Preserving Interactive Multimedia Art: A Case Study in Preservation Planning

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Abstract. Over the last years, digital preservation has become a particularly active research area. While several initiatives are dealing with the preservation of standard document formats, the challenges of preserving multimedia objects and pieces of electronic art are still to be tackled. This paper presents the findings of a pilot project for preserving born-digital interactive multimedia art. We describe the specific challenges the collection poses to digital preservation and the results of a case study identifying requirements on the preservation of interactive artworks.

1 Introduction

The last decades have made digital objects the primary medium to create, shape, and exchange information. An increasing part of our cultural and scientific heritage is being created and maintained in digital form; digital content is at the heart of today's economy, and its ubiquity is increasingly shaping private lives.

Furthermore, the field of arts has more and more adopted the new media. Digital photography has long exceeded the analog pendant in popularity, and more and more artists focus on digital media in their work. As opposed to initial expectations, however, digital content has a short live span.

The ever-growing complexity and heterogeneity of digital file formats together with rapid changes in underlying technologies have posed extreme challenges to the longevity of information. So far, digital objects are inherently ephemeral. Memory institutions such as national libraries and archives were amongst the first to approach the problem of ensuring long-term access to digital objects when the original software or hardware to interpret them correctly becomes unavailable [22].

Traditional memory institutions primarily own collections of digitised material and large homogeneous collections of electronic documents in widely adopted and well-understood file formats. In contrast, collections of born-digital art pose a whole new problem field. Electronic art is extremely complex to preserve due

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to the heterogeneity of employed media as well as the complexity of file formats. Moreover, artists cannot be obliged to conform to submission policies that prescribe formats and standards, yielding to highly heterogeneous collections of proprietary file formats.

This paper presents findings of a pilot project dealing with the preservation of born-digital multimedia art. Specifically, we focus on a collection of interactive artworks held by the Ars Electronica[1]. We describe the context of the collection and the specific challenges that interactive multimedia art poses to digital preservation. We then focus on the requirements that potential preservation strategies have to fulfil in order to be fit for purpose in the given setting.

The remainder of this paper is organised as follows. Section 2 provides an overview of previous work in the area of digital preservation and introduces the challenges born-digital artworks pose to digital preservation, while Section 3 introduces the PLANETS approach to preservation planning. We then describe the case study and the results we obtained in Section 4. In Section 5 we draw conclusions and give a short outlook on future work.

2 Related Work

Digital preservation is a pressing matter – large parts of our cultural, scientific, and artistic heritage are exposed to the risks of obsolescence. The rising awareness of the urgency to deal with the obsolescence that digital material is facing has led to a number of research initiatives over the last decade. Research has mainly focussed on two predominant strategies – migration[21,14] and emulation[17,23]. Migration, the conversion of a digital object to another representation, is the most widely applied solution for standard object types such as electronic documents or images. The critical problem generally is how to ensure consistency and authenticity and preserve all the essential features and the conceptual characteristics of the original object whilst transforming its logical representation. Lawrence et. al. presented different kinds of risks for a migration project [13].

In contrast to migration, emulation operates on environments for objects rather than the objects themselves. Emulation aims at mimicking a certain environment that a digital object needs, e.g. a certain processor or a certain operating system. Rothenberg [17] envisions a framework of an ideal preservation surrounding for emulation. Recently, Van der Hoeven presented an emerging approach to emulation called *Modular emulation* in [23].

The challenge of preserving born-digital multimedia art, which is inherently interactive, virtual, and temporary, has been an actively discussed topic in the last years. In 2004, the ERPANET project organised a workshop [7] on archiving and preservation of born-digital art. Besser reports on the longevity of electronic art in [4]. The Variable Media Network, a joint effort founded by institutions such as the Guggenheim Museum New York and the Berkeley Art Museum/Pacific Film Archives, investigated properties of an artwork that are

[1] `http://www.aec.at`

subject to change and develops tools, methods and standards to implement new preservation strategies for unstable and mixed media[6]. The most prominent results of this initiative is the Variable Media Questionnaire [15], developed at the Guggenheim Musem New York, which assists artists and curators in understanding which properties of an artwork are subject to change and how these should be handled in the best possible way. Guggenheim is also participating in the project "Archiving the Avantgarde"[1] together with the Pacific Film Archive, which develops ways to catalog and preserve collections of variable media art.

In the field of computer science, the most notable work has been carried out in the PANIC project [11,10] which developed preservation strategies for multimedia objects [9]. However, they focus on dealing with composite objects that contain different content; interaction is not covered.

