InterPARES 2 Project

International Research on Permanent Authentic Records in Electronic Systems

International Research on Permanent Authentic Records in Electronic Systems (InterPARES) 2: Experiential, Interactive and Dynamic Records

APPENDIX 2

The Concept of Record in Interactive, Experiential and Dynamic Environments: the View of InterPARES[†]

by

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[†] First published in *Archival Science* (2006) 6(1): 13-68. Reprinted with permission of the publisher.

Status: Final (copyrighted)

Version: Electronic

Publication Date: 2008 (Appendix)
2006 (Original article)

URL: http://www.interpares.org/display_file.cfm?doc=ip2_book_appendix_02.pdf

How to Cite: Luciana Duranti and Kenneth Thibodeau, "Appendix 2: The Concept of Record in Interactive, Experiential and Dynamic Environments: the View of InterPARES," [electronic version] in *International Research on Permanent Authentic Records in Electronic Systems (InterPARES) 2: Experiential, Interactive and Dynamic Records*, Luciana Duranti and Randy Preston, eds. (Padova, Italy: Associazione Nazionale Archivistica Italiana, 2008). First published in *Archival Science* (2006) 6(1): 13-68. <http://www.interpares.org/display_file.cfm?doc=ip2_book_appendix_02.pdf>

Archival Science (2006) 6:13–68
DOI 10.1007/s10502-006-9021-7

The Concept of Record in Interactive, Experiential and Dynamic Environments: the View of InterPARES★

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Abstract. This article presents the concept of electronic record as articulated by the first phase of the InterPARES (International research on Permanent Authentic Records in Electronic Systems) Project (1999–2001) and discusses it in light of the findings of the second phase of the Project (2002–2006). While InterPARES 1 focused on records produced and/or maintained in databases and document management systems, InterPARES 2 examined records produced and/or maintained in interactive, experiential and dynamic environments. The authors describe the characteristics of these environments and of the entities found in them in the course of case studies conducted on systems used for carrying out artistic, scientific and e-government activities, and propose the new concept of record that InterPARES 2 is eleborating, which expands on that formulated by InterPARES 1.

Keywords: archival theory, concept of record, digital records, diplomatics, dynamic systems, e-government records, electronic art, electronic science, electronic systems, experiential systems, interactive systems

The InterPARES (International research on Permanent Authentic Records in Electronic Systems) Project aims at developing the theoretical and methodological knowledge essential to the long-term preservation of authentic records created and/or maintained in digital form. This knowledge should provide the basis from which to formulate model policies, strategies and standards capable of ensuring the longevity of such material and the ability of its users to trust its authenticity. InterPARES has developed in two phases. InterPARES 1, which ran from 1999 to 2001, dealt with records mandated for accountability and administrative needs that are created in databases and document management systems. InterPARES 2, which began in 2002 and will be completed by the end of 2006, has focused on the portion of society's

★ The authors would like to thank InterPARES 2 research assistant Randy Preston for his careful editing and constructive criticisms. Some of his suggestions have been incorporated in the text of this article.

recorded memory that is digitally produced in interactive, dynamic and experiential systems in the course, and as a byproduct, of artistic, scientific and electronic government activities.[1] The distinctive and novel characteristics of the environments being examined in InterPARES 2 force a re-examination of the findings of InterPARES 1, including its interpretation of traditional archival concepts, especially that of record. This article presents the work of two of the InterPARES 2 researchers. While the authors regard the findings of this article as conclusive, the article should be seen as a contribution to the ongoing InterPARES work, and not as a final product of the project.

This article examines the characteristics of documents in interactive, dynamic and experiential systems, as observed in InterPARES 2 case studies and other empirical instances, in order to determine whether they are or can be records and whether records in such systems have unique characteristics which might necessitate a revision of the traditional concept of a record. The analysis of record characteristics is based on the definition of 'record' from archival science and more specifically on its articulation in InterPARES 1.[2]

This analysis is divided into five sections. Section 1 summarizes relevant findings of InterPARES 1. Section 2 describes interactive, experiential and dynamic environments, and considers their implications for records made or received and/or kept in such environments. Section 3 focuses more specifically on the "documents" that are or might be created in such environments. Section 4 considers "records" that are or might be made or received and/or kept in these environments. Section 5 examines the keeping of such records. Finally, a concluding section draws out the major findings of this analysis.

[1] See the InterPARES website at http://www.interpares.org.

[2] There have been numerous projects that have examined the characteristics of digital documents. Most notable is the Open Archival Information System (OAIS) Reference Model, available at http://www.ccsds.org/docu/dscgi/ds.py/Get/File-143/650x0b1.pdf. The information model articulated in the OAIS standard has been the foundation of analysis of the characteristics of digital documents in several other projects, such as the CEDARS, PREMIS and Persistent Archives projects, respectively accessible at http://www.leeds.ac.uk/cedars/, http://www.oclc.org/research/projects/pmwg/, and http://www.sdsc.edu/NARA/. However, these projects have developed their characterizations of digital documents with a view towards addressing the practical challenges of preserving them. In contrast, this article seeks to identify the characteristics of digital documents that are records. The goal is to describe these records in themselves. Such description must be independent of and transcend any and all approaches to preserving them.

Findings of InterPARES 1

At the beginning of InterPARES 1, the research team adopted a concept and a definition for the terms record, document, information and data, and used them to identify the digital objects in the systems examined in its case studies. The team adopted the traditional archival definition of a record as any document created (i.e., made or received *and* set aside – i.e. kept, saved – for action or reference) by a physical or juridical person in the course of a practical activity as an instrument and by-product of such activity. It defined 'document' as recorded information, 'information' as a message intended for communication across space or time, and 'data' as the smallest meaningful piece of information. Finally, an 'electronic record' was defined as a record that is set aside and used in electronic form irrespective of the original form in which it may have been made or received. The InterPARES 1 conception was fully consistent with the archival principle that whatever the creator treats as a record in the course of any given action is indeed a record in the context of this action. It also made it clear that what distinguishes a record from a document that is not a record is the nature of its relationship with the activity of the creator rather than its formal or content characteristics.

InterPARES 1 researchers explored the assumptions and implications of the definition of 'record' by determining what the necessary characteristics of an electronic record are on the basis of both archival theory and diplomatic theory. These two theories were regarded as complementary because, while diplomatic theory examines records as items, enabling identification of the characteristics embedded in the records themselves, archival theory, by treating records as parts of aggregations, examines their relationships to other records, to the persons involved in their creation, and to the activities in the course of which they are created and used. The research team identified the following necessary characteristics: (1) a fixed form, meaning that the entity's content must be stored so that it remains complete[3] and unaltered, and its message can be rendered with the same documentary form it had when

[3] Completeness here is not mentioned as a characteristic of the record, because an incomplete record is still a record, albeit a bad one, but as a characteristic of a fixed form, according to which a form that is fixed is one that does not lose any of its original elements in the process of being stored and retrieved.

first set aside; (2) an unchangeable content;[4] (3) explicit linkages to other records within or outside of the digital system, through a classification code or other unique identifier;[5] (4) an identifiable administrative context; (5) an author, an addressee, and a writer; and (6) an action, in which the record participates or which the record supports either procedurally or as part of the decision making process.[6]

Having specified the necessary characteristics of an electronic record, the research team accepted as a working hypothesis the fundamental assumption of diplomatics that, regardless of differences in nature, provenance or date, from a formal point of view all records are similar enough to make it possible to conceive of one typical, ideal documentary form containing all possible elements of a record. From this hyposthesis, the team derived the corollaries that, while they may manifest themselves in different ways, the same formal elements that are present in traditional records exist in electronic records either explicitly or implicitly, and that all electronic records share the same formal elements. Thus, the team created a template, that is, a decomposition of the ideal electronic record, first, into its constituent parts,

[4] The stability of the record, as determined by its fixed form and its unchangeable content, is only implied in the part of the archival definition that reads that a record is a document (i.e., rather than just data or information), but it is explicitly stated in the diplomatic definition and concept of record. (See Luciana Duranti, *Diplomatics. New Uses for an Old Science* (Lanham, Maryland, and London: The Scarecrow Press, Inc., The Society of American Archivists and the Association of Canadian Archivists, 1998), pp. 41–58.

[5] This characteristic corresponds to the archival bond, which is implied in the archival definition when records creation is linked to an activity, but it is made explicit by archival theorists of all times and cultures. See Luciana Duranti, "The Archival Bond," *Archives and Museum Informatics* 11, nos.3–4 (1997): 213–218.

