

Study of contemporary art preservation with digitization

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Abstract

Since 2006, the Contemporary Art Group at the Research Department of French Museum Conservation and Research Center (C2RMF - Ministry of Culture) has been working on technological obsolescence phenomena. The purpose of this program is to study the impact of technological evolution on contemporary art works and, more precisely, on their preservation. Among contemporary art collections, our group focuses essentially on technological installations, with audiovisual or digital elements, and is mainly concerned with obsolescence phenomena.

Since the late 1960s, an increasing number of art works kept in contemporary art collections consist in still or moving images. Many of these images are now conserved on obsolete devices and formats which essentially has as consequences that it becomes difficult to produce new copies when operating copies are damaged; it becomes difficult when the state of conservation of originals is altered, to remedy (i.e. to treat or replace); and it becomes difficult to find the necessary equipment to read (or diffuse) these images. It becomes simply impossible to present certain parts of museum art collections: their accessibility is threatened and hence their own conservation and preservation.

Faced with this combined obsolescence of media, devices and formats, those responsible for collections, the curators or conservators, frequently carry out the digitization of repositories for purposes of diffusion or preservation. However, a digitization campaign requires specialized and technological skills which are currently not available in museums.

Because arts works are unique and non standard objects, methods of mass digitization used in other domains, such as television or libraries archives can not be directly imported. We actually focus on avant-garde or experimental cinema digitization, because film in 16 or 35mm will probably soon no longer be available. We made a study on the digitization of such movies, with focused on conservation of colors and on time based phenomena like flicker. Avant-garde and experimental films often consist in abstracts images, based on colors and flicker. We wanted to evaluate the modifications led by the change of technology.

We detail here an experiment focusing on color. We first defined the framework of reproduction adopted by the two main French repositories of art movies. Then, we worked with a postproduction company and analyzed digitization, based on the colorimetric characterization of input and output digitization devices, inspired by color management in photography.

Three colorists did a digitization with the aim of preserving the original colors. The results show a huge difference between film colors and digital colors. An analyze of such differences found correlations between colorists and connects these results with photography, color management and psychophysics. Limits of color conservations in digitalization of experimental movies are exposed here as well as advices in order to minimize then.

Introduction

Since 2006, the Contemporary Art Group at the Research Department of the French Museum Conservation and research Center (C2RMF - Ministry of Culture) has been working on technological obsolescence phenomena in the field of contemporary art. The purpose of this program is to study the impact of technological evolution on contemporary art works and, more precisely, on their preservation.

The management of obsolescence phenomenon concerning the work of arts is a cutting edge frontier. The project initiated by C2RMF in 2006 is based on several recent initiatives. The Variable Media Network [1], created by the Langlois Foundation with the collaboration of Guggenheim New York, has first theorized the obsolescence phenomenon question in the field of contemporary art, in a very efficient and useful way. The project was carried out notably by Alain Depocas for the Langlois Foundation and John G. Hanhardt and Jon Ippolito for Guggenheim.

Among contemporary art collections, our group focuses essentially on technological installations, with audiovisual or digital elements, that are mainly concerned with obsolescence phenomena [2]. The aim of this program, that is studying technological obsolescence phenomena in contemporary art, is to define a deontological framework and an expertise about management of obsolescence phenomenon, and particularly in digitization. The C2RMF would like to identify several cases, problematic and recurrent, and to make a comparative study between silver halide film and digital data. The idea is to characterize images in both technologies, in particular via colorimetric measures.

This article presents the issue of technological obsolescence in contemporary art (an history can be found in French in [3], which present in particular the Variable Media Network). It presents an experiment we made on digitization of experimental and avant-garde cinema which focuses on color reproduction.

Technological obsolescence and contemporary art

Since the late 1960s, a large and increasing number of art works kept in contemporary art collections consist of still or moving images, integrated or not within installations. Many of these images are now conserved on obsolete devices and formats, which essentially has as consequences that it becomes difficult to produce new copies when operating copies are damaged. It becomes difficult when the state of conservation of originals is bad, to remedy (i.e. to treat or replace); and it becomes difficult to find the necessary equipment to read (or diffuse) these images. It becomes simply impossible to present parts of art works collections : their accessibility is threatened and hence their own conservation and preservation.

