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# RISK ASSESSMENT AS A TOOL IN THE CONSERVATION OF SOFTWARE-BASED ARTWORKS

**PATRICIA FALCÃO**

## ABSTRACT

This paper presents the results of research into the use of risk assessment methodologies to identify and evaluate vulnerabilities of software-based artworks. The research was undertaken while studying for a master's thesis at the University of the Arts in Bern, Switzerland, and as part of an Institute of Conservation internship at the Time-Based Media Conservation Department at Tate, London, funded by the Heritage Lottery Fund and Tate. For the thesis, the relevance of risk assessment methodologies to the conservation of software-based artworks was analyzed in four case studies from Tate's collection: *Becoming* (2003) and *Things Change* (2007) by Michael Craig-Martin (b. 1941); *Subtitled Public* (2005) by Rafael Lozano-Hemmer (b. 1967); and *Brutalism: Stereo Reality Environment 3* (2007) by Jose Carlos Martinat (b. 1974). Useful trends in the types of risk were identified at particular stages in the life of an artwork, as well as measures to be taken to make preservation possible in the mid-term. This paper outlines a systematic way of thinking, designed to determine priorities for conservation activity, and demonstrates the importance of the conservator's proactive engagement—at the point of acquisition—to insure that all assets are acquired and information from the artist and programmer is gathered.

## CONTEXT

This paper presents some of the results of the research undertaken as part of a Heritage Lottery Fund (HLF)-funded internship at the Tate and of the author's master's thesis at the University of the Arts in Bern. The thesis focuses on four artworks:

1. Michael Craig-Martin, *Becoming*, 2003, computer-based LCD light box with digital display, 39 x 32 x 11 cm, acc. no. T11812, acquired in 2003. The work consists of an executable file on a monitor with a built-in computer. The executable file displays a group of objects that become visible or invisible in a random order.
2. Rafael Lozano-Hemmer, *Subtitled Public*, 2005, mixed media, dimensions variable, acc. no. T12565, acquired in 2007. This interactive installation tracks the public in space and projects verbs onto them. It involves cameras, software, and projectors. The software maps the space using coordinates and then generates targets on visitors in the gallery. Another piece of software randomly selects one verb from a list. This verb is connected to one of the targets and projected onto the visitor.
3. Michael Craig-Martin, *Things Change*, 2007, three wall-mounted LCD monitors and software, 75 x 378 x 12 cm, acc. no. T13348, acquired in 2008. This work is composed of an executable file running on a triptych of monitors with a built-in computer. The software changes images and colors in a random order throughout the three monitors.
4. José Carlos Martinat, *Brutalism: Stereo Reality Environment 3 AER-3*, 2007, MDF, three printers, paper, tracking system, central processing unit, cables, and web search program, 183 x 214 x 255 cm, acc. no. T13251, acquired in 2010. The installation is composed of a sculpture and a software element, which searches the Internet for phrases incorporating the word "Brutalismo." Industrial printers, similar to those found in cash machines, print out the sentences found. The printers then cut the paper so that scraps gather on the floor around the sculpture.

These artworks were analyzed and documented, and the particular risks for each of them were assessed. *Subtitled Public* was installed at Tate Liverpool and *Brutalism* at Tate Modern; in both cases, collaboration with the artists and their programmers was essential for the successful installation of the work.

## RISK ASSESSMENT

Risk assessment is the first part of the risk management cycle (fig. 1), during which the objects, collections, or artworks are analyzed. The risks are identified in the context of the institution or stakeholders, and according to the objectives defined by all stakeholders. This

