South African Journal of Information Management
[DoE accredited]

Peer Reviewed Article Vol.8(2) June 2006

Interdisciplinary investigation of the authenticity and long-term preservation of electronic records

S. Katuu
South African History Archive
University of the Witwatersrand
Johannesburg, South Africa
skatuu@yahoo.com

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Key words: Digital records, electronic records, long-term preservation, InterPARES, authenticity

1 Introduction

While technological innovations have no doubt enhanced the range and speed of information storage and retrieval both in the office and at home, these have also come with numerous challenges. The rapid pace with which these challenges have emerged in the work environment, coupled with the constant pressure of technological obsolescence, have resulted in increasing concern over the question of long-term preservation of the information generated. Additionally, with the increasing availability of free-ware and share-aware, guarantees to privacy and security are constantly being breached. McCagar (2005) notes:

> 'Since the mid-1990s, it has become increasingly clear that information stored digitally is unnervingly fragile. The very technologies that enabled the rapid dissemination of news are conspiring to create a generation-size gap in the historic record. Lacking the appropriate systems, workflows and metadata to ensure longevity, news archives are setting the stage for future data loss.'

Other questions include: how does one guarantee that the information generated and transmitted is what it purports to be; how can this guarantee be achieved over the long-term?

Historians, archival scholars as well as humanities and social scientists have been battling with these questions for many decades. Yet, their quest for answers has only recently touched the digital arena as

more and more information and documentation are generated digitally.

In the late 1990s, several scholars in Canada put together an ambitious proposal to develop the 'theoretical and methodological knowledge essential to the long-term preservation of authentic records and/or maintained in digital form' (InterPARES 1 2002d). They titled the project InterPARES, which in Latin means 'among peers'. It also served as an acronym for International Research on Permanent Authentic Records in Electronic Systems. This article, by drawing from various InterPARES-related documents, outlines the development of the project throughout its two phases and specifically seeks to demonstrate the interdisciplinary nature of its activities, a phenomenon that is rarely evident in the various information management fields.

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2 InterPARES 1

Between 1999 and 2001, InterPARES 1 focused on the issue of long-term preservation of the authenticity of records created and/or maintained in databases and document management systems. To do this, the researchers primarily relied upon a theoretical and methodological framework based on archival science, diplomatics and records management.

The precursor project to InterPARES 1 defined archival science as 'the concepts, principles, and methodologies governing the treatment of records. It includes the concepts, principles and methodologies defined by diplomatics' (University of British Columbia 1997). InterPARES defines diplomatics as 'the study of the genesis, inner constitution and transmission of archival documents, and of their relationship with the facts represented in them and with their creator' (InterPARES 1 2002b). The International Standards Organization (2001) defines records management as 'the field of management responsible for the efficient and systematic control of the creation, receipt, maintenance, use and disposition of records, including processes for capturing and maintaining evidence of and information about business activities and transactions in the form of records'.

Less significant subject areas consulted were computer science and engineering, jurisprudence and research methods.

During the course of this first phase, major funding came from the Social Sciences and Humanities Research Council of Canada, the University of British Columbia in Canada and the National Archives of Canada as well as the National Historical Publications as well as Records Commission and National Archives and Records Administration of the USA. More than 60 researchers from 13 countries spread over four continents participated in InterPARES 1. They were either practising professionals or academics, at a ratio of 80% to 20% (InterPARES 1 1999).

InterPARES 1 examined textual records that were created or received in digital format in the course of administrative and legal activities. InterPARES 1 also assessed records generated by databases and document management systems. However, these were records in inactive or non-current status, meaning that they had already served contemporary purposes for which they were generated and were being preserved for reference or information value.

During the course of InterPARES 1, researchers also looked at characteristics of e-records and the concept of authenticity as well as the activities of appraisal and preservation from the preserver’s point of view.

The methodology used for this study included the following:

- Theory and methods of diplomatics, archival science and law for the definition of concepts and development of requirements and methods;
- grounded theory in order to select case studies;
- comparative analysis for the study of appraisal and preservation reports;
- chemistry for the study of storage media and computer engineering for the study of digital preservation technology and technological methods of authentication; and

- integrated definition (IDEF) (0) modelling for the representation and definition of the activities involved in appraisal and preservation. InterPARES 1 specifically used IDEF (0) to describe processes or functions involved in preserving electronic records. In IDEF (0), 'a function model is a structured representation of the functions, activities or processes within the modeled system or subject area' (InterPARES 1 2005b).

