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Preservation of Software-based Art at Tate

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Abstract

Software-based art has been part of the Tate Collection since 2003. In the intervening period, practices in different institutions have changed and become aligned and shared within the community of practitioners. It is fair to say that the current body of knowledge has reached a degree of consensus around the specificities of this medium and the processes involved for sustainability and preservation, or the lack thereof. This paper describes our current understanding of the role of the conservator, the lifecycle of the artwork in the institution from a conservation perspective and some of the recent developments in the field. We discuss *intervention*, defined as any action that changes the materials of an artwork, both hardware and software, in terms of its possible intentions and the most usual types. We identify intervention not only at a treatment moment but also possibly as a preventive measure, that increases a system's sustainability.

Conservation of software-based art is still in its infancy, but strategies are being actively tested and developed in different contexts and practices, and Tate as an institution is happy to contribute to those developments through practice but also by disseminating information.

Keywords

Tate, time-based media, museum collection, conservation

Introduction

Conservators are professionals trained in materials and production techniques of objects as well as in the vulnerabilities of those objects. We are further trained on the importance of documenting an object's function and condition. As a profession, we have spent the last 60 years developing,

testing, defining and refuting strategies to reduce decay rates, maintain authenticity and significance and in some cases to restore an object to its original condition.

Conservation has also, over the years, evolved to encompass new materials and objects of conservation, which nowadays range from whole buildings, to pre-historic seeds, from ethnographic objects to software-based art. Why and how these objects are preserved is dependent on both their materials and the context in which the conservation processes happen.

Conceptual art and the apparent disengagement between material and concept brought further changes to conservator's understanding of the object of conservation, where the constituent materials are no longer unique and therefore new forms of preservation are possible (Van Saaze 2018). This is even more so when the focus turns to time-based media art, where a different approach is essential to address the dependencies on technology and the in-built obsolescence of these technological systems.

This evolution has required that conservation in contemporary art museums expands its frames of reference and processes. The latest moment in the evolution is software-based art, which is still a fairly niche field within the discipline of conservation. Nevertheless, as more software-based artworks come to the collections and the care of conservators, a body of knowledge and practices is finally coalescing.

This paper describes our current understanding of software-based art preservation in the context of contemporary art in museums as well as the main strategies being tested and developed in the field.

We will look at the lifecycle of an artwork in a collecting institution and the key moments for preservation; this will provide an insight into the role of conservation in caring for software-based artworks.

The described methods show the depth and relevance of the work of conservators in preserving this fragile heritage, and hopefully instigate closer collaboration between all the different actors in caring for this type of works.

Conservators as Practitioners

Conservators specialise in particular areas such as paintings, objects or photography due to the level of expertise required to safely treat valuable objects. These specialisations also address the context in which conservators work, for instance in the care of ethnographic objects or time-based media art, where we are trying to preserve not only unique physical objects but also immaterial aspects of the conservation object, as discussed

by Muñoz Viñas (2005).

This paper focuses on this last group of professionals, and our role in or in connection to collecting institutions. This is based on my experience of 10 years working as part of a team of time-based media conservators at Tate, the first institution to employ a time-based media conservator, Pip Laurenson, in 2003.

Formal training in media conservation was first created in 1999 at the University of the Arts in Bern, Switzerland. Since then, other courses around the conservation and archiving of electronic media have emerged, but the number of specialised conservators is still very low. Specific training in software-based art conservation is still not available, but some degrees now offer options to choose related subjects and are encouraging students to research in the area. Current experts either have training in other subjects of conservation and then extended their expertise as required or have a background in computer science or engineering and have then trained in conservation or learned about conservation as part of a job.

As any other conservators we are interested in materials and production techniques and ways to preserve and document them. Working in the context of software-based art means understanding hardware, software and the overall technical environments needed to run it, as well as aspects of display, either in the gallery or in a browser on a computer screen.

