CHAPTER 8

Theories, Techniques, Decision-making Models: The European Context

8.1 OPERATIONAL PRACTICES FOR A FILM AND VIDEO PRESERVATION AND RESTORATION PROTOCOL

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Introduction

The operating practices of preservation and restoration raise complex questions of a methodological and theoretical nature. However, there are basically three questions that we must answer in order to work correctly: a) What is the identity of the material that we are analyzing? b) What are its conditions? c) How can we look after it? The first two questions are of a diagnostic nature, whilst the last one concerns the issues of prognosis.

First of all, the film materials need to be identified and classified, giving them historic-documentary, formal-aesthetic, and technological identity; in other words, reconstructing the internal and external history of film, as well as its cultural history. Secondly, we must proceed to recognizing pathologic symptoms and recording useful information for a diagnosis on the state of the material. Finally, the third question is of a prognostic nature and depends on the level of the intervention.

The first level of intervention is the storage (or passive preservation) and involves the safeguarding of materials in air-conditioned environments – or rather with certain temperatures, relative humidity, and air quality – and their periodic checks. Passive preservation guarantees the survival of the artifacts over time. A second level of intervention is the preservation (or active preservation) which “prolongs the existence of all that exists” (Païni, 1997), ensuring
the transmission, the right reproduction of the visual and audio information preserved on the artifact. The preservation procedures are finalized to transmit all the information, but they include an inevitable hybridization and creolization of the information transmitted and a correspondence – not always verifiable or repeatable in the results – with the hardware and software utilized and the decisions made, thus imposing extensive documentation of the interventions at this level of action. A third level is the restoration (and of the critical reconstruction of the text). Restoration is a process and an action that takes place at a different level. Restoration is not limited to preserving what exists or replicating or transmitting information preserved on originals, but aims to recover lost quality, former synchronic and authentic conditions and, in doing so, reveals approaches and finality that can be very different.3

Two appendices can be proposed for this initial synthetic description:

1) The materials – film and video – are not human-readable, but need technological mediation for their reproduction and transmission (they are machine-readable/dependent). The action of transmission represented by the preservation can be seen in systemic and set theory terms (transmission as diasystem);4 in trans-historic and communicative terms (the transmission as interface); and in terms of transition and restoration of the experience (the transmission as emulation, simulation, and remediation).

2) Our frame of reference is mainly represented by film-based artworks and by video art, areas which require other factors being taken into account (the role of the artist and the time when the artwork was made, the technical and aesthetic experimentation) which call for the revision and interpretation of the basic principles set out above in a flexible way.

Guide to the Identification of Different Film Formats

The study of the physical characteristics of the materials5 includes the analysis of the production process, the technological systems involved, and the degree of systemic, technical, and functional obsolescence with respect to the current standards. It allows for the identification of the film material typology and its origins. The method and instruments for analytical surveying also allow for the planning of the best ways for safeguarding and reproduction.6

The information to be researched can be split up into information relative to the structure and the appearance of the material. A useful subdivision of the film structure relates to the area of image, the area of sound, and the area of
the perforations. Another methodological suggestion calls for information to be revealed, dividing into information outside the image area and information inside the image area.⁷

The classes of information useful to the structural analysis of material can be synthesized into:

a. film format (35mm, 16mm, 9.5mm, 8mm, etc.);
b. format and shape of the image area (usually expressed through the relationship between the height and the width of the film: i.e., 1:1.33);
c. format and system for the recording of the soundtrack (area or variable-density optical, magnetic, mono, stereo, and on disc);
d. format of the perforations;
e. type of emulsion and of color system (black and white, color, hand-painted, tinted, toned);
f. type of element (negative, intermediate, duplicate, positive, reversal, etc.); type of base (nitrate, acetate, polyester, etc.);
g. information on the film’s edge (edge code, duplication marks, cueing marks, etc.);
h. editing marks (tape and cement splices, blooping, signs for printing, for fading in and out and cross fading);
i. metadata (labels, note);
j. documentary data on the living and cultural history of the object.⁸

8.1
Edge code of camera negative, in the upper right displaying the notch for the activation of changing light on the printing machine according to the Debre method, cueing carried out during the sight grading. Source: Società Umanitaria – Cineteca Sarda/La Camera Ottica, Università degli Studi di Udine.
Guide to the Identification of Different Types of Video Formats

The identification of the format of video materials is the basis for the understanding the recording system, the definition of technological obsolescence, and recognizing suitable hardware for reading the signal.

The most common type of magnetic device can be divided into five categories of width: 2 inch, 1 inch, $\frac{1}{2}$ inch, $\frac{3}{4}$ inch and $\frac{1}{4}$ inch. However, such classification is not sufficient for recognizing the specifications of the recording system that uses one of these tape formats. Before proceeding to the evaluation of the support and signal’s state of decay and the identification of the equipment, it is necessary to obtain at least three other types of information relating to the material:

- **Recording Format**: the recording system can be ascertained through identifying the traceable device, in many cases, through the indication on the case and on the tape’s rims. By reading the identification codes it is possible to recognize the recording format.  

8.2 Metadata about recording systems, video content, previous filings and cataloging of materials in a $\frac{1}{4}$-inch tape of *Anna* (Alberto Grifi e Massimo Sarchielli, 1972-1975). Source: Fondazione Alberto Grifi/Centro Sperimentale di Cinematografia – Cineteca Nazionale/La Camera Ottica, Università degli Studi di Udine.
be noted that, in more than just a few cases, the same tape can be utilized by different generations of the same recording system. In the playback phase, the alterations can be checked (for example, synchronism and chrominance), which can be interpreted as indications of a recording system that is different from the one recognized by reading an identification code.

- **Manufacturer of the tape**: The identification of the brand can provide useful information on the ways of treating and regenerating tapes.

- **System of transmission of the signal**: The transmission standard utilized (NTSC, PAL, SECAM) can be obtained or deduced from the carrier’s metadata. If the metadata does not explicitly refer to the system being used, it can be inferred from information relating to the time and place it was produced.

Once the format of recording, the manufacturer, and the transmission format have been identified, it is possible to proceed to the verification stage of the chemical, physical, and mechanical conditions (see below under “Guide to the Diagnosis of Physical, Chemical, and Mechanical Decay Syndromes of Video Materials”). After this stage follows the regeneration of the devices, then the playback stage and the digital acquisition of the signal (see below under “Operational Practices for Video Preservation and Restoration Protocols”).

**Guide to the Diagnosis of Physical, Chemical, and Mechanical Decay Syndromes for Film Materials**

The alterations detected during the analysis of the physical and chemical state of the elements can be subdivided into *damages, errors, and defects.*

By *damages* we mean biological, chemical, and mechanical alterations to the material due to use or negligence and the decay of materials. By *errors* we mean the alterations present during the transmission of the contents, or rather during the duplication process of the materials. While the errors belong to the area of cultural history and the copying process, the *defects* are understood as signs and indications of limits, of the characteristics but also of incorrect uses of the recording system and the technology employed at the beginning.

In the specific field of cinema of aesthetic experimentation, such a category must be reviewed and reconsidered in light of the strategy, intentions, and each artist’s techniques, that often “play” and experiment with the alterations of the correct ways of recording, with the exaltation of the technological limits and with the research of damages as an expressive element (see chapter 7.1).

The characteristics and the processes of the decay of the film bases used in
8.3
Frames of a film on a nitrate base in an advanced state of decay.
Source: Collection Vincenzo Neri, Archivio Nazionale del Film di Famiglia – Associazione Home Movies /La Camera Ottica, Università degli Studi di Udine.

Below: 8.4
Cans with 8mm films on an acetate base in an advanced state of decay.
Source: Collection Togni, Archivio Nazionale del Film di Famiglia – Associazione Home Movies /La Camera Ottica, Università degli Studi di Udine.
cinematography are known and have been described in literature. The intensity of the decay of cellulose nitrate can be visually and olfactorily detected and is measured conventionally through the five stages of decay.\textsuperscript{15} The syndrome of the decay of the safety acetate base is known as the “vinegar syndrome”.\textsuperscript{16} An instrument for revealing and monitoring the state of a collection is made up from IPI's A-D Strips (Image Permanence Institute, 2001). Even in the case of cellulose triacetate, the survey can be carried out through visual and olfactory detection and can be identified with one of the five stages of decay defined in literature.\textsuperscript{17} The polyester base, even if very stable, is subject to problems of core set memory and delamination.

The color image decay “can be manifested as color fading, color balance shift, yellowing, or color bleeding”, whilst the silver image decay “can be manifested as microspots, silver mirroring, or overall image discoloration” (Adelstein, 2009: 9).

To “diagnose” the state of a material requires describing and interpreting the symptoms of the decay in order to assign a conventional value to them, to measure the intensity and put them onto the scales of decay. Finally, the result of the diagnostic survey defines a “health status” for an element or a collection.\textsuperscript{18}

Guide to the Diagnosis of Physical, Chemical, and Mechanical Decay Syndromes of Video Materials

We can also adopt a classification for video materials, based on the difference between damages, errors, and defects. In the case of analogue video, the definition of errors also includes modifications to the signal caused by the playback equipment that was used. The reproduction of the video signal is closely tied to the technology of the time. Such equipment can produce changes in the display of the image (after the decay of mechanical or electronic components or as a result of a difference in the calibration between the playback equipment and that which produced the signal). The types of alterations (errors and defects) that can result from equipment malfunction in the production and playback stage are in many cases similar, complicating the analysis of the causes of alterations to the signal. However, in view of the recovery or restoration it will be an opportune moment to define, where possible, the origins of the alteration (productive and interpretative), to proceed to their compensation (for errors), or to their maintenance (for defects and elements of the work’s aesthetic and material history).

