accurate in the sense that a repaired car is never the same as an original, undamaged car – even if it looks the same.

Restoration has its successes and failures, as with car body repairs. There are defects (dents) that can be repaired, and others that can't (or not so well). Also there are differences in the technology used for restoration: some techniques work better on some defects than others, and some techniques are very specific. Therefore restoration is not a single process – you don't really send a film 'to be restored' – you send it into a complex process that will use many tools to do many things – all with varying degrees of success.

There are many tools that can be used for restoration – and terminology can be confusing. Here's a roadmap to the general types of restoration tool

**1. The basic technology of restoration:**

First of all, there are two classes of restoration technology:

- **analogue**
- **digital**

There are some processes that can still be done in the 'real world' (as contrasted with the world of ones and zeroes), and in fact done better. Most analogue media pick up dirt, and so cleaning is important both to preservation and to digitisation. Scratches on the surface of a film can be made nearly invisible by coating the film with liquid when making a print – or when digitising – and so this 'wet-gate' transfer process is cheap, quick and effective.

It is the whole range of specific defects (apart from surface dirt and the sort of scratch that can be dealt with by wet-gate processing) that requires digital processing. Examples are:

- **Film:**
  - line scratch removal ***
  - dust/dirt/blotch removal ***
  - dye fading ***
  - image instability

- grain ***
- missing frames ***
- noise ***
- mold

- **Video:**
  - drop-outs ***
  - noise ***
  - 2 Inch scratch
  - stabilisation
  - line jitter (partially)

- **Audio:**
  - wow & flutter removal ***
  - cross modulation in optical films (the image affects the sound) ***
  - 24/96Hz sprocket buzz removal (for film soundtrack restoration) ***
  - over-softening of noise cancelling systems
  - hiss
  - compression
  - clicks
  - crackle
  - hum

Much work has been done on these defects, and there are dozens more. These are the most common – and **PrestoSpace is developing new or improved digital tools** for most of them – all the ones marked with ***. Fuller information on the PrestoSpace project's tools for restoration is in

**How the tool is used:** In general, a person uses a restoration tool – so the tools can be divided by how much the person does, and how much the tool does.

- **manual –** This is where the person points the tool at the defect, and so this is the slowest category.
- **automatic –** A tool of this sort may need a bit of manual set-up to start, but after that it runs all by itself. These tools are wonderful, and every audiovisual archivists dream. Unfortunately there aren't many! Some tools in audio are pretty effective running on their own (de-hissing and de-clicking if the clicks are all pretty much the same) – and colour fade on long sections where the fade is uniform.
- **mixed –** But most tools need some operator intervention either to set up a section or a frame, or to check results and re-set parameters. They differ from the purely manual tool in that a mixed tool will operate on multiple instances of a defect before again needing manual intervention – whereas a truly manual tool requires the operator to identify, individually, each and every blemish.

"'Speed of operation of the tool:

- real time
- much slower than real time'"

This is an important distinction for two reasons:

- a real-time restoration tool can be integrated with other real-time processes. For digitisation, which often happens in real time (because the players usually work in real time), a real-time restoration tool can then be used without adding anything to the overall time taken by the process. A common example is real-time de-clicking or de-hissing of audio signals when digitising 78 rpm (shellac) recordings.
- time means cost. Marvellous results can be obtained with modern restoration tools, but it can mean months of work to restore an hour of film.

Top **2. History of restoration** Restoration is associated with the cinema, but in fact it is used for all audiovisual media. Cleaning has been a 'restoration process' for at least a century, and there are complex possibilities for altering an image during the photochemical processes of film developing and printing. These process have been used for decades to bring out contrast between light and dark, and to alter and enhance colours. These analogue and largely chemical processes, exclusively used for film work, can be highly

effective but are also laborious, expensive and hard to predict and control – they are an art as much as a science.