Context, Tate and the collection

In the context of time-based media conservation we use the term software-based artwork to mean any artwork in which the software is one of the primary media of the work (Falcao et al. 2016). Tate collected its first software-based artwork—Michael Craig Martin's *Becoming*—in 2003. Subsequent acquisitions of software-based artworks by Tate were at a somewhat leisurely rate of one per year until a step change occurred in 2016, when Tate Modern's Director Frances Morris, in her first interview in post, signalled a shift in Tate's curatorial goals: "I am sure that for the collection, the next big challenge is going to be digital. In the 19th century we didn't buy photography. It took us over 100 years to catch up. Let's not be in that position again." (Higgins 2016)[1]

This focus is now clearly reflected in the number, diversity and com-

1 Higgins, Charlotte, Interview with Frances Morris, Director of Tate Modern in The Guardian, 16/04/2016. www.theguardian.com/artanddesign/2016/apr/16/tate-modern-director-frances-morris-interview.

plexity of the works acquired or in the process of being acquired and we have already seen an increase in the rate of acquisition of software-based artworks, or artworks with software elements.

Collecting software-based art raises some new questions about what aspects of a work we can preserve and how we should go-about this. Tate's mission statement, as set out in the Museums and Galleries Act 1992, is essential in defining what we want to achieve, and consequently the actions we must take:

> Our mission is to increase the public's enjoyment and understanding of British art from the sixteenth century to the present day and of international modern and contemporary art. Its statutory aims and objectives set out in its governing document are:
>
> – to care for, preserve and add to the works of art and the documents in its collections;
> – to ensure that the works of art are exhibited to the public;
> – to ensure that the works of art and the documents are available to persons seeking to inspect them in connection with study or research; and
> – generally to promote the public's enjoyment and understanding of British art, and of twentieth-century and contemporary art, both by means of the Board's collections and by such other means as they consider appropriate.[2]

It is important to highlight the relevance given to care and preservation in the first point of the list, as this is then reflected in the institutional view of Conservation - and Collection Care in general -as equal contributors and collaborators and in the resources made available for these actions.

The other important points for software-based art preservation are that works of art must be exhibitable, which in the case of software-based art equates with them being functional. The fact that they must be available for study and research points to the need to maintain or at least thoroughly document historical systems. By systems we mean the combination of hardware, software, data and display specifications. So far the systems supplied by artists at acquisition have all been only a few years old when they come to the Tate Collection, which means we have less experience in dealing with completely obsolete computer systems.

At Tate, time-based media conservation is responsible for the long-term preservation and display of any artwork in the collection that makes

2 Tate, Governance page: www.tate.org.uk/about-us/governance.

use of media such as film, slides, video, sound, performance and software.

The number of time-based media artworks in the collection is increasing steadily, with an average of 35 works being acquired per year over the last five years to a total of c. 650 artworks. The number of works on display at any given moment is also increasing and the extra exhibition space in the new building at Tate Modern is a key aspect, but the overall interest from the different Tate sites has also had an impact. These two aspects, and the importance given to the care and display of these works, means that the time-based media team has grown from being one person in the sculpture conservation team to currently being a team of 12 people specialised in the different media and activities of time-based media conservation. The team includes one conservation manager, four conservators, one assistant conservator, four senior conservation technicians, one conservation technician, and a long-standing group of freelancers as well as eventual interns and trainees.

The now fairly long history of the team means we did not have to start from scratch in considering how to document and preserve these works and can build on an experience of over 20 years in caring for electronic media and time-based media art, and in adapting our systems and processes to accommodate the specificities of the different media, artists and artworks.

For software-based art, the first acquisition in 2003 was a trigger to start researching the subject. Basic preservation procedures, such as testing equipment, creating copies of hard-drives and digital assets and thoroughly documenting systems were tested and put in place for the first time. Since then we have been able to build on those procedures, grow our experience and test new methods for preservation. We have also put our effort into learning from related disciplines, developing new relationships with experts, and maintain and expand our networks of knowledge about specific technologies.

