

Evaluating the SHAMAN Digital Preservation Framework for memory institutions

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Abstract. The paper falls under the category Digital preservation and access management. The aim of the paper is to present the approach to evaluating the EU SHAMAN (Sustaining Heritage Access through Multivalent ArchiviNg) project outcomes from the point of view of the needs and requirements of the memory institutions. The complex approach to the evaluation of the outcomes is defined by the complexity of the projects goals. The evaluation and assessment design draws upon earlier evaluation of digital repositories and other projects in the area of digital preservation. The evaluation has to be carried out from the perspective of the representatives of research and development community, the memory organizations such as libraries, archives and museums, the end-users of technology, such as librarians, curators and archivists and the end-users of preserved materials, such as researchers, educators and artists. Quantitative and qualitative data collection tools and methods are constructed for the use in the assessment process. The particular requirements that memory institutions have for long-term digital preservation systems are taken into account.

Key words: digital preservation, evaluation, assessment methodology, SHAMAN project, EU project

1. Introduction

The growth of digital resources in libraries of all kinds summons a new era in their development. Historically, libraries have always been concerned with the management and preservation of 'atoms', today they must be increasingly concerned with the preservation of 'bits' (Negroponte 1996). The conservation of the physical book and journal issue has its own problems, but national libraries and university libraries have copies of books that are centuries old and which, in many cases, have been preserved in pristine condition. The big question for libraries today, however, is how to preserve digitized materials (we leave aside completely the related problem of how to preserve access to licensed materials not actually owned by the library).

The situation is not confined to libraries alone, however; all kinds of 'memory institutions', responsible for preserving the records of our cultures, are affected – museums, art galleries and archives. All are digitizing original materials or images of 'realia' that cannot be digitized, for example, archaeological finds.

The causes of decay in the digital record are well known and, to a degree well understood: first, the physical medium upon which the bits are stored is subject to decay, thus, Gilbert suggests:

With moderate care, most magnetic media will last for 10 years. With special storage and handling, digital magnetic tape formats can reliably store information for 30 years or more. Optical disc media, such as CD-ROM and CD-R, can last for several decades. Testing by Imation/3M indicates that their CD media will last for over 100 years, although this figure should be viewed with at least a little skepticism. Research by Kodak also shows that CD-ROM media is estimated to last for over 100 years. Older magneto-optical (M-O) and phase change (PD) media have a life expectancy comparable to magnetic media of 10 - 30 years. (Gilbert 1998)

All of these lifetimes are considerably less than acid-free paper, which we know to be durable for 500 years or more. If the durability of the physical medium was our principle criterion then, of course, we would carve everything in stone, since we have such records from 5,000 years ago. Carving bits into stone, however, would hardly be feasible!

The second problem area results from progress in technology – covering both the nature of the medium and the ‘player’. Even in the recent past we have seen a move from the original 8” to the common 5¼” to the 3½” (no longer floppy!) and with the emergence, first of the CD and DVD formats and now the USB ‘pen drive’, these have now disappeared – when did you last buy a personal computer with a floppy drive?

The most spectacular case of what happens when the wrong choice is made for a storage medium is that of the BBC’s ‘Domesday project’. This was a re-enactment of the creation of the Domesday Book, which was compiled following the Norman invasion of Britain in 1066. The idea was to compile a modern account of the state of the UK, with contributions especially from schoolchildren, describing cities, towns and villages and daily life therein. The decision was taken (with the participation of the technology firm Phillips) to use the latest technology – interactive videodiscs (Finney 2009). Today, these discs can no longer be read and although an emulator was built at the University of Leeds by means of which the data could be ‘read’ on a PC, there is still no publicly-available copy (Darlington *et al.* 2003). To all intents and purposes, therefore, the rich source of life in the UK in the 1980s is lost.

The third problem lies in the software for the manipulation and presentation of the information on the physical medium. As noted above, the University of Leeds solved this problem by building an emulator by reverse engineering the original system code for the Domesday discs. This, as may be imagined, was a time-consuming task and we cannot guarantee that resources will be available to accomplish it if we fall into the same technology trap.