The damages of the magnetic audiovisual carriers are determined by factors such as frequency and conditions of use, chemical composition of the tapes, and environmental conditions of conservation.
One of the most common causes of chemical decomposition of the magnetic tapes is the “sticky shed syndrome” (Association of Moving Image Archivists, no date: 7). The causes of sticky shed are generally the prolonged exposure of the tape to relatively high temperatures and humidity. It can be diagnosed through tactile, visual, and olfactory inspection of the device. The upper part of the tape becomes sticky to touch and the tape tends to become attached to the spool. At a visual level, dusty or gummy residues can appear (disintegration of the top coat); furthermore, the device emits a pungent odor. A tape affected by sticky shed, if used without appropriate regeneration treatment (see below) will present problems of drag, caused by the friction between the tape and the reading equipment. The friction inevitably leads to the detachment of parts of the magnetic layer, with the resulting irreversible loss of recorded information.

Another cause of chemical decomposition is the loss of lubricant. The lubricants are added to the binder to reduce the friction between the tape’s top coat and the mechanism. Such substances are consumed, even in small measures, every time the tape is reproduced. The level of lubrication of the magnetic ½-inch tape suffering from biological decay (the presence of mold is due to the high humidity of the storage environments).
surfaces can reduce even in archived tapes due to evaporation caused by temperatures and humidity being too high or too low. Problems with drag of the tape in the reproduction phase can be traced to a loss of lubricant.

The tape surfaces can show biological decay, traces of dust, or crystalline residue indicating the presence of mold, caused by the tape being badly isolated, storing it either in a place that is not clean or that has increased temperature and humidity. This decay affects and damages the reading of the signal (with continuous loss of signal and impulsive noises on the screen) and the playback mechanisms (especially on the video and ACE heads).

Finally, there are faults of a mechanical origin which might affect the polyester base of the tape. The most common is the distortion on the base that can cause problems in the tracking in reproduction. Every time the temperature or humidity suddenly changes, the tape’s flange expands and contracts, causing physical stress to the device and causing permanent distortion of the substrate.

In the same way as errors and defects, faults become apparent during the viewing of the video signal, in the form of image deterioration. The most common form of deterioration present is dropout, which results in the loss of one or more of the lines that make up the image. The losses are often due to lack of magnetic paste on the tape, but they might also be caused by the presence of dust, or other elements which impede the reading of the signal. Another frequent deterioration is that defined as impulsive noise. The defect becomes visible in the form of a white dot with a comet-like tail. When the signal is treated with time base corrector (TBC), the dot, along with the associated drag, is transformed into a white or gray line.

Another type of deterioration is crosstalk (the interference of one video signal with another), which can be caused at the recording stage by the overlapping of another video source, or as the result of a wrong reading of the video tracks by the heads.

Other common types of signal alteration include jitter, the disengagement of the vertical synchronism, and the disengagement of the horizontal and vertical synchronism. The jitter is caused by the partial loss of information relevant to the horizontal synchronism (see Fig. 8.6). It becomes visible in the form of the “flagging” of a part of the image. The lines, and especially those at the top and the bottom of the screen, appear not to be aligned with the rest of the image.

The disengagement becomes visible through a vertical instability of the image, which appears to be the correct shape. This is not really an inherent fault of the player, but compensation of TBC. Without TBC we would not have the disengagement of the picture, but the disengagement of the synchronism with complete loss of image.

Identifying the reasons for the signal’s deterioration is often complex,
given that the same type of image alteration can be traced back to the device's decay, the malfunction of the reading equipment, and errors during copying or production. The analysis of errors in various versions of the same work, and the check on quantity and time for an alteration inside the same video, can help to construct hypotheses relating to the reason for deterioration. The reconstruction of the technological, productive, and aesthetic context of the finding and its original equipment give fundamental information for the diagnostic stage, the classification of the alterations to the signal, and for defining and evaluating the damage to the work.

Guide to the Care, Monitoring, and Storage of Film Materials

To formulate a prognosis on the future of materials, it is necessary to use tools and methods that are able to forecast a life expectancy based on the recorded level of decay and taking into account the predicted conditions of the preservation. The diagnostic tools can be simple (such as the testing of acidity using A-D strips) or complex (such as mass spectrometry) and there are objective scientific tests and subjective surveys to clearly understand them and in order to distinguish them.

In recent years there have been studies on the stability and the behavior of color emulsions over time, and film bases in acetate and polyester based on two distinct methods. The first area of study used the technique of accelerated ageing (Arrhenius approach), a predictive method that produces the life expec-
tancy (LE) of the materials in conventional conditions at 20°C and 50% RH accepted by the International Organization for Standardization (ISO). The second has application in long-term aging, or rather the incubation of “test materials for a period of ten years in order to evaluate life expectancy predictions” (Bigourdan, 2002: 40-41). The two experimental situations have produced results that are to a large extent overlapping; with the capacity, therefore, to confirm the quality of the method of artificial acceleration of time.

The standards for the preservation of film bases are known and published in form of recommendations by the ISO. The materials must also be preserved in horizontal positions inside the cans and wrapped around cores that have passed the photographic activity test (PAT). The IPI recommends a simple protocol of long-term film collection preservation based on concepts and the key actions: identifying, assessing, and storing. The IPI has also developed a preservation management process based on systems of monitoring and tools for recording, analyzing, and interpreting data relative to the main variables represented by the temperature and relative humidity. The definition of “health status” and the methods and management tools for predicting the future state of materials provide a basis for outlining a plan and a strategy for passive and active preservation of single materials, as well as entire collections.

Guide to the Care, Handling, and Storage of Video Materials

To ensure a future readability of the information contained in the magnetic layer of the tape, it is necessary to keep the device in a clean environment, with a stable climate and an adequate temperature/humidity ratio.

The ideal conditions indicated by various organizations (Cuddihy, SMPTE, NARA) are a temperature of 18°C with a possible range of 2°C and the relative humidity at 40% (with a possible variation of about 5%). The ANSI standard allows for a maximum temperature of 20°C with relative humidity between 20% and 30%.

A key factor in the correct conservation of the magnetic materials is the environmental stability. The variations in humidity and temperature over a 24-hour period must not exceed 2°C (for the temperature) and 5% (for the humidity). For this reason it is necessary to provide constant monitoring of the temperature and humidity of the environment and a period of acclimatization of the films before putting them in the archive and before taking them out again.

Although the risk of demagnetization is very low, it is advisable to guarantee that the environment in which the work is placed does not have an external
static magnetic field intensity that is over $4 \text{kA/m}$ and the external variable magnetic field over time is not more than $800 \text{kA/m}$ (Deggeller and Gfeller, 2006).

**Operational Practices for Film and Video Preservation and Restoration Protocols**

**FILM PRESERVATION AND RESTORATION PROTOCOLS**

Here we propose some protocols. The first protocol originally comes from the fields of art restoration and literary philology; the second is aimed at the remediation of sound recordings. The third and fourth protocols come from the experience of preserving experimental cinema, the fifth analyzes and represents the decision-making processes applied in the field of film preservation. Finally, the last protocol proposes a system of preservation, documentation, and digital access to cinema for film archives.

The first protocol is aimed at the preservation of specific versions and single textual occurrences. It is based on the principle that every act of preservation cannot be defined without being documented. This protocol (Canosa, Farinelli, and Mazzanti, 1997) provides for the creation of a *preliminary statement*, an *intervention report*, a *diary of works* and a *final report*. Alongside the expert diagnostic investigation on the state of the materials, the *preliminary statement* includes the description and documentation of the available film and non-film materials. The reliability and authenticity will be made problematic for all non-film materials described, they will be dated and measured in relation to the weight they have in defining the decision-making process. For the film materials described, the history and relations with other materials will be reconstructed. The *intervention report* will be based on the preliminary statement, according to verifiable limits (technical, economic, political, cultural) and prearranged objectives.\(^2\)

The intervention report should contain experimental tests and should clarify the workflow that is predicted with diagrams and detailed protocols. The *diary of works* can be considered an accurate survey, the daily notes of the differences and modifications made during the work with respect to the intentions laid out in the plan. The final report represents the testimony to the work carried out and should be published in the most suitable places.

A second example of a protocol comes from the “remediation of sound documents.” In musicology, a valid protocol for a “sound signal transfer on a new recording device” must minimally describe and include the following working stages: a) choice of sample to transfer; b) restoration of the recording device; c) choice of equipment; d) adjustment to intentional alterations of the
recorded signal; e) adjustment to incorrect recording settings; and f) adjustments to involuntary alterations of the recorded signal (Canazza, and Casadei Turroni Monti, 2006).

A third protocol is a series of guidelines proposed by Jon Gartenberg for the specific treatment of experimental cinema materials, starting from the experience accumulated over the course of many preservation projects (Gartenberg, 2007). The guidelines suggested by Gartenberg are “1. Know the history of the genre […]; 2. Establish a working collaboration […]; 3. Focus on the artist’s creative process […]; 4. Document the version of the work preserved […]; 5. Shadow the economic models of the commercial film industry […].” (2007: 40-45). Gartenberg continues with a schema for the technical restoration of experimental films based on the above principles:

1. Assemble and study detailed documentation about the artist’s career and related individual works. 2. Track down all camera originals, prints, and related production elements. 3. Perform detailed physical inspections of each individual film element. 4. Perform detailed comparisons for all elements of a given film. 5. Make preservation and access decisions consistent with the guiding principles. 6. Document in written form the preservation history of the work and the preservation decisions made (2007: 45-47).

