

## The digital restoration of film

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### Abstract

This article focuses on the issues of conservation and restoration of films through digital technologies. Films, as an expression of collective memory, become part of the common heritage of humankind, which deserves to be safeguarded and disseminated. As a consequence of this awareness, the issue of preserving cinematic materials becomes a pressing one, especially when the structural frailty and transience of the film stock is taken into account.

The current condition of audiovisual media is one of transition: the analog and photochemical element is gradually replaced by the digital apparatus. Such condition radically influences the practices of production and distribution of the cinema, as well as the theoretical debates on the medium: the archiving criteria and restoring procedures are no exception to this logic.

### Resum

Aquest article tracta sobre la conservació i la restauració de pel·lícules amb tecnologies digitals. Les pel·lícules, com a expressió de la memòria col·lectiva, formen part del patrimoni comú de la humanitat, i mereixen ser preservades i difoses. Per això, la qüestió de la preservació dels materials cinematogràfics està guanyant pes, sobretot si tenim en compte la fragilitat estructural i la curta durada de l'estoc de pel·lícules.

L'estat actual del mitjà audiovisual és de transició: a poc a poc l'element analògic i fotoquímic és substituït pel sistema digital. I això influeix molt en les pràctiques de producció i distribució del cinema, i també en els debats teòrics sobre el mitjà: els criteris d'arxivament i els processos de restauració no són una excepció a aquesta lògica.

### Resumen

Este artículo trata sobre la conservación y la restauración de películas con tecnologías digitales. Las películas, como expresión de la memoria colectiva, forman parte del patrimonio común de la humanidad, y merecen ser preservadas y difundidas. Por eso, la cuestión de la preservación de los materiales cinematográficos está ganando peso, sobre todo si tenemos en cuenta la fragilidad estructural y la corta duración del stock de películas.

El estado actual del medio audiovisual es de transición: poco a poco el elemento analógico y fotoquímico es sustituido por el sistema digital. Lo cual influye mucho en las prácticas de producción y distribución del cine, y también en los debates teóricos sobre el medio: los criterios de archivo y los procesos de restauración no son una excepción a esta lógica.

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## 1 Film restoration and its methodologies

The issues of film philology and restoration are among the most relevant aspects in contemporary film studies debates. Inasmuch as objects, films are considered as part of a cultural heritage to be protected and restored in their formal qualities. Such problematization—both of the praxis and of the object—has led to the definition of an epistemology of the cinematic *matter*: scholars in this area have moved from a theoretical level to a material one, with the goal of preserving the features and the cultural value of moving images.

Since the 1960s, the film stock regains centrality in historical and critical debates on the one hand, and in relation to the formal choices determined by the techniques and the support medium of cinematography. New film historians begin to trace a history made of "relics" and fragments; in the 1980s, following the UNESCO General Conference in Belgrade,<sup>1</sup> the cultural value of moving images is officially recognized.

Films, as an expression of collective memory, become part of the common heritage of humankind, which deserves to be safeguarded and disseminated. As a consequence of this awareness, the issue of preserving cinematic materials becomes a pressing one, especially when the structural frailty and transience of the film stock is taken into account.<sup>2</sup>

The hybrid condition of cinema has required contributions from several fields in order to sanction the legitimacy of the preservation and restoration procedures. The leading disciplines in restoration are art restoration, in Cesare Brandi's innovative perspective, and literary philology, which provides a methodology for determining the authenticity of the texts, and for restoring them (Canosa, 2001, p. 1.080). Hence, film restoration is the work of exegesis of the filmic text: it is rooted in practice, and it faces problems of technical nature; at the same time, it implies a philological research based on the most advanced methodologies, and the restitution of the *oeuvre* in its original form.

According to Brandi's theory, "restoration is the methodological moment in which the work of art is appreciated in its material form and in its historical and aesthetic duality, with a view to transmitting it to the future" (Brandi, 1977, p. 6). A critical and comparative analysis of heterogeneous sources becomes necessary: the goal is to interpret the *oeuvre* in the most accurate way, according to the ethical principles of adherence to the original form. The process of transferring an artwork onto a new support medium, which is an indispensable step in film restoration, must follow ethical principles related to the obsolescence of the formats, and the traceability and reversibility of each intervention, according to the criteria of transparency to which the restorer is bound.