The history of controlled, repeatable and precise restoration begins with digital technology, and this is a recent field. Film and video restoration builds on tools developed over decades (since the early satellite photos of the 1960's) for image restoration -- but with a major and vital difference. Film (and video) is about motion, and adding motion detection and prediction to a sequence of images opens a new dimension to processing possibilities – totally unavailable to image restoration where there only is a single image, and no motion.

Some landmarks in digital moving image restoration **[2]**:

- Ph.D. Thesis (on digital film restoration), Anil Kokaram, (Cambridge University,1993)
- Limelight (1995) – software for moving image restoration; a research project
- Hardware (digital signal processing chip = DSP) implementation, Nanyang University, Singapore (1996)
- DRS (Digital Restoration System), by MTI (1997) **[3]** – commercial software
- Textbook: "Motion Picture Restoration", A. C. Kokaram, (1998)
- Revival Digital by Nirvana Digital (1999)
- DIAMANT system (HS-Art Digital) (2002) – commercial software
- Archangel system (Snell & Wilcox) (2003) – commercial hardware

Meanwhile, digital processing was also being applied to audio – in this case starting in the 1960's. Much of the early work was about getting speech out of noise for intelligence and forensic work (including processing the infamous "Watergate tapes" in the early 1970's). All the work on improving intelligibility failed. The signal sounded better, but speech recognition scores on controlled trials did not improve – indicating that human processing still exceeded anything the machines could do.

In the 1980's, it was realised that success could be dragged from the embers of failure – and that a 'better sound' was just what was needed for many situations, and for the recording, broadcasting and cinema industries in particular.

Early work was again at Cambridge University (1980's) under Professors Peter Rayner and Simon Godsill **[4]** – and early successes included work on recording of the British Library Sound Archive, under their sponsorship. The work was so successful that it became a commercial company which now has a range of hardware and software products and services: Cedar Audio Ltd.

**Systems for audio restoration:** This is just a short list is the major companies specialising in audio restoration.

- Cedar Audio Ltd. (1988)
- Sonic Solutions (1980's)
- Cube-Tec Audio Cube (1996) and Quadriga