Of course, in addition to these technology-related issues, there is always the possibility of a major catastrophe – war, floods, earthquakes, fires – demolishing the physical building and its contents.

Today, therefore, memory institutions must think about the long-term preservation of their digital materials and about how this may be accomplished. Many have had strategies in place for decades to deal with the major disasters and the problems and solutions are well understood (see, for example, Listen 2003, Alire 2000, Upton and Pearson 1978). It is only relatively recently, however, that consideration has been given to the conservation of the digital record.

Given the role of ‘memory institutions’ is to maintain, preserve and make available for study and research the record of the cultural heritage, they have very specific requirements regarding long-term, digital preservation. The several sets of requirements upon which the SHAMAN project is based include those relating to the digital record itself, in that it must be a *complete* representation of the original, it must be an *authentic* representation (i.e., it has not been altered in, or following, the digitization process), and systems must be in place to ensure *data integrity* and, where these fail, processes to draw the attention of archive managers to that failure, so that restoration may take place. In this paper, we present the approach to evaluating the SHAMAN project outcomes from the point of view of these needs and requirements of the memory institutions.

2. SHAMAN Digital Preservation Framework concept for memory institutions

SHAMAN (Sustaining **H**eritage Access through **M**ultivalent **A**rchivi**N**g) is a European Union project involving seventeen partners in the EU and the University of San Diego in the USA. It is built on a theory of digital preservation, which

...extends the concept of digital preservation from one that is focused on sending the records (metadata) into the future to one that can also send into the future a description of the environment that is being used to manage and read the records. The true test of a preservation environment is whether it describes the entire preservation information context sufficiently well that the records can be migrated into an independent preservation environment without loss of authenticity or integrity. (Watry 2007: 42)

SHAMAN aims to accomplish this goal by extending the metadata approach of OAIS (the Open Archival System Reference Model) through the integration of existing standards and technologies.

SHAMAN proposes the use of grid technology, which will enable interoperability among storage depositories located on local data grid networks. Thus, an archive located, say, in Berlin, may be accessed for agreed operations, from any node in the overall grid network. The Open Grid Forum (<http://www.ogf.org/>) has evaluated data grids from the persistent archive perspective and Watry reports:

The data grid requirements for persistent archives include data distributed across multiple sites and storage systems; data managed independently of the storage system; consistent management of file properties; persistent identifiers and access controls; and a scalable storage environment. (Watry 2007: 50)

In addition to the technology infrastructure of data grids, SHAMAN is working within a number of standards affecting different aspects of the persistent archives process. First, TRAC, the RLG/NARA Trustworthy Repositories Audit and Certification: Criteria and Checklist, is being developed by the grid community and SHAMAN will employ these criteria in the development of systems.

Secondly, the Open Archival Information System (OAIS) Reference Model (International... 2003) has been supported in software developed by the data grid community, but assumes that managing the metadata is a sufficient basis for preservation. SHAMAN assumes that this is *not* so and that the OAIS model requires extension to support migration of the preservation environment.

Finally, the *integrated Rule Oriented Data System* (iRODS) is being developed to enable the virtualization of preservation processes and the policies of archival agencies over data grid systems. SHAMAN will also seek to satisfy the requirements of iRODS in its development work.

3. Evaluation of the outcomes of long-term digital preservation projects

According to Berman, long-term preservation technology belongs to the cyberinfrastructure. Critical characteristics of the cyberinfrastructure are that it is 'useful, usable, cost-effective, and unremarkable' (Berman 2008: 51). As far as it meets these requirements one may consider it a well-functioning entity. On the other hand, the usefulness, usability, etc., of each element within a cyberinfrastructure is defined in a specific way. The evaluation of the long-term preservation applications is in its first phases, though certain experience and frameworks that can help already exist.

Looking for relevant literature one immediately finds a number of projects evaluating digital repository software. Kaczmarek *et al.* (2006) provide an overview of these projects and note that evaluations of repository software usually use checklists and scoring methodologies considering characteristics of specific functionalities, tool interoperability and extensibility. The evaluation of an application largely depends on what kind of materials will be ingested for access and preservation.