[6] While characteristics 4 and 6 can be deduced from the archival definition, characteristic 5 derives from the diplomatic concept of record: it was considered important in order to distinguish records from digital objects resulting from simply querying a database. The author is the person issuing the record, the writer is the person determining the articulation of the discourse in the record, and the addressee is the person for whom the record is intended. As a record must participate in an action and any action must fall on somebody, the addressee is necessary to the existence of the record. See the Appendix 2 of the book *The Long-term Preservation of Electronic Records: the InterPARES Project* on the InterPARES website at http://www.interpares.org/book/index.cfm. This book is also distributed in print by the Society of American Archivists: Luciana Duranti ed., *The Long-term Preservation of Electronic Records: the InterPARES Project* (San Miniato, Italy: Archilab, 2005).

and then, within the part "form," into its elements.[7] In the template, the parts and elements are defined and their purpose is explained. The research team used the template as an instrument for the systematic analysis of the electronic objects contained in several different systems, for the purpose of establishing which ones are records.

The template is composed of four sections corresponding to the four necessary constituent parts of every record: documentary form, annotations, context, and medium.[8] The documentary form[9] includes, among the intrinsic elements,[10] the names of the persons concurring to the creation of the record, the chronological date, the place of origin of the record, the indication and description of the action or matter, the attestation, and a statement of validation; and, among the extrinsic elements,[11] overall presentation features (e.g. text, image, sound, graphic), specific presentation features (e.g. layouts, hyperlinks, colors, sample rate of sound files, resolution of image files, scales of maps), electronic signatures and seals (e.g. digital signatures), digital time stamps, and special signs (e.g. digital watermarks, organization crests, personal logos).[12]

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[7] The reason why the constituent parts of the record ended up in the template that is supposed to represent the ideal form of a record is that all identified constituent parts used to be regarded as necessary extrinsic elements of form by traditional diplomatists. It was important to show their presence, definition and purpose, and the fact that they are now independent of form.

[8] In a previous research endeavour commonly known as the UBC-DoD project, the parts constituting the records were identified as: medium, form, action, persons, archival bond, content and context. See Luciana Duranti and Heather MacNeil, "The Preservation of the Integrity of Electronic Records: An Overview of the UBC-MAS Research Project," *Archivaria* 42 (Spring 1997): 46–67; and Luciana Duranti, Terry Eastwood and Heather MacNeil, *Preservation of the Integrity of Electronic Records* (Dordrecht: Kluwer Academic Publishers, 2002): Chapter 1. In the context of InterPARES, it was decided that action, persons, archival bond and content, contrary to the other constituent parts, continue to manifest themselves in formal elements and are inextricable from them, so they do not have to be identified separately from the form. As it regards the annotations, which in the UBC-DoD project were included among the elements of form, they were added to the constituent parts because they are often linked to the record rather than embedded in it, and need therefore to be looked at separately from the record form.

[9] Defined as "The rules of representation according to which the content of a record, its administrative and documentary context, and its authority are communicated."

[10] Defined as "The elements of a record that convey the action in which the record participates and its immediate context."

[11] Defined as "The elements of a record that constitute its external appearance."

[12] See "Template for Analysis,"Appendix 1 in *The Long-term Preservation of Electronic Records: the InterPARES Project*, cit.

The annotations[13] fall into three fundamental groups: (1) additions made to the record after its creation as part of its transmission (e.g. priority of transmission, date of compilation and date of transmission in an e-mail record, the indication of attachments), (2) additions made to the record in the course of handling the business matter in which the record participates (e.g. date and time of receipt, action taken, name of handling office), and (3) additions made to the record in the course of managing it as a record (e.g. filing date, class code, registration number). The categorization of the contexts of the record[14] and the list of what would reveal them correspond to an hierarchy of frameworks that goes from the general to the specific: (1) juridical-administrative context (manifested in, for example, laws and regulations), (2) provenancial context (manifested in, for example, organizational charts, annual reports, tables of users in a database), (3) procedural context (manifested in, for example, workflow rules, codes of administrative procedure), (4) documentary context (manifested in, for example, classification schemes, records inventories, indexes, registers), and (5) technological context (manifested in, for example, hardware, software, system models, system administration).[15]

The medium[16] was difficult to place within the template, because, although it is still necessary for an electronic record to exist, it is not inextricably linked to the message, does not store the record as such, but stores one or more bit-streams which can be used to reproduce the record, and its choice by the record-maker or keeper can be either arbitrary or based on reasons related to preservation rather than to the function of the record. In addition, the medium is not a relevant factor in assessing a record's authenticity – one of the primary purposes of InterPARES – at least from the perspectives of the creator and of the record preserver.[17] This was confirmed by the case studies undertaken by the research team, by the end of which the team was convinced that, with electronic records, the medium should not be considered a constituent part of the record but a part of the record technological context.

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[13] Defined as "Additions made to a record after it has been created."

[14] Defined as "The framework of action in which the record participates."

[15] For details related to annotations and contexts, see the Template for Analysis referenced above.

[16] Defined as "The physical carrier of the message."

[17] An additional reason for the InterPARES team to dissect the concept of record was to identify what parts or elements contribute to the authenticity of the record and to the ability to verify it.

While the physical medium is not a significant consideration for electronic records, the way an electronic record is organized and stored in one or more bit streams has a role analogous to that of physical medium for analog records. The research team identified those bit strings necessary to reproduce an electronic record and requiring distinct preservation measures as its *digital components*. With an analog record, the choice of physical medium is dependent on the overall presentation features of the record: a textual record can be recorded on paper, but an audio record cannot. With an electronic record, its organization into one or more digital components is dependent on the data type of the record. 'Data type' is a set of binary values used to encode data. Textual data can be encoded as ASCII, but audio data cannot. An analog record may be preserved authentic even when it is copied from one physical medium to another, provided the replacement medium is appropriate; for example, textual records originally recorded on paper can be preserved as authentic copies on microfilm. Similarly, electronic records can be authentically preserved even when they are transformed from one set of digital components to another, provided the replacement set preserves all the essential attributes of the record.

The concept of digital component was elaborated as a consequence of the recognition that it is literally not possible to preserve an electronic record like a record on paper. An electronic record is an object that is output from a computer system, typically on a screen, when needed by a human, or in interactions between systems, but cannot be stored in the form in which it is seen or used,[18] except by being converted to an analog form outside the system, but in that case it would no longer be an electronic record. Instead, it is stored as one or more strings of bits that require processing by a computer to be seen or used again as a unit. Thus, the research team determined that, empirically, preserving an electronic record consists of preserving the ability to reproduce it. A system that preserves electronic records must be able to identify and locate all the digital components of each record and apply the appropriate software to each component to reproduce the record.

[18] There may be only minor differences between the form in which a record used in interactions between systems, rather than presented to a human, is stored on a digital medium and the form in which it is used in automated transactions; nevertheless, it remains true that the way the digital data which constitute the record are inscribed on a physical medium, any physical medium, and the form in which they are transmitted between systems or the form in which they are stored in a computer's memory during transactions are never identical. In contrast, a traditional, analog record is inscribed on paper and transmitted and read in exactly that form.

Digital components may contain all or part of a record, and/or the related metadata. For example, an e-mail containing a textual message, a picture and a digital signature has at least four digital components: the header data, which enable systems to properly route and manage the message, the text of the message, the picture, and the digital signature. In contrast, a report with four textual attachments might be constituted of only one '.pdf' file (i.e., one digital component), but it might also consist of a word processing file that contains the body of the report, and four other files, possibly in different formats, for each of the attachments (i.e., five digital components). An important aspect of digital preservation is that it is possible to preserve the ability to reproduce an electronic record even when its digital components are altered. A report consisting of five word processing files could be combined into one file, and then converted from a word processing format into '.pdf.' So long as a '.pdf' reader faithfully renders the same document as would have been displayed by the original word processing software to the original five files, it would not matter that the encoding of the record in digital components had changed from five files to one and from a word processing format to '.pdf.'

Finally, the InterPARES 1 team felt the need to point out that the relation between a electronic record and a computer file can be one-to-one, one-to-many, many-to-one, or many-to-many, thus we should never use the terms record and file interchangeably; that the same presentation[19] of a record can be created by a variety of digital presentations and, vice versa, from one digital presentation a variety of record presentations can derive, thus fixed form does not imply that the bit streams must remain intact over time; and that it is possible to change the way a record is contained in a computer file without changing the record, thus the name of a record's documentary form does not necessarily indicate what digital object we are dealing with.

The analyses of the case studies conducted using the template indicated that only about one half of the examined systems contained records (12 out of 22), primarily because the objects identified within the other half did not appear to possess either a fixed documentary form or a stable content. When systems did contain records, these could rarely be compared with the model represented by the template, because, although they were able to achieve their purposes, they were not good records. For example, in most systems, there was no explicit

[19] 'Presentation' in this analysis means the act of materializing the overall and specific presentation features of an electronic record or the result of this action.

manifestation of the relationship among the records participating in the same affair or matter, and, although it was easy to identify the business processes supported by the system, it was not always possible to determine how the records participated in or supported specific actions. In addition, it was often difficult to determine the significance of the presence or absence of given elements of documentary form or of annotations.