Technological or media art works came into collections that were based on fine arts. To study the ageing of materials of

cultural heritage works, there is a deontological code of rules and a profession (restorer). But there is no deontological code or profession in museum that is able to deal with technological obsolescence phenomena. Issued from traditional fine arts, deontological frameworks for restoration and conservation are not adapted for technological obsolescence. It results in a lack of management of technological art works which leads to isolated and non adapted practices, a lack of documentation of works of arts in general and in particular for technical points, and a lack of documentation about restorations and reparations made on them. The concept of perennization is rarely considered.

Faced with this combined obsolescence of media, devices and formats, those responsible for collections, the curators, frequently carry out the digitization of repositories for purposes of diffusion or preservation. There are two different cases:

- the physical devices (like the silver halide cinema film) are available, even without reading machines and stay a reference in terms of conservation (we could always see a photogram and look at the original color of the image)

- recording on magnetic tapes (like analogue video) are not viewable without a reading machine and are no longer available once the reading machine has disappeared. In this case, when the original is not available anymore, the digitized work became a "new original".

Digitization of works of art collections engage not only diffusion (i.e. presentation) but also, depending of the context, the conservation of the work of art.

In the library and archives domain, where digitization is much more advanced than in museums (because of the large volumes treated), digital archiving is an new discipline. In contemporary art, where this problematic is new, there is a lack of competences.

But, it is not possible to import practices of library or archiving center because the problems are very different for us:

- Library and archives treat standard documents and look for mass and automatic treatments.
- Contemporary art collections have unique and non standard work of art that need special and in context treatment.

It is necessary to consider in detail the question of digitization in contemporary art. Nowadays, times, money and abilities available for responsive of collections do not allow them to produce a specification with the precision needed for those objects, that are on reproducible devices and that are the consequences of unique and out of norms intentions. They can not evaluate neither the work of digitization made by the firms which quotation substitutes specifications and quality evaluation.

Study of patrimonial films digitization

Presentation

With technologic obsolescence of cinema films and in particular the increasing difficulty to edit copies in others formats other than 16 or 35 mm, it becomes more and more difficult to expose and diffuse rare and precious cinema films. Curators of avant-garde and experimental cinema (not produced and diffused in classical cinema circuits) examine digitization for exposition, diffusion and even for conservation.

There are in France two main structures for the conservation of experimental cinema: le MNAM (National Museum of Modern Art, centre Georges-Pompidou), and the independent distributor

Light Cone. They consist of about 4000 films. The MNAM has a representative collection of the main movements of independent cinema, from the 1920-1930's avant-garde cinema to 1960-1970's experimental cinema. Light Cone collects more recent films and favors French experimental cinema above others young experimental cinema. Both collections have begun digitization of their repositories.

Digitizations are made by an external firm, with or without the control of a curator. They are made by a colorist (in charge of digitization and color parameters), with a telecinema (film digitization device), and delivered in SD format (Standard Video, as opposed to High Definition), for documentation purpose (consultation in documentation area, on Websites and sometimes on TV).

In this process of digitization of experimental cinema, we chose to study color rendering. Indeed, in this cinema and in particular with abstract films, color is not a photorealist parameter but constitutes the main subject. Color must be reproduced in the best way possible, as close as possible as the original.

Protocol

Three experimental films were lent by Light Cone (they are exploitation copies and not the originals).

- « Quiet chaos of desire », Carl E. Brown, 2007, color, 35 mm, 3'20. This film is made of pieces of heteroclitics films and abstracted plans, scratched and painted by hand. Color tones choose by the artist vary over vivid and dark red to cyan and dark green.

- « Vincit Veritas », reMI, 2002, couleur, 35 mm, 10'. This film is issued from digital experimentations around defective image and sound files. Although it was created in video, this work of art is diffused in 35mm. Colors are saturated and simple, mainly primary and complementary colors and ramps.

- « Cécile Fontaine vs. Dany Brillant », François Rabet, 2004, 35mm, 7'. The author used the technique that removes the film emulsion and transfer it on another device. This makes a shapeless image. The film was tainted in yellow-orange and in green.

We worked with a cinema post production firm called Teletota and three colorists. We asked the three colorists to digitize the films in order to respect the colors, using their usual working methods. The first colorist (Et.1) has a 21 years experience, the second (Et.2), 7 years and the third (Et.3), 3 years.