It is useful to compare Gartenberg’s proposal with the restoration project of a large collection of Dutch post-war experimental films. In these materials, “Non-standard techniques were constantly used to reach particular aesthetic and visual effects and no film or copy was ever made in the same way. […] That’s why these films are also so unique and at the same time so fragile.” The organizer’s opinion is that many artists’ work must be thought of as “a constant work in progress,” to which can be added, “the almost total lack of historical documentation.” It is difficult to respond unequivocally to the choice between respect for the material or the aesthetic experience, “once we accept this a whole new range of possibilities become available as long as the restoration process is well documented and the filmmakers themselves still recognize in the new products their ‘artistic intention’” (Monizza, 2008).

A fifth protocol is made up of the result of a qualitative study based “on the methodology of ethnographic fieldwork.” A study made by investigating the context in which film preservation takes place in the United States aimed to document decision-making processes and the “individual tasks performed by archivists, curators, catalogers, and projectionists in specific situations and explored the many difficult decisions that they must make during the course of preservation work” (Gracy, 2003:3).
Here is the general process that was documented:

[...] preservation is a linear process involving activities, inputs, and outputs, from the initial stage of selecting a film to the final step of providing access to it through exhibition or other means [...] 1. Selecting a film for preservation; 2. Procuring funding and/or resources; 3. Inspecting and inventorying a film; 4. Preparing a film for laboratory work; 5. Duplicating a film at the laboratory; 6. Storing the master elements and access copies; 7. Cataloguing the master elements and access copies; 8. Providing access to the preserved film (2003: 6).

Finally, the European project EdCine (2006-2009) had, as an objective, in its archiving programs “Digital Storage and Access System for Film Archives with relevance to other digital born and film originated, digitally derived content” (EdCine/Archives, 2008: 1). The architecture of the proposal consists of:

[...] two packages, the Master Archive Package (MAP), for long-term preservation, and an Intermediate Access Package (IAP) designed to make the access to the stored items [...] where the content (image, sound, texts, etc.) is stored jointly to its technical metadata [...] to ensure that the content is correctly displayed when accessed (2008: 3).

EdCine proposed some requirements to respect the film (or to put it better, the cinematographic experience) in the various forms that it had over the course of a century, amongst which: “[...] 1. The resolution of the projected screen image should not be visually lower than that of the original film image [...]. 2. The frame rate of a digital cinema projection should be the same as that of the original film. 3. The aspect ratio of the image should be that of the original film [...]” (Ibid.: 4).

The protocols described a swing between the treatment of single materials and experiences and projects of digitization and large-scale migration, through the preservation of entire collections. The importance of the documentation, metadata and consequently of reversibility, the innocuousness and the criticism of the operations carried out, is evident in all the experiences that are described, but it rarely becomes reality in public and editorial forms. The documentation should be at the basis of the definition and choice of more complex digital storage protocols, extended to hardware and software, which the reading and transmission of data (encapsulation) depend on, and to the construction and management of digital assets. For the latter, and in general, there must be a strong presence of detailed pertinent metadata, including human readable reports.
The debate on the definitions of decision models and protocols for the preservation and restoration of the video work has been developed in Europe and the United States since the beginning of the 1990s. The first publications make up a technical guide for archiving, care and preservation of analogue devices.

Over the course of the 1990s and at the start of this century, coinciding with the development of a series of projects on the preserving migration of video materials kept in museums, some manuals that define the practical outline for a technique of treatment, regeneration of the chemical-physical characteristics and the digitization of the video signal were published. The procedure described in these manuals can be synthesized in a process that has five phases: 1) cataloguing, examination and documentation; 2) tape preparation; 3) remastering; 4) documentation of remastering and preparation; 5) keeping the original material and new masters safe.

The first phase is the inventory, the collection of metadata and the photographic documentation of all the materials. There must be a check and documentation of the state of conservation for all the devices (Wheeler, 2002: 3). The modality for the inspection of materials for the diagnostic means of a single device or an entire collection are as set out above, under “Guide to the Diagnosis of Physical, Chemical, and Mechanical Decay Syndromes of Video Materials”.

The tape documentation phase is followed by planning for interventions on materials for restoring the functionality of reading and digital acquisition (Hones, 2002).

The most common modalities for the preparation of tapes are the practices of baking and cleaning. The baking of tapes allows for the temporary readability of tapes affected by hydrolysis of the binder. They are put in a ventilated oven (see Rarey, 1995) at a constant temperature of 50°C for a minimum of eight hours. This procedure temporarily restores the consistency of the binder on the surface of the tape, therefore allowing the tape to pass through the reading mechanism without losing the magnetic paste. This is a controversial procedure, some conservers maintain that baking is too invasive and, in the long run, damages the tape.

Cleaning is used to eliminate dust and biological contamination from the surface of the tape. As with baking, there are different conclusions on the effectiveness and the long-term consequences regarding the techniques used. The most common technique, known as dry cleaning, involves putting the surface of the tape under pressure, in contact with a dry cloth. This technique is the opposite of wet cleaning, which involves the addition of chemical agents to the cleaning. The latter practice is more effective than the former; however,
the long-term consequences of the chemical stability of the device are still being debated.34

The remastering stage includes the reading of the tapes, the stabilization of the signal and the digital acquisition of the signal (see Fig. 8.7 in color section). The main differences in this stage of the technical protocol regard format and the destination hardware of the new digital master. The digital signal’s conservation format has to include all the information from the starting signal and has to have compensated for the possible alterations introduced by the system of reversing. The conservation copy is then divided based on the use of material preserved in terms of the access copy.35

During the preparation and remastering stage, the parallel process of documenting the interventions that have been carried out is introduced, allowing the recording of material history. At the end of the preservation process, the originals and the new digital masters are made safe and archived in ideal climatic conditions (see above, under “Guide to the Care, Handling, and Storage of Video Materials”).

Despite the highlighted differences, the technical protocol that has just been mentioned represents a shared base of the main experiences of video art preservation gained over the last twenty years. This workflow does not however take into account the issues relating to the conservation of the aesthetic and historic designs of the work, which is subject to preservation. For this reason, alongside the study of operational practices aimed at preserving migration of the signal contained in obsolete devices, museums and research centers proposed decision models and action protocols aimed at verifying the effectiveness of the preservation procedures in relation to the transmission of works’ aesthetic historic and cultural values.

A common reference point in the definition of the methodology of the intervention is the decision model outlined by the Foundation for the Conservation of Contemporary Art in Amsterdam, aimed at describing and regulating the process through which decisions are made, about the restoration and conservation of contemporary art.36 The conventions and preservation trials that followed investigated and analyzed the critical points that emerged from the Dutch model, referring them to time based works. The main methodological points that have largely polarized the scientific debate on the preservation of time based works are the definition of acceptable alterations, the role of stakeholders in the preservation process and the replacement/emulation of the work’s original components. The theoretical deepening and the completion of experimental preservation projects led to the production and testing of intervention models, working diagrams and instructions for interviewing artists.37

A comparative analysis of different experiences of video art preservation
highlights divergent methodological and protocol choices that are sometimes contrasting, in relation to issues such as the choice of the version to preserve, the involvement of stakeholders, the evaluation of the alterations definable as damage and acceptable corrective interventions. In comparing the preservation experience carried out by ZKM in Karlsruhe (Frieling and Herzongerath, 2006), the Netherlands Media Art Institute (Coelho and Wijers, 2003), and the Laboratori La Camera Ottica and CREA at the University of Udine, important differences emerge, in the adopted decision model and the program of intervention in relation to the afore-mentioned points. If on one hand such divergences in action can result from a heterogeneity in the preservation objectives and the conditions of material, on the other hand it is clear that much of the methodological discordance is attributable to the lack of a shared model for intervention and documentation.
The search for adequate preservation and restoration protocols that are capable of fulfilling the specific requirements for the conservation of complex digital cultural goods has revealed an ambivalence that is characteristic of the current situation in the conservation and restoration of computer-based art forms. On the one hand, documentation has assumed an increasingly important role in preserving art – not least because the objects, at the time of being recorded, seem so fleeting and fragile that a permanent preservation or access to them becomes difficult or almost impossible; many objects, moreover, assume different (physical) forms of appearance. On the other hand, the objects themselves seem to resist this effort as it is sometimes not clear on which system of reference the documentation should rely. Finally, conservators – most of whom have not received a basic education in computer science – are nevertheless expected to analyze information objects in a technically sustainable way. Among other things one result is that very heterogeneous formats of documentation exists which cover just certain aspects and are often hardly compatible to each other.

Richard Rinehart, for example, presented a comprehensive “System of Formal Notation for Scoring Works of Digital and Variable Media Art” in 2004, based on the Extensible Markup Language (XML) and containing a “Survey of Related Work” (2004 and 2008). Metaphorically speaking, the system he proposes takes the metadata as its starting point; the question of how the relevant information is retrieved in the first place is, naturally, not touched on. By contrast, an outline of this latter approach is contained in the guidelines for the documentation of networks such as DOCAM, INCCA, Virtual Platform, and the Inside Installations Project as well as the guidelines for the acquisition of the Matters in Media Art Project; these, however, can only identify the relevant data up to a certain depth, and anything that lies beyond this point constitutes a gray zone.