The MIDESS project evaluated multimedia repository software using functionality analysis (essential and important functions) as well as staffing, support, accessibility and other requirements. The checklist was built on the basis of a user needs analysis (JISC 2006). Technical evaluation of open source repository systems in New Zealand included the following major evaluation criteria: scalability, ease of working on the code-base (extensibility), security, interoperability, ease of deployment, ease of system administration, multiple language interfaces, open source licence, quality and configurability of workflow tools, strength of community. Each criterion was broken into sub-criteria. Criteria and sub-criteria were given an importance rating (0-4, 0 – lowest, 4 – highest) (Maxwell *et al.* 2006). The Open Society Institute (2004) has compiled a guideline on specific technical components of the repository software using an evaluation checklist (a feature and functionality table).

Kaczmarek *et al.* set a goal to check how repository software 'applications might support the activities of an institution... interested in digital preservation' and eventually its becoming a trusted digital

repository (Kazcmarek *et al.* 2006: 3-5). They benchmarked four repositories using an Annotated Audit Checklist distinguishing between repository software and a repository on the institutional level, which ‘implies a larger institutional commitment’ (Kazcmarek *et al.* 2006: 3).

The *Trustworthy repositories audit & certification: criteria and checklist* (OCLC & CLR 2007) is the result of a rather intensive work in this area.

There also exist audits and assessments of trusted repositories using DRAMBORA (Digital Repository Audit Method Based on Risk Assessment) in combination with TRAC, OAIS (Open Archival Information System) and other standards (e.g., Quisbert 2008, Steinhart *et al.* 2009). The list of DRAMBORA users may be found on the DRAMBORA Interactive website (<http://www.repositoryaudit.eu/users/>).

The EU project CASPAR*, which focused on the same problem of long-term digital preservation using the OAIS reference model, produced a solid evaluation report. The goal of the evaluation was to present evidence that the CASPAR approach is useful in helping to preserve digital objects. The External Review Committee composed of internationally recognised experts and/or EU representatives was used to evaluate the project outcome according to a set of criteria. Each project objective was assessed by a link to relevant Digital Preservation Metrics, and Project Impact Metrics (a Key Performance Indicator) using a progress assessment methodology.

Here we present some example of the metrics as they may be useful for evaluation of the project outcomes in other digital preservation projects.

Digital Preservation Metrics:

- The theoretical underpinnings – peer reviewed theoretical underpinning for the specifics of a digital preservation (e.g., CASPAR or SHAMAN) approach. Evidence – papers submitted to peer-reviewed journals and presented at international conferences and the review by External Review Committee.
- Practical demonstration of usability of digital information and format migration (software and hardware changes and changes in designated communities).
- Improved trustworthiness of repositories according to a certification standard in use of CASPAR techniques in a number of repositories.

Project Impact Metrics

- Adoption of CASPAR results in the preservation community. Evidence – number of users and external entities interested in CASPAR framework.

The project used typical preservation scenarios based on standard preservation risks (e.g., users may not be able to understand or use the data; the chain of evidence to prove authenticity may be lost) for evaluation of test beds accommodating changes in hardware, software, environment (including legal framework) and knowledge base of designated communities. The evaluative judgement (Excellent, Good, OK, Incomplete, Unknown) was provided by the External Review Committee (CASPAR 2009b).

The CASPAR partners believed that ‘The metrics were designed to be applicable to essentially any project which claims to be furthering digital preservation’ (CASPAR 2009a: 30). However, the limiting factor in CASPAR’s approach was the group of evaluators composed of experts rather than of potential customers and users of the technology. It is very difficult to overcome this limitation in technology development projects as most of them produce prototypes, rather than fully operational systems. Therefore, some substitute for the customer and user evaluation is provided by the project impact metrics (e.g., outreach scale, number of demonstrations, number of logins, etc.).

* Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval

The EU project PLANETS develops tools for the preservation planning process and decision making for the selection of preservation strategies. It is working on the tools that help one to compare and automatically evaluate potential preservation actions. This evaluation framework connects requirements and criteria to measurable factors in the environment and in digital objects. So far, they have experimented with comparing technical characteristics of migration and emulation services (conversion tools) (Becker 2008; Becker *et al.* 2009). In the evaluation of the project outcomes PLANETS has tried to overcome the above-mentioned evaluation limitations by asking for feedback on conducted experiments from their fourteen partner organizations that installed the local instance of the test bed. The feedback was mainly collected through the questionnaires to organizations (PLANETS 2008).

A short overview of the evaluation approaches of digital preservation projects show that they are widening and developing gradually by incorporation of elements that have not been used or were not developed earlier. There is also an impression of accumulated experience that is not lost but appropriated and extended with each new big project.

5. Evaluating SHAMAN for memory institutions

The SHAMAN project, as a part of continuing efforts to create the most reliable, useful and cost-effective systems for long-term digital preservation, was created with an idea of extensive evaluation of its outcomes (SHAMAN 2008).

5.1 SHAMAN Assessment Framework

An indicative feature of the SHAMAN Assessment Framework is the comprehensible evaluation of the project outputs as a whole. There are two work packages (WP) responsible for the evaluation. WP18 is responsible for project evaluation and troubleshooting as a part of the project management. WP14 gives special attention to the evaluation of the systems under development, i.e. integrative prototypes and demonstrators (within the work packages 11, 12, and 13) (see Fig. 1).

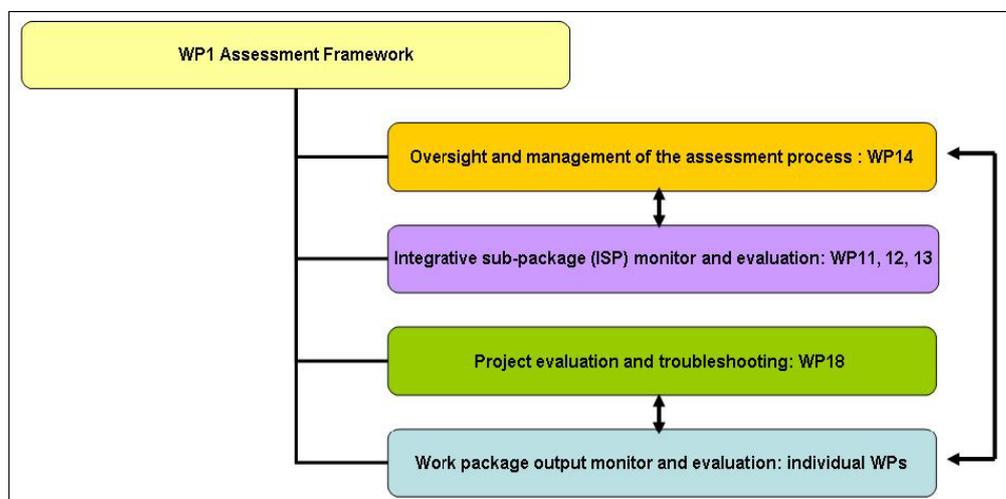


Fig. 1: Evaluation of the project outcomes and impact in SHAMAN (SHAMAN 2009: 87)

The other difference for SHAMAN project outcome evaluation lies in the area of the assessors.

SHAMAN evaluation is closely related to the demonstration of the project outcomes to three audiences: the research and development community, customers, and end-users (SHAMAN 2008). 'Customers' in this context means the organizations and institutions that have an obligation and a commitment to the long-term preservation of digital objects. In this paper they mean memory institutions (national and academic libraries, museums, archives, depositories of various documents, cultural heritage institutions, etc.). The end-users fall into two categories:

- 1) librarians, curators, archivists, record managers, publishers, etc. or the users of the preservation technology, and
- 2) researchers, students, writers, artists, etc. or the users of the preserved documents.

Both latter groups can be involved in the evaluation of the prototype systems only in a limited way during the project time, nevertheless, we are going to demonstrate not only the possibilities of the systems to the archiving and preservation professionals, but also the access to the documents that would be of interest to the end-users of preserved materials. We are preparing the instruments to capture their opinions and assessments (especially, critical ones) of the presented system possibilities.