The restoration consists in re-composing the structure of the film against the inexorability of time: in a thorough hermeneutic, the text is considered in its fragments and gaps (Bertetto, 1991, p. 34). This approach has brought to a methodological awareness concerning the necessity of film analysis: the issue of the multiplicity of interpretations, and the problems arising from the gaps in the filmic text have been taken into account, in the effort of obtaining a copy as close as possible to the original one, and yet open to eventual further interpretations.

Due to the advances of technology and to aesthetic and ethical transformations over the course of history, the attitude of restoration is one of uncertainty and openness: in order to accommodate for this, almost every school of thought promotes a symbiosis between archive and laboratory. Moreover, the need for the safeguard of moving images arises from a history of destruction of the film stock —due to the chemical and physical decay of the support medium, but also to voluntary eliminations, and to the changing history of taste and ideas.

A legislative void has surrounded the restoration of moving images. As a consequence, it has occurred that some techniques and procedures, which had not been previously verified and standardized, have caused further decay to film stock that already found itself in critical conditions. Secondly, the concept itself of film as *artwork* has been accepted only after a long period, both in professional circles and among the audiences. Cinema has been often considered as nothing more than entertainment, with an undervaluation of its strong artistic component and its ability for intellectual engagement. This has occurred despite a wide theoretical debate on the epistemology of media imaginaries, the emotional and intellectual involvement of audiences, and the impact of cinema on the intellectual history and the social dynamics of the Twentieth century.

The constitution of a specific audience for restored films, with the ability to appreciate visual and representative standards of bygone eras, is undoubtedly the first achievement of film preservation and restoration. Such a dialogue between different eras rests on a renewed and enriched awareness of the cultural value of moving images.

## 2 The specificity of digital formats

The current condition of audiovisual media is one of transition: the analog and photochemical element is gradually replaced by the digital apparatus. Such condition radically influences the practices of production and distribution of the cinema, as well as the theoretical debates on the medium: the archiving criteria and restoring procedures are no exception to this logic (Fossati, 2009, 6). The implementation of information technology allows operating on the images with a significant flexibility (although always according to binary coding and decoding systems). Despite the fundamental difference between analog and digital formats — namely, the absence of isomorphism in the latter (Rodowick, 2007, p. 49)— the technological hybridization is considered as the hallmark of the current media condition, in which new and old forms and languages coexist. The old medium, then, does not disappear completely due to the daily use of digital technology. The claims of "purity" and the static definitions of a medium are easily refuted: they do not account for the experimentation and contamination within the media system, which take place before any process of standardization occurs.

The methodology itself of digital restoration (and digital conservation as well) is strongly intertwined with the transitional condition of contemporary media. David Rodowick, a prominent scholar in the area of digital technologies and cinema, argues: "The electronic image has not come into being *ex nihilo* from the invention of digital information processing, but through a series of displacements in the relationship between the formative and the constitutive moving-image media [...]. Every medium consists of a variable combination of elements. In this respect, moving-image media are related more by a logic of Wittgensteinian family resemblances than by clear and essential differences." (Rodowick, 2007, p. 86).

Many of the audiovisual artifacts in the new millennium appear as particularly complex cultural objects, due to the dialectics between a claimed indexical referentiality and their illusory graphic elaboration. Diverse forms of fruition for these new cultural products emerge, and the debate on restoration begins to merge with the one concerning the role of digital technologies in our lives.

In contemporary audiovisual culture, in fact, the invasiveness of digital processes has become customary. Digital interventions can be executed on a large quantity of frames through automatic procedures, but they can also concern single frames in order to erase flaws and gaps with greater detail (removing stains, scratches, dust or else; spotting out; fixing badly glued splices; and so on). With such an extreme versatility, the risk exists of creating 'digital artifacts' (signal disturbances due to the techniques of acquisition and coding which cause a distortion in the final result).

