CONSERVAR PATRIMÓNIO

ARTICLE / ARTIGO

Decision-making process and restoration work of a photographic-based artwork by Ernesto de Sousa

Tomada de decisão e intervenção numa obra de arte fotográfica de Ernesto de Sousa

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Abstract

This paper discusses the conservation challenges posed by the mixed-media photographic artwork, *Revolução, Corpo, Tempo* (1978) by Ernesto de Sousa, from Museu Nacional de Arte Contemporânea do Chiado, in Portugal. Due to the artwork's poor condition and an exhibition request, a conservation intervention was needed. However, the definition of a conservation plan was challenging because of the complex and singular creative process of Ernesto and the highly deteriorated exhibition mounting. The lack of existing information led to the start of a research study and to the production of new documentation. This paper examines the gathered knowledge on Ernesto de Sousa's work and case study, and his possible position regarding the artwork's deterioration and evolution over time – fundamental issues for decision-making in conservation. Based on visual observation, archive research, informal interviews, photo-documentation, infrared spectroscopy, and x-ray fluorescence spectroscopy, this paper discusses the challenges, the methodology and the applied treatment.

KEYWORDS
Ernesto de Sousa
Photography
Mixed media
Condition assessment
Decision-making
Conservation and restoration

Resumo

Este artigo discute os desafios na conservação da obra fotográfica de técnica mista, *Revolução, Corpo, Tempo* (1978) de Ernesto de Sousa, do Museu Nacional de Arte Contemporânea do Chiado (Portugal). Devido aos danos na obra e um pedido para exposição, foi necessário realizar uma intervenção de conservação. A definição de um plano de conservação foi desafiante devido à falta de informação sobre o complexo e singular processo criativo do autor e aos extensos danos nos elementos da montagem. Este artigo analisa a informação recolhida sobre a obra e o caso de estudo, e discute a possível posição do artista face à deterioração e evolução da obra ao longo do tempo – questões fundamentais para a tomada de decisão em conservação. Através da observação visual, pesquisa em arquivos, entrevistas informais, foto-documentação, espectroscopia de infravermelho e micro-fluorescência de raios X, apresentam-se os desafios, a metodologia e o tratamento realizado.

PALAVRAS-CHAVE
Ernesto de Sousa
Fotografia
Técnica mista
Avaliação do estado de conservação
Tomada de decisão
Conservação e restauro

Introduction

The photographic work by Ernesto de Sousa (1921-1988) raises many challenges to curatorial and conservation decisions. His work is characterised by the relevance of a conceptual nature to the detriment of processes, techniques, and materials, like many artists from the neo-vanguard period [1-2]. The presence of unique display mountings and complex assemblages with different elements and often made of precarious materials is also commonly found in this artist [1-2]. The *povero* character, the appropriation of materials from the mass media, and the artwork being understood as a process, are characteristics of Ernesto de Sousa's work, which poses challenges to conservation praxis. The *povero* character refers to the connection of Ernesto's work to the "Arte Povera Movement" initially developed in Italy in the 1960s. As Ernesto was a profound connoisseur and admirer of the Italian art and culture of this period, his artistic work adopts the practice of using materials linked to everyday or non-artistic use in the sense of valuing the ideas and not the material in artistic terms, hence the use of plastics, ropes, fabrics etc. Also, his photographic work relies on a broader and more polysemic discourse, that, as the expression indicates, it is influenced by other areas of thought. For this reason, his work should be understood in the perspective of different fields of knowledge such as semiotics, communication theory, politics, and literature. Ernesto's works result from merging various forms of art and communication, many times categorized as mixed-media rather than photography [1-2]. His artworks should also be understood as hybrid documents that may change meaning over time and – from an exhibition point of view are always thought of – procedural instruments for a dialogue with the public. Ernesto de Sousa consciously refused any understanding of his photographic work as a unique object, and he did not have any interest in exploring the aesthetics of materials. It is, on the other hand, the polysemic, democratic and accessible character of the photographic document that – for the artist – constitutes the starting point for its use in more complex and interventionist models of artistic-political thoughts.

The artwork *Revolução, Corpo, Tempo* (1978) – in English, Revolution, Body, Time – (Figure 1), belongs to the collection of the Museu Nacional de Arte Contemporânea do Chiado (MNAC) since 2012, when Ernesto de Sousa's widow, Isabel Alves, donated the artwork to the museum. It is composed of three vertical strips of laminated photographic print sets (developing-out-paper), assembled by adhesive tapes. A wood element is positioned at the end of the third strip. For display, each strip is fixed to the wall through perforations of two metal eyelets and nails at the top and bottom.

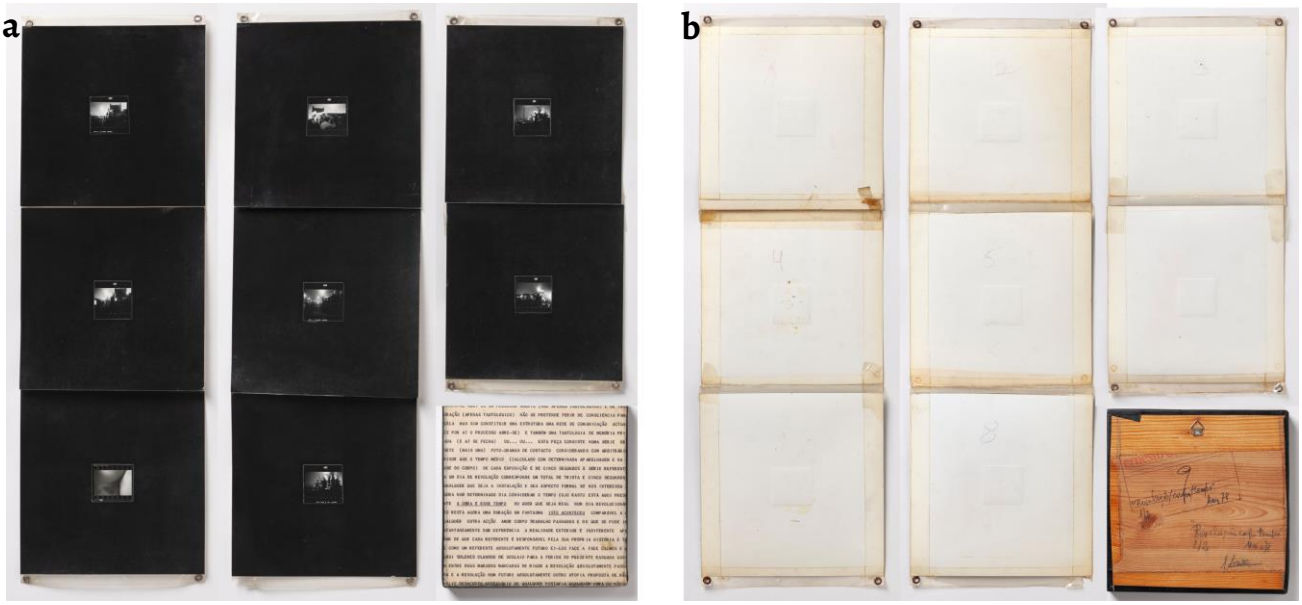

Figure 1. Ernesto de Sousa, *Revolução, Corpo, Tempo*, 1978: *a)* front and *b)* back, before the conservation and restoration work (photo: J. P. Ruas, ADF – DGPC).

When acquired by MNAC, the artwork was already in poor condition, especially evident in the overall distortion of the laminated prints, the deteriorated adhesive tapes, and the loss of two metal eyelets. Therefore, the artwork could not be exhibited, being kept in storage since then. In 2021, in preparation for the upcoming exhibition *Ernesto de Sousa, Exercícios de Comunicação Poética com Outros Operadores Estéticos*, organised by Empresa de Gestão de Equipamento e Animação Cultural (EGEAC), marking the artist's birth centenary, the artwork was requested to MNAC. This exhibition and the partnership between MNAC and the Department of Conservation and Restoration (DCR) from NOVA School of Science and Technology launched the opportunity to start a conservation study for *Revolução, Corpo, Tempo*.

Even though Ernesto is one of the most important Portuguese artists in the twentieth century [1-3], with a tremendous amount of works in renowned national collections (such as Museu Berardo, MNAC and Fundação Calouste Gulbenkian), there is a limited number of objective publications concerning Ernesto's working methods, materials selection, and display options. Several of his artworks were already subject to conservation interventions or have suffered mounting display changes, yet publications concerning such decisions are non-existent.

This paper draws special attention to the decision-making involved in the conservation and restoration work of this artwork, focusing on characterisation and production of documentation for such decisions. It also contributes to raising awareness for the demands posed by this type of artworks and highlights the urgency of studying and sharing strategies for the conservation of mixed-media photo artworks.

Materials and methods

Informal interviews

Conversations with Emília Tavares were carried out because of her role as curator of MNAC and proponent of the current conservation and restoration work to DCR, as well as her familiarity with Ernesto de Sousa's work [1-2]. Isabel Alves, widow of Ernesto, was interviewed for her in-depth knowledge of Ernesto's working process. Both testimonies were fundamental to collect information about the artwork's biography and its evolution over time.

Photographic documentation

Photo-documentation of the artwork was performed with a DSLR NIKON D500 camera. A workflow was designed to minimise handling and to prevent unnecessary exposure to light. For that, a consistent setup was established, including sequencing the shots, to minimise the changing of accessories and equipment from one technique to another and perform an effective image capture protocol. The standardised setup and workflow were based on recommendations given by Warda [4] and Chen and Smith [4]. The lighting setup included different light sources and angles to capture technical aspects and features of the artwork as well as damages. Tungsten lamps were used for visible/normal and visible/raking illumination and a Philips TLD 36W/08 for UV illumination. A more detail description of the setup can be found elsewhere [4-5].

Additional images were taken with a Dino-Lite digital microscope, AM7915MZTL model, for higher detail and magnification of damages. The microscope was mounted on a stand to help with focus and microscope positioning. Optical fibres were used for incident and raking illumination, in addition to the microscope's lighting system.

All images were saved as TIFF formats without any other adjustments. With the TIFF files, JPEG files were generated and altered in *Adobe Photoshop* software (CS6). The image alteration consisted of crop and contrast adjustment made on the "Levels" option by adjusting to the curve.