Preserving the inherent complexities of interactive multimedia is a very difficult task, particularly because formats used in multimedia art are ephemeral and unstable. It also poses a conflict between the transformation necessary to keep the work accessible, and desired authenticity of each piece of art [5]. Jones [12] reports on a case study which used hardware emulation to recreate one of the first interactive video artworks. Emulation is often able to retain the original appearance of the digital object, and its proponents claim it is the ideal preservation solution [17]. But there are also a lot of critical voices. The main points of criticism are its complexity and the fact that intellectual property rights might prevent the creation of emulators [3,8].

The main obstacle to the second prominent approach, migration, in this context is the diversity and complexity of obsolete file formats that are used in the field of digital art. Depocas [5] argues that efforts to preserve born-digital media art always have to be based on structured documentation and adds that often the documentation is the only thing that remains.

3 Preservation Planning

A range of tools exist today to support the variety of preservation strategies such as migration or emulation. The selection of the preservation strategy and tools is often the most difficult part in digital preservation endeavours; technical as well as process and financial aspects of a preservation strategy form the basis for the decision on which preservation strategy to adopt. Both object characteristics and different preservation requirements across institutions and settings influence the selection of the most appropriate strategy for digital preservation and make it a crucial decision process. This process is called Preservation Planning.

The preservation planning approach of PLANETS[2] allows the assessment of all kinds of preservation actions against individual requirements and the selection of the most suitable solution. It enforces the explicit definition of preservation requirements and supports the appropriate documentation and evaluation by assisting in the process of running preservation experiments. The methodology is based on work described in [16,20] and was recently revised and described in

[2] `http://www.planets-project.eu`

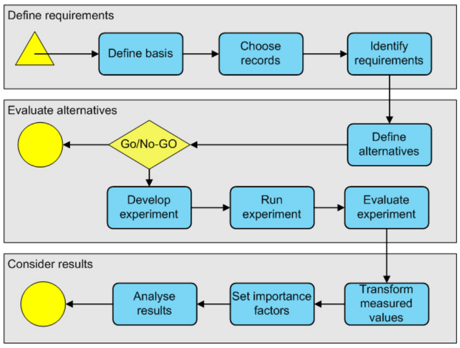


Fig. 1. Overview of the PLANETS preservation planning workflow

detail in [19]. It combines utility analysis [24] with a structured workflow and a controlled environment to enable the objective comparison and evaluation of different preservation strategies. The workflow consists of three phases, which are depicted in Figure 1 and described in more detail below.

1. **Define requirements** describes the scenario, the collection considered as well as institutional policies and obligations. Then the requirements and goals for a preservation solution in a given application domain are defined. In the so-called objective tree, high-level goals and detailed requirements are collected and organised in a tree structure.

   While the resulting trees usually differ through changing preservation settings, some general principles can be observed. At the top level, the objectives can usually be organised into four main categories:
   - *File characteristics* describe the visual and contextual experience a user has by dealing with a digital record. Subdivisions may be “Content”, “Context”, “Structure”, “Appearance”, and “Behaviour” [18], with lowest level objectives being e.g. color depth, image resolution, forms of interactivity, macro support, or embedded metadata.
   - *Record characteristics* describe the technical foundations of a digital record, the context, interrelationships and metadata.
   - *Process characteristics* describe the preservation process. These include usability, complexity or scalability.
   - *Costs* have a significant influence on the choice of a preservation solution.

   The objective tree is usually created in a workshop setting with experts from different domains contributing to the requirements gathering process. The tree documents the individual preservation requirements of an institution for a given partially homogeneous collection of objects. Strodl et. al. [19] report on a series of case studies and describe objective trees created in these.

   An essential step is the assignment of measurable effects to the objectives. Wherever possible, these effects should be objectively measurable (e.g. € per year, frames per second). In some cases, such as degrees of openness and stability or support of a standard, (semi-) subjective scales will need to be employed.

2. **Evaluate alternatives** identifies and evaluates potential alternatives. The alternatives' characteristics and technical details are specified; then the resources for the experiments are selected and the required tools are set up, and a set of experiments is performed. Based on the requirements defined in the beginning, the results of the experiments are evaluated to determine the degree to which the requirements defined in the objective tree were met.
3. **Consider results** aggregates the results of the experiments to make them comparable. The measurements taken in the experiments might all have different scales. In order to make these comparable, they are transformed to a uniform scale using transformation tables. Then the importance factors are set, as not all of the objectives of the tree are equally important, and the alternatives are ranked. The stability of the final ranking is analysed with respect to minor changes in the weighting and performance of the individual objectives using Sensitivity Analysis. After this a clear and well argued accountable, recommendation for one of the alternatives can be made.

PLANETS is developing a decision support tool for preservation planning, which supports the process and integrates distributed software services for preservation action and object characterisation. In the future this system will also allow for semi-automatic evaluation of alternative preservation strategies.

