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Toward a Conceptual Emulation Framework for the Preservation of Archaeological 3D Visualizations

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Through the Preservation of Complex Objects Symposia (POCOS), leading researchers and practitioners have managed to propose strategies for preserving digital art and computer games. The same is not true for the preservation of archaeological visualizations. This article therefore discusses the following question: "Can emulation be employed to effectively preserve obsolete computer visualizations from the Archaeology domain?" Guidelines and test results coming from this work would be of great benefit to the archaeological community, and would contribute knowledge to other research communities, specifically those interested in similar data types/3D visualizations.

KEYWORDS digital preservation, 3D visualizations, emulation, preservation metadata, best practice, complex digital objects

INTRODUCTION

Archaeologists are often early adopters of new technologies and techniques for visualizing their datasets (i.e., documentary archive—CAD files, databases, spreadsheets, 3D data—and material (finds) archive (ADS 2014), but there is a discontinuity between the means for creating such work and the means to preserve and ensure its long-term accessibility.

Awareness of different risks associated with the long-term accessibility of digital information arose in particular in the mid- to late nineties. The European Commission (EC) funded Digital Preservation (DP) research activities, via the sixth and seventh Framework Programme, started in the first

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years of the twenty-first century. The PLANETS (Preservation and Long-term Access through NETworked Services) project (2006–10) developed the first tools and frameworks supporting different preservation tasks, such as file format characterization, migration, emulation, and preservation planning. KEEP (Keeping Emulation Environments Portable) (2009–12) is another completed EC funded project. The purpose of KEEP was to provide access to part of our modern Cultural Heritage (CH)—e.g., video games and digital art—for future reference, utilizing mainly the DP strategy of emulation.

EMULATION VERSUS MIGRATION

Digital publications are stored on various types of carriers that are rapidly getting old. Moreover, machines used to read or run these publications are also getting old fast and cannot be maintained in a working state in the medium or long term. This is the reason why central repositories (e.g., national libraries and universities) need to consider carrier transfer, or carrier imaging, and hardware virtualization, or emulation, as the only durable way to preserve digital publications and the possibility to access, that is run, them. Emulation also provides interesting advantages compared to migration, which is the preferred solution thus far for static (i.e., text, audio, pictures) electronic publications:

- Digital artifacts can be left untouched (i.e., the original bitstream remains unaltered): Preservation of the functionality and appearance (look-and-feel) of digital artifacts.
- Emulators are cost efficient, because they only need to be adapted to future hardware and operating systems approximately every four years.
- Emulators are written in Java (platform-independent programming language). This in fact facilitates their migration process.

Migration is focused on the digital object itself. Emulation does not focus on the digital object, but on the hardware and software environment in which the object is rendered. It aims at (re)creating an environment in which the digital object can be rendered in its original form. This is performed by an emulator, a software application that runs on a host computer platform and recreates the targeted platform (Figure 1) (Keeping Emulation Environments Portable, n.d.).

DIGITAL DOCUMENTATION

Preservation Metadata

Having access to a digital file (e.g., archaeological 3D reconstruction) is not enough. In the case of emulation, information about the initial technical

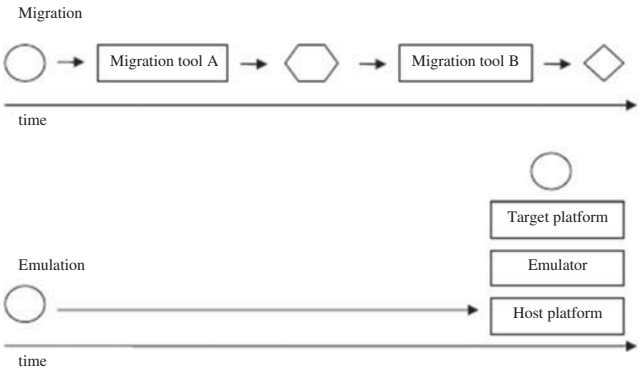

FIGURE 1 Preservation strategies migration and emulation.

conditions (a description of the object's file format, as well as the software applications, operating system and hardware needed to make the object usable) of the object is required.