Technical step of digitization chain color characterization

The devices used by the post production firm are the Thompson Spirit Datacine telecinema, the calibration device Da Vinci 2K and the CRT screen Sony BVM20F1.

Contrary to an image treatment chain in graphic arts (photography, press) [4], the chain of treatment in the cinema area does not have a normalized procedure for color calibration (cinema industries are currently working on this point). This study needed a preliminary step of color measures and device's characterizations. In order to compare colors on film and colors validated by colorists, we characterized the telecinema and the screen in the calibration room [5].

Note that the three colorists used different methods. One looked at the color on the films (delayed mode), one used the LAD charts (color reference chart) and one didn't use a color reference.

Once the film digitized, the amount of digital data is huge so we choose 30 images to represent each film. Then we developed a Matlab algorithm to analyze data.

The result of this protocol allows us to compare the colors of the films and the digital colors as seen on the control screen calibrated on SD standard. We worked with the $L^*u^*v^*$ color space that allow us to represent lightness, hue and saturation of the different points [6].

Color differences between films and digitizations

Results

We see in the table 1 that the average difference between the film and the digital version is important, about 25 delta E. This means that colors are not well reproduced with digitization [7].

We can see a lot of differences in color reproduction, as some colors are close (minimum mean 2,6 delta E) and others are really different (maximum mean 59 delta E). All colors are not reproduced with the same differences for one film. Those analysis on means are a summary and color differences depend on film and colorists. For example, Et. 3 has a relatively low mean delta E of 15 on « Quiet chaos of desire » but the film « Vincit Veritas » seems to be much more difficult to reproduce (36,77 delta E).

Table 1: color differences between film and digitization, in Delta E, for the 3 films and the 3 colorists.

		Color differences between film and digitization (in delta E), all points.		
		mean	Minimum	Maximum
Quiet chaos of desire	colorists			
	Et.1	27,24	1,65	65,04
	Et.2	18,15	2,01	52,51
Vincit Veritas	Et.1	35,23	3,01	80,27
	Et.2	20,62	3,68	39,92
	Et.3	36,77	3,2	81,99
C. Fontaine vs D. Brillant	Et.1	27,19	3	64,02
	Et.2	23,08	1,36	51,55
	Et.3	21,26	3,63	47,18
average		24,98	2,67	58,97

Table 2 gives the percentage of points of one film reproduced as a function of delta E, that are weighted data of table 1. For example for « Quiet chaos of desire », Et.3 obtains 15% of points of the films in a value less than 4 delta E (so digital colors are really closed to film colors) and 58% of color points are reproduced with less than 14 Delta E (that is acceptable for diffusion). Opposed, Et.3 obtains only 45% of points reproduced with less than 34 Delta E that means that this digitization is far away in term of color reproduction.

Table 2: percentage of points of the films reproduced with a color difference less than 4, 14, 24 et 34 Delta E, for the 3 films and the 3 colorists

		Percentage of points of films reproduced with a color difference less than :			
		4 delta E	14 delta E	24 delta E	34 delta E
Quiet chaos of desire	colorists				
	Et.1	7	27	39	70
	Et.2	32	46	53	98
Vincit Veritas	Et.1	15	58	77	94
	Et.2	5	12	18	59
	Et.3	6	29	59	86
C. Fontaine vs D. Brillant	Et.1	4	21	24	45
	Et.2	4	35	59	68
	Et.3	19	33	55	79
average		2	37	73	80
average		10	33	51	75

A more precise visualization of those differences is given in figure 1 and 2 that represent vectors of color differences between film and digitization (color point) in CIELUV space. Figure 1 shows vectors for the film « Quiet chaos of desire » and Et. 1 in u^*v^* plane. The gamut envelop of screen is in grey (gamut contains all the reproducible colors by a device). Figure 2 shows vectors for Et.3 for « Vincit Veritas » in L^*v^* plane.

Those representations in 3D, here showed in 2D, allow us to analyze more precisely the behavior of colors during digitization, depending of colorist and technical constraints. Indeed, all the reproducible colors (gamut) by a device depend upon it technology and is different from another device [8]. So, in the case that interests us, there is an unavoidable difference between colors that can be reproduced by a film and a screen for example. Some colors of the film could be modified by the digitization, independently of colorist. Figure 3 shows the gamut of the film (yellow/light) and the screen (purple/dark), we see that some colors on film cannot be reproduced by the screen and vice versa.