While the digital preservation community is increasingly developing solid methods of dealing with common digital objects such as electronic documents and images, dealing with complex interactive content is still an open issue. The next section will outline the challenges of interactive multimedia art in the context of digital preservation, referring to a real-word case. We will then apply the preservation planning methodology outlined above and analyse the requirements for preserving interactive multimedia art.

4 A Real-World Case: Ars Electronica

More and more modern museums hold pieces of born-digital art. The Ars Electronica in Linz, Austria, is one of the most prominent institutions in the field of electronic art. It owns one of the world's most extensive archives of digital media art collected over the last 25 years.

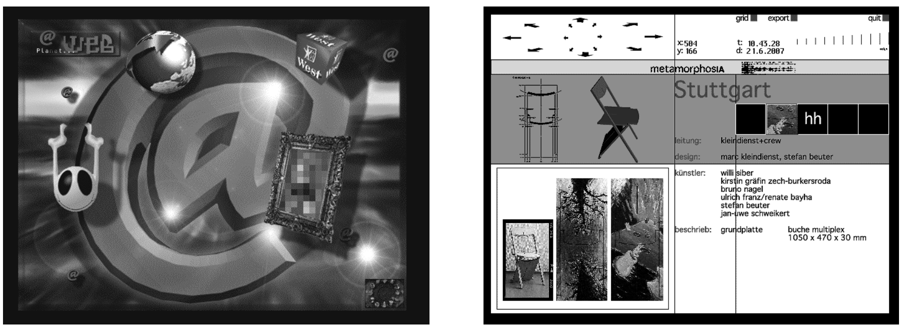
The collection of the Ars Electronica contains more than 30.000 works and video documentation and is growing at a rate of over 3000 pieces per year. Of these works, about 6200 pieces have been deposited as CDs containing multimedia and interactive art in different formats like long-obsolete presentation file formats with interactive visuals, audio and video content. The CDs are divided into the categories Digital Music (4000), Computer Animation (1000), and Interactive Art (1200). These collections pose extreme problems to digital preservation due to their specific and complex characteristics. The main issues arising in this context are the following.

1. The collections are highly heterogenous, there is no common file format. Instead, digital art ranges from standard image and video files to specifically designed, proprietary software pieces which are sometimes highly dependent on a specific environment. Some pieces of art even deal with the issues of digital deterioration, damaged content and the like.
2. Often artists object to the idea of preserving their artwork, because they feel its value lies in the instantaneous situation, it should be volatile or they want to retain control about the original object.
3. Many of the artworks are integrated applications, for which the underlying file format can not easily be identified. For example, some interactive artworks combine multimedia content with viewer applications specifically designed to render the contained objects.

Contrary to traditional digital preservation endeavours, these specific issues also bring about the need for particular actions. For specific objects, it might be necessary to involve creators in the definition of requirements to ensure that their intentions are communicated through a probably transformed representation of their artworks. Other pieces might only be preservable by developing custom software particularly for this purpose.

In a joint effort, the Vienna University of Technology and the Ludwig Boltzmann Institute Media.Art.Research are investigating possible approaches to deal with the preservation of born-digital interactive art. The aim is to not only preserve these pieces of art over the long term, but also make them accessible in a satisfying form on the web. In a pilot study, we concentrated on a sub-collection of the large collection the Ars Electronica owns. This collection contains about 90 interactive presentations in the formats Asymetrix Compel, Asymetrix Toolbook, and Macromedia Director. The companies that created these formats have ceased to exist; only the latter format is supported by current software[2].

The aim of the pilot project is to find means of preserving the original intention of the artists as well as the user experience and thus truly preserve the original artwork. To achieve this, we applied the preservation planning approach outlined in Section 3 and analysed the requirements on preserving interactive