We greatly appreciate the different approaches and try to combine certain aspects. In the text that follows, we wish to introduce the concept of “work logic”. This concept proposes to transfer the parameters of the classical, material based documentation in conservation science to the semantics of digital artworks. From these parameters, we develop a methodological procedure that has been tested on complex digital objects (artworks). We conclude with some practical routines that are suitable for the conservation and restoration of computer-based art forms.
Work Logic and the Structure of Complex Digital Objects

Since the late 1980s, we have seen a host of very different artworks and artistic applications whose visible appearance is calculated in real time by a computer. Based on digital instructions (algorithms), the system generates certain audiovisual or haptic effects that are embedded within a larger artistic concept and are either self-contained or “open” to the outside (Lurk, 2009b). In the latter case, artists may, for instance, start live meta-queries of web services such as Google, Flickr, Wikipedia and many other portals, and then display them as parts of an artwork (Lurk, 2010).

With their manifold appearance, many such digital artworks correspond to the definition of complex digital artworks. According to this definition, a digital object is complex if a) there is no simple description of its technical file format, its display or its reproduction, or if b) the object is dynamic, that is, it includes interactive components or embedded programming.

What makes these artworks so specific in their essence, then, is that software components are fundamental to what they are and therefore are essential for ensuring their authenticity. In the past, conservators approached the problem of preservation by focusing on a machine’s casing, and often redundantly bought and stored reproduction devices in large quantities. In the long run, however, a sustainable preservation policy requires an understanding of information technology. To this end, the concept of work logic was developed; this proposes to identify and classify the computer-based elements of an artwork in all their complexity, and to document how they connect to other system components.

The concept of work logic does not conceive of the artwork as a self-contained entity but instead distinguishes between, on the one hand, its “core” which constitutes its essence, and, on the other hand, aspects of its appearance, its artistic concept, and its historical context (see Fig. 8.8). All four areas contain definitions of significant properties that are key to preserving an artwork’s authenticity and thus providing us with a differentiated and hierarchical picture (Laurenson, 2006).

In other words, the concept of work logic encompasses those (digital) components of an artwork that constitute its authenticity while distinguishing between core components and the hierarchically ordered work-relevant components. As can be seen from the system for the graphical classification of the components (see Fig. 8.9 as well as the case study at the end of this chapter), we develop a layered model that begins with the core and indicates a decreasing relevance as it moves to the periphery. A decrease in relevance means that a stabilization measure may become more invasive (such as when updating the operating system).
The discussion of possible changes should follow the standards of conservation and restoration (American Institute for Conservation of Historic and Artistic Works, 2009). Generally, one must ask whether the conservation strategy is one of fluid actualization (migration) or one of freezing the work in its current state – known as the “enclosing encapsulation” approach (virtualization/emulation) – and why one approach is preferable to the other. While fluent actualizations by migration seem less invasive in the short run (but may lead to significant changes in the long run), the enclosing encapsulation approach means that the adjustments that go along with stabilizing the work will stagnate as soon as the first preservation action has taken place. The latter method thus centralizes the preservation of the artwork’s historical integrity. It is important to document and evaluate every preservation action in a transparent and detailed fashion.

The concept of work logic registers “hard facts” (in the sense of the technological facticity of the artwork) as well as “soft facts”, in terms of the artwork’s meaning. The meaning of an artwork triggers the preservation strategy and should be adjusted to the artist’s intention and the specific environment.
in which he conceived of his work. Thus, it is important to evaluate the relevance of the technologies that were used. Furthermore, the work logic schema (Fig. 8.8) differentiates between the individual artist’s intention and the more general historical context which the artist reflects on in one way or another (in the guise of the “Zeitgeist”). It is also subject to very general historical conditions (Klütsch, 2007; Krameritsch, 2007; Lurk, 2009a).

From the Work Logic to a Structure of Documentation

The work logic principle does not only identify an artwork’s (core) components. It can also be applied to the structure of conservational documentation, consisting of the identification and description of the object (semantically and in terms of cultural history), a documentation of examination (detailing the present state of the object), a treatment plan (generally including a specific risk management plan) and a documentation of treatment which fully and transparently documents all preservation measures (Falcão, 2010). Finally, where possible, handouts with information about further treatment are recommended; these should also provide information about monitoring routines.

A model for documentation that is based on these aspects would have the following format:
CHAPTER 0: FRONT PAGE

Title (and subtitle)
Illustration/image of the artwork (incl. caption)
Short record information:

<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artist</td>
</tr>
<tr>
<td>Year</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Owner</td>
</tr>
<tr>
<td>Preservation period</td>
</tr>
<tr>
<td>Documentation date</td>
</tr>
<tr>
<td>Author(s)</td>
</tr>
<tr>
<td>Achievements</td>
</tr>
</tbody>
</table>

Summary: This brief summary (ca. 500 characters) identifies the object and the purpose of documenting it.

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CHAPTER 1: DESCRIPTION OF THE ARTWORK/INSTALLATION

Description: A semantic description of the artwork’s external features.

Historical context: The historical context provides information about the meaning of the artwork; it may also include autobiographical information about the artist and about related works, either by the same artist or by other artists using the same technology.

Form and structure: A technical description that includes specific information about the type/genre, behavior, and handling (installation) and further elements regarding the participation by viewers.

Materials used and techniques employed: A description of technological components, including applications, software modules, and libraries that are needed for all kinds of technological interfaces and for the internal communication with the operating system.

Preservation history: If possible/accessible, provide information about earlier restoration measures or other changes made to the artwork (including modifications by the artist).
CHAPTER 2: IDENTIFICATION OF THE ARTWORK’S COMPONENTS

The following analysis identifies the components of an artwork or installation in detail. This type of object identification usually takes place during the object analysis as soon as more precise information (regarding, for example, the software components) becomes available.

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtitle</td>
<td></td>
</tr>
<tr>
<td>Acronym</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Artist</td>
<td></td>
</tr>
<tr>
<td>Programming</td>
<td></td>
</tr>
<tr>
<td>Concept/text</td>
<td></td>
</tr>
<tr>
<td>Material/technology</td>
<td>E.g., computer, camera, beamer, software</td>
</tr>
<tr>
<td>Type/genre</td>
<td>E.g., interactive, software-based installation</td>
</tr>
<tr>
<td>Resolution/aspect ratio</td>
<td>E.g., 1024x768px/4:3 Or comments like: “Installation box is not exactly specified.”</td>
</tr>
<tr>
<td>Components</td>
<td>Files delivered by the artist/addressed by the application, including software libraries Work-relevant components, such as the grabber Details can be specified below</td>
</tr>
<tr>
<td>Client-side software</td>
<td>Operating system (OS) information, further details can be specified below</td>
</tr>
<tr>
<td>Reproduction software</td>
<td>Media player if required/other tools required for display</td>
</tr>
<tr>
<td>Signature</td>
<td></td>
</tr>
<tr>
<td>Remarks</td>
<td>Such as: “The artwork was part of the media production for Expo 2000.”</td>
</tr>
<tr>
<td>Number of versions</td>
<td></td>
</tr>
<tr>
<td>Further versions/editions</td>
<td></td>
</tr>
<tr>
<td>References</td>
<td>E.g., the artist’s website</td>
</tr>
<tr>
<td>Owner</td>
<td>Including number/edition index, e.g., (#1/5)</td>
</tr>
<tr>
<td>Inventory number</td>
<td></td>
</tr>
<tr>
<td>Client/corporation</td>
<td></td>
</tr>
<tr>
<td>License</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 3: DOCUMENTATION OF THE CURRENT STATE

The documentation of an artwork’s current state lists all its relevant components. It identifies the significance of both the work’s core and the work’s relevant components, and explains the relation of the core software to the systemic environment as well as the communication with the hardware. This form of recording thus also provides curators with a first idea of the artwork’s proneness to errors and identifies, within a risk management framework, those elements requiring stabilization.

Hardware
Even in cases where the artist did not provide any information about the hardware (because it can be replaced or otherwise procured by the museum), it nevertheless makes sense to roughly specify the requirements. Relevant information includes:

- Information regarding the operating system; these could be as vague as “Linux-compatible personal computer”
- Information regarding the graphics card, e.g., Open GL-compatible graphics card
- External interfaces: e.g., video input/camera; video output/beamer; intersections for audio devices or for homemade interfaces, etc. It is absolutely necessary to specify the latter’s command structure (plug-in position, etc.).

Generally, the more specific the information, the easier it is to preserve the object and ensure its authenticity.

Operating system
Describe the version of the current operating system (OS). If possible, note the first OS to have ever been used for the artwork’s application (first installation). This is important with regard to the technical context and the genesis/development of the artwork.

Work files
It is important to document in detail the list of all available work files and all further data and information that were provided by the artist. The following information must be recorded: title/file name; specification of the software type used and its corresponding function; exchangeable/related software or hardware components; remarks about the license under which the work was produced; if possible, identify all possible alternative software tools/components that, for example, may have been used in earlier versions.

Explicit dependencies
This is a very important area in which dependencies that exist within the artwork are classified. We distinguish between explicit dependencies resulting from, for example, a specific hardware or software or the addressing of web services (for net art), and implicit dependencies.