Out of this process resulted clearer definitions of concepts (e.g. record, document, data, reliability, authenticity, identity and integrity) and principles (e.g. trusted custodian), and a series of analytical instruments (e.g. an electronic record template of analysis) for studying new types of digital documents and developing new requirements and methods as needed.

Additionally, the InterPARES 1 project generated the following:

- Authenticity requirements for those who generate and keep records and for those who preserve them, for example metadata for identity and integrity, and access privileges (InterPARES 1 2002e);
- selection and preservation methods and procedure, including models representing activities and responsibilities (InterPARES 1 2002b); and
- a framework for the development of policies, strategies and standards related to the proper creation, maintenance and preservation of digital records that can be proven authentic over time (Duranti 2005b).

According to the InterPARES project director, the most important finding is that, for a digital object to be considered an electronic record, it must have:

- a fixed form and unchangeable content;
- identifiable administrative and documentary contexts, and explicit linkages to other records within or outside the digital system;
- five identifiable persons involved in its creation; and
- participation in or support an action either procedurally or as part of the decision-making process (Duranti 2005a).

Additionally, Duranti adds:
'Most systems that should contain records do not, because the entities in them lack fixed form and stable content. The systems that do contain bad records, primarily because of lack of identifiable contexts and relationships. Inactive records that are no longer kept in active systems often cannot be preserved because either they were not created and/or maintained in preservable formats or they are obsolete' (Duranti 2005a)

The study concluded that the preservation of authentic electronic records is a continuous process that begins with the record's creation of which the purpose is to transmit authentic records across time and space. This preservation process must be predicated on the concepts of a trusted record keeping system and the role of the preserver as a trusted custodian, and it must incorporate records appraisal and archival description (InterPARES 1 2005a).

Additionally, the only way of preserving an inactive electronic record is to make an authentic copy of its last instantiation as an authentic record of the creator. Also, the individual or organization managing the preservation process must be concerned with both the assessment and the maintenance of the authenticity of electronic records throughout their life-cycle (InterPARES 1 2005a).

InterPARES 1 researchers learnt several lessons. First, the solutions to the preservation problem are inherently dynamic due to technological change and the increasing complexity of its products. Secondly, technology cannot determine the solution to the long-term preservation of electronic records and, thirdly, archival needs define the problem and archival principles must establish the correctness and adequacy of each technical solution (Duranti 2005b).

Based on the limited scope of this first phase of the research, it was felt that a new phase of the research should examine not only textual and database generated records, but all other kinds of digital entities in

complex systems. To do this, it would go beyond the limited scope of inactive records and concern itself with the entire life-cycle of the record. This expansion of scope would then assist in the development of a preservation model capable of guaranteeing authenticity. Additionally the new phase of the research would investigate, using concepts and methodologies developed in InterPARES 1, digital entities created in the course of scientific, artistic as well as government endeavors.

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3 InterPARES 2

InterPARES 2 was initiated in 2002 and is expected to be completed at the end of 2006. While its researchers focused on the issues of authenticity and long-term preservation, they also examined reliability and accuracy from the perspective of the entire life-cycle of records, that is, from creation to either disposition or permanent preservation. To do this, the researchers focused on records produced in complex digital environments in the course of artistic, scientific and e-government activities.

During the course of InterPARES 2, its researchers relied upon various subject areas including archival science, diplomatics and records management; music theory, composition, performance; film theory, production, description; dance and theatre theory; social sciences; jurisprudence; computer science; and engineering.

During the second phase, major funding came from the Social Sciences and Humanities Research Council of Canada and the University of British Columbia, as well as the National Historical Publications and Records Commission and National Sciences Foundation of the USA. Additionally UNESCO started its funding in the middle of 2003. In this phase, 21 countries were involved from five continents, with over 100 researchers participating from both the public and private sectors with the ratio of academics to professionals being 80% to 20% (InterPARES 2 2002b).

In examining complex digital environments, researchers used different case studies to focus on the concept of records in interactive, experiential and dynamic systems (Appendix 1).

An interactive system is defined as a system in which each user causes a response from or an action by the system. An example of a case study that was built on interactive systems is Electronic Café International.

An experiential system is defined as a system in which the objects whose essence goes beyond the bits that constitute the object to incorporate the behavior of the rendering system, or at least the interaction between the object and the rendering system.