More importantly, the case studies showed that, with electronic records, a key concept to consider is that of *records attributes*, which are the defining characteristics of each given record or of a record element in it. A *record element* is a constituent part of the record's documentary form and, as seen earlier, may be either extrinsic, like a seal, or intrinsic, like the salutation.[20] An attribute may manifest itself in one or more record elements. For example, the name of the author of a record is an attribute, which may be expressed as a letterhead or a signature, both of which are intrinsic elements of documentary form, that is, record elements. In addition to attributes that manifest themselves in the form of the record, that is, on the face of the record, as record elements, every record has attributes that are implicit elsewhere, such as the name of the creator or of the medium, but in electronic records they are explicit, albeit expressed outside the documentary form. They are mostly transparent to the user, because they manifest themselves as metadata included in either a record profile,[21] another digital object linked to the record, or documentation about the system or application in which the record is created. Attributes made explicit outside the record as metadata demonstrating its identity are *important* to uniquely identify any electronic record, but they are *essential* to the identification of digital objects that do not have – or at least for as long as they lack – a stable content or a fixed form.

The concept of electronic record presented above, with all its characteristics, parts, formal elements, attributes and digital components, has worked quite well with databases and document management systems. However, it may appear problematic when applied to the objects examined by InterPARES 2, because fluidity is part of their nature and contributes to the accomplishment of their purpose as instruments of, or support for action.

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[20] A defining characteristic, or attribute, of the record element "seal" may be its legend.

[21] A record profile is an annotation inextricably linked to the record that includes several fields, which are either automatically or manually filled in with the record's metadata.

Interactive, Experiential and Dynamic Environments

InterPARES 2 has conducted case studies in the artistic,[22] scientific, and electronic government fields, focusing on cases which make use of digital technologies in innovative ways. This focus enables the project to examine whether there are differences in the nature of the records produced in environments that only exist in the digital domain. For the purpose of beginning its investigation of new technologies, InterPARES 2 initially adopted the Institute of Electrical and Electronics Engineers (IEEE) definition of an interactive system as "one in which each user entry causes a response from or an action by the system."[23] Interactive systems include a wide range of possibilities, starting with simple cases where the user's entries are constrained to a limited number of choices and the system's responses follow fixed paths from these choices. More complex situations occur where the number and variety of possible interactions are so great that the results are practically unpredictable. In even more complex cases, user input may become or generate new data that are included in subsequent outputs. The systems examined by InterPARES 2 include more complex and less predictable sequences of interactions with users and applications; for example, in the Electronic Café International[24] system, a multimedia international network for showcasing creative, multicultural, multidisciplinary, collaborative telecommunications, actions or responses are triggered by inputs from other systems.

There is a large class of applications where a system carries out individual transactions acting not simply as a machine, but as an agent for the system owner. This class includes systems used for electronic funds transfers between financial institutions and, more commonly, automated teller machines (ATM). Such systems produce, for the bank or other financial institution, an electronic record of a withdrawal, deposit, or transfer of funds, but do so without any physical,

[22] Traditionally, works of art and recordings of performance art would be regarded as end products of artistic activities, rather than records. However, the traditional definition of 'record' in archival science poses no restriction on the type of information object which may be a record. Provided it satisfies the requirements for records summarized in section 1 above, a work of art or recording of an artistic performance may be a record.

[23] IEEE. Standard Glossary of Software Engineering Terminology. In *IEEE Software Engineering Standards Collection*. IEEE, 1990. Std 610.12-190.

[24] See: http://www.interpares.org/display_file.cfm?doc=besser_eci.pdf.

real-time involvement of an officer or employee of the bank.[25] Such systems also receive records sent by other systems, for example when an ATM owned by one institution records a transaction against an account in another institution. In such cases, the system controlling the ATM sends a record of the transaction to the system of the institution which holds the account and, again, the transaction is completed and recorded without involvement of any human agent of either institution.[26] The receiving system subsequently completes other actions automatically, such as adjusting account balances and producing reports or other records accounting for such transactions.

In light of these examples, the definition of an interactive system needs to be expanded to "one in which each user entry *or input from another system* causes a response from or an action by the system."

As with interactive systems, for experiential systems, the InterPARES team looked for a definition that would provide a point of reference for selecting case studies. It decided to use Clifford Lynch's description of an experiential digital object as an object whose essence goes beyond the bits that constitute it to incorporate the behavior of the rendering system, or at least the interaction between the object and the rendering system.[27] This definition has not proved fruitful in qualifying either computer systems or documents created in them as experiential or not. InterPARES researchers have also conceptualized experiential systems as ones that immerse the user in a sensory experience. This concept, however, refers to a subset of the experiential computing described by Ramesh Jain, who, in addition to subjective experiences, such as story telling, folk computing, and personal event experience, identifies experiential applications used for administrative or research purposes, such as business-activity monitoring, homeland security, or bioinformatics. Jain depicts experiential computing as enriching cognition through sensation:

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[25] Of course, bank officers/employees are involved in producing the record of the transaction in so far as they are responsible for establishing and enforcing the bank's ATM policies and procedures (which would make them the *de facto* writers of the record), and ensuring that these policies and procedures are translated into a system that in turn outputs appropriate transaction records in response to user requests/actions.

[26] Again, there is human involvement via consideration of who the competent writers and authors of the records are, as well as who the addressees are, all of whom are persons, not computers.

[27] Clifford Lynch. "Authenticity and Integrity in the Digital Environment: An Exploratory Analysis on the Central Role of Trust." In *Authenticity in a Digital Environment* (Washington, D.C.: CLIR, 2000), pp. 32–50, available at http://www.clir.org/pubs/reports/pub92/pub92.pdf.

> "[Users] must be able to explore and experience events from multiple perspectives and revisit them as often as needed to obtain that insight. In an experiential computing environment, users apply their senses directly, observing event-related data and information of interest. Moreover, users explore the data by following their own personal interests within the context of an event."
>
> "Experiential environments free users from the tedium of managing enormous volumes of disparate heterogeneous data. They don't try to interpret an experience; instead, they provide an environment that can be used to naturally understand events...."[28]

In this conception, experiential environments are necessarily interactive, but provide user interaction driven not by pre-programmed options, but by the user's interests, and they are likely to offer a greater variety of ways in which users can interact with the system than in interactive systems which are not also experiential. This conception promises to be more productive than the definitions adopted by InterPARES up to this point.

As regards dynamic environments, the InterPARES team initially defined them as "dependent upon data that might have variable instantiations and be held in databases and spreadsheets," thereby adopting Seamus Ross's view of dynamic computing.[29] However, in the course of research for this article, it emerged that dynamic is an attribute attached to a variety of environments.

> " 'Dynamic computing' is a term that is used to describe flexible and adaptable approaches to tailoring computing resources to demands. It includes real-time distributed computing, adaptive computing, which can automatically adapt or configure computing resources to suit different tasks, and agent-based computing. Agent-based computing uses freestanding software agents that are variously described as intelligent, intentional, mobile, and remote acting. Such agents support applications, ranging from dynamic routing of network traffic, to automated email answering, business process management, military applications, and multidisciplinary problem solving in scientific research. Dynamic

[28] Ramesh Jain. "Experiential Computing," *Communications of the ACM* **46**(7) (2003): 48–54.

[29] Seamus Ross. 2000. *Changing Trains at Wigan: Digital Preservation and the Future Scholarship*. London: NPO Preservation Guidance Occasional Papers.

> computing has emerged as a dominant trend in the information technology in the twenty-first century.''[30]

Such applications may employ a variety of techniques known collectively as evolutionary computing.[31] Dynamic systems are used in a variety of practical applications, such as engine testing in the aerospace industry and manufacturing execution system applications in the auto industry.[32] In many organizations, various categories of actors require different overviews derived from heterogeneous information and tailored to their different needs:

> ''Business analysts would like to run decision support queries over the state and history of the company. Sales staff would like to understand the total relationship between the company and a given customer, including all past interactions and the current state. Financial planners would like to integrate overall budgets based on budget projections of units below them and would like to track previous forecasts with the actual operations of the business.''[33]

Dynamic systems supporting such diverse needs are interactive and could be experiential. The information they present to users or to other systems is highly variable and contingent on multiple and diverse inputs from both users and other systems.