Implicit dependencies
These frequently result from conceptual decisions or from chain of events within a program’s process structure.
CHAPTER 4: CONSERVATION CONCEPT AND RISK MANAGEMENT

The conservation concept is based on a precise analysis of the work’s core and of its individual components. It discusses possible stabilization measures and weighs the necessity of conservational and restoration measures (see Hummelen and Sillé (1999); Kucsma (2008); Lauterbach (2010); Wijers (2010); Thibodeau (2002)). Frequently, there will be several options, and it is necessary to distinguish between the best possible and the minimally necessary options.

Because digital works of art allow for several approaches, and because the measures are often not performed on master files but on working copies (cf. the process definition given below), we may consider several parallel approaches.

Please note that a risk assessment must be carried out individually for all components mentioned above. Furthermore, a final comprehensive risk analysis is necessary. Contrary to the default risk, as was already determined for the individual components, here the interaction of the different components comes into focus. In this way, it is possible to weigh priorities and gauge future procedures as well as possible contingencies.

In order to ensure that a “return to 0/initial state” is possible at all times, backup copies must be stored in a safe location and remain untouched. Please note: one only ever works with the copy, never with the “original” artwork, which is stored in an “audit-proof” filing system. An audit-proof filing system ensures that an object will not be altered or lost once it has been stored in the archive (see below).

CHAPTER 5: DOCUMENTATION OF TREATMENT

The documentation must transparently record every intervention and operation. Here, it makes sense to use the structural analysis of the work that was developed as part of the conservation concept and often results in a graphical representation, and to add a list of the measures performed. Another important feature of digital objects is that they lend themselves to the possibility of a primary documentation, that is, documentation of the (original) object on the code level. This must be done by an expert who is proficient in programming in order to avoid irreparable damage to the object. Because of the possibility of “out-commenting” certain areas of a software, changes can be inserted right next to the original code and labeled accordingly. This double structure of the old code and the stabilized version can be rearranged as necessary so that either the original or the updated version of the artwork is used.

CHAPTER 6: RECOMMENDATIONS FOR FURTHER TREATMENT

The subsequent treatment identifies the artwork’s weak spots and its fragility as well as the monitoring routines.

APPENDIX WITH REFERENCES

References may include detailed information and analysis protocols, the artist’s biography, a bibliography, an exhibition history, correspondence, and additional professional literature.
Organization and Planning

The steps sketched above can be combined to form a relatively simple working model whose handling relies on the established OAIS model (Open Archival Information System). OAIS uses the term SIP (submission information package) to refer to archival material that, having been submitted to the owner, museum, or archive, must be inventoried or enhanced with specific metadata to create an archive master (International Organization for Standardization, 2012). Similarly, digital conservation produces a master copy only when the object is first recorded; this is then stored, preferably in an audit-proof filing system, as an archival information package (AIP). Audit-proof filing is a technical term that describes the most secure and reliable form of archiving documents. Working copies and master copies that are produced at later stages are stored in the archive either before changes are made, or as soon as a condition has been achieved in which the object is worthy of documentation or preservation.

In order to be able to distinguish at all times between the source (original), the backup and working copies, and the object currently in use (the dissemination information package, or DIP), we recommend archiving/storing the digital masters and DIPs, together with the documentation, in an audit-proof filing system.

8.10
Schema of the documentation procedure (by Tabea Lurk)
archive; for example, in the institution’s administration department. As most damages are the result of negligent handling, this makes the whole procedure more reliable.

The procedure, then, is as follows: after the initial backup of all digital files/data carriers (hard drive of the main computer, all CDs/DVDs/floppy disks/other hard drives/flashcards, etc.), two copies are made: one copy, as the archive master, the other becomes the working copy which is used for identifying the core components. This backup procedure should not be performed on the original, nor on the initial backup. If possible, the initial backup should be made without connecting the computer to a power supply or letting it boot automatically.

The next step is the analysis of the computer system, that is, the location of the artwork in its technological environment. If the artist does not provide information about the artwork’s core components (for example, in the form of a backup copy), the analysis can be conducted by means of the exclusion principle. This means looking for those components that differ from an equivalent “empty” basic installation.

As soon as the relevant hard- and software (interfaces) have been identified, a risk assessment must be made in order to identify unstable components. We recommend a prioritization beginning with the most fragile components (for example, hardware obsolescence -> software interface -> system libraries, etc.)

The next step is providing an executable working copy (AIP1). After that, the original can be booted and compared to the working copy. This is followed by stabilization measures and the establishment of monitoring routines.

In the monitoring process, all components are checked for functionality; it is also necessary to assess whether the risk of possible damage has changed in the meantime. In the above image (Fig. 8.10), the loop arrow on the left represents the repetition of the process each time something has changed.

**Case Study: Liquid Perceptron**

The following excerpt of a conservation file applies to the above schema for the stabilization of an artwork and an artistic working tool.

**Description:** *Liquid Perceptron* (2000) is an interactive computer-based installation by Hans Diebner, which simulates a dynamic, neural network. The neural cells are represented by pixels in a two-dimensional field, which displays an image of the user on a screen. The cells are stimulated by the user’s movements and trigger wavelike structures/movements, thus irritating the simple video image (feedback) (see Fig. 8.11 in color section).
Form and structure of the artwork: Liquid Perceptron analyzes data from a video source and generates a real-time image from it. This is projected onto the wall as a full-screen projection. The only specific installation instruction by the artists is to fill the entire wall (see Fig. 8.12 in color section).

Materials and Techniques Applied: Because of the scientific character of the simulation, the source code, consisting of a looped differential equation (LiQ-PerFastClean.cc), was identified as the artwork’s core. The artwork is based on a Linux platform; the external hardware (camera, beamer) can be replaced without interfering with its meaning.

The following comparison of the original structure and the stabilized structure of the artwork summarizes the graphical schemas that were described in detail in the complete documentation file.

8.13 Work logic of Liquid Perceptron; the top diagram depicts the initial state, while the bottom diagram illustrates the stabilized version (by Jürgen Enge, 2010).
As can be seen from the comparative schema of the work’s architecture in Fig. 8.13 (top: initial state, bottom: present state), the V4L1 (video for Linux 1) function was replaced by the current version of the same library (V4L2). This supports the usage of different video camera interfaces like Firewire (IEEE1394) and TCP/IP camera signals. In order to feed the video signal into the work core (LiqPerFastClean.cc), a new video grabber subsystem was implemented. This communicates with the V4L2 module and is based on a C++ class library. Open source components for grabbing video signals from various devices and for the decoding of the raw image frames are conducive to sustainability.

Conclusion

Preserving computer-based art is no trivial matter, and requires a methodological approach and transparent documentation. Where these requirements are met, artworks can be preserved for the future in a careful and sustainable manner. Thus digital conservation relies less on craftsmanship or on electrotechnical engineering than on an understanding of mathematics and logic which emerges at the interface of informatics and the humanities. In accordance with the standards established in 1994 by UNESCO’s Nara Conference, this approach enables minimally invasive stabilization measures and avoids the inadvertent creation of dimension-reducing documentation.53

For this reason, artists should be asked for the source codes of the artworks that are to be preserved as soon as they are acquired; otherwise, seemingly simple applications may quickly present significant conservational challenges. Aside from accessing the source code, a work-specific analysis and a listing of the components means, metaphorically speaking, looking behind the screen’s surface. A careful approach to the preservation of artworks, however, also implies the possibility of working in parallel and of employing alternative procedures and, in this respect, differs from classical conservation. The above account has detailed the conditions that are necessary for this approach to be successful.
Tate’s collection of time-based media art currently consists of approximately 350 works,\(^5\) the majority of which have been collected from the 1990s onwards. Most of these works are artist’s installations rather than single-channel pieces.\(^5\) Tate is actively collecting and acquires about 50 time-based media works a year, which averages out at about one a week. The first permanent post for time-based media conservation at Tate was established in 1996; this grew to become a dedicated conservation section in 2004. Time-based media conservation is part of the Collection Care Division, and is responsible for the conservation of all works in the collection, for registration, art handling, photography and Tate’s library and archive.\(^3\) Tate’s Conservation Department is divided into conservation sections for paintings and frames, sculpture, paper, time-based media, and conservation science. The guiding principle underpinning conservation at Tate is the idea that all works in the collection should receive the same standard of care regardless of medium. Within a contemporary art collection, this drives innovation to find solutions to challenges presented by new materials and new forms of artistic practice.