It has always been clear that any procedure must be adapted to the individual artwork and the basic steps must be revised over time, to follow the evolution of the technologies used by artists and of the tools for preservation. The experience and knowledge on how to stabilise, treat and document this type of artworks is also constantly being expanded by sharing of museum practice and collaboration with researchers in software preservation and digital preservation in general.

The increase in numbers and complexity of artworks being acquired does highlight the urgency of new scalable strategies for preservation, also to mitigate risks for preservation and display of both obsolete and brand-

new technologies. And this brings us to a basic question about what are we trying to preserve.

The artworks

Between 2003 and 2016 Tate acquired the following artworks:

Year Acquired	Year Produced	Artwork	Artist
2003	2003	Becoming	Michael Craig-Martin
2007	2005	Subtitled Public	Rafael Lozano-Hemmer
2008	2007	Things Change	Michael Craig-Martin
2010	2007	Brutalismo	Jose-Carlos Martinat
2012	2005	Colours	Cory Arcangel
2012	2006	Astrophotography	Cerith Wyn Evans
2013	2002	Adji	Meshac Gaba
2015	2009	Sow Farm (near Libbey, Oklahoma)	John Gerrard

There are currently another six works in the process of acquisition. These include three software-based art installations, two works classified as netart and one webpage that is part of a larger physical installation.

The majority of the artworks such as José Carlos Martinat's *Brutalism: Stereo Reality Environment* from 2007 (T13251) or Rafael Lozano-Hemmer's *Subtitled Public* from 2005 (T12565) are meant to be installed in a gallery.[3]

Most works so far were delivered as computers, with all the required software installed[4] and ready to be used in a gallery display. We often also receive other hardware needed to display the work, such as video cameras or printers. For all our artworks these are only one instantiation of the work, and the artists have stated that they are happy to see the hardware

3 For a description of these artworks, see Falcao 2010.

4 Installed is used with two meanings in this paper, one referring to the computer science concept and the other to the actions needed to set-up an artwork in the gallery. Where doubt may exist it will be made explicit.

and software changed as needed to keep the work running. This then opens up the question of what do we mean by preservation and what are we trying to preserve? To answer this it is helpful to start by introducing the lifecycle of an artwork in the museum from a preservation perspective.

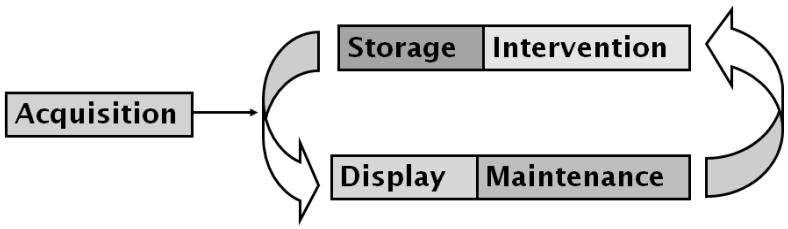

Figure 1. Lifecycle in the Museum.

The artwork's lifecycle in the museum

There are four key moments that can be singled out; Acquisition, Display (and the related maintenance processes), Storage and Intervention (Fig. 1).

At Tate, the acquisition process includes all the initial decisions to collect a work from a curatorial perspective, which then trigger the steps related to conservation. From a conservation perspective, this is the moment in which conservators are involved to identify and secure the components and information needed for preservation and display. At this point, a baseline of information is created about a work, both from the artist and/or galleries but also through technical analysis of an artwork's components by conservators and technical experts. This analysis informs the creation of a preservation plan highlighting any risks related for instance with obsolescence or specific dependencies. This may lead to an initial intervention, with the agreement of the artist, to improve the sustainability of an artwork.

The information gathered will feed any decision for display, and whenever possible artists have further input to the discussion. Display allows us to test the information we have, correct any errors or clarify inconsistencies. It also helps to gain an understanding of how an artist's views may have evolved since a work was acquired. It also often triggers the need for changes in technology.