Sampling

Samples were collected from the artwork with a Ted Pella micro tool and a scalpel. The complete set of samples was stored between two glass slides with concave indentations, used as sample holders. This set included samples from the lamination film, the adhesive tape found on the edges of all prints (main adhesive tape), small pieces of adhesive tapes looking like patches, and adhesive residues. In addition, another artwork by Ernesto de Sousa was also analysed due to its identical characteristics to the case study (an assemblage of photographs with adhesive tapes and the presence of a lamination film). The artwork is entitled *Pretexto II* (1982) and can be found in [6]. *Pretexto II* is an installation composed of a ready-made, some texts by Virginia Woolf and Sigmund Freud (4 silver gelatin prints, 50 × 40 cm) and a strip of laminated prints (26 elements, colour, 236.5 × 13 cm). For this research, the strip of prints was analysed due to the similarities with the artwork *Revolução, Corpo, Tempo* (1978).

Infrared spectroscopy

Samples collected from the artworks *Revolução, Corpo, Tempo* and *Pretexto II* were analysed by infrared spectroscopy in attenuated total reflection (ATR-FTIR) with the Handheld Agilent 4300 spectrophotometer, equipped with a ZnSe beam splitter, a Michelson interferometer, and a thermoelectrically cooled DTGS detector. Spectra were acquired with a diamond ATR module, 128 scans and 4 cm^{-1} resolution, between 4000 and 650 cm^{-1}. Background spectra were collected between every acquisition.

X-ray fluorescence spectroscopy

Micro-scale energy-dispersive X-ray fluorescence (μ-EDXRF) analysis were conducted using an Artax spectrometer from Bruker, with molybdenum X-ray source, focusing polycapillary lens and electro-thermally cooled xFlash (Si drift) detector, with 170 eV resolution (Mn Kα). The accurate positioning system and polycapillary optics enable a small area of primary radiation (Ø~70 μm) at the sample. The spectrometer was operated at 40 kV, 0.6 mA, at low vacuum. Elemental composition of two areas per sample and at least three different measurements were carried out.

Results

Artwork description and biography

The description of this artwork is complex due to the diversity of elements, formats, assemblages, and sequential distribution of elements in the artwork (Figure 1).

The elements designated as “prints” are an assemblage of a contact print overlayed on the centre of a silver gelatin print with maximum density (Dmax) acting as a frame, which are laminated together (Figure 1 and Figure 2). The prints with Dmax have the backprinting “Agfa”, stamped on with a grey ink, indicating the paper manufacturer. According to Thompson et al. and Abbaspour et al. [7-8], this brand was in use during the 1950s and early 1960s in North American countries, Canada and the United States of America. However, to our knowledge, there are no studies focusing on the use of photographic papers by Portuguese artists. Regarding the contact prints, no information was found regarding provenance, because the reverse of those prints is covered with the Dmax “Agfa” prints. Most subjects in the contact prints are documental scenes of street protests and a nude of a woman.

The total set of eight prints is laminated and the sequence of prints is assembled with a main pressure sensitive tape (PST), framing each one of the prints (Figure 1 and Figure 2). The prints are sequentially numbered, inscribed with black ink on the back (although barely visible), indicating their order (Figure 2). On the top and bottom prints from each strip, the artist placed metal eyelets to fix the artwork onto a wall while on display (Figure 1 and Figure 2).

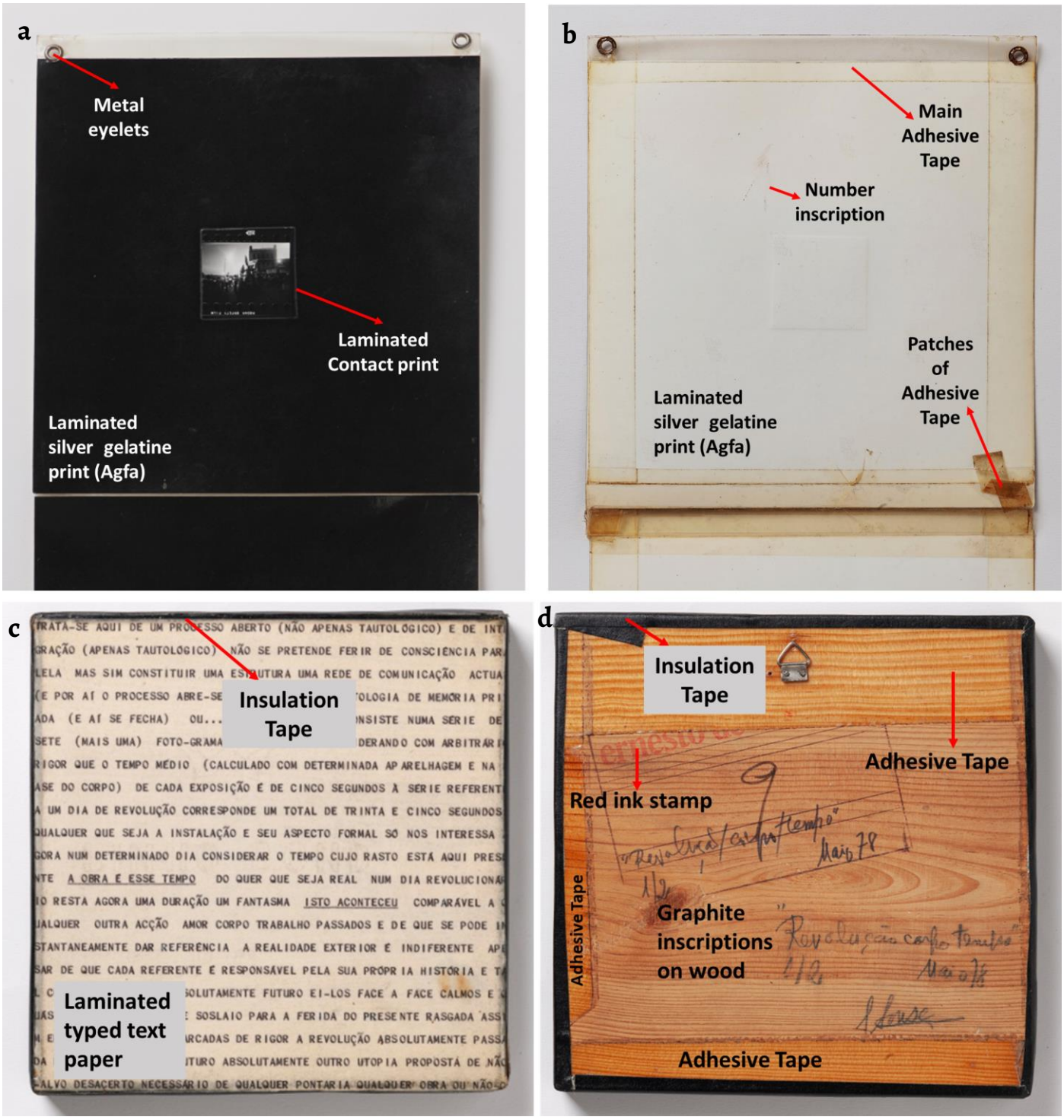

Figure 2. Detail of the strip 1: *a)* front and *b)* back; and of the wooden block: *c)* front and *d)* back. The arrows indicate the place and designation of the different artwork elements.

The wood element is composed of a woodblock covered in the front by a laminated typed text paper, and partially covered in the back by a PST with a large width (Figure 2). A watermark on the paper is partially discernible, however, it was not possible to confirm the inscription or shapes present. The woodblock may be pine wood by visual assessment and comparison with a sample set in Ruffinatto and Crivellaro [9]. Additionally, a black PST (insulation type) was used as a side finish (Figure 1 and Figure 2). On the back, black ink and graphite inscriptions were used to register the artwork's name, production date and artist signature (Figure 1 and Figure 2). The name of the artist is partially stamped with red ink (Figure 2). The partial absence of the stamp might indicate that the PST could have been partially removed in the past, nevertheless,

no clear justification was found. Additionally, there was no explanation for the presence of the inscription "½", also found on the back of the wooden element (Figure 2d). This issue was discussed with MNAC and Emília Tavares suggested that the inscription might indicate the material typology present in the work (laminated prints and wooden element), rather than the possibility of this artwork being a part of a series of two artworks with the same title and year, which was commonly done by Ernesto and other artists from this period. Each element of the artwork measures 18 × 18 cm, making a total dimension of 54 × 54 cm.

The artwork was produced in 1978 and displayed at the exhibition *18 × 18 – Nova Fotografia*, commissioned by Ernesto de Sousa at Grafil – Galeria de Arte Cooperativa, in Lisbon, and then at Centro de Arte Contemporânea from Museu Soares dos Reis, in Oporto [3]. For those exhibitions, the images were limited to the 18 × 18 cm format, and only one single work per artist was allowed, as requested by Ernesto.

According to Isabel Alves, *Revolução, Corpo, Tempo* has not been displayed after 1978 and remained forgotten in a non-identified storage of a Portuguese museum until it was given back to her. As she described, the artwork came inside a packaging which she did not open to avoid any damage. Based on her testimony, the artwork remained in those conditions up to its donation to MNAC in 2012.

From 2012 up to the EGEAC exhibition, the artwork remained in MNAC storage.

Materials identification and discussion on conservation impact

When examining the artwork with UV radiation a bluish fluorescence was observed on the contact prints and back of the Agfa prints (Figure 3a), indicating the presence of optical brightening agents (OBA) [10-11]. According to Messier et al. [10], a decline in the use of OBA occurred between 1965 and 1979, nevertheless, some manufacturers continued using these agents to improve the photographic paper quality, which may explain their presence in an artwork from the late 1970s. The presence of OBA was also confirmed in the typed text paper on the wooden element (Figure 3b).