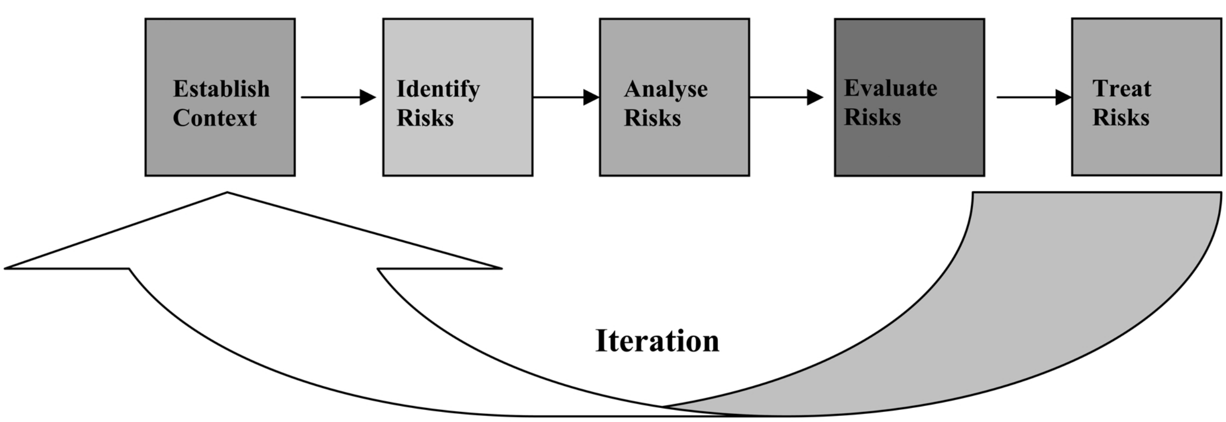


**Fig. 1. The stages of risk management according to the Australian and New Zealand Standard on Risk Management (Cooper 2007).**

process should start while an artwork is being acquired and should inform what is asked of the artist regarding the media, the acquisition agreement, and the archiving process.

The Australian and New Zealand Standard on Risk Management (Cooper 2007) defines the following stages for risk management: (1) establish context; (2) identify risks; (3) analyze risks; (4) evaluate risks; and (5) treat risks. These stages were incorporated into the following steps in the methodology developed by Brokerhof for the Inside Installations project. As P. Laurenson (2007, 2–3) states:

1. Establish the anatomy of the installation
2. Develop a 'statement of significance'
3. Determine the relative value of the elements identified to the whole work
4. Develop scenarios and identify risks
5. Explore the possibility of recovering lost value
6. Carry out a qualitative or (semi)-quantitative assessment of risks

The above methodology was followed in the thesis. For the case studies, it was found that a qualitative analysis of the risks was appropriate. Attributing quantitative scores to the magnitude and impact of the risks was difficult and not very useful. This is mostly because many risks were connected to the technology and its developments, and are very difficult to predict.

The main goal of a risk assessment is to plan for the long-term preservation of an artwork, collection, or both. The risk assessment process also brings many other benefits, such as:

1. Encourage the structured analysis and discussion of the artworks and risks involved from different viewpoints and in the context of the institution. "In particular it provides a space for structured thinking about the assumptions of the different stakeholders and their notions of value and risk" (Laurenson 2007, 2).
2. Help all stakeholders' understanding of the artwork or collection and the risks liable to impact it.
3. Define clear evaluation criteria, which make decision-making processes more rational and substantiated.
4. Identify monitoring needs and facilitate the development of tools or mechanisms to do so.
5. Finally, Bermès (2007, 4) states that, "The objective is not to avoid all risk, but to define the acceptable level of risk according to the institution's mission and means."

## SOFTWARE-BASED ARTWORKS AT THE TATE

As of the summer of 2010, Tate had acquired or was in the process of acquiring the four software-based artworks mentioned above. With three additional artworks slated for acquisition in 2012, the variety of incoming technologies and associated issues is already very clear. The four works in the case studies use three different operating systems, three different programming languages, five different computer models, and a series of input and output devices including video cameras, projectors, monitors, and printers. The oldest operating system is Microsoft Windows XP, and the oldest programming language is Lingo (for Adobe Director). All the equipment is still functioning.

To be able to deal with all this variety, it is important to understand what type of information must be gathered at acquisition. Because most systems are custom-made, a checklist of needed information is hard to establish; a better strategy is to engage with each work and understand how it functions. A good start toward understanding the artwork is learning what is required to display it and how complex and involved the installation process will be.

For all these works, the basic technical information and installation instructions had already been gathered as part of the normal acquisition process at Tate. The hardware and software had been documented, and both artists and programmers had been interviewed for all works except *Brutalism*. Also, all the works, except *Brutalism*, had been installed and run before the case studies started.

## SPECIFIC CHARACTERISTICS OF SOFTWARE-BASED ARTWORKS

The software-based artworks in this study fall under the definition given by Richard Rinehart:

> Amid the variability and portability, there is one aspect of digital media that separate them from traditional art media and even other electronic art media; source code. Source code is usually a text file written by a programmer in a standard programming language like C++. Using a separate piece of software called a compiler, this source code is compiled into a full-fledged piece of software such as MS Word (2006, 18).

Software-based artworks run on computers, and this allows for variability not possible with other technologies. By contrast, while a DVD player is a complex system, its function is clear and the parameters by which it can vary are limited. It may read CDs and DVDs, and it may play PAL or NTSC video, or mono or stereo audio. The format in which DVDs are recorded is a well-defined and clearly documented industry standard.