Having a record of how an artwork has been displayed also ensures that later displays will take into account any changes and decisions made at this stage. Joanna Philips proposes a documentation model to create a record of the changes of an artwork over time, based on its multiple itera-

tions. She also highlights the benefit of it "serving as a tool for institutional self-reflection, making current choices transparent to future interpreters, and thereby helping to prevent uninformed and compromising realizations of an artwork." (Philips 2015: 168)

As part of a display, and to ensure that a work is shown in accordance with an artist's instructions there are a number of maintenance processes that need to be followed. These will be dependent on the artwork's needs and may include things like dusting the inside of a computer or ensuring a projector is focused and has new lamps.

For any digital artwork there is an expectation of permanence of its components, and storage for both digital and physical components is essential. I will go into more detail looking at storage as a preservation strategy, but at this point it is relevant that storage must happen for as long as an artwork is in the collection, so even historical components are stored permanently.

A very important moment that can happen throughout the whole lifecycle is intervention, which includes any process by which an artwork is changed to ensure its continued displayability. Again, this is discussed in more detail as part of the preservation strategies, and the point to be made is that these change processes are often triggered either at acquisition, as described before, at the point of display, or by imminent risk in terms of obsolescence. As I mentioned, all the moments in the life cycle are closely linked to the preservation of an artwork, so it is useful to define what we understand as preservation and its aims.

Preservation and preservation strategies

When preserving software-based artworks we have two main objectives, preserving the experience of an artwork and at the same time its technical history. One important aspect of preservation is to maintain, as much as possible, the experience of an artwork. This requires that we understand what an artwork does and how it is meant to be displayed. For that it is helpful to understand if the work can be defined by a set of functions that is performing, and whether the means by which these functions are performed can be replaced. An example is for instance the projection of words in Rafael Lozano-Hemmer's installation. It is fair to assume that we will continue to project images over the foreseeable future, and therefore that function can be replaced.

The importance of preserving the production and technical history of an artwork can be illustrated by the frequent articles in academia and the media, for instance on how the X-ray of a painting brought to light an art-

ist's work process. With electronic technology and its inherent need for change, this history can be easily lost, particularly if the information is not captured in a timely fashion, and this is a key aspect for conservators at Tate.

Sometimes much of the information is captured and transmitted by the artists themselves, for instance, the documentation created by Rafael Lozano-Hemmer and his team for *Subtitled Public* is exemplary.[5] Rafael's engagement with Lizzie Muller and Caitlin Jones in their documentation case study of *Subtitled Public* at the Daniel Langlois foundation in 2007 has probably influenced this, as has his collaboration with conservators in collecting institutions.[6]

More frequently it is the role of the conservators at Tate to gather the information needed to preserve and display the works. At Tate that involves curators in conversation with conservators and registrars, among others.

Defining significant properties and risks

An important step in this analysis and risk assessment of an artwork is defining its significant properties, a term used in the context of Digital Preservation to mean: "The characteristics of digital objects that must be preserved over time in order to ensure the continued accessibility, usability, and meaning of the objects." (Wilson 2007: 8)

In our context, the object is an artwork and more often than not for time-based media works, it only exists when installed correctly in space. The importance of defining these properties is for instance to understand the value put on specific elements or functions by an artist. An example is the choice of hardware and the options to replace a piece of equipment. For the work *Brutalism: Stereo Reality Environment 3,* 2007 by José Carlos Martinat Mendoza. At Tate the work was described as:

> "This sculpture is a scale model of the Peruvian military headquarters, an example of 'brutalist' architecture it was nicknamed the 'Pentagonito' (or 'little Pentagon'). During the Fujimori presidency, the building became notorious for the torture, murders and disappearances conducted by the secret service. The sculpture incorpo-

5 Lozano-Hemmer and Anti-modular Research: http://www.lozano-hemmer.com/subtitled_public.php and http://www.lozano-hemmer.com/texts/manuals/subPublic_manual.pdf.

6 www.fondation-langlois.org/html/e/page.php?NumPage=2111.