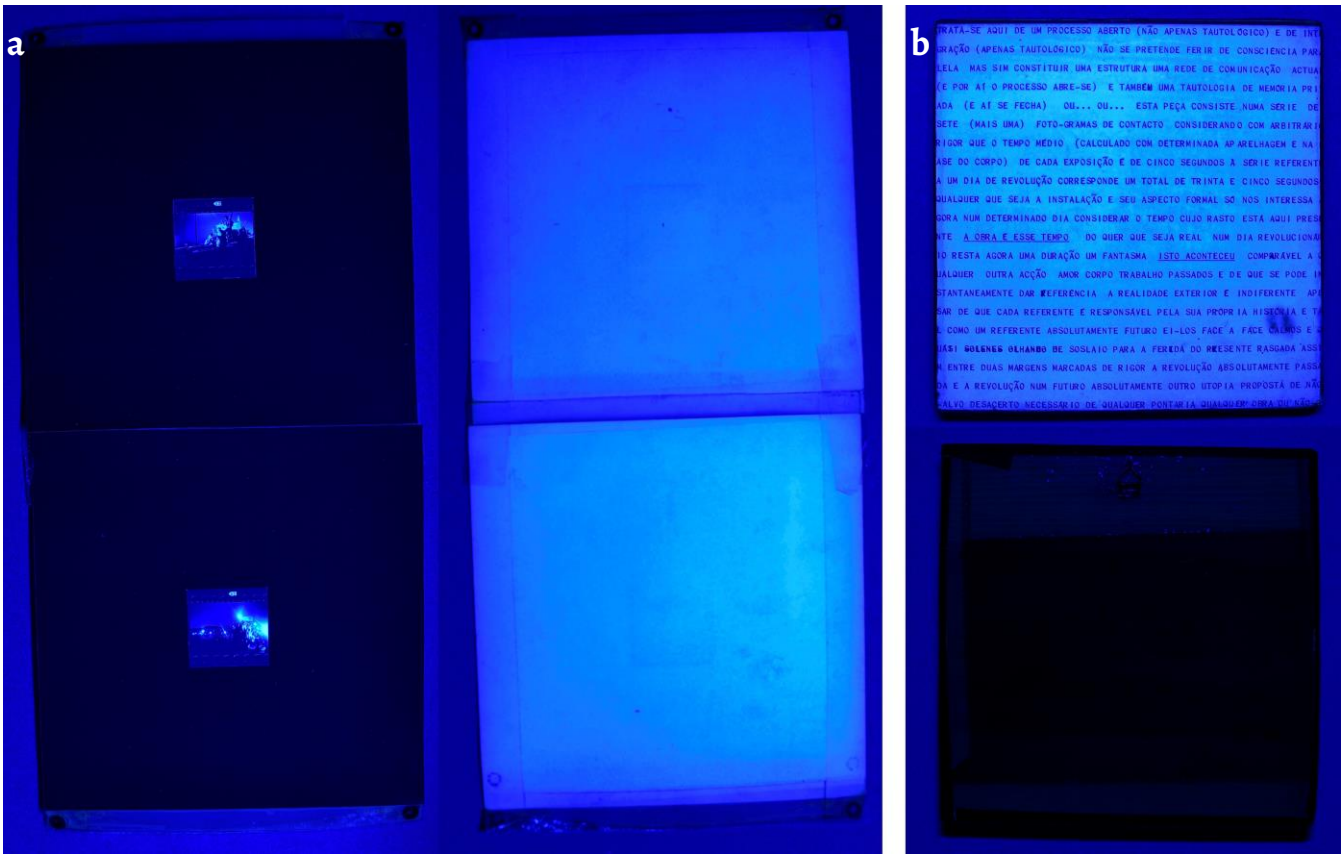

Figure 3. Views of the artwork under UV radiation: *a)* front and back of strip 3; *b)* front and back of the wooden block.

It is important to mention that even though the black area (Dmax) does not fluoresce, OBAs can still be present. But, solely based on the presence of those brightening agents, it is not possible to conclude that the two papers in the artwork are from Agfa. The UV examination also points out for the susceptibility of at least these two papers to light, high relativity humidity and aqueous treatments (e.g. optical brighteners loss, bleaching, yellowing of the paper substrate) [11], indicating the need of specific guidelines for future display, storage and conservation.

Visually, there was already an idea that *Revolução, Corpo, Tempo* was possibly made of different materials because as example, the PSTs found on the artwork were showing different characteristics and damages. ATR-FTIR confirmed this assumption and clarified the chemical composition of PSTs and other materials in the artwork (Figure 4 and Figure 5) - assignment in Table 1 [12-17]. As mentioned above, another artwork was also analysed (*Pretexto II*). While both artworks showed a lamination film made of polyethylene (PE) and polyester (PET) detected by ATR-FTIR – which may indicate the artist's preference for this mounting, regarding the PSTs (similar tone, opacity, and dimension, 19 mm width), a different composition was found (Table 2): In *Revolução, Corpo, Tempo*, the main PST is made of a cellulose acetate (CA) carrier and polyacrylate-based adhesive, whereas in *Pretexto II* the spectra indicate a PST made of a polyacrylate-based carrier and adhesive.

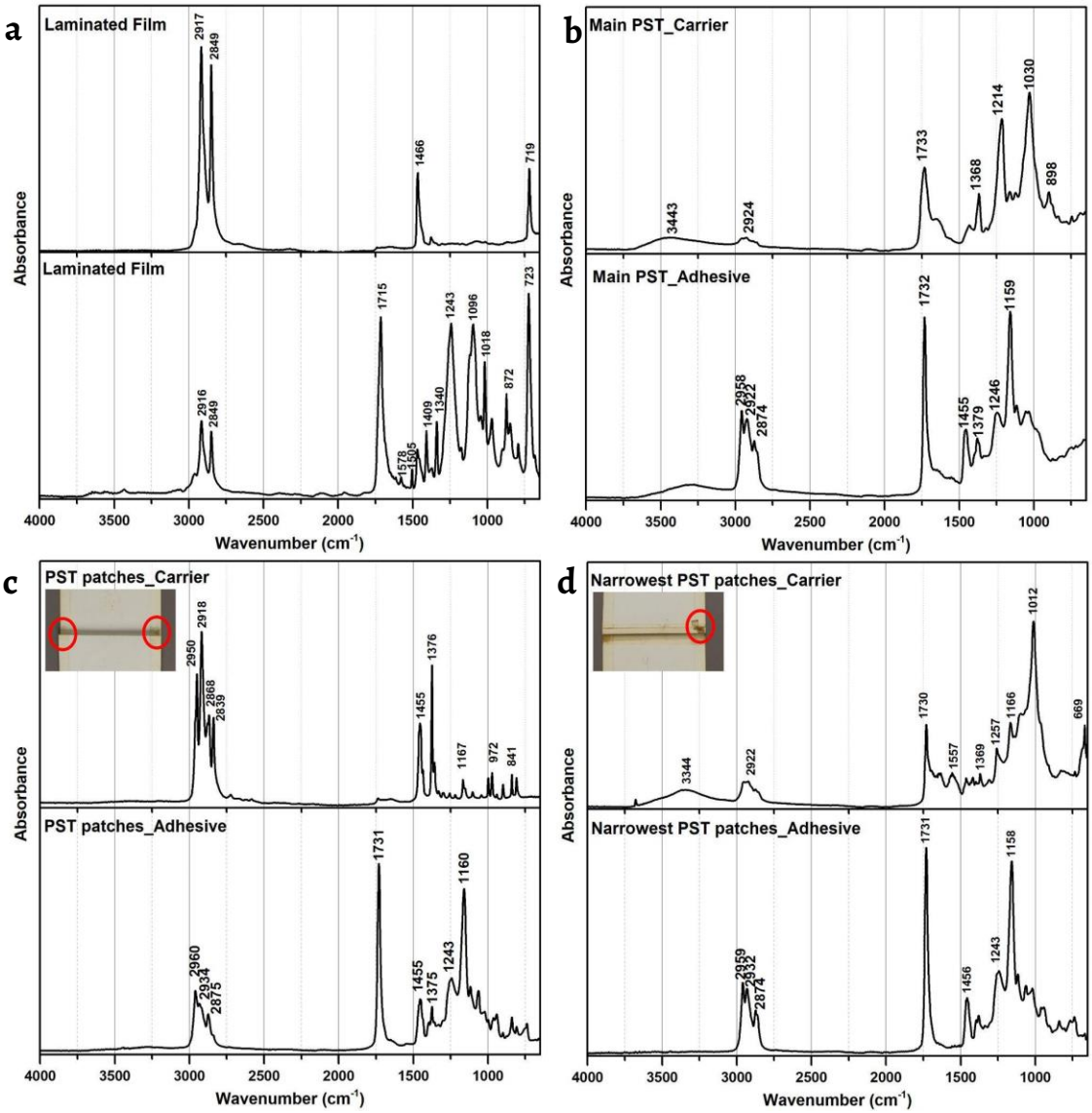

Figure 4. ATR-FTIR spectra of materials collected from *Revolução, Corpo, Tempo*: *a)* laminated film, two sides; *b)* main adhesive tape framing the contact prints; *c)* and *d)* patches of adhesive tapes. Carrier and adhesive layers have been analysed and included in this Figure.

Table 1. Assignment of the main absorbance bands in the ATR-FTIR spectra of materials from *Revolução, Corpo, Tempo* by Ernesto de Sousa (MNAC) and of the Scotch Magic Tape by 3M. For the assignment of the bands, previous studies were accessed [12-17].