An interesting dynamic environment is that of systems which mediate interactions between organizations. Adaptability of such systems is seen as key to enabling organizations to form virtual alliances with loosely coupled business processes. A 'virtual alliance' is formed when interacting systems conduct actions or execute transactions as if the organizations had agreed to such collaboration beforehand. One of the values of dynamic systems is that, to enable such actions, they do not require that the organizations either integrate their respective business processes, or design either system to interact with the other.

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[30] Summit Strategies. The 2005 Summit Seven: Dynamic Computing Gets Down to Business. Market Strategy Report 4EC-07. December 2004, available at http://www.summitstrat.com/store/4ec07detail.

[31] A. E. Eiben and J. E. Smith. *Introduction to Evolutionary Computing* (Berlin: Springer, 2003).

[32] Janos Sztipanovits, Gabor Karsai and Ted Bapty. ''Self-adaptive software for signal processing: Evolving systems in changing environments without growing pains,'' *Communications of the ACM* **41** (5) (1998): 66.

[33] Narinder Singh. ''Unifying heterogeneous information models: Semantic tags support knowledge webs,'' *Communications of the ACM* **41**(5) (1998): 37.

> "The utility of complex systems is enhanced if the system can learn from experience and adapt its behavior. The ability of the system to develop and act on internal models that simplify the external world is basic to this mechanism. It allows the system to infer the results of actions before they are taken, and to choose actions that have productive results.... Next-generation systems must allow autonomous business object components to decide with whom to collaborate, what services to offer, what services to request, and what behaviors to exhibit."[34]

Subsystems of these systems, called "business object components," act as agents in the conduct of business. They may be programmed to make decisions and take actions; although such actions remain the responsibility of an official or employee, he or she does not carry them out personally. Such systems are clearly interactive, although the interaction may be limited to interactions between or among systems, without any direct, real-time, human involvement.

'Interactive,' 'experiential,' and 'dynamic' are thus attributes of systems, rather than types of systems. A system may be simply interactive, but an experiential or dynamic system is also interactive, and a system may be both experiential and dynamic.[35]

Interactive, Experiential and Dynamic Documents

The fact that a system is interactive, experiential or dynamic does not entail that documents made or received in it be themselves interactive, experiential or dynamic. Thus, we need to examine the information objects that exist in interactive, experiential or dynamic systems to

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[34] Jeff Sutherland and Narinder Singh. "Application integration and complex adaptive systems Association for Computing Machinery," *Communications of the ACM* **45**(10) (2002): 59–64.

[35] The distinction among these three systems/attributes remains a matter of debate among InterPARES 2 researchers, primarily because they are more arbitrarily and subjectively than logically and objectively defined. As noted earlier, experiential and dynamic systems are types of interactive systems. However, in light of the need to compartmentalize them, another way of distinguishing them is by their relative levels of direct, real-time, human user involvement; with experiential and dynamic systems situated at opposite ends of the spectrum, and interactive system falling somewhere in between. In fact, from the definitions here provided, it seems that the only real difference between the interactive and experiential attributes is that only the latter ipso facto requires direct, real-time, human user involvement. One cannot help wonder whether the nuanced, largely subjective, distinctions among these three types of system attributes are: (a) actual and workable, (b) necessary, or (c) ultimately helpful.

determine whether any of them are documents. The InterPARES definition of 'document' as recorded information is a variation on the traditional diplomatic definition whereby a document is information affixed to a medium. This difference has important consequences. A "hard copy" document, by virtue of being affixed to a medium, has a fixed form and unchangeable content. But, in the digital environment, it is possible to generate something that to all appearances is a document, but is not affixed to a medium. Interactive, experiential or dynamic systems may display or otherwise present information that appears to be a document, but the system may not contain any object that corresponds exactly to the apparent document.[36] We might describe things that appear to be documents, but are not stored, as pseudo-documents or 'pseudocs.'

Live interactions, experiences, or dynamic processes do not necessarily produce or involve documents, even as a matter of appearances. For example, a dynamic system that monitors traffic on a network may simply trigger changes in the routing of messages to balance load across the network without producing any document about such actions.

A priori, there is no restriction on the form or content of a document, but it must be a finite entity: it must be possible to determine what information is and is not contained in that document, to specify its form, and to show how the content in that form constitutes an indivisible whole. With a hard copy document, the content, form, and wholeness of the document are embodied and manifest in the physical inscription on a medium. In the digital environment, the physical inscription of bits on digital media cannot reliably indicate what, if any, documents are written on those media.

One of the most important findings of InterPARES 1 was the recognition and articulation of the difference between the form in which an electronic document is manifested to a person and the form in which it is stored digitally. This difference is fundamental in two respects. First, it distinguishes a digital document from a traditional one, where the document is exactly what is inscribed on a physical medium in the way it is inscribed. Second, it makes necessary to describe the exact nature of a document and to determine whether it continues to exist across changes in the way it is inscribed on a digital

[36] As established in the first phase of InterPARES, a computer system may be said to contain an electronic document when it has the capability of reproducing that document. It may, but does not necessarily, do this by storing the document as a single data object.

medium. Without this fundamental distinction, we would not be able to assert, for example, that a document preserves its identity even when it is moved from a magnetic to an optical disc, or when it is translated from a word processing format to HTML for publication on a website.

The content, form, and wholeness of electronic documents are determined conceptually and logically rather than physically. A person's conception of a digital document depends on how it is manifested to him or her. It may be manifested on a screen or on some other output device. This manifestation is fundamentally different from the way the document is encoded and inscribed on a durable digital medium. The digital encoding, which is typically described by technologists in a logical model, enables a computer to produce or reproduce the intended manifestation, but it does not have the same form and in practically all cases will not have the same content as the manifested document. For example, a manifested document may be a textual narrative. It may be encoded either in character mode, such as in a word processing format, or as a document image, but neither the numeric byte values that correspond to printable characters nor the bits that are projected as pixels in an image have the same extrinsic form as in the manifested document. Such differences extend to other presentation features, such as organization into paragraphs and page layout. The content of the digitally encoded document will also vary from that of the manifested document because it includes data that indicate how to manifest the document. Simple examples are data that indicate presentation features such as line spacing, page breaks, and italics. More complex examples are specifications for extracting data from different tables in a large database, combining them with invariant data and presenting them as a single page form. There are many elements of the content of the digital components of a document that are not manifested to a person. If the manifested document is adequate to communicate the information intended by its author, the invisible or imperceptible digital elements may be necessary to manifest the document, but they cannot be said to be parts of the manifested document itself.

It is useful to distinguish three different types of data in which a document is encoded digitally: content data, which constitute the content of a document; form data, which enable the system to reproduce the document in correct form; and composition data, which tell the system what form and content data belong to which document. Form and composition data together determine the structure of a digital document; however, they are not equivalent to structure. The term

'structure' is commonly used in reference to the manifest organization of a document. Form data impose that organization on the content a document, while composition data tell the system what objects in storage need to be brought together to constitute the document and map them to the different elements of structure defined by the form data.[37] The three types of data – content, form, and composition – may be contained in a single digital component or separated in different components. For example, software recognizing that a stored object is in a word processing format will assume as a default that the object represents a single document, and contains all of its content and form data. But, if the same document were encoded in Tagged Image File Format (TIFF), each page of the document might be stored in a separate file. In that case, the system would use metadata about each file to determine which files belong together as a single document and in what order. Even in the case of a word processing document stored in a single file, some of the data necessary to display the document with the correct specific presentation features will not be stored in that file. Specifically, the data necessary to interpret the binary digits representing each letter or number for display in the appropriate font are stored in a separate dynamic load library file. In other cases, the form, content, and composition data may be stored separately. For example, in a database application, for the digital equivalent of a printed report, the specifications for the documentary form are stored in a report file, which does not include any content data, while the content data are stored in database tables, but it is most likely that the report only uses a subset of the content data and that it arranges it differently than the database itself. Composition data that map the data elements to be included in the report to the logical data model of the database are stored as an object called a database 'view.' To produce a specific instance of the report, additional composition data are needed, and are often supplied by the user who requests the report. For example, the report file for a monthly report of expenditures specifies the content and form for all months, while a user must specify a particular month.

[37] Archival literature frequently describes records as consisting of content, context and structure. The discussion above describes the relationship of the three types of data to content and structure, but not to context. This is because, as described in section 1 'Findings of InterPARES 1' above, the significant context is external to the record. It is constituted by the record's relationship to other records, the administrative environment in which the record is created and maintained, the action in which it is involved, and the persons involved in its creation. Some of the content of a record may indicate or reveal its context; nevertheless, it is made of content data.