A dynamic system is defined as a system in which a record the content of which is dependent upon data that might have variable instantiations and held in databases and spreadsheets internal or external to the system in which the record is generated.

To do this, the study has used a multi-method design of surveys, case studies, modelling, prototyping, diplomatic and archival analysis, as well as text analyses in order to deal with domain and cross-domain research questions.

InterPARES 2 was structured into several intersecting areas of inquiry. The research team responsible for each area was composed of investigators from a variety of disciplines and cultural backgrounds.

Figure 1 InterPARES 2 organizational matrix

	FOCUS 1 Artistic activities	FOCUS 2 Scientific activities	FOCUS 3 Governmental activities
DOMAIN 1 Records creation & maintenance	**Working Group 1.1**	**Working Group 1.2**	**Working Group 1.3**
DOMAIN 2 Authenticity, accuracy & reliability	**Working Group 2.1**	**Working Group 2.2**	**Working Group 2.3**
DOMAIN 3 Methods of appraisal & preservation	**Working Group 3.1**	**Working Group 3.2**	**Working Group 3.3**

Terminology

Policy

Description

Modeling

The matrix structure of Figure 1 has cross cutting focus groups and domains with four cross-domain groups. There are three focus areas of inquiry, each addressing records created in the course of one type of activity. Focus 1 is studying records of artistic activities; focus 2 is studying records of scientific activities; and focus 3 is studying records of e-government activities.

Each focus is divided into three domains of inquiry, each addressing a specific set of research questions. Domain 1 is investigating the nature of the records of the pertinent activity and the process of their creation. Domain 2 is studying the concepts of reliability, accuracy and authenticity, as they are understood in the context of the disciplines encompassed by the specific focus. Domain 3 is testing existing and proposed appraisal and preservation methods on specific instances of the records in question, and develops new methods where needed.

There are four cross-domains that deal with research questions common to all areas of inquiry:

- The Terminology cross-domain is controlling the use of terms and related definitions in all areas of the research, to ensure consistency among research units.
- The Policy cross-domain is analysing existing policies, strategies and guidelines for the creation, maintenance and preservation of digital records, and develops new ones as needed.
- The Description cross-domain is examining existing descriptive schemas in each discipline involved in the project, and develops new ones capable of supporting the creation, maintenance and long-term preservation of accurate, reliable and authentic digital records.
- The Modelling cross-domain is examining the functions, information and resources involved in the creation, maintenance and preservation of accurate, reliable and authentic digital records. Additionally the Modelling cross-domain supports the representation and analysis of the case studies results.

By the beginning of 2006, several achievements had been reached:

- Fifteen of the 22 case studies had been completed and represented in activity and entity models and analysed according to diplomatic and archival principles (InterPARES 2 2006);
- surveys had been made of governments' Web sites, of digital photographers, composers and film makers, of the practice of preservation of interactive music, of file formats and encoding languages used for non-textual materials, and the analysis of a prototype had been developed for a persistent archive based on data grids; and
- annotated bibliographies and literature reviews had been carried out as well as conceptual analyses of the findings of the reviews, and bibliographic databases had been developed for the management of references.

The description cross-domain has made significant progress with a Metadata Schema Registry. This is a centralized repository of schemas that will aid to identify:

- metadata sets, or the combinations of elements from several sets, which are appropriate to serve various record-keeping needs
- the relationship between metadata and archival description
- collaborations with modeling
- policy cross-domains.

The policy cross domain has been working on identifying barriers to preservation that currently exist in laws, regulations, policies and standards concerning copyright and intellectual rights, privacy and freedom of information, authenticity and authentication, open standards and open source, and records and archival management.

The terminology cross-domain has made significant progress with a terminology database that has four lexicographic instruments, a register, a dictionary, a glossary and a thesaurus.

Lastly, the modelling cross-domain has just completed the MCP (Manage the Chain of Preservation) model depicting all the activities involved in the management of electronic records throughout their lifecycle, from creation to permanent preservation.

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4 Conclusion

During a seminar held in Namibia in May 2006 on recent global developments in electronic records management, there was a presentation on InterPARES achievements. One of the seminar participants asked: 'What relevance does InterPARES have for the challenges of managing electronic records in the developing world?' The discussions that followed highlighted the fact that InterPARES may be a ‘phenomenon’ with immediate relevance to ‘first world’ problems. However, with the current speed of change and the effects of globalization, these ‘first-world’ problems would, within a few years, become global problems.