The third distinctive feature is related to the application of several approaches integrated for the evaluation of the outputs produced by the SHAMAN project.

SHAMAN's aim is to develop and implement the infrastructure for users requiring long-term preservation and reuse of data, that is, to a degree, software systems that will enable effective archiving within existing or new repositories. Consequently, the assessment framework includes criteria that relate to the development of effective information systems. Such information systems have three dimensions: a technical dimension, a management dimension and a user dimension. Assessment criteria are needed for all three, in order to provide a full evaluation of the systems produced within the framework. DeLone and McClean (1992, 2003) proposed what is now a widely accepted model for the evaluation of information systems that will be applied for the evaluation of the prototype systems. On the other hand, the prototypes have to accommodate the requirements of digital repositories and help to avoid the risks related to digital preservation in repositories. This part of the assessment is based on the TRAC and DRAMBORA auditing checklists, which support the main requirements for repositories. iRODS is also involved because of the employment of grid technologies. The integration of the criteria from different approaches has been done and we are now working on the development of measures and indicators for the assessment.

In addition, bibliometric assessment is carried on the material published or presented by the participants of SHAMAN. This evaluation is mainly related to the evaluation carried out by the research and development community, but we hope that in time the response to the published material will be available from the customer organizations and professional archiving and preservation communities.

5.2 Memory institutions' requirements for long-term preservation

Traditionally memory institutions have worked mainly with huge amounts of documentary material, although some also have a variety of other objects to deal with (e.g., in museums). With their roots in paper-based publications, the most widespread digital object formats are document-style formats containing text and images, with dedicated image, sound and video formats important for some institutions. Memory institutions are also a node where many actors meet, starting with all kinds of authors (writers, translators, performers, etc.), a wide range of mediators (material producers and providers, distributors and disseminators, curators and keepers), and users (students, researchers, professionals, organizations, citizens, etc.) who need access, retrieval, searching and usage facilities. Memory institutions mainly exist within the public domain and are regarded as performing publicly important functions. Therefore, they attract the attention of many interest groups (politicians, educators, business leaders, funders, cultural workers, etc.). Technology developers are also among those interested in the work of memory institutions.

The reason for their interest is the fact, that memory institutions are using a variety of technologies and information systems (library management systems, records management systems, content repositories, etc.) to manage their vast collections and, as a result, have defined quite strict workflows for various work processes. It seems that neither curators, archivists, librarians, nor the users of library or museum collections interact directly with preservation system, but reach it by using other systems available in organizations. Memory institutions have been among the first developers and users of metadata standards: METS, preservation metadata standards, descriptive metadata standards (e.g., Dublin Core and others).

These institutions have also adopted various legal and administrative requirements (policies) to help in performing their functions. These policies regulate the relations between memory institutions and document providers, including the rules of pre-ingest and ingest processes of digital objects, selection and acquisition procedures, protection of systems and collections, conditions of access to the collections and many other aspects of their work.

Thus, memory institutions preserve and use documents in very complex contexts. SHAMAN technologies have to take into account all these features and factors in order to be accepted by the memory institutions as a useful and reliable preservation system.

5.3 The process.

The assessment workflow as derived from Moore (2008) can be described in six steps:

1. Definition of assessment criteria (in our case: information systems, TRAC, DRAMBORA)
2. Definition of policies enforcing the assessment criteria
3. Definition of rules that apply the policies (iRODS rules)
4. Definition of capabilities that implement the required (preservation) functions (microservices)
5. Definition of (preservation) metadata that capture information about the application of the preservation functions (persistent state information, e.g., audit trails)
6. Query the (preservation) metadata to assess whether the assessment criteria have been satisfied (SHAMAN 2009: 76).

In the case of memory institutions the output of SHAMAN is intended to be a prototype and three demonstrators of the prototype. The prototype is intended to be a functional system, capable of demonstrating the SHAMAN design principles and testing their feasibility. The demonstrators will be specific instances of the prototype, aimed at specific problems in persistent archive, i.e.:

- Demonstrator 1 will target indexing and archiving book-like objects in libraries;
- Demonstrator 2 will target indexing and archiving digitizations; and
- Demonstrator 3 will target scientific publishing and archiving heterogeneous inter-linked materials.