Interactive, experiential and dynamic environments can produce the digital equivalents of traditional documents. When an interactive online catalog is used to transact sales, it should produce the types of documents needed in any sales system: orders, packing slips, invoices, receipts, etc. It does not matter whether such systems are enhanced with experiential or dynamic characteristics. Likewise, dynamic systems used to collect scientific observations should satisfy the requirements of the relevant scientific disciplines for reliable observational documents. Similarly, e-government systems used to obtain permits or licenses or to pay fees or fines should produce and keep the kinds of documents needed for such transactions, regardless of the characteristics of the system. For example, the Alsace-Moselle Land Registry, an InterPARES 2 case study in the government focus, is an interactive system used to make and receive electronic records in traditional documentary forms. The Registry produces electronic records which correspond exactly to the ordinance of inscription, the inscription in the register, and to associated records, such as contracts and cadastres, which have been produced in real property transactions for centuries.[38]

The situation is more complex when the objects produced by or contained in interactive, experiential and dynamic systems either differ significantly from traditional documents or have no traditional counterparts. The following sub-sections will describe interactive, experiential and dynamic documents separately; however, the discussion will illustrate that for documents, as for systems, these attributes are not mutually exclusive.

Interactive documents

An interactive object could be described as one which, when presented to a person or another system, allows the person or other system to input data that engender changes in the subsequent presentation of the same object. In a basic sense, all digital documents could be described as interactive because user interaction is required to select the document to be manifested, but this would be a trivial way of looking at interactivity. This analysis excludes interactions that are generic possibilities offered by the computer and

[38] Jean-Francois Blanchette, Francoise Banat-Berger, and Genevieve Shepherd, Computerization of Alsace-Moselle's Land Registry, InterPARES Case Study CS18. 21 September 2004. See also: http://www.interpares.org/display_file.cfm?doc=ip2_alsace_characterization.pdf.

not specific to a particular document. Generic interactions include selection of documents for retrieval and output, variation in the size of the window in which a document is viewed, magnification, viewing of one or more pages within a window, and accessibility features such as ones that change the size of text or render text aurally rather than visually. A document is appropriately described as being itself interactive only when it includes specific features that provide for user input and that use such input to change the content or form of the manifested document. The difference between generic and document-specific interactivity is illustrated in the options for navigating within a document. Navigation tools such as ''Page Up'' and arrow keys or a ''Go To'' box are generic options, while a hyperlink which enables a user to move from text that is currently displayed to another location in a document or to display content that is not stored as part of the document, is a document-specific option. A simple, but not primitive, interactive object consists of one or more sets of fixed data and related instructions (software) for selecting and presenting those data. Data input by a user could trigger specific instructions which select particular stored data and present them to the user. The user's input could also trigger other instructions that determine in what form and sequence stored data are presented. Examples of such interactive objects include web pages delivering government services online, musical performances based on human–computer interaction, and commercial video games.

Interactive documents might appear similar to traditional forms of documents, but their appearance does not reflect their substance, because it is limited to what the system presents at a particular moment. Assume, for example, that what the system displays looks like a document that could be printed on paper, as in the case of online sales systems, where stored content data include data that constitute the catalog of goods offered for sale, other data about which items are in stock, additional data about shipping and payment options, and data about individual orders, customers, and payments. A customer may browse the catalog, starting by selecting a category of goods from a textual list. The system would then display images and basic information about the goods in that category and it might allow the user to request a different image, a larger image, more textual information about a particular item, or reviews by other customers who had purchased that item. The user inputs are compositional data. The system changes what it displays in response to each user input. The form data are stored in one or more HTML files which specify how a web browser should display the selected content data.

The first difficulty with identifying such interactive objects as clearly defined documents is that the system does not store any object equivalent to what the user sees. Rather, it stores one or more databases from which content is selected, and one or more sets of instructions that interpret user inputs to select, retrieve and present some of the content. This difficulty, however, can be resolved by applying the distinction made in the first InterPARES project between the storage format and the representation format of electronic records. In interactive documents, any given presentation is a transient manifestation of a palette of possibilities provided in the stored digital components. The Preservation Task Force report of the first phase of the InterPARES project noted, ''(r)eproducing an electronic record entails (1) reconstituting it, that is reassembling its digital components if it has more than one, or extracting any digital component stored in a physical file that contains more than one such component; and (2) presenting it in proper form.''[39] It further distinguished digital components from the technological methods used to reproduce the records.[40] This distinction suggests that the digital components consist only of content data; however, the analysis of interactive objects leads us to clarify that the domain of digital components includes the instructions which select and present content in a given form (i.e., form data), as well as composition data which further define the content selected.

The second difficulty with identifying interactive objects as documents is that user feedback can change both the content and the form in which information is displayed. Unless the system keeps an audit trail of the user's feedback, the system literally cannot reproduce what the user saw.[41] Every instantiation could be different. However, the

[39] *The Long-term Preservation of Authentic Electronic Records: Findings of the InterPARES Project*, available at http://www.interpares.org/book/interpares_book_f_part3.pdf, p. 6.

[40] Ibid. pp. 7–8. For a fuller discussion, see How to Preserve Electronic Records, Appendix 6 in *The Long-term Preservation of Authentic Electronic Records: Findings of the InterPARES Project*, available at http://www.interpares.org/book/interpares_book_o_app06.pdf.

[41] If the system does keep an audit trail, the relevant concern is not necessarily whether the system can reproduce every sequence and consequence of every ''input → computation → output'' process, but rather whether the system can reproduce only those process sequences and/or consequences that correspond to what the user (or the author/system, depending on the perspective involved) identifies as the documents/records that correspond to the user's interaction with the system.

system has the ability to reproduce the entire catalog or any selection of its content, and would produce the same instantiation in response to the same user inputs. Thus, a system can be said to keep an interactive document, regardless of any variability in form and/or content, when the system retains the ability to present that document on demand as a response to identical inputs. The fact that no user may ever see the entire online catalog is no more problematic than the fact that people only open a dictionary to look up one or a few words.

Experiential documents

An experience is a person's live, subjective involvement in or reaction to some event, activity, or entity. An experiential object is one which gives rise to experience or in some way captures an experience. Examples of experiential digital objects include works of electronic art, audio and moving images embedded in a web page, business monitoring applications which enable users to tap a rich variety of data sources, and virtual reality systems.

Experiential systems may produce or contain digital objects which are the electronic equivalents of traditional types of documents; for example, the script for a play or an audio recording of a musical performance can be either analog or digital. While computers create possibilities not available to an artist working in traditional media, the same could be said of different traditional media, such as oil and watercolor in visual art. Many works of visual computer art basically differ from traditional paintings and drawings mainly in the fact that they are digital.

Digital objects which include heterogeneous types of data, such as sound and moving images embedded in a web page, may appear more challenging to identify as unified entities, but are comparable to analog recordings of sound and motion video, which often are linked to related textual documents. As with visual art, there may be signficant differences in documentary form, due to fact that computers enable a greater variety of forms. For example, traditionally, the script and the film of a motion picture, and still photos and posters used for publicity, are different documentary forms, but in the digital environment they might be brought together on a

web page, which can be treated as a single document. The heterogeneity of data types and the multiplicity of objects which may be combined in a single digital document in themselves pose no greater difficulty to identification and preservation than does a textual document on paper, which includes other data types, such as photographs or charts, or consists of several entities which could be independent documents; for example, a report with multiple attachments.

Excluding from consideration the live, personal involvement, two types of experiential digital documents can be distinguished: those used in producing an experience and those which capture it or, more specifically, those which record either the presentation which gave rise to a subjective experience or some aspect of the experience, such as the reaction of participants. A musical score embodies the first type of experiential document, one that enables a potentially unlimited number of performances by providing instructions for performing a work, while an audio recording of a performance, which captures a specific execution of those instructions, embodies the other type.[42]

The distinction between objects that enable performance and those that capture it might not seem to apply to the visual arts. Traditionally, in the visual arts, such as painting and drawing, artists produce works on physical media that can be experienced for as long as the physical instantiation endures. In the digital environment, works of visual art cannot be kept in the form in which they are accessible to humans, but only in some binary representation, which is independent of any physical medium. To experience the digital work, viewers rely on a system capable of reproducing the work from its digital components. Digital documents that enable reproduction of static works of visual art are comparable to recordings of performances in the performing arts, as they both freeze an end product in the creation of an artwork and enable that specific instantiation to be retrieved subsequently. However, digital documents that enable presentation of

[42] There is some disagreement among music theorists on whether the score is also a musical work in its own right, but this does not invalidate the the ideas presented here.

interactive visual art belong to the class of objects that enable performance.[43]