There are currently three time-based media conservators at Tate and one conservation technician. The conservators divide their time between work related to acquisitions, exhibitions and displays, loans, and collection care. Whilst the point of acquisition is critical for all works entering the collection, it is perhaps particularly so for time-based media works of art. One could say that at this point a work is prepared for its future life in the collection. When a work is acquired, information is gathered that will guide its care and display. Copies of the media elements are made in different formats for access, display, and archival purposes and information from the artist and their representatives is gathered which helps to establish what it is that is important to preserve. Conservators also consider any equipment needed to display the work and its significance for the meaning and identity of the work in order to determine its status and whether spares should be acquired. Tate’s conservation department hold detailed information in the conservation files but core collection management data related to each component is also held on the collection management system. The cycle of display is invaluable for time-based media works of art as it provides moments of close engagement, and re-engagement, with the work. Many of these works are installed slightly differently each time they are displayed – perhaps because of technological changes or changes in
response to a space. For each display, conservators work with those involved in the exhibition, often the artist as well as the curator, to provide detailed floor plans and specifications. The conservation of time-based media installations goes beyond the care of the material components to also consider how best to preserve the performative aspects of the work which are only fully realized when it is installed. A proactive approach to the conservation of time-based media works of art is essential to their care. So in addition to the reactive work of responding to the loan, acquisition, and display programs, conservation has a structured stream of activity that maintains maintenance and migration schedules for the range of works in their care. This includes migrating video onto new stock and new formats, preparing items for cold storage, monitoring vulnerable software-based works, and managing the potential impact of and increased rarity of equipment.59

Laurenson trained as an object conservator at the City & Guilds of London Art School with a specialization in the conservation of polychrome, wood, and stone objects. She came to Tate as a sculpture conservator under a Henry Moore Foundation internship in 1992. During the period of her internship, Tate acquired Bruce Nauman’s Violent Incident (1986). Tate’s acquisition procedures for works of other media being accessioned into the collection were already highly developed, however, when working on this piece she realized there was little established to guide the acquisition of time-based media artworks. With a travel scholarship from the Gabo Trust she visited museums and artists who were working with time-based media to explore possible strategies for their conservation. Laurenson indicates that during this time she learned a great deal from the artist Bill Viola, who is deeply concerned about the preservation of his work and was supportive in helping her to understand what needed to be established at Tate. Laurenson’s appointment as a conservator of time-based media coincided with the moment the collection of time-based media started to rapidly grow. She gradually developed a conceptual framework within which she could operate, particularly around the challenges of preserving installations (see, amongst others, Laurenson, 1999, 2004, and 2006). Inspired by Jonathan Ashley-Smith’s book Risk Assessment for Object Conservation (1999) she developed an approach for assessing the most significant risks for time-based media works, for example, the risks posed by the failure and obsolescence of particular technologies, within the context of a work specific analysis to understand where value and meaning lies.
Where Time-Based Media Conservation Is Different: A Need to Think Ahead

In Laurenson’s view, the practice of conserving time-based media works is firmly embedded in the wider practice of fine arts conservation. She indicates that in the context of contemporary art museums, conservators often act as brokers between a number of different people and activities as part of the team that facilitates various events, from acquisitions and loans to exhibitions and displays. The nature of time-based media does however impose a slightly different focus for conservation; where the traditional emphasis might be on technical skill associated with treatment, the focus of time-based media conservation is on understanding what is important to preserve both in terms of the tangible and the intangible from the moment of acquisition. As Laurenson indicates, the conservation of time-based media works entails a need to be pre-emptive because ensuring that a work is displayable in the future requires action to be taken as early as possible in the life of a work. Whereas for other types of art ‘benign neglect’ might not be immediately problematic, in the case of time-based media works this is not an option. Collecting detailed documentation on the concept, significance, production, display, and experience of the work is of crucial importance in order to be able to preserve and exhibit it in the future.

Conservators at Tate are deeply involved in the collection process. The curators identify and select key works, write interpretative texts indicating the importance of the works in the context of the collection, and work closely with the artist and the gallery on the details of the acquisition. However, it is the conservators and registrars who are charged with the responsibility of how practically to bring the works into the collection to enable them to begin their life in the museum, ensuring that the museum has what is needed to keep them displayable. Tate is a demanding environment for display, for example at Tate Modern time-based media works need to be fully operational for 70 hours per week.

When a time-based media work is considered for Tate’s collection an assessment is made to establish clearly what it is that is being acquired, what is important to the conservation of that work and how it was made. Often, this is the first time artists are asked these detailed questions, especially if it concerns works from the 1960s or 1970s that were not made for the art market or museum system. Established artists, such as Bill Viola or Gary Hill, have large studios that support their practice and can provide detailed instructions about their installation. In other cases works may be more “thinly specified” (Laurenson 2006) and the artist may be less concerned with the production of the complete and tightly defined works. In other cases a work might be
acquired early in its life and the technical details may not be fully resolved. This was the case with the acquisition of Carlos Garaicoa’s *Letter to the Censors* (2003), a sculptural installation consisting of a scale model of a fictional Cuban cinema theater in which a montage of the opening credits of censored films is screened (see Fig. 8.14 in color section). There were some practical problems with elements of the work overheating, presenting the potential risk of damage to the model. In addition, in order to see the work in all its detail it is necessary to get so close that the very act of viewing creates risks of damage, especially at Tate Modern where visitor numbers exceed five million a year. In this case, conservators and conservation technicians worked closely with the artist to resolve any outstanding issues, coming up with solutions to various practical problems, such as designing a special crate for the model and determining various conditions for the display of the work.\(^\text{60}\)

As Laurenson indicates, in cases like this a time-based media conservator should adopt a more process-oriented model of documentation, whereby the museum stays in dialogue with the artist in understanding how the work may evolve over time while still remaining true to its conceptual core.\(^\text{61}\) This balance, between allowing for evolution while still paying attention to the integrity of the work, is a core challenge in the contemporary practice of time-based media conservation.

**The Conservator as Broker: Collaborating with Artists**

Laurenson acknowledges that for many artists understanding the role of museum staff, in particular conservators can be difficult; specifically in the delineation of roles between the conservator and the artist or studio when dealing with works which are not fully technically resolved. She rejects the sometimes voiced opinion that these ways of working appear to reposition the conservator as co-author of an artwork.\(^\text{62}\) In Laurenson’s view, conservators are working in a professional context, acting as brokers between the artist and the museum in order to facilitate certain technical aspects of integrating works into the collection when a work is first acquired. In this context, she sees the role of the conservator as a facilitator and the conservation of time-based works as a process where decisions are based on a dialogue between the artist and the museum staff.\(^\text{63}\)

As Laurenson indicates, exhibition plays an important role in the conservation of time-based media. The first installation of a new work in a museum exhibition may be the first time the artist experiences the work as fully installed. In fact, the exhibition of the work is the only moment it really exists as a whole: the synergy between sound, image, and environment that charac-
terizes a work in its installed form disappears when the work is dismantled and stored. Although the inaugural exhibition may be an important point of reference for later exhibitions and for conservation decisions, a work may also evolve either to a fixed form or to an identity that is more fluid. Because of the link to the performative in the display of works as installed events in the gallery, the concept of the “original” that is so prevalent in traditional conservation does not operate in the same way for time-based media works. Tracking the different iterations of a work – its manifestation in exhibitions at different places and moments in time – provides a frame of reference for future conservation and display decisions (see also Jones and Muller, 2008). During the lifetime of the artist, he or she is one of the major stakeholders in decisions about conservation and display. Once the artist is no longer around, one can use this frame of reference to “intelligently install the work,” as Laurenson describes it.

Challenges in the Preservation of Time-based Media Works

Time-based media conservators are currently caught between two equally urgent priorities: dealing with older technologies and issues around obsolescence, and addressing new challenges presented by software-based art. Despite the urgency of the questions raised, it remains difficult to secure research funding to develop sustainable solutions to these challenges.

With regard to the management of older technologies used in the production and display of time-based media works of art in Tate’s collection, the disappearance of the knowledge on how to handle that technology is perhaps as great a challenge as the obsolescence of the technology itself (see also Laurenson 2010). A particularly apt example is the collection of works based on 35mm slides. These works are a cause of concern, especially since in the summer of 2010 Kodak announced the discontinuation of the production of Ektachrome 35mm slide duplication stock and can offer no replacement for this product. This is a good example of the fact that the preservation of technology-based works is often at odds with developments in a commercially driven industry.

Laurenson indicates that, as with all time-based media works, a first step is to establish the role, significance and function of the technology in the artwork. In the case of works based on 35mm slides, some artists have used this technology because at the time it was the most easily available material for their purposes. For these works the artist may be open to replacing the analogue 35mm slides with digital projections. Whilst a shift to digital technology might represent the loss of a link to a particular time and the role and status of 35mm slide technology at that time, and also a significant change...
in the look and feel of the work, the museum might value these links to the original technology more highly than the artist. Other artists, however, value the analogue photographic material for its specific characteristics, such as a very high level of detail and a particularly rich rendition of color. A 35mm slide creates an image by light passing through the transparency. This creates a still image very unlike an image generated electronically; an electronic image is a constantly changing scan, trace, or pulse of light and is therefore never truly still. Tape slide technology is, for example, central to the practice of the artist James Coleman. In her extraordinary essay “…And Then Turn Away?” Rosalind Krauss explores the way in which Coleman has taken tape slide “from a commercial world of advertising or promotion and imported it into an aesthetic context” not simply adopting this as a novel support but, she argues, inventing a medium (Krauss 1997: 8). Structurally, the works of Coleman are dominated not only by the luminous quality of slides as large projected images that slowly dissolve and change: the medium and apparatus of tape slide is also significant in the circularity of the carousel, the choreographed rhythm of the images as they are repeated, and the way in which the voice-over works, or works against, the images. In this case, therefore, the relationship of the medium to the work of this artist is far from incidental or trivial.