### Top 3. Notable examples of film restoration

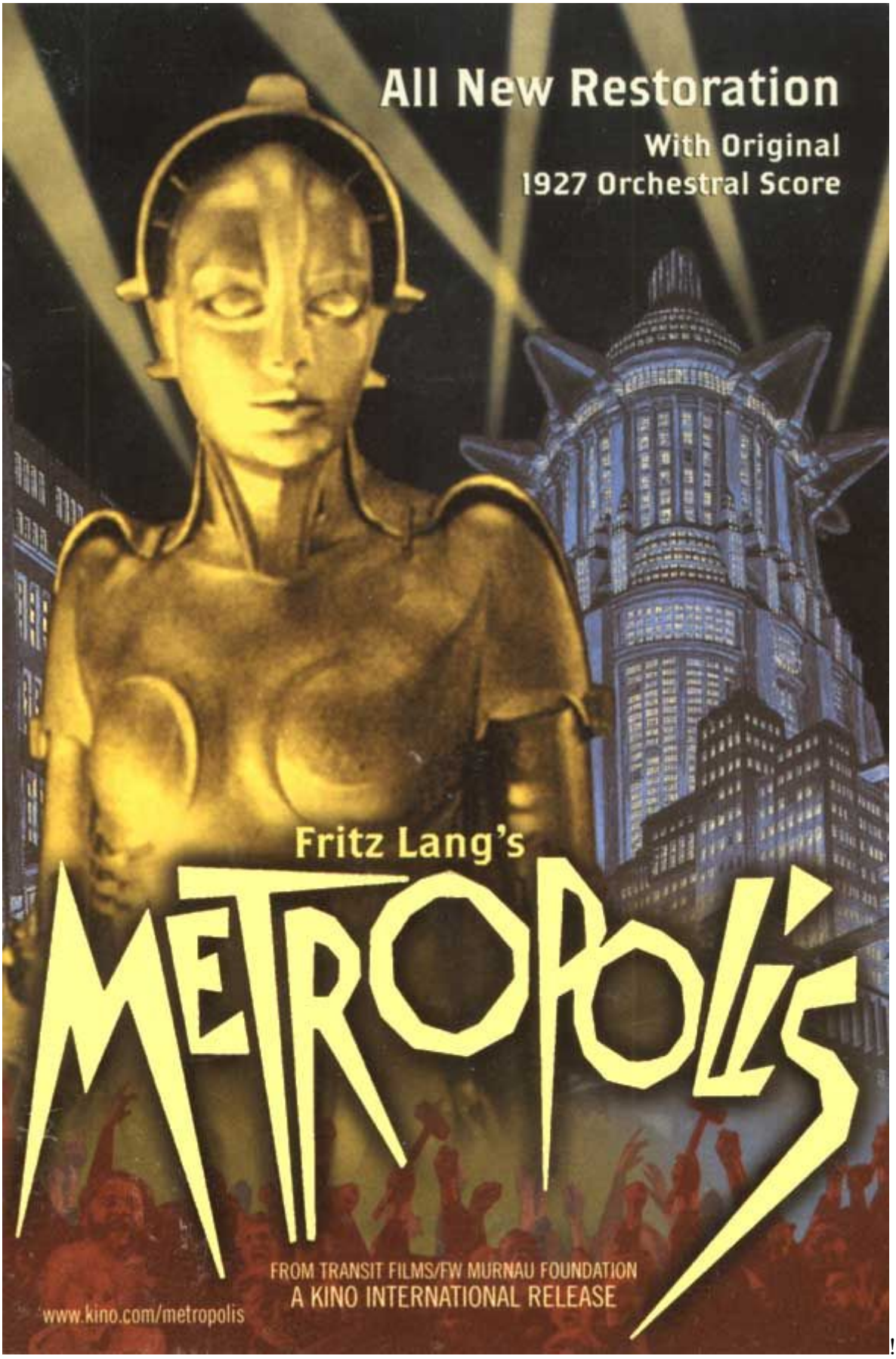
Snow White – an early all-digital restoration: **[5]** **[6]**

**Snow White and the Seven Dwarfs (1992)**

Opernball **[7]** - EC project FRAME, using Joanneum and other technologies


**Opernball (Opera Ball) (1998)**

Metropolis **[8]** - A much larger project than Opernball, which revived commercial distribution **[9]** of this classic



!|**Metropolis (2001)**

**4. How it works**

**Briefly, the existing technology for media restoration is a combination of software and hardware. The standard approach to restoration differs according to media, as follow:**

**Audio**

- Software based
- much of the software runs in realtime, at least at the professional level
- software uses a ”plug-in” (modular) structure, so functions can be separately selected
- the operation is file to file: the software operates on an input file, and makes a new output file
- real-time hardware (eg from Cedar) for de=hissing and de-clicking also exists

**Video**

- Hardware based in the 1990's and into the following decade eg Archangel from Snell & Wilcox (now Snell)
- working in standard definition and in high definition
- running in real time
- no plug-ins; instead of modules manufacturers sell specific hardware
- SDI to SDI (real time serial digital signal at input and output); SDI will directly connect to digital video tape recorders and other broadcast equipment
- software also exists in many forms: as specific applications and as plug-ins to standard video editors. Software had by 2010 completely replaced hardware for image, video and film restoration

**Film**

- Software based
- working is standard definition and in high definition, but going beyond that to 2k, 3k and higher numbers of lines per frame
- non-real time
- modular plug-ins
- file to file operation, as with audio
- the file format(s) for digital video are not standardised (yet)