Pioneering computer artist, Myron Krueger, for example, has created computer mediated installations which respond to viewers' inputs received from a variety of devices, project computer-adapted video of the viewers, and enable audience members to alter the video projection by virtually ''touching'' the projected images of themselves, other members of the audience, or computer-generated objects, ranging from graphic images drawn by the artist in real time, software-generated strings and ovals to animated organisms.[44] The content of these artworks consists of data produced during experience of the work: visual objects created algorithmically from data input from various sensors, which detect the presence and movements of spectators, and other visual objects either drawn by the artist observing the spectators' movements in real time or generated by stored algorithms but modified based on data from spectators. In a basic sense, such works have no fixed content, but viewed at a level of abstraction one step removed from that of the work as experienced, the content is bounded by the possibilities allowed by the artist either in the sensors and

[43] The digital environment enables an artist to record an artwork in different documentary forms. In addition to the documents enabling performance and the recording of a performance, the InterPARES 2 case study Waking Dream is documented on a website, which is regarded by the principal author as part of the art work, and which includes the 'script' along with information about the performance space and the gadgets used, résumés of the artists, and videos and images from performances. The web page is a document whose digital components include the web page itself and the objects accessible from the page, such as documentation in textual form, audio-visual recordings of actual performances, and sample still pictures of imagery projected during performance. The computer code is neither included nor described on the website. The web page is neither a recording of a performance of Waking Dream, nor a document enabling a performance, such as the script of a play or score for a musical work. Rather, it is an alternate form of presentation of the work. For a complete description of the case study, see: http://www.interpares.org/display_file.cfm?doc=ip2_waking_dream (complete).pdf. The Waking Dream web page illustrates a third type of experiential document, one that enables a user to experience a work by interacting with the system: the nature of the interaction is in fact more active than passive, or more participatory than observational. This is a more complex form of an interactive system, possibly including heterogeneous types of data and correspondingly more varied possibilities for presenting those data, and providing more flexibility or sensitivity in responding to user input.

[44] Söke Dinkla. The History of the Interface in Interactive Art. 1994: http://www.kenfeingold.com/dinkla_history.html. See also: http://a.parsons.edu/~praveen/thesis/html/wk05_1.htm1, and http://www.artmuseum.net/w2vr/timeline/Krueger.html.

projectors (input and output devices), which form each installation, or in the computer programs the artist wrote for the work. The computer programs, as well as the documents describing the installations, fall into the category of documents that enable performance. While users' actions in marketing applications indirectly influence the selection and form of presentation of content data, in interactive art installations user actions not only directly shape the performance, but also provide part of the content.

From such examples and case studies of visual art, InterPARES is beginning to advance the proposition that, in the digital world, the difference between performing arts and other forms of art is disappearing, in that artists in any field can produce digital works that can only be manifested over time by re-creating them on the basis of a set of instructions and related information needed to carry out the instructions as intended by the artist.

The InterPARES case studies of electronic music indicate that the set of instructions recorded by the composer – which might include a score, computer codes and other instructions on performance – may not be sufficient to reproduce the piece: the work may also require specific software patches, hardware or other devices, such as a synthesizer, and even a specific kind of interaction between the performer(s) and all of the above. Such interaction so far has never been described in a way that can be reproduced. On the basis of the case studies results,[45] increasingly, both composers and InterPARES researchers are arriving at the conclusion that a work of digital music can only be reproduced if the author describes each digital, intellectual and performing component of it and the interactions among them, by producing a set of instructions for re-creating each part of the piece and the piece as a whole. Thus, the case studies of digital music, as well as digital theatre – as we will see below with the case study Waking Dream – reveal that the class of experiential documents which enable experience includes at least two subtypes: one consisting of instructions whose execution produces a performance, and the other describing the components, context, preconditions, or requirements for performance whose execution allows for future performances. In other words, the artist will have to become an active participant in preservation.

[45] For example, "Obsessed again..." an interactive piece for bassoon and computer by Canadian composer Keith Hamel. See http://www.interpares.org/display_file.cfm?doc=ip2_obsessed_again(complete).pdf.

The distinction between experiential documents that enable performance and those that capture it is valid for non-traditional art forms as well. Waking Dream, for example, is a multimedia theatre artwork that explores the border between being awake and dreaming. In performance, two dancers personifying 'Wake' and 'Dream' move about the stage and through the audience, accompanied by a soundtrack, while both live and digitally recorded videos are alternately projected. One of the two performers wears a head-mounted camera and holds a remote control device, which allows or blocks the video projection.[46]

The digital objects that enable performance of Waking Dream include: a textual document that describes the performance and provides details for staging it, a collection of core sound samples that is remixed prior to each performance to create its sound track, digitally recorded images, and a specially developed computer code, through which the computer mediates interactions among the camera, remote control device, video projector, and audio devices. Like an interactive sales catalog, the digital objects that enable performances of Waking Dream include content data – audio and video in this case – and instructions for presenting the work, which constitute both form and composition data. Similarly, an instantiation of the work involves variable sequencing of the stored content data, and the presentation of the data depends on the interactions from one of the dancers. All four types of objects might be considered as documents in their own right, since they each have fixed form and content. The second type of experiential digital document also exists in this case. A performance of Waking Dream has been recorded in Apple Quicktime '.mov' format: this file reproduces that performance, or at least those aspects of the performance that were capable of being recorded, since much of the performance happens almost in the dark, with only infrared light.

A very different type of experiential object is created in online marketing applications. Unlike artistic works, which enable unique, subjective experiences, online marketing applications aim at producing an experience that will lead to a specific behavior; namely, the purchase of the goods or services offered by the sponsor of the application. Superficially, such sites appear comparable to online sales applications, but unlike online sales catalogs, marketing applications may not even offer the possibility of online transactions. For example, websites sponsored by pharmaceutical companies do not offer for sale medicines requiring a prescription, but such sites have proven very effective in building brand loyalty and inducing their visitors to talk

[46] InterPARES 2, Waking Dream Case Study Final Report, cit.

to their doctors about a particular medicine. These sites are designed in recognition of the facts that most visitors to a medical site will not return and are reluctant to provide personal medical data online. Given such barriers, it would seem unlikely that these websites could significantly influence behaviors, but they do. Rather than providing a visitor with information that directly supports a sale transaction, marketing sites are designed as personalized information resources. They do not ask visitors to input information about themselves, but minutely observe online behavior, gathering information from visitors' actions on a site to anticipate their individual requests for information and respond to them with the most appropriate marketing message: "Conscious of it or not, even the most tight-lipped visitors communicate to every website they visit. Every keystroke is a clue to their situation, needs, and preferences – if the site can interpret and act on it."[47] The digital components of such websites include HTML documents that provide the basic documentary form of the site, a store of relatively atomic messages that can be delivered in response to user inputs, rules for collecting data about users' navigation of the site, rules for interpreting such data as the basis for selecting and presenting stored information, and possibly rules about saving user inputs to create profiles either of individual users or classes of users. Such profiles are subsequently used to refine determinations about what messages to present to users and in what form. In contrast to an online catalog, whose content is likely to be stable at least for some finite time, sites which continuously collect data about user interactions with the site and use the data to modify subsequent presentation of content create documents which, in effect, are always in progress. They are never finished, unless the application is terminated.[48]

A visit to a marketing website can be regarded as an experience and the information provided by the site during a visit can be considered as analogous to a performance, though it might be better termed a production. Accordingly, the stored messages, the HTML documents, and the rules can be said to enable the production, and the data captured about user navigation of the site can be regarded as

[47] David Reim. "Online behavior: A brand builder's best friend," *Pharmaceutical Executive* **22**(4) (2002): 104–108.

[48] In this and many similar cases, the most likely and workable solution to the absence of a clearly identifiable entity that can be kept as a document is to establish intermediary 'termination' points (these could be predefined or randomly chosen to facilitate statistical analysis of the results, if desired, or they could be triggered whenever a predetermined set of user interaction criteria are met, etc.) in the ongoing process, when documents are produced that attest to the state of the system at those points.

composition data that subsequently determine both the content and form of information presented on the site.[49] The user navigation data might also be considered as a recording of an experience of that site, but such data are not used to reproduce the experience, and are unlikely to be organized in a way that would make it possible to reproduce the experience.[50]

In general, documents that enable performances also enable variations in performance. Performances vary, depending on how much discretion the instructions give to the system executing them or the performers interpreting the work, on the ability of the performer(s), the characteristics of the instruments or devices used, the characteristics of the performance spaces, etc. As with purely interactive documents, the documentation of an artwork may call for variations in content; for example, the remixing of core sound samples, the alternation between live and recorded video, and the differences due to movements of the dancers in Waking Dream. While there is an element of artistic license whenever live performers execute written instructions, and the limits of artistic license are subject to argument, there are also, inevitably, boundaries to the variability. The narrative describing the movements of the dancers in Waking Dream, for example, is set out in broad terms, but the work must be performed by exactly two dancers, one of whom controls the video projection. If the core sound samples or the stored images were changed, the result would be a different artwork, albeit one closely related to the first. Variability in performance based on documented instructions is common to both digital artworks and those recorded in more traditional forms.