Key features of the digital system are the interactivity and rapidity of intervention, as well as the great liberty in image manipulation: this combination leads to a potential 'distortion' of the image, and to its



substitution by a falsifying and overly adjusted copy. The problem lies in the potential inauthenticity of the restoration, against the ethic principles of restoration, such as the fidelity to the original, the transparency of interventions, and above all the preservation of time's 'patina'.<sup>3</sup>

Nevertheless, a conscious use of information technologies with the goal of a careful and ethically grounded intervention in film restoration can provide an effective tool for the acquisition, preservation and public access to the moving image heritage: the recuperation of a film's functionality entails the possibility of bringing back to the audiences its aesthetic pleasure.

Given the indispensable passage of duplicating the film on a new support medium, this becomes a key theoretical issue around which the debate on film restoration revolves: some perspectives privilege the adherence to the original format (considered as a philological aspect of the film), whereas others pay more attention to the film's final appearance (due to its impact on the eventual access and distribution of the *oeuvre* itself).

Paul Read and Mark-Paul Meyer argue that film restoration consists in the technical, editorial and intellectual procedures aimed at balancing the loss or decay of moving images, by bringing them to a condition as close as possible to the original one, and by keeping (whenever possible) the original format (Read; Meyer, 2000, p. 66). They define as digital restoration the process which, in addition to the former procedures, transfers the image on a digital support medium, in order to modify it and then transfer it again onto a screen-based medium (Read, 2002, p. 335).

Giovanna Fossati contests this argument, as she highlights the importance, within cinema restoration, of the duplication of the film stock: it is such duplication which guarantees the preservation of the film's appearance, rather than its format. According to Fossati, a restoration should not aim at maintaining the original format (whether this may be 35mm or 16 mm film, or even a digital file); it should rather preserve the overall visual features of the original —its colors, grain, saturation and contrast, which are more relevant in the audience's experience of the film itself (Fossati, 2009, p. 71-72).

Many scholars insist on a stark division between the digital apparatus and the photochemical medium, as does Paolo Cherchi Usai, who focuses on the material specificity and historical identity of the film<sup>4</sup>. He raises the issue of cinema's singularity, as a specific cultural experience related to the projection of images from a photochemical support: a film restoration should safeguard not only the object, but also the experience of fruition, rooted in a specific socio-cultural phenomenon.

The cinematic language itself carries with it a specificity, which is not separable from the organic matter of the chemical elements composing the photosensitive medium. The technological advances have determined an improvement in the resolution of digitally based visual media and in their level of detail, bringing them near to the formal qualities of the film stock. Nevertheless, it is undeniable that the fruitions of digital and photochemical images still diverge: they are *analogous* but not *homologous*. The perception of a sequence of photochemical images at 24 frames per second will necessarily be different from the perception of an audiovisual sequence projected from a digital electronic source (Cherchi Usai; Francis; Horwath; Loebenstein, 2008, p. 108).

As a consequence, also the practice of archiving is rapidly changing, together with the modalities of preservation of the moving image heritage. New forms of digital archives appear on the Internet, which take advantage of participatory practices and *user-generated* content; and more open forms of access emerge, compared to those offered by traditional archives.

According to Giovanna Fossati, film archives and museums are questioning their own role, and interrogating themselves on the difficulties introduced by the new medium: "As a consequence, film archives and film museums are struggling with questions about their role. As a response they could either close their doors to new media, or accept them and challenge some of their views and assumption about the film medium. Whatever the choice, it will determine their future" (Fossati, 2009, p. 15).

Let us consider the semantic distinction between 'analog' and 'digital': an analog device stores data in physical units which are always variable, whereas the digital one utilizes a binary code based on discrete units. Hence, the main feature of the two systems is that the former is 'continuous' whereas the latter is 'discrete'. The continuity between cinema and the digital image is granted by an overall analogy between their outputs, in which what emerges is not the specificity of the medium, but rather the social practices that characterize it.