However, this is not to say that InterPARES's approaches offer universal solutions and should be accepted without challenge. At the core of every research project is the quest to identify fundamental problems and refine ideas. This leads to continuous debate and contestation. In 2004, a peer review committee that was mandated by InterPARES funding agencies recommended that the InterPARES 2 research team, among other things, should 'engage in the immediate and extensive dissemination of the project’s findings' (InterPARES 2 2004) This article is an attempt to contribute to immediate and extensive dissemination processes undertaken by InterPARES in a quest to share experiences and give opportunity for contestation.

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Appendix A InterPARES 2 case studies (Cardin 2006)

Type of discipline	Case study title	Description
	Preservation of the City of Vancouver GIS database (VanMap)	**Type of creator:** City of Vancouver, BC, Canada **Type of organization:** Municipal government **Managerial framework:** Team, within government hierarchy (IT department) **Type of digital entity:** GIS database. Purpose: to allow the City of Vancouver to 'meet the needs of internal users in providing services to Vancouver's citizens and businesses'
Archaeology	**Archaeological records in a geographical information system: Research in the American Southwest**	**Type of creator:** Center for Desert Archaeology (CDA) **Type of organization:** Private, not-for-profit centre located in Tucson, Arizona, USA **Managerial framework:** Small private organization **Type of digital entity:** GIS Database. Purpose: provide answers to archaeological research questions relating to the aggregation and migration of prehistoric peoples in the American Southwest
Archival	**Archives of Ontario Web site exhibits**	**Type of creator:** Provincial archives **Type of organization:** Government body (Province of Ontario) Canada **Managerial framework:** Within governmental hierarchy, under Management Board Secretariat **Type of digital entity:** Three Web exhibits
Astronomy	**MOST Satellite Mission: Preservation of space telescope data**	**Type of creator:** Microvariablity and oscillations of stars satellite mission **Type of organization:** Partnership between Canada Space Agency, industry, universities **Managerial framework:** Based on partnership **Type of digital entity:** Space telescope data and engineering telemetry
Cooperative	**Legacoop Bologna Web site**	**Type of creator:** Cooperative network **Type of organization:** Provincial body of cooperative network in Bologna, Italy **Managerial framework:** Divided into

		departments, within network hierarchy **Type of digital entity:** Web site. Purpose: to increase communication with and maintain the cooperative network of Legacoop Bologna's members
Cybercartography	**CyberCarto-graphic atlas of Antarctica**	**Type of creator:** Geomatics and Cartographic Research Centre (GCRC), Carleton University **Type of organization:** University research group in Ottawa, Ontario, Canada **Managerial framework:** Granted research group
Engineering and manufacturing	**Preservation and authentication of electronic engineering and manufacturing records**	**Type of creator:** Various US government departments [Research Division of the Electronic Records Archives (ERA), San Diego Supercomputer Center (SDSC), element of the U.S. government with responsibilities in the science, engineering, design and manufacture of complex assemblies] **Type of organization:** Government departments (Federal); university unit **Managerial framework:** Within governmental hierarchy; within University of California, San Diego **Type of digital entity:** Digital engineering and manufacturing records; knowledge enhanced digital object file
Law	**Electronic filing system (EFS) from the Supreme Court in Singapore**	**Type of creator:** Supreme Court of Singapore **Type of organization:** Legal body **Managerial framework:** Within hierarchy of justice system **Type of digital entity:** Electronic civil and criminal law records filing system
Media	***Horizon Zero/Zero Horizon* online magazine**	**Type of creator:** Media and Visual Arts Department **Type of organization:** Institute, part of larger centre; in Banff, Alberta, Canada **Managerial framework:** Within organizational hierarchy, made possible by grants **Type of digital entity:** Issues of the online magazine, *HorizonZero/ZeroHorizon*
Motor vehicle licensing and driver registration	**The New York State Department of Motor Vehicles**	**Type of creator:** New York State Department of Motor Vehicles **Type of organization:** Government department (state) **Managerial framework:** Within governmental hierarchy **Type of digital entity:** Web site. Purpose: to provide online access to critical state services
Moving images	**Digital moving images – Altair 4 multimedia**	**Type of creator: I**ndependent producer (Altair) **Type of organization:** Small private