When using a computer, an artist or programmer has a multitude of hardware and software choices. He or she can choose different hardware, like video cards, graphic cards, and processors. Other choices include the operating system, programming language, programming tools and interfaces, file formats, encoding, and numerous other variables.

Software-based art is just as dependent on industrially produced technology as a video installation. This dependency has two consequences:

1. Because electronic equipment is usually mass-produced, there are very few cases where one individual device is essential for the artwork. In most cases, one device can be replaced by another performing the same function. This means that at a first stage, it is easy to replace elements of an artwork. If a FireWire video surveillance camera breaks down during an exhibition, there is no apparent issue in replacing it, because the other option would be for the artwork to not function. This replaceability introduces the risk of uncontrolled change, but also creates the possibility of preservation. Without this possibility, most computer-based artworks would cease to exist as soon as the first hardware component broke down.
2. On the other hand, it is a liability that the equipment is mass-produced using complex production processes in expensive and specialized facilities. Once this equipment is no longer commercially available, it becomes very difficult to replace any of its elements. Recreating the production processes for a FireWire surveillance camera, or even the charge-coupled device (CCD) inside the camera, would be impossibly expensive for museums.

It is usually possible for a sculpture conservator to remake a missing element for a sculpture by using the same or similar materials. However, a time-based media conservator cannot re-make a working CCD without the involvement of the electronics industry.

Finally, like most installation art, software-based artworks only show their true form when turned on and working. What Pip Laurenson (2005) says about installation art is equally true of software-based artworks: “Lying somewhere between performance and sculpture, these works exist as installed events, dependent on display to be fully realized." One needs a computer that will run particular software. Often the software is custom-made and specific to that particular artwork. Any software, in turn, usually requires a specific operating system. All the programs, from the firmware to the operating system, must run properly. All settings, plug-ins, and codecs must be in place. Without all of these, there is no artwork, or only a thwarted form of it.

In practice, this means that each artwork is a custom-made system with a number of hardware and software components. These components may vary with each iteration of the work, both as a result of an artist's decisions and changes in technology. Even if a conservator is not required (or able) to fully understand how all components influence the system, he or she must be aware of how these components are used in the particular system and how they influence the risks and options for long-term preservation.

## RISK, MAGNIFYING FACTORS, AND OBSOLESCENCE

Risk in the cultural context can be defined as "the probability that a hazard will cause the undesired effect in specified conditions and within a specified time" (Ashley-Smith 1999, 19). A. Brokerhof (2006, 2) defined it as the "possibility of loss of value." Ashley-Smith defined a list of hazards that will affect cultural objects. They can be tangible hazards, like physical forces, fire, water, criminals and vandals, pests, contaminants, radiation, incorrect relative humidity, incorrect temperature, electricity, and inherent decay. There are also intangible hazards, information dissociation being the most relevant for object conservation. For technology-based artworks, it is necessary to consider malfunction, the risk of something being improperly installed or functioning in a way different than originally intended. An example is software being run on a processor much faster than the one for which the software was programmed. This was an issue raised by Michael Craig-Martin's *Becoming*, because the increased speed of the processor caused the images to appear on screen faster than intended.

Magnifying factors influence the consequences of a risk (fig. 2), and can usually be described as a lack of something, such as emergency procedures. For example, if there is a fire and staff does not know what to do, then fire has more time to spread and damage objects. The consequences of the fire hazard are therefore worse than if there were emergency procedures in place. Obsolescence is the main magnifying factor affecting software-based artworks.

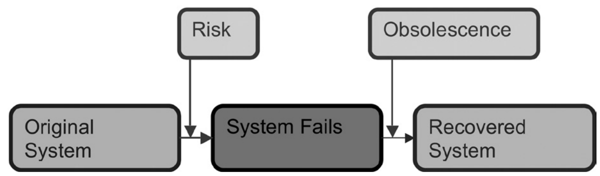


**Fig. 2. Risk and obsolescence on system failure.**

In the context of conservation of contemporary art, obsolescence can be defined as a condition that affects an element or system when it or its parts are no longer commercially available or supported by the industry that initially produced them. This is usually because a new product that fulfills or substitutes for the function of the previous product was introduced in the market.
Like other magnifying factors, obsolescence only affects an artwork once something stops working and recovery comes into play. Unlike other types of magnifying factors that tend to be constant over time (or until action is taken), the effect of obsolescence tends to increase over time.