Lamination Film		**Main Adhesive Tape**		
One side (PE)	**One side (PET)**	**Carrier (CA)**	**Adhesive (acrylic-based)**	**Assignment**
Band (cm^{-1})				
		3443		ν(O-H)
			2958	$\nu_{as}(CH_3)$
2917	2916	2924	2922	$\nu_{as}(C\text{-}H_2)$
			2874	$\nu_{s}(CH_3)$
2849	2849			$\nu_{s}(C\text{-}H_2)$
	1715	1733	1732	ν(C=O)
1466				$\delta_{as}(C\text{-}H_2)$
			1455	$\delta_{as}(O\text{–}CH_3)$
		1368	1379	$\delta(C\text{-}H_2)$
	1243			ν(C-C(O)-O)
		1214		ν(C–O)
			1159	ν_{s}(C–O)
	1096			ν(O-C)
	1018	1030		δ(C–H), δ(C–O)
	872	898		δ(C–H)
719	723			δ(C–H), $\delta(C\text{-}H(\text{-}C\text{-}H_2))$
Patches of PST (19 mm width)		**Patches of PST (11 mm width)**		
Carrier (PP)	**Adhesive (acrylic-based)**	**Carrier (acrylic/polysaccharide-based)**	**Adhesive (acrylic-based)**	**Assignment**
Band (cm^{-1})				
		3344		ν(O-H)
2950	2960		2959	$\nu_{as}(CH_3)$
2918	2934	2922	2932	$\nu_{as}(C\text{-}H_2)$
2875	2875		2874	$\nu_{s}(CH_3)$
2839				$\nu_{s}(C\text{-}H_2)$
	1731	1730	1731	ν(C=O)
				$\delta_{as}(C\text{-}H_2)$
1455	1455		1456	$\delta_{as}(C\text{-}H_2)$, $\delta_{as}(O\text{–}CH_3)$
1376	1375			$\delta(C\text{-}H_2)$
1167	1160	1166	1158	ν_{s}(C–O)
		1012		ν_{s}(C–O)
972				$\delta(C\text{-}H_3)$, $\nu_{s}(C\text{-}C)$
841				δ(C–O)
719	723			$\delta(C\text{-}H(\text{-}C\text{-}H_2))$
Adhesive Residues on the Centre of Strip 1 (polyisoprene)		**Scotch Magic Tape by 3M**		
		Carrier (CA)	**Adhesive (acrylic-based)**	**Assignment**
Band (cm^{-1})				
		3443		ν(O-H)
2961			2958	$\nu_{as}(CH_3)$
2918		2924	2922	$\nu_{as}(C\text{-}H_2)$
2853			2874	$\nu_{s}(CH_3)$
1663				ν_{s}(C=C)
		1733	1732	ν(C=O)
1447			1455	$\delta_{as}(C\text{-}H_2)$, $\delta_{as}(O\text{–}CH_3)$
1376		1368	1379	$\delta(C\text{-}H_2)$
		1214		ν(C–O)
			1159	ν_{s}(C–O)
		1030		δ(C–O)
838		898		δ(C–H)
743				$\delta(C\text{-}H_2)$

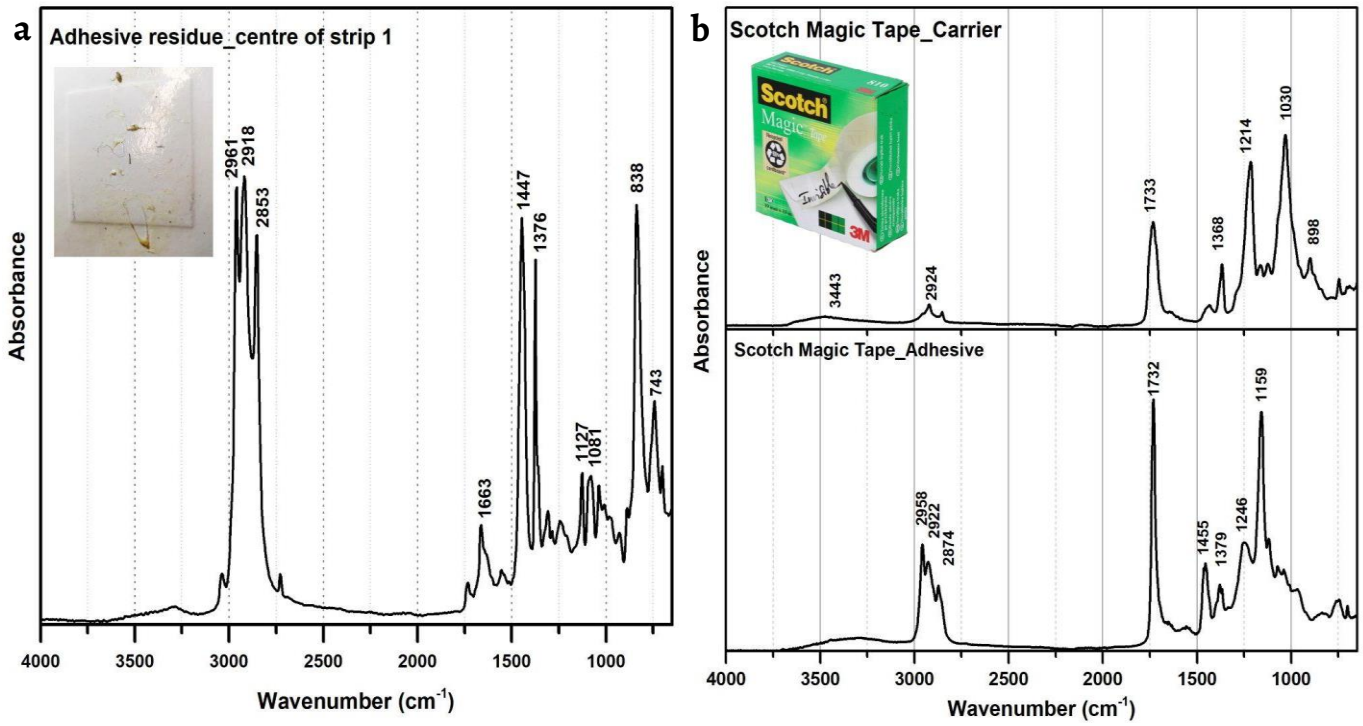

Figure 5. ATR-FTIR spectra of: *a)* the adhesive residue found on strip 1 of *Revolução, Corpo, Tempo*; *b)* the Scotch Magic Tape selected for repairs. Carrier and adhesive layers of the Scotch Magic Tape have been analysed and included in this Figure.

Table 2. Pressure sensitive tapes (PSTs) in the artworks analysed, including their location, function, visual characteristics, condition, chemical composition (based on ATR-FTIR) and list of figures.

Artwork	PST / Location / Function	Visual characteristics	Condition	Chemical Composition	Figures
Revolução, Corpo, Tempo	Main PST framing and assembling the laminated prints, on the back	Transparency Dimensions (19 mm width) Shinny	Still transparent Discoloration (slight yellowing)	Cellulose acetate carrier and polyacrylate-based adhesive	1, 2
Revolução, Corpo, Tempo and *Pretexto II*	PST small patches on the back of the laminated prints / Mending option	Transparent Dimensions (19 mm width) More shinny	Still transparent Discoloration (slight yellowing) Peeled Loss of adhesion	Polypropylene carrier and polyacrylate-based adhesive	1, 2, 6
Revolução, Corpo, Tempo	PST small patches on the back of the laminated prints / Mending option	Transparent Dimensions (thinner width: 11 mm) More shinny	Slight darkening Discoloration (brownish hue) Detached / loss of adhesion	Polyacrylate-based adhesive and carrier	1, 2, 6
Revolução, Corpo, Tempo	Insulation PST on the wooden element, as a side finishing	Black tone Opaque Medium width	Carrier retraction Detached / loss of adhesion	Not analysed	1, 2

Additionally, other PSTs in *Revolução, Corpo, Tempo* (small pieces with a patch appearance) were identified as: polypropylene (PP) carrier and polyacrylate-based adhesive (in the more shiny and transparent patches); and polyacrylate-based adhesive and probably, a polyacrylate/cellulosic-based carrier (in the narrowest and brownish tape, 11 mm width).

All these PSTs belong to the large family of film tapes, which are commercially available since the 1950s (starting with tape carriers in cellulose acetate and evolving to PP films and polyacrylate-based adhesive) [16, 18-20]. According to Satas [19] despite having less tack and adhesion than other rubber like PST, these film tapes were recognized for their resistance to oxidation and discoloration.

From the visual observation and analytical results, it might be suggested that the artist had specific demands for PST properties, such as dimension, tone, and level of opacity/gloss, as he

continued to use these types of PST at least from 1978 to 1982. For this reason, this aspect should be considered for restoration purposes, especially when replacements are needed.

The elemental composition of the metal eyelets was also identified with μ-EDXRF analyses, allowing the detection of iron (Fe) and nickel (Ni), indicating a nickel coated steel alloy and refuting the possible presence of chromium.

The artwork condition

The laminated prints showed distortions (especially on the edges) (Figure 6a), probably due to the inherent properties of the materials, but mostly due to the size of the storage system that was used for more than 30 years: folded and wrapped strips in tissue paper inside a grey-white conservation cardboard box with dimensions close to 18 × 18 cm (Figure 7). This folded option may have caused the formation of creases and tears that are observed on the edges and folding areas between prints (Figure 6b-c). According to MNAC, the artwork was kept in this way at least since 2012, and from the interview with Isabel Alves, this packaging system could have been in place as early as 1978, which may have compounded the damages.

Figure 6. Details of some damages found on the artwork: *a)* distortion; *b)* tears; *c)* material losses; d) grime and bristle embedded on glue residues resulting from self-adhesive tape carrier shrinkage; and e) adhesive residues on the back and centre of the laminated prints.

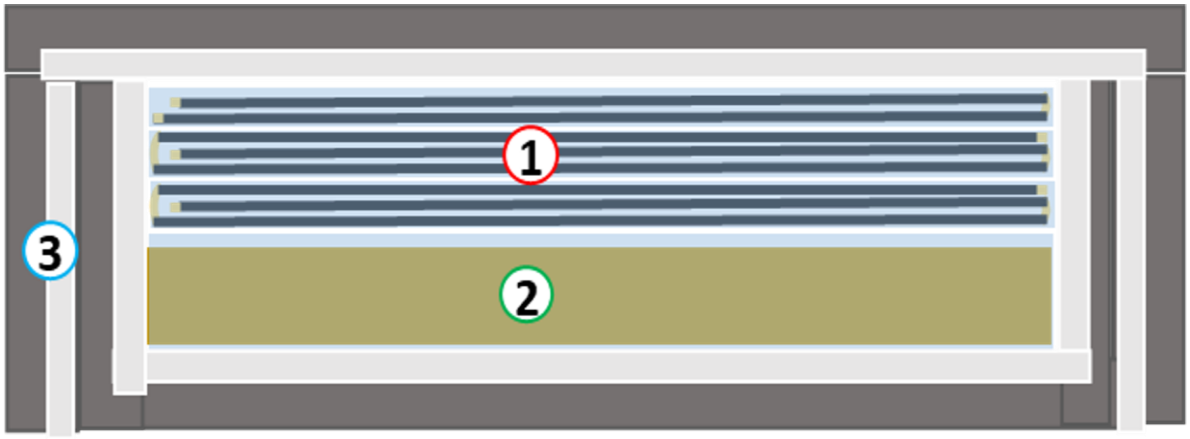

Figure 7. Diagram of the previous enclosure system: folded and wrapped strips in tissue paper (1), superimposed above the wood block (2) and inside a grey-white conservation box with dimensions close to 18 × 18 cm (3).

