KEEPING AUDIOVISUAL CONTENT ALIVE

PRESTO CENTRE

Tutorial: Restoration of AV material

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Introduction

Restoration is the process of returning a work to its original state, or a better state, usually attempting to undo damage caused by time, climate, use or other factors.
Because audiovisual media are so easily damaged, restoration is an important process in preservation. A restored item is never completely the same as the original one, even though it might look and feel the same or better.

Restoration has its successes and failures. There are defects 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 and digital.

There are some processes that can still be done in the 'real world' (as contrasted with the abstract, digital 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 cost-effective and quick..

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 can require digital processing. Examples are:

Film:
- Line scratches;
- Dust/dirt/blotches;
- Dye fade;
- Image instability;
- Grain;
- Missing frames;
- Noise;
- Mould.

Video:
- Drop-outs;
- Noise;
- Tape scratches;
- Image Stability;
- Line jitter.

Audio:
- Wow & flutter;
- 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.

The tools to restore these flaws can be divided by their level of automation:
With manual tools, the operator manually points the tool at the defect, and so this is the slowest category.
An automatic tool 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.
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 needing manual intervention again, whereas a truly manual tool requires the operator to identify, individually, each and every blemish.

The tools can also be divided by their speed of operation: real time or much slower than real time. This is an important distinction for two reasons:

1. 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;

2. 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.

2. History of restoration

Restoration is associated with cinema, but in fact it is used for all audiovisual media. Film 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 processes 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.

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– 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. Other companies working on audio restoration are listed in the PrestoCentre service provider directory.

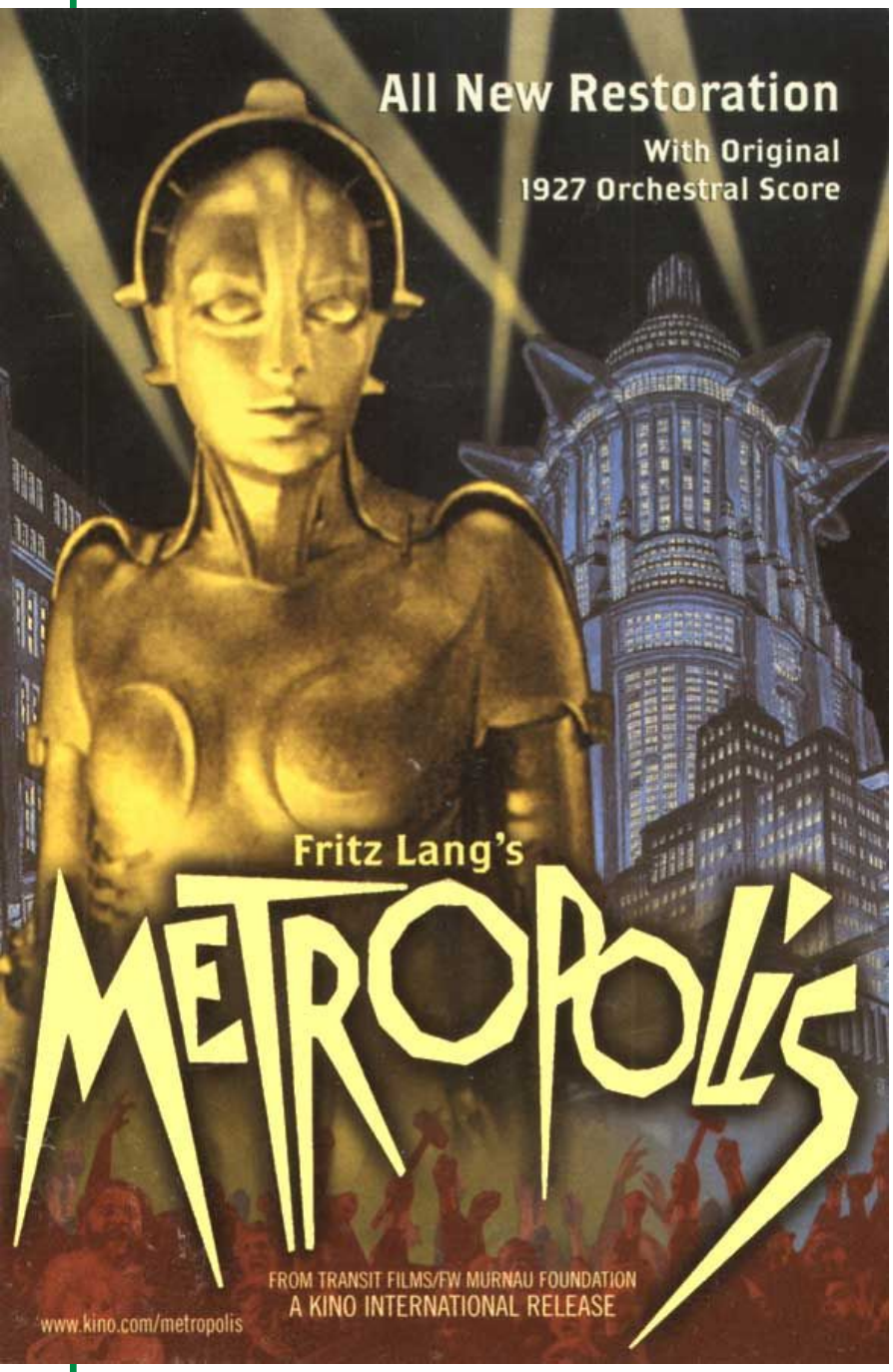
Some good examples of digital film restoration include:

- Snow White and the Seven Dwarfs (1992) – an early all-digital restoration;

  Opernball - EC project FRAME, using Joanneum and other technologies[1];

- Metropolis - A much larger project than Opernball, which revived commercial distribution of this classic;
- Dr. Strangelove, a restoration of the original black and white film to 4K.[2]

Figure 1. Opernball (Opera Ball) (1998) Metropolis (2001)



4. The restoration process

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

Audio:

- Software based;
- Much of the software runs in real-time, 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.

Video:

- Hardware and software systems;
- Working in standard definition and in high definition;
- Hardware for real time processing;
- SDI to SDI (real time serial digital signal at input and output) for hardware systems; SDI will directly connect to digital video tape recorders and other broadcast equipment.
- File to file (an input file is read, an output file is written) for software systems.

Film:

- Software based;
- Working in standard definition and in high definition, but going beyond that to 4K or more;
- Non-real time;
- Modular plug-ins;
- File to file operation, as with audio (and software for video);
- The file format(s) for digital film are not fully standardised, though DPX is common in digital cinema production work.

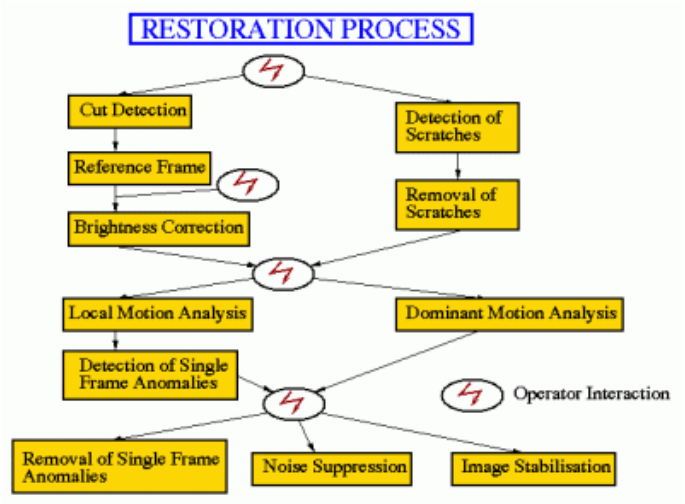


Figure 2. A typical sequence of operations in film restoration

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)l
- 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.

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 is becoming increasingly powerful and fast. It is hard to see how 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 translates 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. 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 do significant work using consumer and pro-sumer level tools.

Finally, just because restoration is labour intensive, commercial work is being 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.

6. How restoration fits into a preservation strategy

According to our definition, preservation is about 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 effects of time and handling. Therefore whenever an audiovisual item has become noticeably impaired, there is a role for restoration.

In the preservation strategy, restoration can be linked to digitisation. 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 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.

References

- Ph.D. Thesis (on digital film restoration), Anil Kokaram, (Cambridge University,1993)
- Textbook: ”Motion Picture Restoration“, A. C. Kokaram, (1998)
- 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".
- Systematic list of problems: TTUUhttp://brava.ina.fr/brava_public_impairments_list.en.html
- Godsill, S.J., Rayner, P.J.W (1998), Digital Audio Restoration. Show this book on amazon.com accessed Jan. 27th, 2011
- for Snow White: http://www.cinesite.com
- for Snow White: http://www.kodak.com/
- For Opernball: http://www.vcpc.univie.ac.at/activities/projects/FRAME/
- For Metropolis: http://www.kino.com/metropolis/index.html
- Restoration company in India: http://www.efxmagic.com/

[1] For more information on the project: http://www.vcpc.univie.ac.at/activities/projects/FRAME/

[2] See: http://www.sonypicturesmuseum.com/film/restored/ strangelove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SEVENTH FRAMEWORK
PROGRAMME