> rates a computer which has been programmed to search the internet for references to 'Brutalismo / Brutalism', picking up extracts about Latin American and global dictatorships but also on architecture, forging associations between different kinds of 'brutalism' which it spews out onto the gallery floor."[7]

For the gallery display a computer must be placed on the floor near the main sculptural element, as an indication of the connection to the internet. The computer supplied by the artist was a generic looking black desktop, as used in many offices around 2007. In discussion with the artist, while preparing for a display at Tate Modern in 2011, it became clear that the look of the computer was important, and therefore that when it fails it should be replaced by a similar looking computer. The other option in this case is to keep the case of the original computer and hide a smaller computer inside it. Because the computer is generic, and its function easily replaceable we can say that we will be able to retain its significant properties, that include its look and the ability to run the software, even once the original electronics fail. Consequently, the risk of loss of function is minimal and we can address it by caring for the original computer as if it were a sculptural object but without having to ensure that it remains functional.

For the same work, one of the main risks is its dependency on the Google API to make web searches. As an external dependency beyond the control of the museum, any change by Google to the API requires a change to the software. To pre-empt issues related to loss of the internet connection the artist's programmer has designed the software system to include a database, where the results of the searches are stored and then retrieved for printing. This not only means that the work will run even if an internet connection is not available, but also that the history of the search results is stored as part of the work. The artist did state a clear preference for the software to run with live searches, and therefore we already know that the next time the work is displayed we will have to update the API. Due to the modularity of the software system it is unlikely that any of the other modules would need to be changed.

To summarise, when identifying risks and significant properties we try to define the following aspects:

– What are the display parameters? How is the work meant to look like in a gallery?

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7 https://www.tate.org.uk/art/artworks/martinat-mendoza-brutalism-stereo-reality-environment-3-t13251.

- What can or cannot be changed and within which parameters?
- What are the obsolescent, or at risk elements and how can we recover them if needed?
- How would the artist like to see the artwork preserved?

Analysis

An essential part of the acquisition process is the description, analysis and documentation of the systems supplied by the artist. These are more often than not a computer with all the software installed and ready for gallery display.

Before the analysis itself we have in the last few years started to add an initial step of creating disk images of the hard drives in the computers. To prevent the accidental deletion of data we do any copying via a device named write-blocker. This is now basic best practice in digital preservation (John 2012). By creating an exact copy of the original disk we can start to investigate the software components without putting the original computer/s at risk, and we can also test the hardware while being assured that we can recover the system if it fails.

A clear list of the hardware—from the computers to any peripherals—and software—from Operating Systems to specific libraries—makes possible risks clearer, and helps to plan for the purchase of any replacements, if necessary.

The result of this analysis allows us to then plan for the future preservation of the work and to evaluate the applicability of the different preservation strategies (Fig. 2).

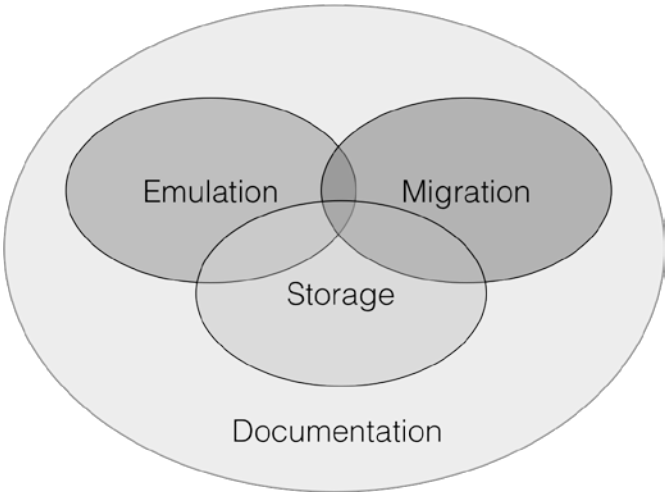

Figure 2. Preservation Strategies.