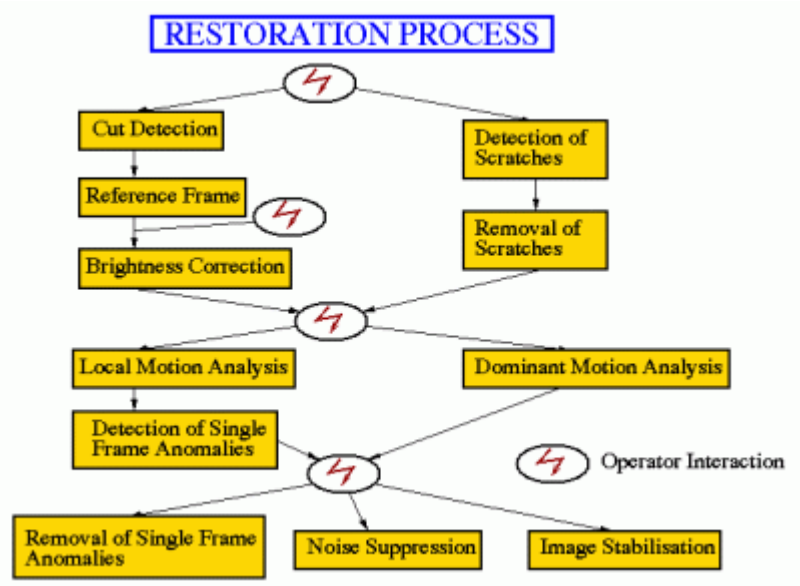



**Fig 8 - a typical sequence of operations in film restoration**

## 5. Costs

The good news is that restoration software has come down in price, although as institutions become seriously involved they tend to want more computing power behind the software. Hardware reduces in price also, but again that reduction just feeds a desire to increase capacity and throughput. The following is the author’s ‘rough guide’ to costs of restoration:

- entry level: now under 10k € (for the software; find your own hardware)
- **professional:** 10k to 100k € for software and hardware to support a small team engaged in restoration
- **high-end:** 100k to 1 M € -- for the sort or restoration facility that could compete globally for commercial restoration work

In general, restoration hardware is about 10 times the price of software – and runs 10 to 100 times as fast. One of the most significant developments regarding software is that the ten-fold reduction in cost (compared to hardware) allows many more collections and other interested parties to begin to do restoration work. As computer costs drop, the software approach will become increasingly powerful and fast. It is hard to see how a special purpose restoration hardware will remain competitive, except for niche applications that absolutely demand real-time processing.

The above prices are the cost of the kit. What about the cost of the work itself? Because the work is labour intensive, the cost of the restoration is dominated by the labour cost. In a research environment, with graduate student labour, restoration costs translate into the salary of the student – and a student can do about one restoration project (feature-length film) per year!

There are rumours that the Disney restoration of Snow White cost around $1.5 million in 1992 **[10]**. A major restoration for film involves many physical elements (bits and pieces of extant negative and prints, to get the best originals for each frame), various analogue and chemical processes (cleaning, scanning, printing), all the digital work – and then restoring (for a sound film) or re-making (for a silent film) the sound track. The conclusion is that feature film restoration is a major enterprise – though it should be remembered that the individual graduate student, researcher or dedicated archivist can use entry-level software on a reasonable sized personal computer and do significant work.

Finally, just because restoration is labour intensive, commercial work has been globalised – and companies in Hollywood are sending hard drives of digitised film (and soon will be using very high speed network connections) to India, where labour costs per month are roughly equal to cost per hour for film restoration in major commercial facilities in London **[11]**.

### 6. How restoration fits into a preservation strategy

We have used the CCAAA definition of preservation – **permanent accessibility**. Restoration is very much about accessibility in the wide sense: access to what the people who created the film or video or sound recording made at that time. So restoration is about getting back to the original – removing the affects of time and handling. Therefore whenever an audiovisual item has become **noticeably impaired**, there is a role for restoration.

Ideally, restoration would be applied in every case of impairment, at the time that an item was being replayed – for transfer to new media or just for checking. Unfortunately the ideal is unaffordable, so the usual route is to perform ‘restoration on demand’ – at the time that an item from a collection is taken out (rather than when a new copy is created).