### **3 The digital cinematheque: film conservation in the realm of new technologies**

The different theoretical positions on the relation between cinema and digital technology have influenced the different perspectives on film preservation and restoration; they also determine a different awareness of issues such as the material difference of the support media, the degree of image manipulation, the danger of obsolescence and the logistic difficulties of archiving and standardized decoding. The choices implemented by archives and curators are not homogeneous: some are addressed towards accepting the challenge of contemporary technologies, and re-inventing the medium by investing on state-of-the-art technologies; others keep operating in the perspective of a material specificity of the cinematic apparatus.

Those who are more oriented towards the coherence of the film's reception tend to maintain the original visual qualities rather than the original format —in other words, they prioritize content over the support medium; nevertheless, contemporary researches tend to problematize the content according to the support medium on which it is conveyed (and which contributes to its formalization).

In contemporary film restoration, computer graphics techniques play an ever-growing role in the restitution of images which have undergone damages, due to physical-mechanical accidents or to the chemical decay of the material.

Unfortunately, the photochemical tools sometimes have a limited potential of intervention both on the heavily damaged parts and on limited areas of the frame. Thanks to specific software, on the contrary, it is possible to digitally combine elements of the image from non-damaged frames, often with outstanding results (Fossati, 2009, p. 42).

The transparency and reversibility of the interventions are among the standard features of the most

common restoration software. It is required for the software to automatically provide a report of each intervention: thus, the registry file allows keeping or erasing the interventions by returning to the original materials.

Nevertheless, the clients, the companies of home video production and distribution, as well as the audiences (who demand always higher image qualities), often opt for a very invasive use of technology, without concern for the level of manipulation occurred during restoration, and the structural modification of the film through computer graphics. This gives way to a structural ambiguity: on the one hand, there is the need of keeping the pleasure of the cinematic spectacle; on the other hand, the source of such pleasure must be respected (and such source was produced in another context, detached from the contemporary milieu).

Among the main problems of preserving digitalized films we find the issue of determining a long-term policy. Already in 2000, Howard Besser identified five problems for the preservation and longevity of the digital objects: problems of "viewing, scrambling, inter-relation, custodianship, and translation" (Besser, 2000, p. 155). What is meant by problems of 'vision' concerns the difficulties caused by the obsolescence of formats: unlike analog formats included in traditional nomenclature, digital formats have developed into different and incompatible typologies. The 'scrambling', on the other hand, concerns compressed or encrypted formats, currently used in the film industry. As for the 'inter-relation', we need to consider the complex nature of the cinematic *oeuvres*, and the numerous elements which contribute to the final product: directors combine shots into sequences, adding soundtrack, titles, and special effects. The inter-related elements are generated by analog systems: original camera negative, work prints, soundtrack negative, negative duplicate, projection prints. Hence, elements of different generations coexist in the same process, and archivists know that it is indispensable to safeguard materials of previous generations. With digital systems, on the contrary, the relations among such elements are not easily established, and in order to identify the different sections that contribute to the final version of the film, archivists need to create systems of metadata.

There are several kinds of metadata which support the preservation of digital objects: for instance, the EDL, *Editing Decision Lists*, used in the field of digital editing and postproduction; descriptive metadata (similar to the archiving systems of libraries); and technical specifications.

The doubts concerning the actual duration of the film stock, its future in distribution networks, and the hypothetical duration of digitally-based support media are key issues within contemporary debates on the digital preservation of moving images. In the past, the standardization of film stock formats has allowed a swift circulation of materials among commercial and independent cinemas as well as film archives. When the isomorphic support medium is no longer in use, the issue of coding and decoding compatibility becomes an absolute priority, an indispensable condition for the films' circulation. The possible duration of a digital support is not comparable to that of analog formats, even if we take into account the need for continuous software and hardware updates due to their constant evolution, the possible lack of availability on the market, and problems of format compatibility.