Tina Weidner, a time-based media conservator at Tate, has invested a great deal of time and attention acquiring in-depth knowledge about the duplication of analogue slides, understanding all the parameters of working with sets of old slide stock and collaborating with labs. Slide-based installations require a large number of duplicates to be produced whilst the work is on display as the process of being projected causes the images to fade. Therefore, while master images can be preserved by cold storage, duplication is still necessary to ensure the work remains displayable. In the near future, alternatives to traditional methods of slide duplication will have to be found in order to be able to continue to show slides as 35mm transparencies. This requires detailed and focused research to ensure that the aesthetic qualities of slide-based works are understood in order to fully comprehend what it is we are trying to preserve and evaluate alternative conservation strategies. As Laurenson indicates, it is extremely difficult to obtain funding for this type of research; however, Tate has recently been awarded a grant from the Esme Fairbairne Foundation to pursue this work.
New Challenges: From Analogue Film and Video to Software-based Works

Laurenson explains that, contrary to film archives which may only hold an occasional viewing of a specific film, Tate needs many prints in order to display film-based works, since 16mm film works might be on display for periods of either six or twelve months or more and the lifetime of one print is only a few weeks.65 Usually it is not possible to obtain the negative from the artist, so Tate acquires an inter-positive, two inter-negatives and two reference prints, one from each inter-negative, as well as an artist’s proof supplied by the artist as reference for the sound, color, and contrast. All of this material is created when the work is acquired and is kept in a cold-storage facility. In addition, they archive sound elements of the film as a digital file and an optical sound negative (Laurenson, 2011: 38). For the production of accurate and high-quality prints from these materials, the time-based media conservation department closely collaborates with a range of film laboratories in various locations around the world who are still able to produce 16mm film.

For their video works, Tate has established what Laurenson describes as an “orderly migration programme.” As with all the works in their collection, time-based media conservators work with the artist to document the way in which the piece was originally produced. This has become increasingly important now that artists can edit their video on laptops using a wide range of different technologies and software. The acquisition process, led by the conservator Kate Jennings, therefore begins with a series of questions regarding how the work was made. From this, a decision is made as to what is the most suitable form for the work to be supplied from the artist to the museum. This is known as the “artist-supplied master”: a version of the work that represents the best available master. For example it may be a DV file within a QuickTime wrapper or a digital Betacam tape. From this, Tate produces an archival master in an uncompressed video format, which is migrated every seven years (although previously this has been to D-5, a professional, uncompressed digital video format, material is currently being moved to a file-based system). Uncompressed video is more resilient than compressed video as the greater redundancy of information helps to mitigate against errors. Uncompressed video also creates less risk of errors arising should there be a change of compression algorithms in a given migration path. This archival master is preserved alongside the native format in which the artist or their gallery supplied the video.

Tate is currently moving towards preserving uncompressed video as data on servers and data-tape formats such as Linear Tape-Open (LTO). For this, they are exploring the potential of using a system that has been developed by the BBC called Ingex. Ingex is a suite of open source software applications.
designed for low-cost flexible tapeless recording, both for television production and for archiving (ingex.sourceforge.net). The suitability of this system for the preservation of Tate's video collection is being explored alongside other systems such as those which are based on the use of JPEG 2000.

Besides exploring digital data storage for video, Tate is also facing the challenges of preserving and exhibiting software-based works. Matters in Media Art, a collaborative project funded by the New Art Trust between Tate, the Museum of Modern Art in New York, and the San Francisco Museum of Modern Art, is currently looking at both the requirements of a digital repository for artworks and also the specific needs of software-based art. One of Tate's time-based media conservators, Patricia Falcão, has conducted research into the preservation of software-based artworks and is integrating the results of this research into the conservation of the works in Tate's collection. At present, the museum is in the process of acquiring a work, one element of which is a website: Sandra Gamarra's website of the fictitious but highly realistic Lima Museum of Contemporary Art, LiMAC (www.li-mac.org). This is a work in process, since the artist will continue to contribute and collaborate with others to create content for the website as it evolves. Tate has formed an internal working group to address the challenges of collecting Internet artworks with staff from the Information Systems Department, working closely with conservators and registrars to identify and develop the necessary infrastructure and skills needed in order to collect this type of work. The strategy being developed for this work is to create a mirror website, for which the museum will secure the assets, code and permissions from the artist, so that if a time comes when the actual site is no longer available, the museum can use this mirror site to ensure that the work will still be accessible to the public. Such an acquisition again requires new expertise, for example an understanding of the structure of servers and the dependencies and vulnerabilities of web-based artworks.

Laurenson sees the acquisition of a work like LiMAC as an opportunity to find out what is involved in the display and conservation of this type of Internet-based work. At the same time, the knowledge and skills obtained from this case study feed back into the bigger picture and informs the strategies for the conservation of other similar works in the future.

The Future of the Profession: Specialization

Laurenson indicates that it is difficult to generalize regarding the knowledge and skills needed for the conservation of time-based media works. A basic requirement is a good understanding of the broader context of conservation as a profession – an understanding of the ethical principles underpinning
conservation decision making, a structured approach to assessing risk and the development of strategies for the long-term care of works of art and the documentation of decisions made in the process of conservation. Laurenson again stresses the importance of taking the long view, of understanding from the start how these works might be maintained, how they should be revisited, both during exhibition and storage.

Conservators of time-based media art are dealing with a wide range of people and technologies – the field of expertise required is very broad and extends beyond the heritage sector, into the broadcast and media industries, for example. Therefore, it is crucial that time-based media conservators are able to communicate with all kinds of specialists in many different fields, such as technicians and computer programmers. Time-based media conservation is a rapidly evolving profession; dependent on a rapidly changing technological environment and emerging artistic practice. Time-based media conservators therefore have a steep learning curve throughout their career; in learning about new technologies, responding to changes in the industries on which those technologies depend, and also in understanding new meanings that technological mediums take on and the ways in which they are harnessed and exploited by artists. Often these conservators are dealing with problems for which there is little precedent within conservation.

Finally, even within the rather young profession of time-based media conservation Laurenson observes a gradual specialization towards certain types of time-based media works, such as analogue or digital ones. At Tate, for example, Tina Weidner has developed a thorough expertise in analogue slides and film. She collaborates with a range of professionals who work with film and photography, including those who work within laboratories and in the maintenance and production of equipment. It is Laurenson’s expectation that this tendency towards specialization will only expand in the near future.
NOTES

* Chapter 8.1 was jointly written by Alessandro Bordina and Simone Venturini. Together, they wrote *Introduction*; Simone Venturini wrote the sections on film materials and Alessandro Bordina wrote the sections on video materials.

1 The analytical proposals in this musicological field become useful in the area of cinematography and video, see Orcalli (2006: 17): “The study and remediation of audio documents includes both the document’s internal history (that is the set of transformations of the document in the process of making and transmitting the recorded sound) and its external history (or rather the characteristics of the materials, of the systems and the technological devices that produced it and made it accessible).” Compare with the “cultural history” outlined in Cherchi Usai (2001: 1027, and 2000).

2 The canonical aims of film restoration, as they are theorized and can be found in the practice, coincide with the reproduction of the state of the copy (“the unrestored film as it has come to us”), the first public screening (the opening night: the film as it was seen by its first audiences”), or other confirmed historic occurrences, the will of the author (“the film that its creator intended to make”) and the adaptation to contemporary taste (“a film that keeps in mind a modern audience and the way we may see things”). In musicology the aims and approaches to sound documents are partly the same as the documentary, sociological, reconstructive, and aesthetic approaches. See, respectively, Bowser (2006: 38-39), and Orcalli, (2006). The restoration practices involve other issues relevant to ethics and documentation, since they record (and at times sacrifice) the original material according to instances generated in the present, with aims of communication. The politics of access collide with the long-term preservation practices adopted to stabilize magnetic tapes, for example, or to postpone the difficulties and *aporiae* of recovery to future stages and more advanced technology.

4 See Segre (1979: 58-64 in particular).

5 This study must always be associated with the analysis of film-related materials. A pioneering text (the first version dates back to the 1950s), which is essential in identifying the materials of early cinema and, in a more general sense, to understand the “evidential paradigm” at the basis of the method of analysis, is Brown (1990).

6 The following books can be considered useful manuals: Farinelli and Mazzanti (1994); Read and Meyer (2000); National Film Preservation Foundation (2004).

7 See the “critical analysis of materials” which is described and summarized by Farinelli and Mazzanti (1994).

8 For a broader description, in terms of history and examples of the various elements of the classes that are quickly indicated here, such as color, see chapter 7.1.

9 A quick way is by looking up the guides to the identification of video systems; some of them can be found on the web. The Videotape Identification and Assessment Guide Texas Commission on the Arts (http://www.arts.state.tx.us/video/pdf/)
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video.pdf), the Video Format Identification Guide (http://videopreservation.conervation-us.org/vid_id/index.html), and the database of the Video History project (http://www.experimentaltvcenter.org/history-tools, last access: 23 October 2010) are the most complete.

10 For example, a U-matic tape that was produced before the production of SP recording systems can be used with SP recording systems.

11 Different brands of tapes react in a different way to the preservation environmental conditions. For example, the Sony ½-inch tapes seem to have more problems relating to the hydrolysis of the binder and the loss of the lubricant.

12 This division is well known and used in Italy. It has been recently used again by Wallmüller (2007). It should be emphasized that in recent years American literature proposed again part of the European scientific tradition, French and Italian in particular.

13 The Image Permanence Institute describes the three categories of “environmentally induced decay” as follows: “Biological Decay. Biological decay includes all the living organisms that can harm media. Mould, insects, rodents, bacteria, and algae all have a strong dependence on temperature and RH [...] Chemical Decay. Chemical decay is due to spontaneous chemical change. [...] Chemical decay is a major threat to media that have color dyes and/or nitrate or acetate Decay Caused by Improper Storage [...] Mechanical Decay. Mechanical forms of decay are related to the changes in size and shape of water-absorbing materials such as cellulosic plastic film supports or the gelatin binder in photographic materials. RH is the environmental variable that determines how much water is absorbed into collection objects” (Adelstein, 2009: 2).