One important element of the PrestoSpace project is to link digitisation with restoration. At the time that an audiovisual item is being digitised, information should be gathered about whatever defects can be detected. This information forms part of **preservation technical metadata**. The result of this approach is two benefits:

- when a digitised item is accessed, there will be a report describing its technical condition. The user or collection manager will know, from the metadata, the amount of impairment and damage that has been found on the item – and hence its suitability for various forms of re-use.
- when restoration work is done, there is already a map (yes, another map) of just where the damage is, and what it is. The automatic identification of defects during digitisation eliminates the need to do all that work during restoration.

PrestoSpace has defined the measurements that are important for restoration, and can be efficiently created during digitisation. These are documented in **D8.3 "Audiovisual Defect & Quality Description Schemes and Descriptors"** . An important part of the definition of a PrestoSpace preservation factory is an approach to digitisation that will be capable of producing restoration metadata.

**More information on restoration:**

- Systematic list of problems: **http://brava.ina.fr/brava_public_impairments_list.en.html**
- Images, examples: **http://ourworld.compuserve.com/homepages/PeterFinklestone/2inchQuad.htm**

- Prices for audio restoration: **http://www.denoise.com/restarch_restoration.cfm**

### Top 4.4 Digitisation

Digitisation is so important that it causes a problem – it overshadows other vital preservation requirements. Conservation and documentation are equally vital, but easier to overlook. Restoration is the magic wand that relies on digitisation, but involves far more complex (and expensive) processes.

For a preservation plan, there are two major uses of digitisation:
- production of new (digital) masters
- production of digital access copies

For audio and video, moving from analogue to digital masters is a significant step, which in the long run should make maintenance cheaper and easier – because it's easier to copy files than to copy physical media.

- **1. Why digitise?** The time, effort and cost involved in digitising an audio visual archive is a major investment. It's quite reasonable to ask for strong and compelling reasons to undertake this transformation. PrestoSpace have an **online tutorial Why Digitise** exploring the reasons for making this move from discrete and/or analogue storage, into a digital mass storage system. The tutorial breaks the reasons down into those sections which PrestoSpace addressing:
- Preservation
- Restoration
- Metadata Access and Delivery
- Storage and Archive Management.

- **2. How?** There are now many sources of information on the process of digitisation, though this is a skilled technical process and one of the best options is to use a professional service provider. An excellent overview of both audio digitisation and the whole issue of mass storage has been provided by IASA in their publication IASA TC-04: Guidelines on the Production and Preservation of Digital Objects **[12]**.

Technical professionals – in archives and other collections or in the services industry – can get advanced digitisation technology from PrestoSpace, as described in Section **6.1**[?] (PRE deliverables).

For anyone planning their own digitisation work, it is impossible to overestimate the importance of technical standards and quality. Digitisation will only happen once, and any loss of quality is permanent.

Beyond PrestoSpace, other online sources of information about digitisation are:
- **US Library of Congress** Digital Audio-Visual Preservation Prototyping Projects **http://www.loc.gov/rr/mopic/avprot/avprhome.html**
- **TAPE** Training for Audiovisual Preservation in Europe **http://www.tape-online.net/**
- **Moving Image Collections (MIC)** Preservation Portal **http://mic.imtc.gatech.edu/preservationists_portal/presv_index.htm**
- **Conservation OnLine:** video preservation: **http://palimpsest.stanford.edu/bytopic/video/**
- **Conservation OnLine:** audio preservation: **http://palimpsest.stanford.edu/bytopic/audio/**
- **Conservation OnLine:** film preservation: **http://palimpsest.stanford.edu/bytopic/motion-pictures/**
- **National Film and Sound Archive** (Australia): **http://www.screensound.gov.au/Screensound/Screenso.nsf/HeadingPagesDisplay/Preservation?OpenDocument**
- **IMAP online preservation resource guide**: **http://www.eai.org/resourceguide/preservation.html**

- **3. Digital media and storage** After digitisation, there are lots of ones and zeroes sitting somewhere? How they are stored, and the implications for access and maintenance, are the subject of much further PrestoSpace information, introduced by another online tutorial: **Selecting Your Storage Solution**.