What became clear through the case studies was that the risks for software-based artworks are not very different from the ones affecting other time-based media artworks. However, software-based artworks are more vulnerable to those risks because:

1. Systems are customized for each artwork.
2. Systems are easily changed. Something as simple as connecting a computer to the Internet and making

an automatic update can mean that a particular executable file will no longer run.

3. The technical environment is rapidly changing. For example, seven years after acquisition, problems had already developed in opening some of the original graphic files for *Becoming* because the Adobe Illustrator software had been launched in six new versions since 2003.

## SIGNIFICANCE, RECOVERY, AND RECOVERABILITY

"Significance" refers to the values and meanings that items and collections have for people and communities. . . . Significance may also be defined as the historic, artistic, scientific and social or spiritual values that items and collections have for past, present and future generations. These are the criteria or key values that help to express how and why an item or collection is significant. (Russell and Winkworth 2009, 10)

When working on risk assessments of classical objects or collections, a set of values is examined to determine the object's significance and to better understand what must be preserved. These values were listed by the Collections Council of Australia (Russell and Winkworth 2009, 10) as:

- Historic
- Artistic or aesthetic
- Scientific or research potential
- Social or spiritual

For the software-based artworks in the Tate collection, all these values are closely interlinked. The fact that an artwork was acquired into a national collection like Tate's adds to the work's value, more than if, for instance, the artwork belonged to a private collector. Because Tate's collection is a national art collection, the artistic value is implicit (or may be attributed by the act of acquisition), as are the historical, social, and scientific and research values. Therefore, significance and value are attributed by stakeholders, and are not concrete, unchangeable parameters.

The degree of significance can be evaluated by four comparative criteria. These are modifiers of the main criteria:

- Provenance
- Rarity or representativeness
- Condition or completeness
- Interpretive capacity

For artworks in the Tate collection, provenance must be very clearly established and documented before the acquisition process. A clear statement about representativeness must also be made by the curators. For software-based artworks, completeness may mean different things for different artworks. Completeness may mean having a whole system of the hardware, software, manual, certificate, and sample materials. It may also mean having a DVD with a piece of software and a page of loose set-up instructions. In most cases, it is something in between.

By understanding what is significant for a particular artwork, the conservator can make better decisions for preservation. At acquisition, it is particularly important to discuss the significance of the different elements of an artwork with the artist. Two similar devices in different artworks may have completely different values. A very generic-looking computer in *Brutalism* proved to have more significance, or more value, than expected. This became apparent when the artist was asked about which computer model to acquire for the back-up system being created for display. Jose Carlos Martinat was keen on having a model that looked as close to the original as possible. This was particularly important because the computer can be seen next to the sculptural element on the floor of the gallery.

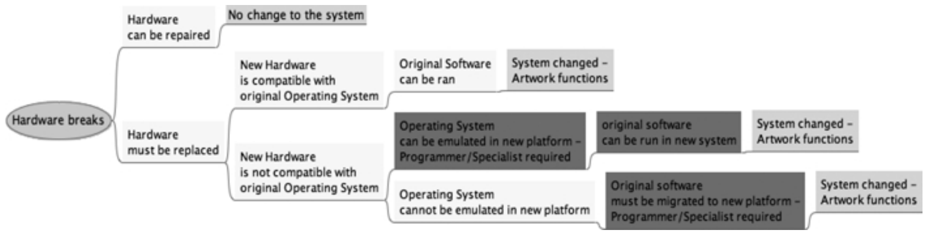


**Fig. 3. The effects of obsolescence in the recovery of an artwork's hardware element.**

Recoverability is the ability to recover from loss, damage, or failure. For software-based artworks, 100% recovery may be possible. However, the technical and financial feasibility must be considered, as well as the degree of significance attributed to the original elements.

In traditional fine art conservation, the authenticity or originality of an item is defined almost exclusively by its component materials, and any change in these creates a loss of value. For artworks that use mass produced elements, like technology-based artworks, the change or replacement of parts is usually seen as maintenance and does not entail any loss of value. There are exceptions to this rule, like when a piece of equipment is signed or altered by the artist, but these are a minority of cases. For example, figure 3 shows recovery options for a piece of hardware in a software-based artwork. In this example the hardware element itself is not considered historically, aesthetically, scientifically, or socially significant, as defined by Russell and Winkworth. Only the hardware's function is important. If the hardware element was otherwise significant, the first branch of the diagram would be the only option. The original equipment would have to be maintained and repaired for as long as possible. Because the hardware element is not significant, it is possible to replace it with a similar element without changing the artwork. Replacing the element with a different device compatible with the original system introduces some change, but the loss of value is related to the technical history of the artwork. In terms of the display of the work, no change would be noticeable. Further options would result in changes to the original system. These are possible, but involve a much higher risk of compromising the integrity of the artwork.