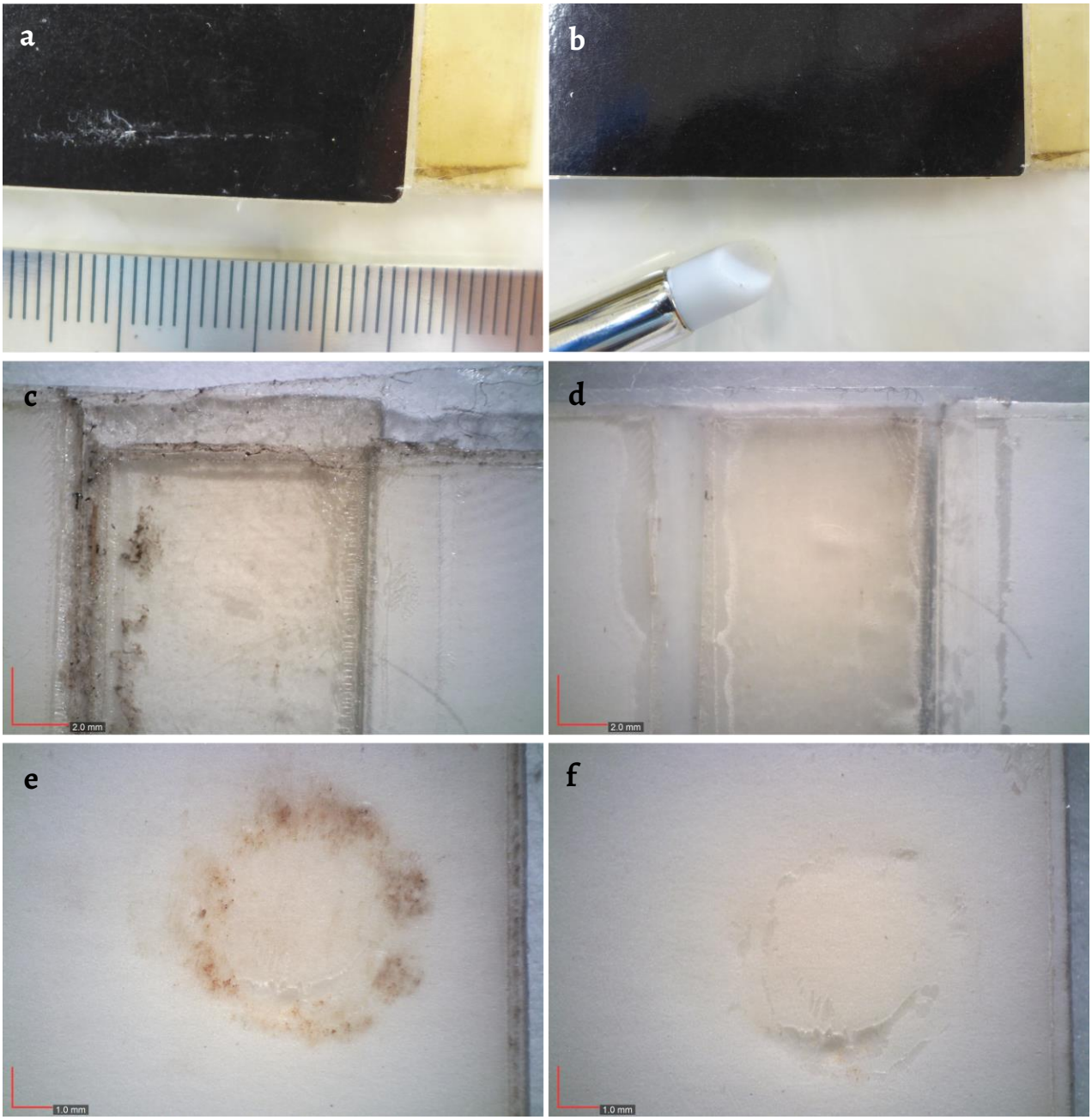

Figure 8. Examples of cleaning interventions on the artwork: *a)* dirt deposits in the front of the laminated prints *b)* after cleaning; *c)* dirt deposits in adhesive tapes in the back *d)* after cleaning; *e)* metal eyelets corrosion transfer to adhesive tapes *f)* after cleaning.

From the storage option and/or past use, other damages such as optical changes (specifically of gloss) occurred on the surface of the lamination film. Extensive areas with grime and fibres embedded on adhesive residues were also found (Figure 6 and Figure 8), which probably resulted from the shrinkage of the PSTs carriers. These residues had a yellow-brownish hue due to grime and oxidation of the adhesive. The damages, especially on the front, caused a detrimental impact on the perception of the artwork. In some cases, where the PSTs carriers were detached, a transfer of the adhesive to other areas of the artwork was observed. Additionally, another type of adhesive residue (more opaque and thicker) was found on the back of one of the prints, and identified as polyisoprene (Figure 6, Figure 8, and Table 1).

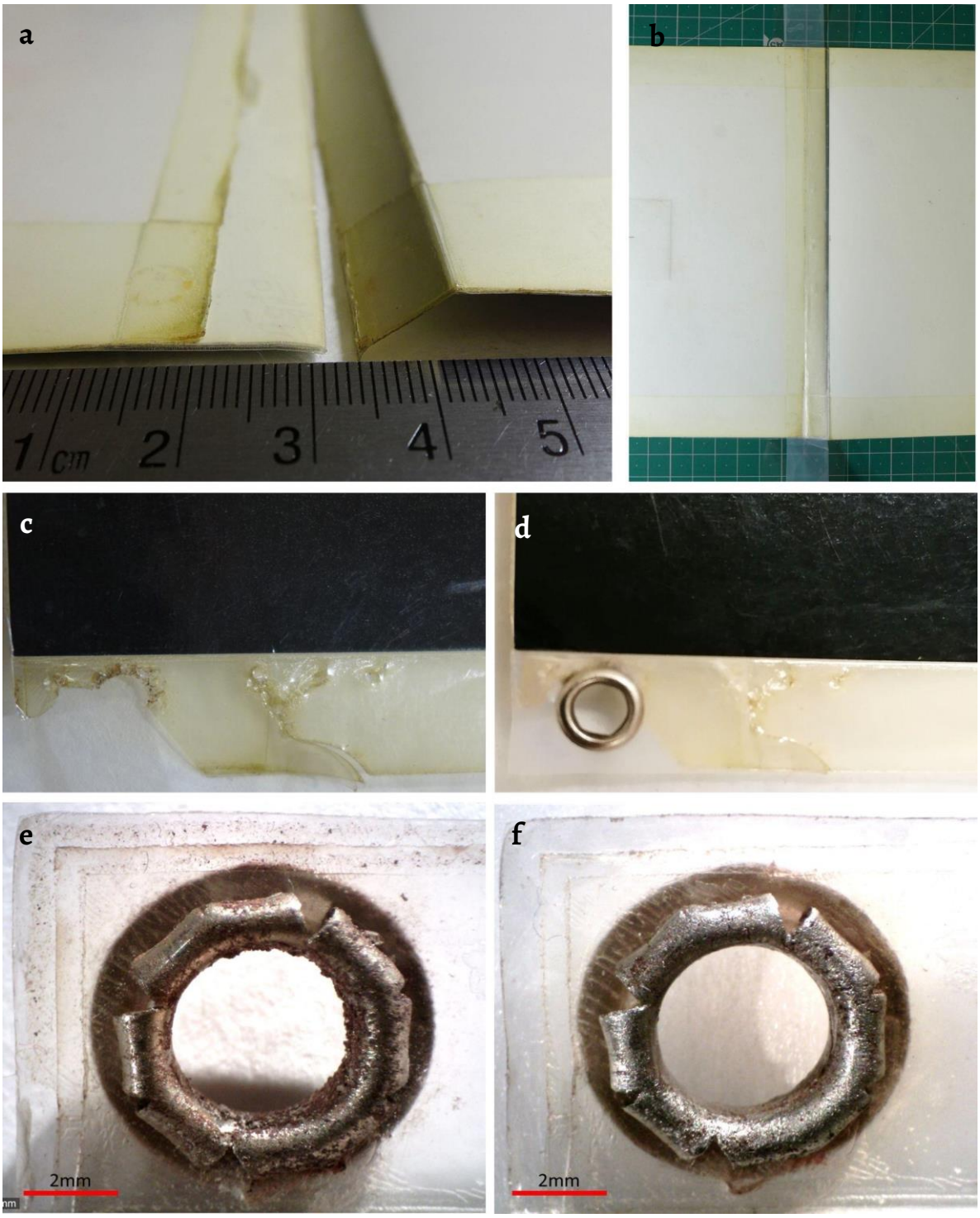

Figure 9. Examples of structural, infillings and cleaning interventions: *a)* and *b)* tear repaired with the addition of adhesive tape; *c)* missing eyelet *d)* after infilling and addition of new metal eyelet; *e)* corroded metal eyelet *f)* after cleaning and stabilisation.

Regarding the metal eyelets, and possibly due to their composition and past storage conditions, the nickel coating presented discontinuities all over, either from fissures or gaps in the coating. Material losses were probably caused by iron corrosion products from the bulk of the eyelet. The yellowish, reddish, and brownish colour of these corrosion products are consistent with iron oxides and hydroxides, that were found both on the coating surface and the bulk of the eyelet (Figure 1, Figure 2 and Figure 9). The corrosion products in contact with the lamination film resulted in increased fragility of the film probably due to the formation of small tears around the eyelet. Moreover, one metal eyelet was already missing, and another was detached and disfigured. These damages were particularly alarming, since the display of the artwork relies on the physical resistance and stability of the mount. Due to incorrect storage, the corrosion products also caused deformations and orange stains on the surface of the laminated prints (Figure 6).

Concerning the typed text paper on the wooden element, overall discolouration was observed, as well as a brown stain in the lower right quadrant and darkening in the edges. These damages may have resulted from the release of volatile organic compounds (VOC) from wood, along with a certain level of moisture retention due to the hygroscopic nature of wood. Concerning the UV examination, the heterogeneity of the bluish hue may have resulted from OBA migration and/or paper decay [10-11]. Additionally, on the back of the wood, shrinkage of PSTs' carriers was observed, leaving adhesive residues to which dust, fibres and dirt adhered (Figure 2). The black insulation tape was detached in some areas and a deep scratch on one of the sides was observed, leaving a white sublayer visible.