Storage

Museums are very good at storing physical objects, and in most institutions, even with limited budgets, resources are invested in keeping objects in clean areas, with controlled environmental conditions, avoiding variations of humidity and temperature, and managing and controlling any issues with pests. For software-based art, as for any other type of artwork, any hardware and objects supplied as part of an artwork are kept and stored under the appropriate environmental conditions, and adequate packing is designed to keep those elements.

What is generally less well developed is archival digital storage, even if the requirements have been defined. The digital preservation community has developed guidelines[8] and standards[9] that can be applied for any type of digital information, including software and software-based art. The implementation of those standards at an institutional level and for larger amounts of data requires a commitment from the institution in the long-term, just as physical storage, and this often requires good advocacy skills from stakeholders and interdepartmental collaboration. For smaller collections, such as an artist's archive, it is possible to create a fairly robust archiving system with a modest investment.

The aim of having archival digital storage is to ensure that any digital file exists as multiple copies in at least 2 different locations, and that their condition is monitored, so that if a file is corrupted this can be corrected. These files must also be easily found and retrieved. There are open source and free tools to achieve many of these objectives, for instance the Bagger tool from the Library of Congress[10] or the software Exactly and Fixity by AVPreserve[11].

Intervention—Migration, emulation and anything else that helps

As explained before, in this context intervention is an action that changes the materials, both hardware and/or software, of an artwork.

There are a few different approaches that often must be applied in con-

8 For instance the NDSA levels of Digital Preservation https://ndsa.org/documents/NDSA_Levels_Archiving_2013.pdf.

9 Such as the ISO Standard 16363, Audit and certification of trustworthy digital repositories http://www.iso16363.org.

10 github.com/LibraryOfCongress/bagger.

11 www.weareavp.com/products.

junction. Interventions can range from migrating a system to new hardware, migrating a piece of software to a more recent version, completely rewriting a piece of software. or running the original software on emulators. Which techniques are used, and possibly in which combination can only be decided when facing a specific artwork and understanding the effects of the intervention.

Two intentions can lead to a decision to intervene, a preventive intention, to make an artwork more sustainable over time, or a treatment intention, to allow an artwork to run and be displayed. Preservation risks for an artwork are often identified early on in its lifecycle in the collection, hence it is often possible to take steps to increase the sustainability and robustness of specific systems. An example is the work done with Arturo Diaz, José Carlos Martinat's programmer, to change the software for *Brutalism* so that it works with USB printers, rather than requiring replacement printers to have parallel ports, given that printers with the latter connections are now obsolete.

Another recent example, on a currently ongoing acquisition we were going to receive an application for MacOS created using the platform Unity. In conversation with the artist it became clear that it would be simple to provide a second version that would be compatible with a Windows OS, and this would not only increase flexibility in terms of showing the work, but could also facilitate emulation in the future, given the legal limitations of running MacOS in non-Apple hardware systems. By taking these steps at an early stage we can pre-empt problems later, when the artists or their programmers may be no longer available to make and advise on these changes.

The aim is always to increase the sustainability of a system by making use of current standards, avoiding issues around proprietary systems and reducing the impact of obsolescence in a system.

The interventions with a treatment intent can happen at any time in the artwork's lifecycle, but very often they will be prompted by display needs. For instance, when planning a display at Tate Modern conservators may have to create back-ups of hardware to allow any hardware to be replaced if a fault occurs. A display often means a computer running 24/7 over up to one year, and this prompts the need to create a new back-up of that computer. At this stage obsolescence may have an impact and trigger the need for a treatment.

Most of these interventions are perfectly reversible, provided they are performed in copies of the data, but nonetheless some questions must be considered:

- How will this intervention affect the artwork?
- Will it maintain all the significant properties of the artwork?
- Will there be any loss in those properties, and if yes, how will that affect the experience of the work?
- How will it interfere with the original system of hardware and software, and how will those changes be documented?
- How sustainable will that intervention be? Is the treatment only meant to allow the next display, or is it meant to ensure displayability for a longer period of time?