A specific performance captured in one or more documents has narrower bounds of variability than that permitted by the documents that enable performance.[51] Nonetheless, the reproduction of a recorded performance will vary depending on the quality of the recording and the system used to reproduce it. While some works of performance art may require elaborate and complex arrangements for

[49] Of course, one should not be induced to believe that the content and form are unique entities created on the fly from an infinite pool of possibilities, as they are simply manifestations of predetermined combinations of content and form that are then selected from a finite pool of such combinations in response to user behavior.

[50] To a degree, this is precisely what the history cache in a web browser does, which users are able to reproduce by using the browser's back and forward buttons.

[51] Because the documents in which the performance is captured are 'static' and/or are incapable of capturing all aspects of the actual performance, they ipso facto must embody less variability than is permitted by the rules describing the components, context, preconditions, or other requirements for the performance.

performance, in the digital environment, the reproduction of a performance may be accomplished simply by the reproduction of the document in which the performance is recorded. For example, the presentation of music or other sound recorded in digital audio format, such as '.MP3,' is accomplished simply by "playing" the file on a computer with an appropriate sound card, software and speakers. Similarly, regardless of the complexity of the software used to create them, static digital images of visual art, as well as many cases of motion video, can be reproduced simply by presenting the digital document in which they are recorded.

Reproduction of a digital document is not sufficient to reproduce a performance; for example, in cases where there are special requirements, such as that a person experiencing a performance be in a specially designed space, or where the performance requires special gadgets, such as virtual reality goggles. Clearly, both the format(s) of the document's digital components and the system used to render a recorded performance must be adequate for the work. This can range from the simple case where digitally recorded music cannot be reproduced on a computer which lacks either a sound card or speakers, to complex ones where the person experiencing the performance must have appropriate means of interacting with the system used to reproduce it. But once this threshold is achieved, the question is one of the qualities of the reproduction, not whether the work is reproduced.

In sum, in experiential environments we have found two types of documents which may themselves be qualified as experiential: (1) documents that enable performance or production of a work, including both the documents which describe the work and/or the instruments, devices or other things used in the performance of the work, and those which provide instructions on how to perform the work, and (2) documents that capture a specific performance or experience. The essential purpose of characterizing a document as experiential is to emphasize that it is clearly intended not merely – perhaps not at all – to communicate specific information, but to engender subjective experience.[52]

Dynamic documents

As with interactive and experiential systems, dynamic systems may produce digital equivalents of traditional documents. Dynamic

[52] This is consistent with the definition of 'experiential' by InterPARES researchers, but broader. The project's definition is restricted to 'sensory experience,' but an experience could be intellectual or affective, as well as sensory.

systems may, for example, interact with other systems to conduct business transactions or even form contracts without human mediation, but the documents which are produced in such interactions should conform to requirements for records of transactions and contracts.

However, dynamic systems also produce objects which could be described as dynamic themselves. An object may be said to be dynamic when (i) it has a fixed form, but draws its content in real time from other sources, (ii) the content data available for presentation are fixed, but their presentation, both in form and selection of elements of content to be presented, varies in response to real-time inputs from a person, another system, or an input device, or (iii) the content data, though stored as part of one or more digital components, change frequently by additions, deletions or replacements. These types of dynamic objects are not mutually exclusive. An object may belong to all three types; however, belonging to any one of them is sufficient to categorize it as dynamic. Moreover, all three types are also interactive and may be experiential.

An object that dynamically acquires content data may have a fixed form in that its extrinsic and intrinsic elements manifest themselves in such a way that the appearance of the document and its intellectual structure do not change, as in the case of websites which present information on the weather or on international currency exchange rates. Such objects can be described as documents that have fixed form, some fixed data and some variable data. Fixed data on a weather site include, for example, the locations for which weather data are available and, on an exchange site, include the currencies for which exchange rates are given. The variable data include current temperature, precipitation, exchange rates, etc. Some digital documents of this type may also allow variations in the way content data are presented, similar to interactive documents whose content data are stable. In these cases, the variation in presentation is governed by rules or instructions.

This type of dynamic document can also be found in many other systems, including the marketing applications or interactive visual artworks described in the last section on 'Experiential Documents.' The source of the content data in dynamic documents of this type could be a scientific instrument in a laboratory, a satellite transmitting live imagery, a video camera aimed at a highway, or wireless equipment transmitting heart rate, blood pressure, or other biometric data about

an outpatient, or any number of other sources external to the system.[53] This type of document may have some fixed content, only variable content, or a combination of the two. Objects which acquire, process and present, but do not keep, data from external sources are analogous to temporary or intermediary printed forms; for example, when ordering an item at a tools store outlet, one writes the item number and description onto a temporary paper form, hands it to the clerk who then enters the data from the paper form into a permanent order form on the company's computer system and throws the paper form away. Someone in the warehouse then views the order form on a computer screen, pulls the order from the shelves, then prints a hard copy of the computer version of the order form. The printing is necessary in that type of transaction because, while variable data entered on a paper form become part of the document, with online 'forms,' the data are included only in the display of the document, and elements of it are discarded or replaced in response to successive user inputs or other external stimuli. Because the data from external sources are not kept within the system, they are part of a document only while it is being presented by the system or, of course, when the form is printed out. As with other cases we have considered, the form and content of a document are determined by instructions which govern processing of the external data.

Documents in online marketing applications also belong to the second type of dynamic objects, where the content data available for presentation are fixed, but the selection of content data and the mode of their presentation vary dynamically. These include web applications that enable persons to explore a website using a variety of options. Such applications continuously collect data about user actions on a site, such as how many seconds a user spends on any portion of the site, where each mouse click occurs, etc., but such data are never presented. Rather, they are used by the application to determine what stored messages to display next and how to present them. Such documents have fixed total content, consisting of information about the site's sponsor and its products, continuously changing composition data about visitor interaction with the site, and a specific documentary form and content determined by the rules for interpreting data

[53] Nicola Ferrier, Simon Rowe, and Andres Blake. "Real-Time Traffic Monitoring," In *Proceedings of the 2nd IEEE Workshop on Applications of Computer Vision, Sarasota, Florida, 5–7 December 1994*, pp. 81–88, available at http://ieeexplore.ieee.org/iel2/998/7985/00341292.pdf. Noel Baisa. "Designing Wireless interfaces for patient monitoring equipment," *RF Design* April 2005: 46–54, available at http://www.rfdesign.com/mag/504rfdf4b.pdf.

about user interactions. Online sales applications that collect data about user interactions and use them to determine presentation also fall in this category. It might be noted that this is exactly the same process described above for experiential documents associated with marketing websites.

The third type of dynamic object, where stored content changes frequently, is actually a variation on the second, and is found in e-government applications. One of the InterPARES 2 case studies, VanMap, is an example of this type of dynamic object. VanMap is a GIS system that allows the City of Vancouver to meet the needs of city officials and employees in providing services to Vancouver's citizens and businesses. VanMap supports the functions and activities of the following departments: Community Services Group, Engineering Services, Corporate Services Group, Board of Parks and Recreation, Vancouver Police Department, Fire and Rescue Services. Decisions about how to organize information into GIS layers and what sets of data each layer should contain are made collectively by the departments and the VanMap Technical Team. Data are uploaded by each department directly in Oracle Spatial or taken as extracts from external offices databases (for example, permit and license data stored in PRISM or License+ are extracted to an SQL server; property tax data are extracted from the SQL Property Tax System, etc.) for inclusion in VanMap by the Technical Team, which is responsible for its administration. Engineering and constructive solid geometry (CSG) graphics are created in the form of CAD drawings in AutoDesk, or keyed or drawn in the Oracle Spatial database. VanMap data are overwritten at each update and, every once in a while, existing layers are modified to receive different kinds of data sets, and new layers are added. The data about transactions which the system supports are replaced or erased whenever any data used in support of a process are updated, or new data layers are added, or whenever the instructions for a process are modified.[54]

Dynamic systems often support extraction and processing of information from heterogeneous sources, where the sources themselves may vary even in the course of a single run. Dynamic systems also vary in the output they produce. Variations in the types of data in the input stream change both the possibilities and the requirements for processing input and, therefore, require systems that can reconfigure themselves on the fly. Changes in the way the system executes its

[54] For more information about the VabMap case study see: http://www.interpares.org/display_file.cfm?doc=ip2_vanmap_characterization.pdf.

processes may occur autonomously as the system assesses in real time the external data sources supplying data, what data are supplied, or the characteristics of those data. In the face of such variations in data, the system may invoke different software agents or components or, in more advanced cases, may modify the software it uses to present the data. Changes in software may in turn modify the content data, for example, by applying different calculations on raw data. Such techniques are used in practical applications such as scheduling and modeling of financial markets, as well as in computer art and "edutainment;" that is, applications which achieve educational goals through entertaining means.[55]

Conclusions on the Classes of Digital Documents

The preceding three sub-sections show that interactive documents constitute a major class of documents that can only exist in a digital environment. This class is distinguished from other digital documents that do not have document-specific features enabling user interactions that alter the form or content of the document when it is manifested. Thus, we may postulate a basic division of digital documents into static and interactive categories. The preceding sub-sections also show that dynamic documents are a subset of interactive ones, characterized by the fact that their variability derives, at least in part, from variation in the rules used to generate the document.[56] Experiential documents, however, do not constitute a separate category or sub-category within this scheme. Distinguished on the basis of their role in engendering subjective experience, experiential documents may be static, interactive, or dynamic. For example, a visual artist may create a static digital picture which is entirely analogous to a traditional painting. But the artist could also add interactive features to such a picture, and could use dynamic algorithms to change the way the image is generated, as well as its form and content.