In order to avoid compatibility problems, and with the goal of homogenizing commercial standards in collaboration with the main U.S. production and distribution companies, a common compression format has been adopted, which guarantees a *lingua franca* of digital cinema. Its name is JPEG 2000, and —together with files containing methodological instructions— it is delivered through storage systems or satellite networks to cinema theaters, within a DCP (Digital Cinema Package).<sup>5</sup> JPEG 2000 is *de facto* a standard format promoted by U.S. majors, or rather related to U.S. information technology industry: recommendations from UK Data Archive also include mention to different formats, such as TIFF (Tagged Image File Format), but due to less variance in specification JPEG 2000 is definitely the most used format.

The resolution is another key factor. Even if it is lover of the visual quality of a photochemical film, 2K standard has been accepted as minimum model of cinematic projection. The 2K standard means 2000 pixel for horizontal line. It is a generic definition: if the reference is the standard of Digital Cinema Initiative 2K native resolution or Cinemascope cropped or Flat cropped, you will have respectively 2048 × 1080 pixels, 2048 × 858 pixel or 1998 × 1080 pixels.

Even if audiovisual media are addressed towards high definition, from TV to home video formats (4K cameras are currently available also for amateurs), 2K minimum has been accepted in order to extend digital systems to various level of public fruition. Of course, we should consider the requirements for a theatrical screening, which needs an enlargement of the image on a wide surface. Considered that many archival materials don't require high resolution due to their grain or decay level, a 2K resolution copy of a film means to lose the 75% of the original detail (Fossati, 2009, p. 289).

The most updated archives are trying to follow the direction of the contemporary practice of hybridization, which already entails the whole distribution system: this means that many international archives are dealing with issues of storage and medatata, and they are learning to use the new standards in order to update their preservation procedures. Of course, this implies a series of problems related to the management of space, the need for highly qualified staff for the use of information technology (rather than film historian or archivists), as well as the energetic costs due to the machines implied in such systems. As technological obsolescence goes hand in hand with the advances in hardware performances, hopefully the costs will decrease and the storage capacity will increase at the same time, making it possible to manage a greater quantity of data and higher resolution films, in accordance to their iconic values and aesthetic qualities.

#### **4 IT's planned obsolescence: a matter of costs**

The industry's planned obsolescence<sup>6</sup> partially limits the benefits of digital technologies for archives and for the preservation of the audiovisual heritage. In fact, the management of digital audiovisual documents is still quite problematic. In this process, the most relevant profits go to the IT industries, which have created the technological advancements, but which have created above all the *need* for these advancements. The high costs of digital archiving systems for cinema must be added to the costs of the traditional analog conservation processes (indispensable). Archives have to plan cyclical transfers ('migrations') of data onto new carriers at certain time intervals, because of the risks of hardware and software obsolescence. Recent studies on the workflow of digital preservation examined costs parameters and a mapping of costs and related benefits: bits are different from paper and require continuous care, so a constant funding (Rosenthal; Rosenthal; Miller; Adams; Storer; Zadok, 2012, p. 195-196)<sup>7</sup>: high resolution



formats (those standards that respect the formal features of the film) are still less accessible to film archives. As a result, today's digital archives need permanent care, maintenance, and thus financial resources (one of the major disadvantages of this approach). On the other hand, many types of film stock still offer excellent long-term stability, and traditional archiving of the (analog) film negatives is a cost-effective, long-term storage solution, within cold storage rooms, in order to safeguard the chemicals of the film<sup>8</sup>.

The increase in scientific publications on the use of digital technologies for the preservation of the cultural and visual heritage—from interventions on manuscripts to applications in the fields of archeology, architecture, and photography—testifies a will to integrate the operations of preservation and restoration and the precision and extreme flexibility of contemporary technological tools. The attempt to critically discuss their role and effects (avoiding the excesses of technological utopianism or Luddite controversies) aims at provoking a thoughtful debate on the potentialities and risks of the use of such instruments with regards to the audiovisual heritage.