It will be clear from the foregoing that we are not concerned with the evaluation of a fully-operational system already being used in national and other archives. Rather, we are concerned with evaluating the feasibility and applicability of the SHAMAN preservation framework. That is, is it possible to develop effective systems within this framework that will allow persistent archiving with the maintenance of authenticity and data integrity?

At the beginning the only output, in relation to memory institutions, will be a number of demonstrators, therefore, evaluation must be concerned with how far these demonstrators show the applicability of the SHAMAN framework and how successful they are in showing that the framework is appropriate to the demonstrated context. The appropriateness should include suitability for the requirements of a customer organization, satisfying the needs of the archivists, librarians, curators, and other members responsible for preservation inside an organization, and the applicability of the preservation results for further use by their end-users.

By the end of the project additional features will be added and the prototypes developed for testing them with a variety of end users.

5.3 The tools and evaluators

All three audiences related to the memory institutions and mentioned above are involved in the assessment and evaluation of SHAMAN technologies. At present the developers of the preservation

systems from other projects are already providing feedback to the theoretical foundations of SHAMAN in publications and first demonstrators (e.g., National Archives and Records Administration from the USA in October 2009).

We have compiled a database of the memory institutions that might be interested to participate in demonstration and evaluation activities and conducted investigation of the preservation requirements in some of them not only with those who are directly involved in preservation processes, but also with the end users of the preserved documents. Thus, the contacts with the representatives of all three audiences are already established.

A number of tools are designed to be employed in the evaluation process, depending upon the functionality of the demonstrators. First, there are the 'technical' tools that record the machine operations of the system, measuring such things as memory usage, response speed, and so forth. These will be automatically generated by the system and will be linked to the specific operations being performed.

Secondly, a major 'user group' is the potential 'customer' organizations, that is, those libraries, museums and archives services that have expressed an interest in SHAMAN and a willingness to test the demonstrators. Members of these organizations will either be interviewed after each demonstration, or asked to complete a 'reaction' questionnaire, reporting their impressions of the validity of the demonstrated systems, their perceptions of strengths and weaknesses, and their perception of process gaps that would need to be filled in an operational system.

Finally, those members of the staff of the customer organizations who are involved daily in digitization and archival duties, will be interviewed (or complete questionnaires) focusing on the usability aspects of the demonstrators. By usability we mean not only aspects of interface design, but also matters such as ingest rates, speed of response, comparison with existing systems employed for digital archiving, search and access capabilities, and other system-user relationships.

6. Conclusion

SHAMAN is a very large, ambitious and conceptually complex project. Its outputs depend critically upon the work packages developing effective software, which is capable of integration into systems capable of demonstrating certain long-term preservation functions.

Given its complexity, the process of evaluating the outputs is also complex, involving the evaluation of systems *per se* and the evaluation of those systems from the perspective of potential user organizations and the staff in those organizations who would need to operate the systems.

At this point, we have already designed and started applying the evaluation process that is developing further, because the aims of that process develop together with the systems and their increasing adaptation to the requirements of memory institutions.

If the SHAMAN framework is demonstrated to be effective and if operational systems are subsequently built upon the framework, the kind of problems that arose as a result of software and technology decisions in the production of the BBC's Domesday project are unlikely to arise again. The SHAMAN framework would ensure that not only the document context was properly described by the metadata, but also the context of the project was captured by it, the software was properly described and that the original technologies for digitization and display were also properly described, so that software functions relating to specific characteristics of the technology could also be understood.

Finally, you will see, if you consult the reference list, that we make our own small effort to ensure long-term preservation: where possible, cited Web documents have been archived by the WebCite service.

ACKNOWLEDGEMENTS. The authors of this paper would like to thank the team of the SHAMAN project, especially, those who were working on the SHAMAN Assessment Framework, the

requirements of the memory institutions and those who are involved in integrating the first demonstrators and prototype systems for memory institutions. We also thank the Seventh Framework Programme of the European Union co-financing the SHAMAN project.

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