Figure 4 show photograms of digitized films by the three colorists. This is an illustration of the different color interpretations of colorists. Some interpretations, although they are close, stay away from the original film. The original image on film can not be shown here. Note too that the device you use to look at those images can modify the color rendering.

Differences' interpretations

After studying color changes after digitization, we observe common behavior in color transformations made by colorists.

Apart from the colorist Et. 3 in « Quiet chaos of desire », colors obtained by colorists are always more bright than original film colors. Usually, colorists tend to augment chroma to reach the maximum chroma available by the technical device, in the border of gamut. The analysis of « Vincit Veritas » shows that original colors that were mainly along the grey axis were turned into more saturated colors. Colorists tends to use the maximum of the gamut, probably in order to gain visibility, while obtaining colors with more purity. Hues are deviated toward primaries colors. For

example, red-violet colors in « Quiet chaos of desire » are always deviated toward pure red, close to the primary red of the screen.

Experimental cinema use color in non figurative scenes and this is the most difficult case for digitization. Indeed, we know that the color setting chosen by colorists are based upon comparison of digitized color with internal reference they have in memory, due to their experience [9, 10, 11]. These reference colors called memory colors are well known colors associated with objects, like the sky, grass or skin. We do have a precise representation of those colors in our memory and we use them to do any color judgments or corrections. Research on this subject in the field of photography could be applied in our opinion to cinema digitization. They conclude that, without memory colors, as in our case of experimental cinema, exaggeration phenomenon (increase of chroma and lightness) and focalization (deviation toward pure colors) occur [12]. In our case, colorists mainly modified colors to increase lightness, saturation and toward pure ones. In our experiment, the hue doesn't not change a lot, but lightness and chroma do.

Discussion

Results obtain in this study are quite far from the ideal results that could be expected in a museum context. There is an important bias between original and reproduced colors.

Part of the problem is coming from the lack of parameter options in the cinema chain. Indeed, reproducing exact color is a border line case of the work of post production cinema firms because their work is more to interpret color and to look for special rendering! Digital color management in cinema in France is so far only used to solve problems about printing from digital to film. It was not considered as useful for digitization of negative films from shooting because those colors were intended to be interpreted in post production, and this interpretation remains the principal activity of post production firms.

So, colorists do not have complete tools in order to make the closest color reproduction. In our case, references used by colorists Et.1 and Et.2 do not seem to be good enough. A high performance color management system is thus necessary. But it is not sufficient. Indeed, there is an interpretative part in the colorists work that is almost necessary, because of gamut constraints that could be engendered by technologies changes in producing images (film, screen, projectors).

Another problem explaining the important delta E may be that we compare colors on films and colors on a screen, and because one is self luminous and the other is not, even if color $L^*a^*b^*$ measures are equal, there is a difference in perception because of adaptation phenomenon [13].

A much more developed system including the differences in technology, projection parameters, gamut mapping, and data about color appearance (with adaptation phenomenon parameters) is necessary. High performance and standardized tools are currently being introduced in cinema industry, those technologies are in major evolution [14, 15].

Color is a major parameter of digitization's quality of works of arts. It should be taken into account in institutions' specifications according to digitization objectives – for documentation or conservation.

Given current technical constraints, the most important is probably is color traceability. Recording and conserving

digitization parameters would permit the description of a digitized work with the file and the digitization characteristics. Quality and precision of digitization should be decided with the post production firm, that could, depending the technologies it use (implying different costs) give a digital “master” of the work of art, that could be exported later to several formats (DVD, projections...).