There is still limited experience of software-based art being conserved or treated, and even less experience of the sustainability of these results in light of changes in context and technology, but the number of institutions and conservators learning about this types of works is growing and some consensus is being found, for similar technologies. Documentation is essential to build and share this body of knowledge.

Documentation

The main aim of the documentation we create in time-based media conservation is to have a record of the materials that compose an artwork, the artwork's production processes, information about past and present displays and of course any interventions that may have changed them. This diagram summarises the average documentation created for a software-based artwork at Tate. Time-based media conservation is still defining the best form for this information to be captured and used. This can range from a fairly classical conservation report, to an artist's interview, a wiki entry or a metadata export. Most recently the interest in linked data, and the possibility of sharing and re-using technical information seems to be gathering traction, with interesting projects on the subject at the Yale Center for British Art[12] and the work on Wikibase at Rhizome[13]:

12 britishart.yale.edu/collections/using-collections/technology/linked-open-data.
13 wikimediafoundation.org/2018/09/06/rhizome-wikibase.

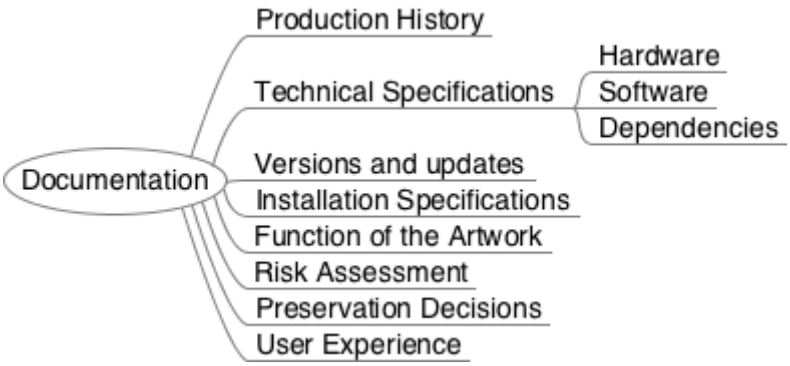

Figure 3. Documentation strands.

Documentation is one of the areas where a level of standardisation can be very helpful, if shared throughout a community, in defining best practices and avoiding each institution making the same mistakes. So let's look into best practices.

Developing best practices

Software-based art conservation is built on the experience and best practices developed for time-based media. Over the years a growing number of museums, not only contemporary art museums, are collaborating to share practice and advice. Some results can be seen for instance in the excellent Media Conservation Initiative[14] at the Museum of Modern Art in NY, which complements the work done by the collaborative project "Matters in Media Art2[15]. We are further seeing relevant research happening in Universities both at MA and Phd level, with Tate for instance supporting a doctoral student, Dr. Tom Ensom, in his research into the documentation of software-based art. Recent relevant Master Thesis include work done at the Moving Image Archiving program at NYU, where students have done timely research in the preservation of technologies such as Virtual Reality and Flash, or at the School of the Arts in Bern, where students were looking at the use of arduinos and Max/MSP in art.

To continue to develop and disseminate these practices it is important that this need is understood, and that research time is considered part of the job. Participation on communities of practice is another way in which

14 www.mediaconservation.io/resources#asdf.
15 mattersinmediaart.org.

knowledge can be created and shared, and Tate is actively engaged with other contemporary art museums, but also with other collecting institutions, in training programs and the broader field of digital preservation. This collaboration will be essential in our next steps, summarised as:

- Improve and refine our workflows
- Work with developers to improve tools available and adapt them to our needs
- Strengthen the collaboration between departments at Tate
- Extend our network outside Tate to include the expertise required
- Work with other practitioners to define and disseminate best practices

These can be seen as ongoing next steps, and without ever being complete, as new technologies, questions and challenges are a given. By creating these networks of collaboration, not just within conservation but also including other careers and stakeholders we are more likely to achieve our aims, of maintaining as much of these works alive for as long as possible.

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