The option omitted from the diagram is making a replica of the original hardware element. This would be both technically and financially difficult, and would only be contemplated for a work of extreme significance.

In summary, the main questions regarding replacement are:

1. Is the element replaceable?
2. Can an appropriate replacement be found or produced?
3. Is an appropriate replacement affordable?

## CONCLUSIONS

From theoretical research, discussions with experts, and case studies, a procedure for the acquisition of software-based artworks has started taking form. It is composed of simple actions that, if taken during acquisition, can diminish the impact of obsolescence in the medium-term.

It is essential to discuss the artwork, technology, and possible preservation measures with both the artists and their programmers. Through an interview or informal conversation, the conservator can identify and define:

1. The display parameters. It is important to define how the work should be presented. Does it require its own space or can it be shown with other works? Does it require a gallery of a specific size? These specifica-

tions may be due to artistic preferences or technical requirements. For example, in *Subtitled Public*, the height of the gallery space is crucial to the interactivity of the piece.
2. What can or cannot be changed, and within what limits. For example, the printers in *Brutalismo* may be replaced, but the replacements must look similar to the original ones.
3. Obsolescent elements and a plan for recovery. Which elements are at risk, and does the artist or programmer have any suggestions on how best to recover them when needed?
4. How the artist would like to see the artwork preserved. What does the artist feel is the core of the artwork? What would be unacceptable change?

It is also important to understand the system, including the hardware, the software elements, and how they relate. A description of the system given by the artist or programmer often does not include important details that can only be identified by running the system. Investigate what the system does and how, in the following ways:

1. Test the system without the artist or his or her technicians. From experience, systems often fail only after the programmer has left the room.
2. Assess the obsolescence of the different components of the artwork so that a mitigation strategy can be developed and implemented.

Over the life of the artwork, it is important to:

1. Document any changes to the system. It is important to know if changes were made to the software or hardware, and why the changes were made.
2. Prevent uncontrolled changes to the original system, such as the automatic update function in operating systems.
3. Monitor new obsolescence issues with the components of the work. For instance, there may be new versions of commercial software like Adobe Director.
4. Re-evaluate preservation needs regularly. Problems and solutions will evolve with the technology, and re-evaluation will allow the identification of both.

Even if preservation strategies vary with time, there are a few steps an institution can take to reduce the effects of failure and obsolescence in the medium-term:

1. Make clones of the computer's hard drive immediately upon acquisition.
2. Create an exhibition copy of the system. It is good practice to start from scratch and do as much as possible without the artist and programmer, working instead with the support of an independent expert or someone from the institution's Information Technology (IT) department.
3. Gather operation manuals, service manuals, and hardware specifications.
4. Save the software versions, source code, libraries, and programming tools necessary to read project files.

The following steps are necessary for long-term preservation:

1. Continue to implement the preservation strategies identified. For example, solutions like software virtualization have been used in software-based art preservation before (Lurk and Enge 2010), but Tate must continue to work to make them a regular part of conservation.
2. Develop clear procedures for the acquisition of software-based artworks. Making the thought process clear and applicable to a series of different artworks will simplify the acquisition of these works. This will allow a museum to acquire larger numbers of software-based artworks.
3. Identify software tools useful for preservation. There are tools developed for programming that can be useful for conservators. To find them, conservators must become familiar with alternative sources of informa-

tion, like discussion forums. Researching these resources in the context of the acquisition of artworks may create a pool of tools that can make a conservator's work easier.

4. Test recovery strategies and confirm results over time. Any recovery strategy applied to any of the artworks in the case studies can only be completely validated over time, as recovery is needed. It is important to keep track of the issues that arise when recovery strategies are applied.
5. Develop relationships with experts in the fields required for preservation. Knowledge of computer sciences and electronics at a specialist level is required for preservation, as well as an understanding of issues related to preserving art and its historical value. An exchange between computer scientists and conservators is essential. Work must be put into building relationships with experts for collaboration. Software-based preservation is too broad a subject to be kept in the conservator's studio.

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Patricia Falcao
Time-Based Media Conservator
Tate
London, UK
Patricia.falcao@tate.org.uk

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