Based on what is described, and according to the European project POPART's four levels of condition chart [21], this artwork was considered to be in poor condition. This evaluation was alarming considering the current main aim which was to display the artwork according to what was identified as the artist's original intention [1-3]. These issues demanded an urgent discussion about the future conservation and display of the artwork.

Discussions on decision making – restoring, removing, or replacing? Confronting documentation and expectations

The loan request for display of *Revolução, Corpo, Tempo* unfolded several issues initially related with the mounting and current condition of this artwork. In order to evaluate the possibility of displaying and to establish a conservation strategy suitable for this case, a decision-making model for contemporary art was taken into consideration [22]. The selection of this model was based on its suitability for the work and because it gives the basis for the evaluation of tangible and intangible aspects. As recommended in the model, beside research on the artwork biography, material aspects and condition, the perspectives of other agents should be considered – in this case, MNAC curator and Isabel Alves (family and expertise).

For MNAC, it was necessary to intervene in the artwork without detracting from the fundamental character of its assemblage. It was mandatory to preserve the sequential order, mounting scheme, and formal character of the display with the PSTs. As pointed out by the museum, not only is this assemblage an important feature of *Revolução, Corpo, Tempo*, but it is also highly characteristic of Portuguese photo artworks from the 1970s [1-2]. Therefore, the precarious nature of the assemblage should be considered an important conceptual part of the work. However, as the museum curator also expressed, if the condition and display of the artwork is at risk due to materials physical and chemical failure, the requirements previously pointed out should be re-evaluated in order to maintain the balance between the conceptual and the material nature of *Revolução, Corpo, Tempo*.

Isabel Alves also pointed out considerations regarding the display and condition of the artwork. Her conservation concerns were particularly related to the distortions of the prints. According to her testimony, this has been happening to other artworks of the artist, being commonly solved by adding PSTs on the back for display purposes. This testimony may justify the presence of extra adhesive tapes and small patches of tapes on the artwork. Alves also

shared a set of instructions that were registered for a particular artwork (non-identified) with a similar assemblage. According to her, those instructions might be used as guidelines for the display of this type of artworks: "[the] photographs should be slightly stretched to avoid any distortions, use transparent adhesive tape to correct any detachments". However, she also mentioned that one specific instruction found in that guideline should not be followed, because "the artist himself had never done it. (…) two thin boards (rulers) must be placed at the top and bottom, well fixed to the wall; it is on these boards that the series of photographs are fixed using the perforations already made".

As not all instructions should be followed, and Isabel Alves did not mention when these instructions were left or by whom, these indications can also lead to wrong decisions if not well assessed. Thus, this oral testimony highlights two important details: i) some artworks by Ernesto might have been suffering changes in their assemblage and display mounting over the years (probably due to the decay/change); and ii) information supporting conservation and display procedures are still not well defined, even when written. It is also important to acknowledge that Alves' remarks on the display and condition of this particular artwork highlight Ernesto's demand for the flat appearance of his works during the exhibition – being a strong argument to correct the deformations of the work.

After collecting and documenting the expectations of the stakeholders on the conservation and display of this artwork and assessing the data, the conservation team designed a preservation strategy that crossed and balanced all the intentions, information and needs.

One example is related to the small patches of PST on the back of the artwork - deteriorated, with misaligned placement and sometimes detached (Figure 1, Figure 2 and Figure 6). These PST led to several discussions, especially due to the lack of written sources or guidelines describing the material selection by the artist. To finally define a restoration proposal to MNAC, the careful observation and material analysis of *Revolução, Corpo, Tempo* and *Pretexto II* were vital, along with I. Alves' testimony. Based on this data, it was possible to consider that the PST patches might have been placed by others (rather than Ernesto) to enable the artwork display. This hypothesis was launched because the patches were inadequately placed, mending tears, and showed a different (and more recent) chemical composition. Thus, it was assumed that they might have been applied to keep the artwork flat or as a temporary "conservation" solution. As their function and condition were highly compromised, their removal was proposed to MNAC, and after debating the pros and cons, the removal was accepted (see the following section).

With their removal, the prints in strips 1 and 3 were completely separated because the original PSTs assembling the prints were entirely torn (due to incorrect storage), requiring a solution for their reassembly (Figure 6). This led to discussions on how to proceed: Should the torn PST be removed and replaced with a new one? Or should the torn PST be left, and a new tape be placed above it? As both scenarios demanded a new PST, the data collected from IR spectroscopy resulted in the proposal of using the invisible Scotch Magic tape from 3M. Then, based on conversations with MNAC and other conservators, at that moment dealing with the conservation of other artworks by Ernesto de Sousa, it was decided to keep the torn PST due to its superimposed position over other PSTs in the back of the work, i.e., its removal would imply the removal of other layers of PST that were in good condition and perfectly adhered to the prints. It was also concluded that this overlap of PSTs is highly characteristic of Ernesto de Sousa's creative process. For that reason, the removal of this artistic and technical characteristic was not performed. The torn tape was kept, and an additional tape was put on top of it (with similar composition). This promoted the maintenance of the original mounting stability.

Another issue, raising several discussions, was related to the metal eyelets: one was already missing when the artwork was first observed (Figure 6) and another got detached due to the high fragility of the artwork's corners. From this situation, several questions arose: Would it be possible to reattach the detached eyelet? How to infill the missing area in the PST? Which eyelet

could be used to replace the missing one? This was a pressing issue because the display of the artwork is structurally dependent on the eyelets and PST resistance and stability. After debating pros and cons, the reuse of the loose eyelet was discarded, as its shape was already disfigured, preventing its reapplication/refixation. Thus, two eyelets needed to be acquired and added to the artwork. To find the best option, several materials suppliers were visited in an attempt to find a similar eyelet in shape, dimension and composition. Unfortunately, constraints on the market and the time available to conduct the restoration work did not allow finding completely identical eyelets. Instead, eyelets made of the same type of metal alloys and colour, but differing in thickness were bought. Finding identical eyelets was an ambitious task given the evolution and changes of the production of these materials during the last thirty years. Another pressing issue was related to how to put the new eyelets onto the artwork, as no corrections would be possible after their placement. Strategies to deal with these concerns are explained in the following section.

The intervention plan was thus established considering all the critical issues presented here and a round of tests (chemical and mechanical) on materials similar to the originals in the artwork.

The conservation and restoration work

The working station was carefully thought out as the artwork was extremely prone to abrasion. Efforts were made to avoid any damage, having been chosen to use smooth and inert materials (polyester tissues as Bondina) for both working station and artwork protection. Whenever these materials showed minimal alterations, they were replaced.

Then, it was urgent to remove dirt and adhesive residues from the artwork (Figure 8 and Figure 9). The cleaning actions had to be well thought out and contemplate particular aspects such as, how to remove dirt and other residues without affecting the artwork's gloss? And what solvent to use? How to dose the amount of solvent?

Given the sensitivity of the artwork materials to abrasion and chemical cleaning, preliminary tests were conducted on selected PSTs, PET sheets, and metal eyelets with features similar to the artwork. Additionally, cleaning assays were also performed on the detached and original eyelet. The materials used for testing and testing results are presented in Table 3.

For general dry-cleaning purposes, a soft brush, cotton swabs, makeup sponges and microfibre cloths were tested given their smoothness and efficiency recognition in [24]. Additionally, for mechanical/dry cleaning of small areas with adhesive residues, rubber silicone colour shapers (RSS) and a vinyl Mars Plastic eraser from Staedtler (small tip) were tested. The use of crepe rubber (commonly used for this purposes) was discarded due to its hardness and risk of damaging the artwork's surface by causing scratches and abrasion. Regarding aqueous and chemical cleaning of adhesive residues, water would not effectively remove polyacrylic-based adhesives and aromatic and aliphatic solvents would be effective, but could also damage the surface of the PET lamination film. Thus, to avoid risks of staining or dissolving the PET film, it was decided to test saliva followed by cleaning with distilled water (solely), ethanol (96 % from Aldrich), and mixtures of water and ethanol (50:50 and 70:30). Ethanol was selected due to its high volatility rate. The tests were conducted on PET sheets (5 × 5 cm) on which a PST was applied on half of the PET film and later removed in order to leave residues on which testing could be carried out, always taking into account that the original PSTs (aged) could behave differently due to ageing. For testing, moderated pressure was used in all the applications of dry materials and solvents. The results are presented in Table 3.

The tests allowed to define and implement a conservation methodology that at the end combined mechanical (dry), aqueous and chemical cleaning, following approaches already used in modern materials [23-26], photograph [27-29] and metal conservation [30-33].

Table 3. Cleaning tests on testing materials before decision making on the artwork.

Materials in the artwork		Testing materials (mockups)	Dry cleaning tests						Chemical cleaning tests			
			Brush	Cotton swab	Makeup sponge	Microfibres cloth	Rubber silicone colour shapers (RSS)	Vinyl eraser Staedtler Mars Plastic (small tip)	Cotton swab and saliva	Cotton swab, ethanol (96%)	Cotton swab, ethanol and water (50:50 V/V)	Cotton swab, ethanol and water (70:30 V/V)
Lamination film	**PE and PET film**	PET sheet film	Scratches Abrasion 0	Scratches Abrasion 3	Scratches Abrasion 1	Scratches Abrasion 2	Scratches Abrasion 1	Scratches Abrasion 1	No stains No abrasion	Stains	Stains	No stains No abrasion
PST	**CA carrier and polyacrylate-based adhesive**	Scotch Magic tape from 3M										

After carrying out of these tests, it was decided to start the intervention with an overall surface cleaning with soft brushes and a vacuum cleaner. For more persistent dust, cosmetic sponges (made of polyurethane foam) were used. Adhesive residues were removed using a combination of mechanical and chemical cleaning. To avoid the dissolution of the artwork adhesives, the cleaning started with RSS, using different tips according to the need (Figure 8b). Whenever the RSS were ineffective, the vinyl eraser (small tip) in a retractable eraser holder was applied. This procedure was followed by chemical cleaning with saliva to remove more persistent residues. Saliva proved to be a good option as it only took one or two passages to clean up the surface. Afterwards, a combination of water and ethanol (70:30 V/V) was used to remove chelating and enzymatic residues from the saliva. The removal of dirt from the laminated prints was particularly important because PET has a static nature that attracts dirt, making it more susceptible to moisture reactions and to hydrolytic breakdown [24]. The woodblock was also cleaned following these mechanical and chemical options.