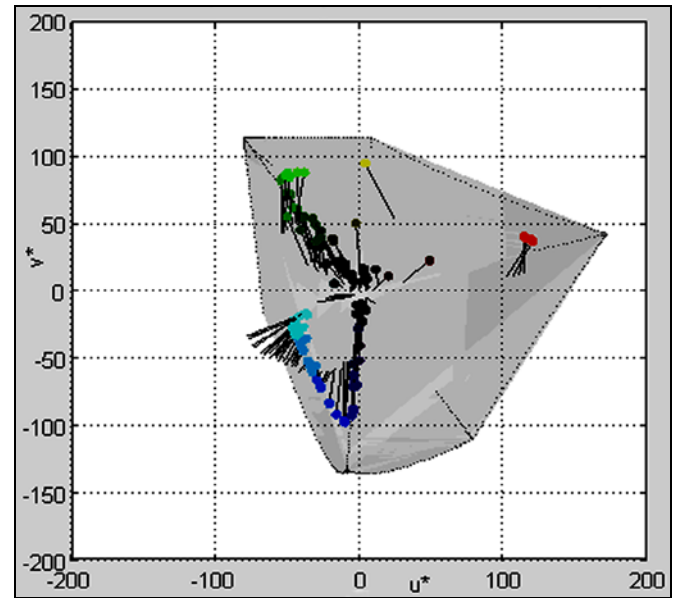


Figure 1. Vectors between the film colors and the screen colors (point), colorist Et. 1, for the film « Quiet chaos of desire » in u^*v^* plane. The gamut envelop is in solid grey.

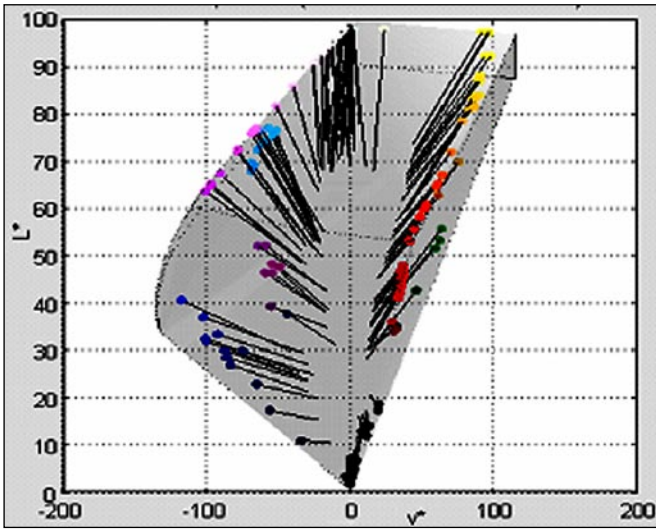


Figure 2. Vectors between the film colors and the screen colors (point), colorist Et. 3, for the film « Vincit Veritas », in L^*v^* plane.

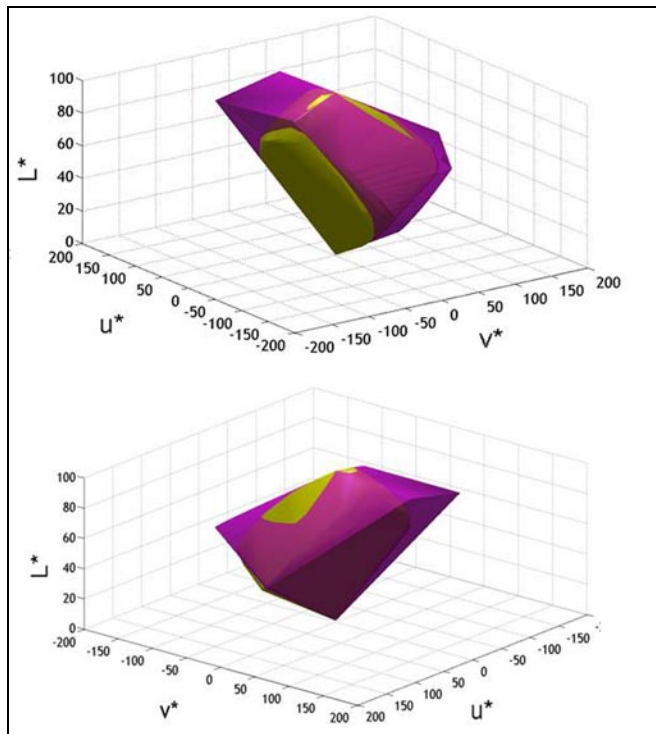


Figure 3. Gamuts of the film (yellow/light) and the video screen (purple/dark)