- **4. Access** There can be many version of an item in an audiovisual collections, and in a digital world this situation becomes more rather than less complex. The overall preservation strategy should include specification of what master quality is kept, and what access formats (probably at lower quality) are derived.

Very roughly, there are three significant qualities (encodings) to be distinguished:

- **best:** master: digitised at a level sufficient to capture the content of an analogue original.
- **good:** online viewing / listening: master quality implies large files which may be slow to move around, so for general in-house access it may be effective to have a viewing quality
- **web:** poor quality, but adequate for web access. Web quality is generally considered poor when compared to proper masters, though with modern encoding and broadband connections, VHS quality is available from the web for streaming (immediate access), and DVD quality is available (if you can wait) for downloads (file transfer from website to local computer).

The following table gives datarates and quality levels for common digital video files and digital videotape. Rec 601 is the engineering standard for full-quality (no data reduction) standard definition digital video **[13]** (**Digital Video – 25th Anniversary**; three articles on "Rec 601" in the EBU Technical review of October 2005).

**Data Rates and Quality Levels for Digital Video**

| Compression Type | Datarate, Mb/s | Quality | Comment |
|---|---|---|---|
| No compression | 270 | Master | Rec 601, standard def TV |
| Lossless JPEG2000 | Approx 90 | Master | Rec 601, standard def TV |
| MPEG-1 | 1.2 | VHS | Wide internet use |
| MPEG-2 | 5 | DVD | Used on DVD and digital TV broadcasting (DVB) |
| MPEG-4 | 0.5 | VHS | Will replace earlier MPEGs |
| MPEG-4 AVC | 8 | HDTV | Will be used on HD DVDs, and possibly on HD TV |
| DVX | 0.5 | Near VHS | Wide internet use |
| Digibeta | 80 | Near Master | Nearly full quality |
| DV, DVCAM | 25 | "Pro-sumer" | Pictures near digibeta quality, quality suffers on repeated decode-encode |
| DVC-PRO | 50 | Near Master | Pictures near digibeta quality, quality suffers on repeated decode-encode |

Mb/s = megabits per second; typical broadband internet connections are 1 Mb/s.

PrestoSpace information on access is available from the 'Metadata, Access and Delivery' area of the project, which is discussed in section 6.6?.

Top **4.5 Documentation** An archive travels on its catalogue. Documentation enables access. Without documentation material cannot be found, and so material will not be used. Any collection that intends to be of use – to a business or to the public at large – can only achieve its potential if adequately documented. This fact has been known since the Library of Alexandria, and digitisation only emphasises that fact. With an analogue collection there was still some chance of 'walking around the shelves' to look for something. In the digital world – certainly in the mass storage world – there are no shelves, and documentation is all.

A preservation strategy should include documentation, and the following steps are suggested:

**1. Survey (map) of existing documentation:** as with the physical collections, it is important to know the status of the documentation. If there are gaps, they will have to be filled as part of digitisation – because an

undocumented digital file will be completely pointless and unreachable.

**2. Define goals for the documentation system:** documentation gaps need to be filled, but there may be other goals:

- **adopting one standard for all documentation**; digitisation tends to centralise content, especially if a mass storage approach to digitisation is used. It becomes increasingly inefficient and expensive to have multiple catalogues attempting to point to various kinds of data files – which historically may have distinct physical media with distinct catalogues. As the distinct physical media disappear, so do all arguments supporting distinct catalogues, or methods of cataloguing.

- **getting all documentation into a computer database**; because manual (card catalogue) access to a file-based system is extremely awkward, and manual access via the web is impossible.

**3. Documentation to support access:** access to audiovisual material requires text, and will continue to do so. The collection strategy should already have defined goals for access, so when considering documentation the issue is making sure the documentation supports the planned access. For instance, public access probably implies a need for simple categories or key-words, and a free-text search engine to back up subject-based retrieval. The best guidance for working out how to use documentation to support and achieve desired access, is to look at successful sites.

PrestoSpace has done a review of professional systems for audiovisual documentation, and of international standards: Analysis of Audiovisual Documentation **[14]**.

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