Concerning the extra PST found at the top of strip 1, the tape was removed because it showed extensive dirt, oxidation, deformation, and detachment and was no longer serving its purpose. After removal, this PST as well as the other removed patches of PST were stored separately in polyethylene (PE) bags along with an identification and detailed information. All areas where PSTs were removed were documented, mapped and photographed. To reassemble the separated prints, invisible Scotch Magic tape from 3M was chosen due to its similar composition – confirmed by IR spectroscopy – dimension, appearance, and transparency to the artwork's main adhesive tape, as well as good stability over ageing.

Next, it was urgent to correct the prints deformations and infill missing areas on the artwork (Figure 6). Given the inherent nature of the artwork's materials, distortions (Figure 6a) would be difficult to correct following the frequently used options for prints and paper, that commonly include humidifying, drying, and flattening. To correct planar distortions and realign creases, ridges, folds and cockling, heat was necessary to be applied on the laminated prints (lamination film made of PE and PET). Considering the melting temperature (T_m) of PE (~110 to 140 °C) [24], localised heat using a heated spatula with a small tip set to 80 °C was applied. The areas to be treated were protected with a silicone-coated (one side) PET film (12 µm), avoiding direct contact of the spatula with the prints. The heat was applied for a few seconds and, afterwards, the areas were left to cool down in contact with Bondina (30 gsm, with a very smooth surface finish), blotter, glass plate and light weight for 15-20 minutes. Whenever needed, the step was repeated.

Following this procedure, other areas showing detachment (such as adhesive tapes at the top and bottom of each strip) were re-attached by activating the adhesive with heat. After finishing flattening and re-attachment actions, the strips were placed under weights, according to the following sequence: first a Bondina tissue (30 gsm) in direct contact with the strip (front and back); secondly, two blotting sheets (front and back), thirdly, a wooden board, and fourthly, soft weights distributed over the entire surface of the board (left for 24 to 48

hours). For infilling of the missing areas (adhesive tape supporting the eyelets) Scotch Magic tape was used. Several tests with this tape were made until a pristine application of the eyelet on the adhesive tapes was achieved. After accomplishing that, the infilling tape and eyelet were applied with minimum overlapping of the new materials over the originals, ensuring the fixing would guarantee the mechanical strength for the exhibition of the work (Figure 9).

The first part of the intervention on the original metallic eyelets consisted in the solubilisation of part of the more friable corrosion products. The eyelets were cleaned with cotton swabs soaked in oxalic acid at a concentration of 5 % (m/V), corresponding to a pH < 1. These values provide more control of the operation, since the preferential dissolution of more unstable corrosion products takes place at a slower rate [31]. Stopping the reaction and removing traces of oxalic acid on the surface was done with cotton swabs soaked in a solution of ethanol [96 % (V/V]: water in the proportion of 1:3 (V/V). Afterwards, the remaining, persistent corrosion products were mechanically dry-cleaned with a combination of a bamboo stylus, scalpel, fibreglass brush and the vinyl eraser [32]. This procedure also allowed the recovery of some of the original lustre of the metallic coating. Removal of traces of vinyl residues from the eraser was performed with acetone on cotton swabs [33]. Acetone also acted as a drying agent, allowing the removal of any remaining water from the cleaning operation with the oxalic acid solution. Two protective coating layers were applied with a brush, the first of Paraloid B72 in acetone at 20 % (m/V) and the second of microcrystalline wax (Figure 9f) [33]. All steps were carried out under a binocular magnifying glass and using an acid-free polyester film mask, in order to protect the cellulose acetate carrier from the surface of the adhesive tape.

At the end, each strip was housed in Timecare Heritage Conservation cardboard (white, 2.2 mm) folder, then reinforced with Filmoplast P90 (white) in direct contact with a layer of Bondina (30 gsm) (Figure 10). The woodblock was wrapped in Bondina (30 gsm) and housed in a conservation grade box of high quality (P.A.T. tested materials).

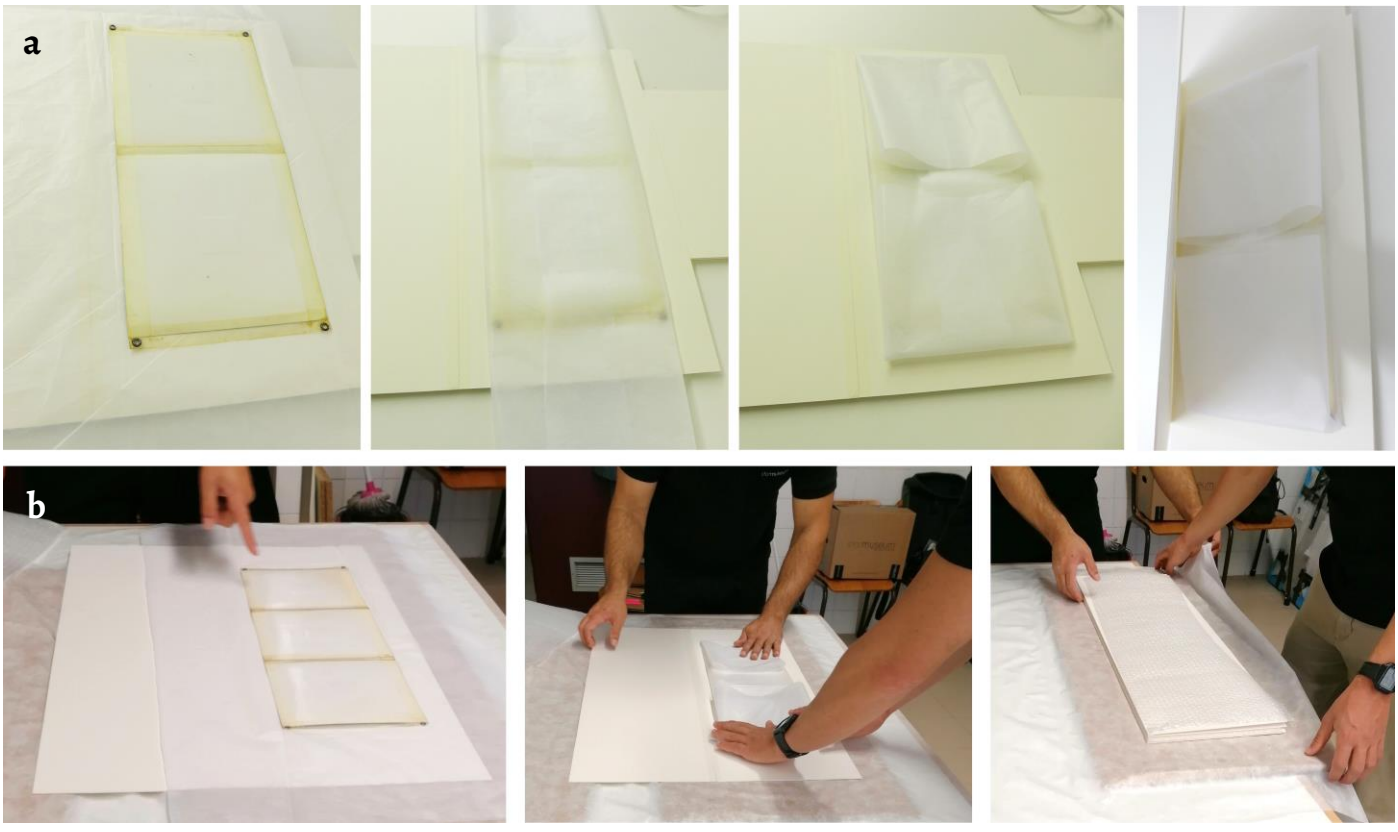

Figure 10. New enclosure developed for each strip of the artwork. Unfolded strip (completely flat) wrapped in Bondina, inside a Timecare conservation cardboard folder, then closed with Filmoplast P90: details of *a)* each step and *b)* wrapping process.

Conclusions

The challenges posed by the conservation of the artwork *Revolução, Corpo, Tempo* were overcome by the combined input of stakeholders, experts, conservators specialised in contemporary materials, metals and photographs, and a conservation scientist. The produced knowledge has especially benefited from the kind share of testimonies by Emília Tavares and Isabel Alves, which resulted in insightful information regarding the artwork's biography, display demands, and intervention strategies already adopted for other artworks by Ernesto. The information gathered from these testimonies, along with a comprehensive examination of the artwork's materials and condition were crucial to define the scope and limits of the proposed conservation treatment. The collaborative work was extremely important when considering procedures that would impact on more than one material and/or immaterial dimensions of the work. For example, the use of gels in the conservation treatment of the metal elements could provide more control of the operation and a more thorough cleaning effect. But gel residues could be left on the artwork and its removal procedure could be harmful for the nearby materials. Therefore, this method was not employed.

The role of conservation science along with the role of art history were also crucially important as one pressing issue was the profusion of materials with different chemical natures and functions, as well as the important artistic values associated with each element/material. For instance, there is the precarious nature of some materials but also the characteristic assemblage and display mounting that express the conceptual intentions of the artist. These two features combine tangible and intangible dimensions that must be preserved.

The examinations, particularly with UV radiation, and ATR-FTIR and μ-EDXRF analysis were also fundamental for a deeper understanding of Ernesto de Sousa's case study and a comprehensive perspective on his choice of materials. As described, knowing the adhesive tapes composition was crucial to identify the presence of materials possibly resulting from later additions for display purposes. Additionally, the presence of OBAs on either, photographic prints and paper on the woodblock, alert for the existence of material readily susceptible to change as previously explained. Moreover, the decay of OBAs is still poorly studied and more research needs to be done. Furthermore, PET and PE are already raising problems in other studies [12, 14, 25]. Thus, from an exclusive tangible perspective, the artwork *Revolução, Corpo, Tempo* is already a complex example due to the extensive presence of metals, PET, PE, inks, silver gelatine prints, OBA's and PST made of cellulose acetate.

The insufficient knowledge regarding Ernesto de Sousa's possible acceptance of variations in the installation of his works (for instance, in the assemblage and display mounting) complicated the discussion around these issues, as well as the decision-making process. But the collaborative work developed in this research enhanced the overall conservation of this artwork, and *Revolução, Corpo, Tempo* was again displayed and experienced by the public. In the end, a shared responsibility in the final conservation decision has been achieved due to the interdisciplinary thinking behind it.