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## Notes

<sup>1</sup> "Considering however that, due to the nature of their material embodiment and the various methods of their fixation, moving images are extremely vulnerable and should be maintained under specific technical conditions; Noting furthermore that many elements of the moving image heritage have disappeared due to deterioration, accident or unwarranted disposal, which constitutes an irreversible impoverishment of that heritage; Recognizing the results yielded by the efforts of specialized institutions to save moving images from the dangers to which they are exposed". (UNESCO, 1980)

<sup>3</sup> "The evolution of flexible silver-gelatine photographic films began with cellulose nitrate as the support in 1889. This had excellent physical properties but its chemical stability was very poor, and also was a fire hazard. In 1922, amateur movie films were introduced using an organic ester of cellulose support (cellulose diacetate) because of its slow burning characteristics. For 30 years, the only commercial safety films consisted of a variety of organic ester of cellulose such as cellulose diacetate, cellulose acetate-propionate or cellulose acetate-butyrate. However, in professional cinematography cellulose nitrate remained the principal support until 1951. In 1948 cellulose triacetate supports (CTA) were introduced as this material

met all the technical and safety requirements for professional motion picture films. In the mid-1950s polyethylene terephthalate material (PET, known in the industry as 'polyester') was introduced and its use began to increase in the 1980s. Today PET has a wide acceptance due to its exceptional physical properties as a safety photographic film support. Its structure is inherently more chemically stable than either cellulose nitrate or cellulose acetate stability. On accelerated-aging test, PET suggests a longer life by five to ten times that of CTA under the same comparable conditions. Currently, cellulose nitrate photographic films are not acceptable for any film production. Poly(ethylene) terephthalate is mainly used as cut sheet polyester film (X-ray and graphic arts applications), microfilms, amateur 35mm camera film, and cinema release prints". (Abrusci; Allen; Del Amo Garcia; Edge; Martín-González, 2004, p. 37-38).

<sup>3</sup> "On monuments and frescos the 'patina' consists in a thin layer, of visibly biological nature, which adheres to the surface. Any cleaning intervention on an artwork tends to remove such patina, as the source of its decay and decomposition of the materials; but its —at least partial— preservation ratifies the idea of respect of a historical distance, of an effective dialogue between different eras, of a thin layer of separation between the past and a present able to understand and respect the past itself" (Brandi, 1977, p. 36). On the concept of patina, see also Brachert, 1985.

<sup>4</sup> "By saying film we refer to a specific historical phenomenon, rooted in the 20th century, with all its distinctive characteristics. However, we also imply that many of the issues facing the analog heritage — especially the challenges of preservation and public presentation— also apply to the digital world, or are bound to do so in the near future (...)". (Cherchi Usai; Francis; Horwath, Loebenstein, 2008, p. 5).

<sup>5</sup> *JPEG 2000* have taken this name from the Joint Photographic Expert Group of 2000; they are associated to XML files (eXtensible Markup Language, a format containing data and instructions directly encoded by computers) and other *MXF* files (Material eXchange Format, a format containing meta-files, encoding criteria and instructions) in order to implement the DCP).

<sup>6</sup> For the concept of planned obsolescence, see: Fitzpatrick, 2011.

<sup>7</sup> I acknowledge Luca Antoniazzi (University of Leeds, Institute of Communications Studies) for pointing this reference.

<sup>8</sup> In 2007, according to the Academy of Motion Picture Arts and Sciences, digital archiving system costed eleven times more than the photochemical film preservation system: "The long-term preservation of, and convenient access to, a company's cinematic assets is clearly going to be an ongoing concern, and yet a danger exists that in an effort to stay on the curl of the digital wave —an effort not surprisingly encouraged by the vendors of digital technologies— the industry may make decisions that produce unfortunate financial and cultural consequences". (Science and Technology Council of the Academy of Motion Picture Arts and Sciences, 2007, p. 1).

In 2012, the Academy pursued a new analysis on the impact of digitization as material longevity in different fields of the audiovisual industry, such as independent directors and productions and no profit archives. "The fact remains that digital data cannot survive unattended, and with the passage of time, answering the call to action becomes increasingly urgent". (Science and Technology Council of the Academy of Motion Picture Arts and Sciences, 2012, p. 2).

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