This kind of information called metadata. There are three distinct metadata categories: a) Descriptive, b) administrative, and c) structural. Each one supports the process of DP. That is why in the relevant bibliography, we can also find them under the umbrella term of preservation metadata (Anderson, Delve, Pinchbeck, and Alemu 2009).

Preservation metadata is not just technical metadata. For this reason, it does not fall into the aforementioned recognized preservation metadata categories. Nevertheless, it can be considered as an informational frame of reference (provenance, rights management, and technical and interpretative environment) around a preserved digital object.

The crux of the matter is that it is not sufficient to preserve only media and bits. We also need to preserve other aspects of digital objects such as understandability, usability, knowledge, and interoperability. The latter are also known as advanced issues of DP. Other usual concerns, which we encounter when trying to preserve digitally encoded information, are, for instance, authenticity, legal position, safety, and reproducibility (Giaretta 2011).

Paradata

Preservation of complex digital objects is much more than ensuring that your files are backed up. Practice shows that in most projects, over 90% of the work goes into the analysis and interpretation of the data, while less than 10% goes into 3D modeling and texturing. Hence, failing to document and preserve the visualization process results in the loss of at least 90% of the invested money (Plentickx 2012).

This means that optimal workflows and specific requirements need to be defined, such that 3D visualization and its digital documentation (paradata)

becomes an integrated part of CH practice. The archaeological community needs to shift toward preservation-ready objects rather than counting on archival employees to do their job properly.

Agreed in advance standards and processes, preservation of supporting documentation (e.g., client's specification) and recording of the methodology followed during a project, among other things, can all result in preservation-ready objects. Sourcing this level of technical information beforehand can save professionals involved with DP a lot of effort.

STORAGE ISSUE

To make matters more complex, technical preservation issues are only a part of the problem. According to the Archaeological Resources in Cultural Heritage: a European Standard (ARCHES) guidance (a best practice manual for the products of European archaeology), an archaeological project should be considered complete only when its archives have been deposited in a "trusted" digital repository where they can be made fully accessible for consultation (ADS 2014).

This means in practice that companies are not the right place to store complex CH objects (sudden bankruptcy, proprietary (commercially confidential) format). On the other hand, storage in a central repository at the national level (e.g., library or university) should be.

Preservation Formats

Published and open formats are always preferable from a preservation perspective: The best options for digital curation and long-term preservation are non-proprietary, open format specifications produced by international standard bodies, such as ISO/IEC 19775-1.2:2008, the Extensible 3D Graphics (X3D). Usually numerous organizations have been involved in the development of these standards and they are generally backwards compatible (Personal Archives Accessible in Digital Media, n.d.).

- Recommended preservation formats for complex 3D objects: X3D (open format used in a number of open source 3D modeling software packages)/OBJ (open format accepted by nearly all CAD/3D modeling software).

CONCLUSION

To take archaeology as an exemplar, it is the case that through excavation it destroys that which it studies. What is more, the Archaeology Data Service Strategies for Digital Data reported that: "The archaeological record could be decaying faster in its digital form than it ever did in the ground" (Condron,

Richards, Robinson, and Wise 1999, cited by Delve, Denard and Kilbride 2012, 127).

Therefore, there are many reasons why archaeological visualizations should be preserved. Archaeological remains are regularly described as being a finite and non-renewable resource and due to natural and man-made processes some sites and monuments will not be with us forever in their current physical form. Other archaeological remains are accessible only to a small minority (e.g., cave and underwater sites) and visualizations are the only way that the majority of archaeologists, and the public, will ever be able to experience them. In addition, many more sites are no longer in existence or entirely ruinous and a digital reconstruction that allows people to explore how they might have once appeared is an extremely valuable tool for understanding the past (Mitcham 2012).

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