One important outcome of this research is the acknowledgment of display changes that some of these artworks have and may continue to be submitted to in the future. This highlights the urgency of gathering and establishing guidelines for their preservation in order to avoid different decisions for similar artworks. In the case of Ernesto de Sousa works, that decision has commonly been laid with the conservator responsible for the decision-making and/or, many times, shared by Isabel Alves during conversations. However, these decisions are not thoroughly documented. For those reasons, it is difficult to access documentation registering the decisions made in the past, and even when data is shared, it is still lacking a systematic description and explanation of the procedures taken at the time.

As far as it is known, this paper adds to the literature knowledge for discussions on the challenges of treating mixed-media photographic artworks, especially the ones made by this artist. To contribute for the continued share of decision-making processes and to support

future conservation projects, the goal of this article was to describe and record all doubts, questions and procedures. Also, considering the materials of the artwork, more studies are being planned to include formal and material characterisation, condition assessment, examination and monitoring of artwork's ageing, as well as exhibition conditions for artworks with conceptual requirements. This is a new line of research at DCR (NOVA School of Science and Technology), which includes the research about Helena Almeida photo-artworks production, conservation and display being developed by master students and supervised by the authors.

Another pressing issue that came out from this research was how to keep the artwork completely flat while in display, without negatively affecting the characteristic assemblage of Ernesto de Sousa. Due to the chemical nature of the laminated prints and their sensitivity to moisture, the strips started to show slight deformations after a few days on exhibition. Even though this was not unexpected, no solution could be devised prior to the exhibition without a comprehensive discussion of possibilities. Thus, finding strategies to correct this change will be the subject of a future study, also benefiting from the collaborative network already established.

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REFERENCES

1. Tavares, E., 'History of Portuguese photography 1970-2000', in *History of European photography 1970-2000*, ed. Vaclav Macek, The Central House of Photography, Bratislava (2016) 541-563.
2. Tavares, E., *Ph. 06 Ernesto de Sousa*, Casa da Moeda, Lisbon (2021).
3. Oliveira, J. A., *A fotografia e o fotográfico em Ernesto de Sousa*, Master Dissertation, Department of Art History NOVA University of Lisbon (2008) http://hdl.handle.net/10362/126349 (accessed: 2022-02-04).
4. Warda, J. (ed), *The AIC Guide to Digital Photography and Conservation Documentation*, 3rd ed., American Institute for Conservation of Historic and Artistic Works, Washington (2017).
5. Chen, J. J.; Smith, T. J., 'Documentation of Salted Paper Prints with a Modified Digital Camera', *Journal of the American Institute for Conservation* **59** (3-4) (2020) 271-285, https://doi.org/10.1080/01971360.2019.1643527
6. de Sousa, E. *Catálogo de Pretexto II*, Brancas Infinitamente, Coimbra (1982).
7. Thompson, T.; Passafiume, T.; Cartier-Bresson, A., *Lingua Franca: a common language for conservators of photographic materials*, Library and Archives Canada, 81, http://data2.archives.ca/e/e448/e011188307.pdf (accessed 2022-02-04).
8. Abbaspour, M.; Daffner, L. A.; Hambourg, M. M. (eds.), *Object: Photo. Modern photographs: the Thomas Walther collection 1909–1949*, The Museum of Modern Art, New York (2014), https://www.moma.org/interactives/objectphoto/#home (accessed 2022-02-04).
9. Ruffinatto F.; Crivellaro A., 'Wood Specifications O–P', in *Atlas of Macroscopic Wood Identification*, Springer, Cham, Switzerland (2019) 287-342, https://doi.org/10.1007/978-3-030-23566-6_11.
10. Messier, P.; Baas, V.; Tafilowski, D.; Varga, L., 'Optical brightening agents in photographic paper', *Journal of the American Institute for Conservation* **44**(1) (2005) 1-12, https://doi.org/10.1179/019713605806082392.
11. Connors-Rowe, S. A.; Whitmore, P. M.; Morris, H. R., 'Optical brighteners in black-and-white photographic paper: appearance and degradation', *Journal of the American Institute for Conservation* **46**(3) (2007) 199-213, https://doi.org/10.1179/019713607806112251.
12. França de Sá, S.; da Cruz, S. M.; Callapez, M. E.; Carvalho, V., 'Plastics that made history–the contribution of conservation science for the history of the Portuguese Plastics Industry', *Conservar Património* **35** (2020) 85-100, https://doi.org/10.14568/cp2019017.
13. Sim, L. H.; Gan, S. N.; Chan, C. H.; Yahya, R., 'ATR-FTIR studies on ion interaction of lithium perchlorate in polyacrylate/poly (ethylene oxide) blends', *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy* **76**(3-4) (2010) 287-292, https://doi.org/10.1016/j.saa.2009.09.031.
14. Andanson, J.-M., and Kazarian, S. G., 'In situ ATR-FTIR spectroscopy of poly (ethylene terephthalate) subjected to high-temperature methanol', *Macromolecular symposia*, **265** (1-Special Issue) (2008) 195-204, https://doi.org/10.1002/masy.200850521.

15. Chércoles Asensio, R.; San Andrés Moya, M.; de la Roja, J. M.; Gómez, M., 'Analytical characterization of polymers used in conservation and restoration by ATR-FTIR spectroscopy', *Analytical and Bioanalytical Chemistry* **395** (2009) 2081-2096, https://doi.org/10.1007/s00216-009-3201-2.
16. Gorassini, A.; Adami, G.; Calvini, P.; Giacomello, A., 'ATR-FTIR characterization of old pressure sensitive adhesive tapes in historic papers', *Journal of Cultural Heritage* **21** (2016) 775-785, https://doi.org/10.1016/j.culher.2016.03.005.
17. Rahman, M. M.; Feng, X.; Zhang, H.; Yan, X.; Peng, Q.; Yu, P., 'Using vibrational ATR-FTIR spectroscopy with chemometrics to reveal faba CHO molecular spectral profile and CHO nutritional features in ruminant systems', *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy* **214** (2019) 269-276, https://doi.org/10.1016/j.saa.2019.02.011.
18. Skeist, I. (ed.), *Handbook of adhesives*, 3rd ed., Chapman & Hall, New York (1990).
19. Satas, D. (ed), *Handbook of pressure sensitive adhesive technology*, 2nd ed., Springer, New York (1989).
20. O'Loughlin, E.; Stiber, L. (compilers), 'Hinge, Tape and Adhesive Removal', in *Paper conservation catalog* (1992), https://www.conservation-wiki.com/wiki/BPG_Hinge,_Tape,_and_Adhesive_Removal (accessed 2022-02-14).
21. Bertrand, L.; Alban, F.; Graham, M. (eds.), *Preservation of plastic artefacts in museum collections*, CTHS, Paris (2012).
22. Giebler, J.; Sartorius, A.; Heydenreich, G.; Fischer, A., 'A revised model for decision-making in contemporary art conservation and presentation', *Journal of the American Institute for Conservation* **60** (2020) 225-235.
23. Daudin-Schotte, M. and van Keulen, H., 'Dry Cleaning Research', in *Issues in Contemporary Oil Paint*, eds. K. J. van den Berg, A. Burnstock, M. de Keijzer, J. Krueger, T. Learner, A. de Tagle and G. Heydenreich, Springer, Cham (2014) 363-372, https://doi.org/10.1007/978-3-319-10100-2.
24. Shashoua, Y., *Conservation of Plastics*, Routledge, London (2008).
25. van Oosten, T.; Bollard, C.; de Castro, C., 'Lights out! The conservation of polypropylene wall tapestries', in *PLASTICS, Looking at the future and learning from the past*, eds. B. Keneghan and L. Egan, Archetype Books and Victoria and Albert Museum, London, (2008) 97-105.
26. Shashoua, Y.; Alterini, M.; Pastorelli, G.; Cone, L., 'From microfibre cloths to poly (vinyl alcohol) hydrogels –conservation cleaning of plastics heritage', *Journal of Cultural Heritage* **52** (2021) 38-43, https://doi.org/10.1016/j.culher.2021.08.009.
27. Bernier, B., 'Issues in humidification and drying of gelatin silver prints', *Topics in Photographic Preservation* **11** (2005) 6-16.
28. Knipe, P., 'The evaluation of four aqueous and non-aqueous surface-cleaning techniques on silver gelatin photographs', *Topics in Photographic Preservation* **7** (1997) 19-27.
29. Oliver, R., 'May I spit on your photograph - A preliminary investigation into the effectiveness of saliva and a synthetic alternative for surface cleaning silver gelatin photographs', in *AICCM Symposium – Conservation of paper, books and photographic materials post-prints and posters*, Australian Institute for the Conservation of Cultural Material, Moonah (2006) 174-193, https://www.researchgate.net/profile/Cheryl-Wilson-3/publication/200550128_Measuring_the_dimensional_stability_of_paper/links/5a713d1f0f7e9ba2e1cb1e01/Measuring-the-dimensional-stability-of-paper.pdf (accessed 2023-06-10).
30. Panias, D.; Taxiarchou, M.; Paspaliaris, I.; Kontopoulos, A., 'Mechanisms of dissolution of iron oxides in aqueous oxalic acid solutions,' *Hydrometallurgy* **42**(2) (1996) 257–265, https://doi.org/10.1016/0304-386X(95)00104-O.
31. Turner-Walker, G., 'The nature of cleaning: physical and chemical aspects of removing dirt, stains and corrosion', in: *Proceedings of* the *International symposium on cultural heritage conservation. Tainan, Taiwan: 6th-8th November*, s.n., s.l. (2012).
32. Basilissi, G.; Brini, A.; Cagnini, A.; Ortolani, C.; Barbone, A. S., 'Evaluation of a dry method using erasers for silver – copper alloy tarnish cleaning and comparison with traditional methods', *Journal of the American Institute for Conservation* **61**(67) (2021) 1–17, https://doi.org/10.1080/01971360.2020.1832396.
33. Logan J.; Selwyn, L., 'Care and Cleaning of Iron – Canadian Conservation Institute (CCI) Notes 9/6', in *CCI Notes* (2007) https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/canadian-conservation-institute-notes/care-iron.html (accessed 2022-02-14).

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