14 For a definition of the errors, see Farinelli and Mazzanti (2001), and Canosa (2001). Canosa, in particular, clarified how the regime variants belong to the regime of the original, whilst the errors belong to the regime of the copy. The methodology of the audio restoration adopts similar, but not identical, subdivisions. In this field, the defects roughly correlate to the category of “involuntary alterations” that result from imperfections and distortions in the recording system or incorrect settings in the recording. The intentional alterations relate instead to the equalization phase.

15 National Fire Protection Association (1994): “Stage 1: Film has an amber discoloration with fading of the image. Faint noxious odor. Rust ring may form on inside of metal film cans. Stage 2: Emulsion becomes adhesive and the film tends to stick together during unrolling. Faint noxious odor. Stage 3: Portions of the film are soft, contain gas bubbles (nitrate honey), and emit a noxious odor. Stage 4: Entire film is soft and welded into a single mass, the surface may be covered with viscous froth, and a strong noxious odor is given off. Stage 5: Film mass degenerates partially or entirely into a shock-sensitive brownish acrid powder.” See also the 2011 update of the same publication.
For a first approach to vinegar syndrome see Reilly (1993) and Gamma Group (2000).

“1. The film begins to smell like vinegar. 2. The film base begins to shrink. As the base shrinks irregularly, the film resists being laid flat. It curls and warps along both length and width. 3. The film loses flexibility. 4. The emulsion may crack and eventually flake off. 5. White powder may appear along the edges and surface of the film” (National Film Preservation Foundation, 2004: 14).

See the sanitary and diagnostic analysis of the Danish Film Institute’s collection, published in Nissen et al. (2002).

See note 20, and National Film Preservation Foundation (2004: Fig. 4).


The photographic activity test (PAT) is an international standard (ISO 18916: 2007) developed by the Image Permanent Institute.

See note 20.

See note 5.

Restoring post-war DUTCH EXPERIMENTAL films, project organized by the former Nederlands Filmmuseum, now the Eye Film Institute, and in particular by Simona Monizza in collaboration with Guy Edmonds and Daniel Meiller.


For example, the project PrestoSpace (http://prestospace.org) and Images for the Future (http://imagesforthefuture.com/en); Europeana (http://www.europeana.eu). Last access: 12 July 2011.

See the pioneering experiences of Eileen Bowser (2006) and several essays and
reports on single restorations at the end of the 1990s. More recently, there have been the restoration reports on Spione (Fritz Lang, 1928) and A Film Johnnie (George Nichols, 1914). The fields of historic-critical texts and the documentary hypertexts deserve a mention. See Bowser (1975), and the magazine Cinegrafie. See also Wilkening (2010) and “A Film Johnnie restoration report” at http://chaplin.bfi.org.uk/restoring/casestudy. Last access: 12 July 2011. For the documentation of restoration practices, see also important works such as Canosa, Farinelli, and Mazzanti (1997) and Kromer (2010).

29 In 1991 Jim Linder coordinated the intervention of video art sources recovery for the Andy Warhol Foundation; the following year the Netherlands Media Art Institute/Montevideo, within a conservation project for the modern art of the Deltaplan Culture Conservation, started reformatting, for preservation purposes some tapes belonging to the Dutch institute; in 1996, Video Data Bank finished the preservation of 65 titles from the Castelli-Sonnabend collection.

30 One of the first conferences to propose a debate on the need for video art preservation, called the Symposium on Video Preservation, was organized by the Media Alliance at the Museum of Modern Art in New York in 1991. See Boyle (1993). Various other technical manuals followed this text by Boyle, see Miller Hocking and Jimenez (2000), Hones (2002), and Wheeler (2002).

31 Tapes that are particularly affected by hydrolysis can require more time; checking the weight before and after baking will show the quantity of water that has evaporated in the process.

32 The effectiveness of baking is limited to a few days, after which the effects of the procedure are nil.


34 For a risk benefit analysis of wet/dry cleaning, see Boyle (1993: 24).

35 For a first approach to the correct conservation format and instruments, see Wheeler (2008).

36 “The various conservation and/or restoration options are considered within a framework of risks, meaning and limitations. In this way, technical possibilities might yield to ethical or economic considerations, or a treatment might be abandoned in the light of ideological priorities,” Foundation for the Conservation of Modern Art (2005: 168).

37 See the models of intervention proposed in the following European experiences: Inside Installations. Preservation and Presentation of Installation Art (2004-2007) coordinated by the Netherlands Institute for Cultural Heritage (http://www.inside-installations.org/project/detail.php?r_id=643&ct=introduction, see also
Scholte and Wharton, 2011); the Media Art Resource Website created by Electronic Art Intermix in collaboration with Independent Media Arts Preservation (IMAP) (http://www.eai.org/resourceguide/preservation.html); and the Variable Media Network coordinated by Jon Ippolito and Alain Depocais (http://www.variablemedia.net/). Last access: 23 November 2010.

38 Compare the preservation and restoration experiences carried out by La Camera Ottica laboratories and CREA at the University of Udine on video sources of the Venice Biennale (2004-2011); by the Videobase group (2009-2011); and on the video archive Anna by Alberto Grifi (2011) documented in Saba (2007 and 2009).


40 See, for example, Inside Installations (2007), International Network for the Conservation of Contemporary Art (2008), Documentation and Conservation of the Media Arts Heritage (2009). A clear account of the preservation procedures can be found in Lee et al. (2002).

41 Until now, by contrast, the software components of computer-based artworks are often copied to equivalent hardware via cloning; these procedures and transformation processes resemble an (unreflected) black box procedure. However, if the reproduction hardware plays a crucial role, such as in Cory Arcangel’s famous Nintendo Game Cartridge Hacks that was created in the 1970s and 1980s with obsolete hardware, this then constitutes the artwork’s core.

42 While some artists consistently work with the most recent tools available, others make a point of deliberately using obsolete software because, for example, they may wish to critically question the immense speed of technological development.

43 See, for example, the different issues of the Journal on Computing and Cultural Heritage, Parikka (2007), and http://computerarcheology.com/ (last access: 21 September 2012).

44 According to Matters in Media Art (2007), these “work files” are also referred to as “assets” in the framework of the acquisition process.

45 This aspect can be illustrated with the help of schematic representations, examples of which are provided at the end of this chapter.

46 For security reasons we would suggest audit-proof filing. This ensures that even if someone accessed the stored documents – as should be possible for the revision of the material, for example – he/she technically cannot manipulate the documents without being caught.

47 While a flawed procedure may result in a dimension-reduced object that would then merely have a documentary function, a total loss frequently occurs only when the computer is started up again after it has been transported or stored for a long period of time.
A backup of the carefully dismantled hard drives can, for example, be made with the help of Clonezilla. This process requires a great deal of care, especially in determining the correct copying direction; otherwise, the object may be destroyed beyond repair (if in doubt, consult with a computer scientist).

Pitschmann (2001) has developed a concept for sustainable collections of web content. See also Frasco (2009).

The complete documentation of “Liquid Perceptron” will eventually be made available through the INCCA network, see http://incca.org/.

The artist is a physicist. The artwork can therefore also be understood as a comprehensive study of his scientific research. This becomes obvious in the programming’s structure whose modeling relies on Fortran.

See chapters 4 and 5 of the complete documentation file that will be made available on the INCCA website, see note 21.

The Nara Document on Authenticity, passed by UNESCO in 1994 and included in the ICOMOS guidelines in 1995, examines the relevance of historical circumstances for the authentic preservation of cultural goods (Lemaire and Stovel, 1994).

Pip Laurenson changed positions shortly after this interview to become the Head of Collection Care Research at Tate.

The interview took place at Tate Britain, London, on 11 October 2010.

As of October 2010.

Single channel video works from distributors usually come under license. For a work to be part of Tate’s collection it is legally necessary for Tate to hold legal title to the work. It is therefore not possible for Tate to acquire licensed works into its main collection.

As Laurenson indicates, the position of time-based media conservation within the division of Collection Care is quite distinctive in that in many modern art museums, for example the Pompidou in Paris, the conservation of time-based media is not done by the collection department but by the media art department, where curators of media art have developed quite a detailed knowledge on the preservation of time-based media works.

Tate is a family of four museums which are served by a central collection. Tate also loans out many of its works to other museums and exhibitions.

Because of the great level of detail and care with which this work was acquired Garaicoa himself jokingly referred to this work as the “Mona Lisa of Havana.” See http://www.tate.org.uk/research/tateresearch/majorprojects/garaicoa/themes_1.htm.

For a discussion of this approach in relation to Garaicoa’s installation, see http://www.tate.org.uk/research/tateresearch/majorprojects/garaicoa/themes_1.htm.

This point is often made in relation to curating media art. For example, new media art curator Christiane Paul states that: “The role of a new media curator is increasingly less that of ‘caretaker’ of objects (as the original meaning of the word
'curator' suggests) and more that of a mediator and interpreter or even producer” (Paul, 2008: 65. See also Cook, 2008: 42). For an example of how the collaboration with an artist can take place, see the discussion of the conservation of Tony Oursler's *Autochthonous AAAAAHHHH* (1995) in PACKED (2010). For a detailed description of the storage of the various parts of installations at Tate, see PACKED (2010). The exact number of weeks depends on the length of the film, the conditions of the gallery, and how well the equipment is maintained.

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