(a) Kolb: Cycosmos (b) Kleindienst,Beuter: Metamorphosia

Fig. 2. Sample interactive artworks from 1997

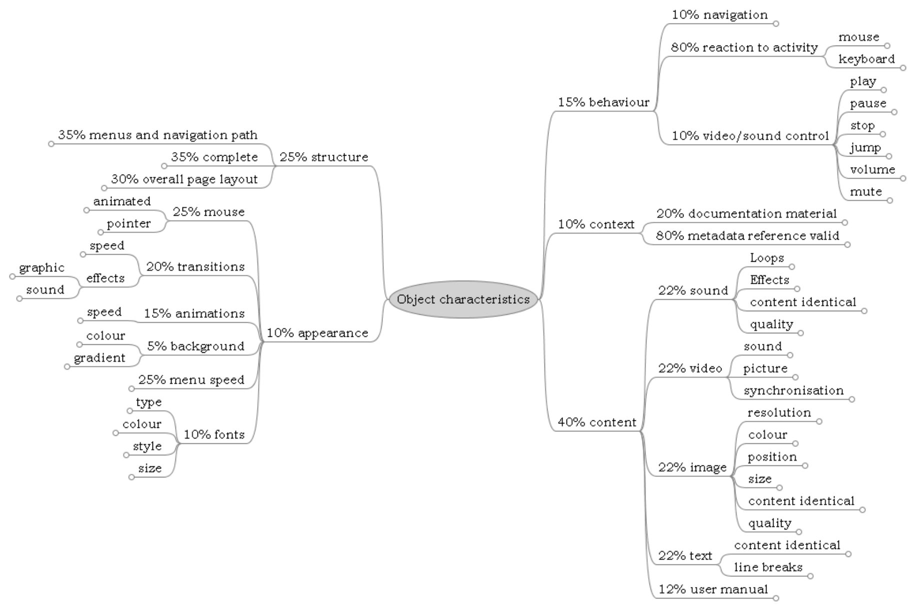


Fig. 3. High-level view of the essential object characteristics showing weights

art. In a series of workshops with curators, art historians, computer scientists, preservation specialists, and management, the first phase of the planning process was completed. Figure 2 shows screenshots of two exemplary sample records that were chosen as part of this process. These sample objects are used for identifying requirements and evaluating the performance of different preservation strategies.

Figure 3 provides an overview of the essential object characteristics that were identified, and also documents the weights that have been assigned to the upper levels of the tree hierarchy. Naturally, the primary focus lies on the content of the artworks, such as the contained text, images, and sounds. The second most important criterion is the completeness of the navigational structure that constitutes each interactive artwork. A purely linear recording of an interactive piece of art will most probably not prevail the true spirit and the spectator's experience. This interactivity is also by far the most important criterion when it comes to behavioural characteristics.

Figure 4 details some aspects of the object characteristics as they are displayed in the software and provides some measurement units to illustrate the quantitative nature of the evaluation process. A particularly relevant aspect is the measurement of interaction features and the degree they have been preserved by a preservation action. In principle, interactive presentations exhibit two facets: They have a graph-like navigation structure, and they allow the user to navigate along the paths.

Different strategies of preserving an interactive presentation will show different strengths and weaknesses in preserving these characteristics. For example, migrating an interactive presentation to a collection of images and videos and

Node	Scale	Restriction	Unit
Object characteristics			
behaviour			
navigation	Ordinal	interactive and integrated/navigatable /none	
reaction to activity			
mouse			
position	Boolean		
clicks	Boolean		
keyboard	Boolean		
video/sound control			
structure			
menus and navigation path	Ordinal	complete and free/partial (linear)/none	
complete	Boolean		
overall page layout	Ordinal	Y/A/N	
context			
appearance			
mouse			
animated	Boolean		
pointer	Ordinal	icon/visible/none	
transitions			
speed	Float		deviation in percent
effects			
graphic	Boolean		
sound	Boolean		
animations			
speed	Float		deviation in percent
background			
menu speed	Ordinal	usable/unusable	
fonts			
content			
sound			
Loops	Boolean		
Effects	Ordinal	Full/Partial/None	
content identical	Boolean		
quality	Ordinal	same/audible degradation/unacceptable	
video			
sound			
picture			
synchronisation	Boolean		
image			
resolution	Ordinal	>=original/<original	
colour	Ordinal	same/reduced/missing	
position	Float		deviation in percent
size	Float		deviation in percent
content identical	Boolean		
quality	Ordinal	same/visible degradation/unacceptable	
text			
user manual	Ordinal	integrated/existent/none	

Fig. 4. Selected object characteristics for interactive multimedia art

documenting the navigational structure externally will preserve the complete structure and the possibility to navigate along the paths, but miss the interactivity. The structural aspect of this is measured in the criterion *menus and navigation path*, while the interaction is covered by the behavioural criterion 'navigation', which can take one of the values *interactive and integrated, navigatable*, or *none*.

Measuring the degree to which the content of pages such as images and sound is preserved is more straightforward. The lower part of Figure 4 provides some examples on the properties that describe images, sound, and video. While currently properties such as image quality have to be judged manually, PLANETS will integrate object characterisation services that are able to evaluate and quantify many of the described characteristics automatically.

5 Summary and Outlook

This paper presented a case study on preserving interactive multimedia art. We focussed on the specific problems that arise in the context of interactive digital art. In the main part of this paper, we concentrated on a collection of interactive artworks in mostly obsolete presentation file formats. We described the essential object characteristics that have been identified by the responsible curators and outlined how they can be quantified.

The next step in the pilot project is the implementation of potential preservation strategies on the sample records and the evaluation of outcomes. The results of this evaluation will then lead to a well-founded recommendation for the preservation of the complete collection of interactive art that we discussed.

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