		corporation **Managerial framework:** Small private corporation, run by three partners in Roma, Italy based on contract **Type of digital entity:** Multimedia virtual reconstruction of the House of Pollybius
Moving Images	**Digital moving images – National Film Board**	**Type of creator:** Public filmmaker (National Film Board) **Type of organization:** Government body **Managerial framework:** Within government hierarchy, under the Canadian Heritage Department **Type of digital entity: D**igital animation products and documentation relating to production
Moving Images	**Digital moving images – commercial film studio**	**Type of creator:** Anonymous commercial film studio **Type of organization:** Large private corporation **Managerial framework:** Large private film studio **Type of digital entity:** Artwork related to animated film production
Moving images	**Digital moving images – WGBH Boston**	**Type of creator:** Public broadcaster (WGBH) **Type of organization:** Large public corporation **Managerial framework:** Large public corporation; in Boston, MA, USA **Type of digital entity:** Original footage and footage logs generated during the production process of a documentary film
Multimedia (collaboration and co-creation)	**Electronic Café International: aging records from technology-based artistic activities**	**Type of creator:** Electronic Café International; individual artists (digital entities) **Type of organization:** Multimedia international network **Managerial framework:** 2 principals, network of artists in Los Angeles, CA, USA **Type of digital entity:** Accumulation of multimedia related to telecollaborative work
Multimedia exhibit	**The Danube Exodus: interactive multimedia piece**	**Type of creator:** Private individual, based in Budapest (installation in Los Angeles, CA) **Type of organization:** Individual, working with an art collective and a research institute **Managerial framework:** Temporary, based on contract or partnership **Type of digital entity:** Complex media installation
Multimedia performance art	**Waking Dream**	**Type of creator:** HCT Laboratory (UBC); 3-individual partnership (digital entity) **Type of organization:** Within university hierarchy **Managerial framework:** Based on partnership

		Type of digital entity: Web site and multimedia performance art piece
Musical performance	**Obsessed Again**	**Type of creator:** Contract between composer and artist in Vancouver, BC, Canada **Type of organization:** Partnership between composer and artist based on contract **Managerial framework:** Based on contract **Type of digital entity:** Digital music score
Performance art	**Performance artist Stelarc**	**Type of creator:** Private individual **Type of organization:** Individual; may work anywhere but is from Australia **Managerial framework:** Individual **Type of digital entity:** Web site. Purpose: advertising, and implementing and documenting the stages of the performance process
Real estate law	**Computerization of Alsace-Moselle's land registry**	**Type of creator:** Le Livre Foncier d'Alsace-Moselle; GILFAM (digital entity) **Type of organization:** Within hierarchy of justice system **Managerial framework:** Distributed between offices, judges, clerks **Type of digital entity:** Database. Purpose: to allow the activities currently underway in the paper-based environment, such as issuing ordinances and completing inscriptions to be done in an automated fashion via a central database
Space flight	**Validation of the InterPARES preservation model using records and data from a NASA spacecraft mission operation**	**Type of creator:** NASA (National Aeronautics and Space Administration) **Type of organization:** Government agency, headquarters located in Washington, DC, The United States **Managerial framework:** Within governmental hierarchy **Type of digital entity:** Records and data from the Mars Global Surveyor Mission and the Planetary Data System records
Tax law	**Revenue online system (ROS)**	**Type of creator:** Office of the revenue commissioners of Ireland (Revenue) **Type of organization:** Government body (Central) **Managerial framework:** Within governmental hierarchy **Type of digital entity:** Internet-based tax filing system (Web site)
Theatre	**Arbo cyber, théâtre**	**Type of creator:** Theatre group **Type of organization:** Private corporation **Managerial framework:** 2 individuals in Québec City, Québec, Canada **Type of digital entity:** Web site (Ludosynthèse). Purpose: maintain memory of group, while allowing audience interaction to continue
Treaty	**Antarctic Treaty**	**Type of creator:** Private corporation

documentation	**searchable database**	**Type of organization:** Small private corporation **Managerial framework:** 2 individuals, in Ohio, USA **Type of digital entity:** Database. Purpose: support teaching of Antarctic Treaty documents, enable those searching for Antarctic Treaty materials

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ISSN 1560-683X

Published by InterWord Communications for Department of Information and Knowledge Management, University of Johannesburg