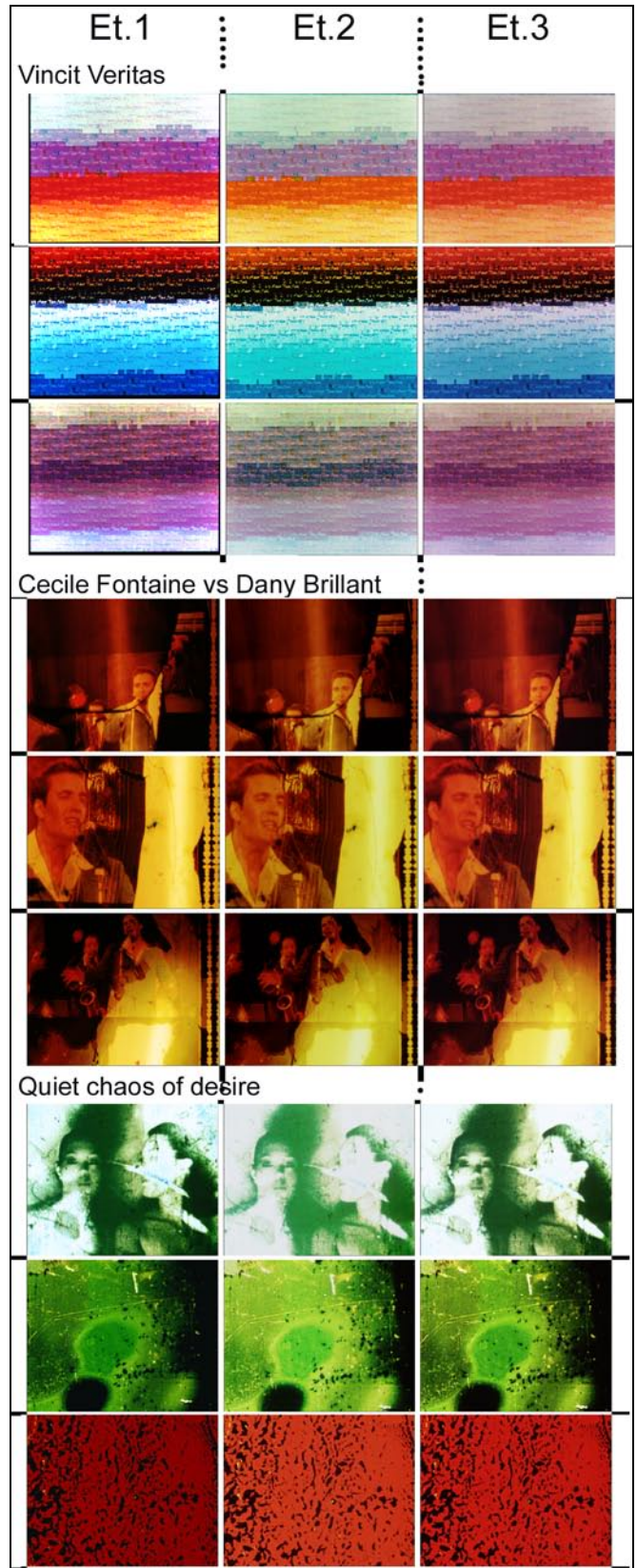


Figure 4. example of images digitized by the three colorists (Et. 1, 2 and 3) for the three films

Conclusion

In the project concerning the management of technologic obsolescence phenomena in the collection of contemporary art, the study of digitization of patrimonial cinema by the Contemporary Art Group of C2RMF doesn't have the objective to always advocate the digitization of films. The perspective is the inverse : given that many collections (it is the case for National Museum of Modern Art and Light Cone) are already engaged in digitization process of their repository, and given the importance of the esthetical quality of projected images, it seemed important to develop a comparative approach between film and digital images. The study about color management only constitutes a preliminary step, another project about flicker conservation is in progress. The idea behind those studies is to find a way to minimize the gap between the original film and the digital version of the same work of art, without denying the structural difference between those images. On the contrary, the formulation, the most precise possible, of the differences in terms of image perception is absolutely central to our approach. The objective of the several projects developed at the C2RMF is to do a "modeling" of work of arts, in their original forms. In other words a description of parameters that, at a perception level, are characteristic of the work of art, of the qualities that we must find, even when the work of art is struck by technological obsolescence and changes its form or format.

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