This analysis enables us to construct a taxonomy of digital documents, as shown in Table I.

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[55] Dale Thomas. "Aesthetic selection of morphogenetic art forms," *Kybernetes* **32**(1–2) (2003): 144–155.

[56] One might argue that dynamic documents are not necessarily a subset of interactive ones. It is possible to conceive of dynamic documents that do not include any interactive features but generate varying displays from algorithms that alter themselves. However, such cases would be properly characterized as pseudocs or even applications, rather than documents.

Table I. Taxonomy of Static, Interactive, and Dynamic Documents

Class	Description
1	Static documents Digital documents are static when they do not provide possibilities for changing their manifest content or form beyond opening, closing, and navigating within the document. Once a static document is retrieved and manifested, its entire content is available to the user and its structure is invariant. A user may need to interact with the system in order to access the content, or different portions of the content, but such interactions do not change the form or content of the document. Any user exercising an option for navigating within the document – which includes options for different manifestations of the document – will be presented with the same result.
1.1	The electronic equivalents or counterparts of traditional documents *Examples* *Letters; reports of scientific experiments or observations of natural phenomena output from dynamic systems; digital sound recordings, digital motion video, and visual art works*
1.2	Documents that have no exact counterpart in hard copy or analog form but have fixed documentary form and content[a] *Examples* *Snapshots of web pages, and recordings of performances of artworks which have characteristics that may exist only in a digital environment, as well as the results of freezing and capturing the output of a system that modifies its own instructions for processing or presenting content data*
2	Interactive Documents Documents that present variable content, form, or both whose rules governing the context and form of presentation may be either fixed or variable
2.1	Interactive Documents which are not dynamic Documents where the rules which govern the content and form of presentation *do not* vary, and where the content presented in any instance is selected from a fixed store of data within the system *Examples* *Online sales catalogs, interactive web pages, and documents which enable performance of music and other works of art*
2.2	Interactive Documents which *are* dynamic Documents where the rules which govern the content and form of presentation *may* vary
2.2.1	Documents where the content and/or its presentation vary because it includes or is otherwise impacted by data that change frequently

Table I. Continued

Class	Description
	Examples *Documents in systems whose design permits updating, replacement or alteration of data but does not provide for keeping older or superseded data, and websites that collect data from users or about user interactions with or actions on a web site and use those data either to generate or determine subsequent presentation*
2.2.2	Documents where the content varies because it includes data received from external sources and not stored within the system
	Examples *Websites which present information on topics such as the weather or currency exchange rates, as well as many interactive artworks*
2.2.3	Documents produced in dynamic computing applications, which select different sets of rules – software applets or service components – to produce the documents depending on variations in user inputs, in the sources of content data, and in the characteristics of that content
2.2.4	Documents produced by adaptive or evolutionary computing applications, where the software which generates the documents can change autonomously
	Examples *Websites which involve the scheduling and modeling of financial markets, as well as some types of dyanmics computer art and 'edutainment' sites*

[a]This class includes the outputs of any method of capturing or freezing something presented by an interactive, experiential, or dynamic system.

Interactive, Experiential, and Dynamic Records

Can interactive, experiential or dynamic documents be records? As established in InterPARES 1, two of the essential characteristics of an electronic record are a fixed form and an unchangeable content. However, the constraints of fixed form and unchangeable content are not absolute. Records that have suffered some loss or corruption of elements of form or content through accident, mishandling or environmental factors remain records, provided the loss or corruption does not compromise their nature. Such alterations must be considered case by case.

For electronic documents in general, fixed form does not mean a completely invariant form, always identical to itself. A textual document on paper has an immutable form: the alphanumeric characters have a definite size and configuration; margins are firmly set, etc. But,

as explained in distinguishing interactive from static documents, both the technology used to manifest digital documents in individual instances, and different choices made by users viewing them can cause variations in the manifest form and/or content, even when there is no variation in the stored digital data used to generate the manifested document.

'Record' comes from the Latin, *recordari*, to remember. The essential function of a record is to serve as a bridge over time, to carry information about an action, event, or state of affairs forward for when it is needed in subsequent actions or for reference about what happened or was described or said in the past. Setting aside variability due to generic features of digital technology, static digital documents clearly satisfy the requirements of fixed form and unchangeable content, regardless of the characteristics of the systems in which they are made or received. Examples include purchase orders and invoices created in transactions executed in online sales applications. In cases of interactive documents whose form or content varies according to fixed rules (class 2.1 in Table I) and documents whose form or content varies according to rules which may themselves be variable (Table I, class 2.2), the variability of form or content will prevent the documents from serving as records. A record that does not contain a fixed message or convey that message in a fixed form cannot be recalled and cannot be a means of remembering.

However, there are cases where the content or form may vary but in a way that does not prevent the documents from serving as records. In many interactive, experiential and dynamic documents, authors or writers[57] intentionally use specific possibilities which digital technology offers for variability in the form in which information is presented. In such cases, the form is 'fixed' in that the design allows certain aspects of form to vary and not others. Documentary forms that include variable elements do not violate the requirements for fixed form, any more than analog audio and motion video recordings, which present temporal variations in sound and imagery. Such variability in presentation intended by the author should be seen as part of the extrinsic elements of the documentary form. In digital documents in which fixed rules govern variation in content and/or

[57] 'Author' and 'writer' are terms used here as defined by diplomatics. See Footnote 6. When the author is an individual, it usually coincides with the writer. When the author is an organization or a collective or collegial entity, the writer is the person(s) who articulate(s) in writing its will, usually the signatory(ies).

form, (class 2.1 in Table I), such bounded variability is not a product of information technology in general, but is embodied in specific digital components of the document, such as interactive forms, software applets that generate varying presentation, business rules, software that uses user input to determine subsequent output, and rules which enable systems to adapt to changing inputs and demands. However, it is difficult to conceive how a dynamic document, wherein the rules which govern form or content change, could be a record, except perhaps as a 'draft' which is in the process of being developed for as long as it remains in the dynamic system.

With electronic records, then, the 'fixed' form consists of those aspects of form which the author or the writer intended or could control. While there may be difficulties in discerning a person's intent, generic variability enabled by information technology should not be considered as expressing an intention of an author or writer. For example, the author of a textual document probably intends, or at least expects, that a document will be displayed to readers with the same type size, line length, colors, etc. the author sees on the screen. But, in some situations, the author has no means of preventing variations of the type described in the last paragraph; therefore, the effects of different hardware, user selected window size, and other aspects of variability due to the technology used to view or experience a document after making it cannot be considered as intended by the author. Aspects of form that require a specific intentional action by the author or writer, such as division of text into sections, inclusion of images in a textual document, and any differentiation of the appearance of a portion of the content, either from adjacent content or from the norm for the rest of the document, convey the author's or writer's intent. There is also at least an element of intent in an author's or writer's choice of digital data type or format.

An author or writer may establish bounded variability in the content of a digital document. A significant class of documents where variability in content does not negate the necessity for fixed content is that of documents which allow variable subsets of the content to be displayed at any moment. Class 2.1 documents in Table I, illustrated by interactive sales catalogs, are reproduced through processes which include options enabling users to select content. Such options might be seen as analogous to the variation a user would see when browsing selectively or randomly through a catalog printed on paper. Although one might argue that the situation is not truly analogous to a selective reading of a printed document, because the possibilities for selecting digital content are not entirely, or even primarily, at the user's discretion, but depend

on rules that are part of the document itself, these rules are not fundamentally different from the restrictions placed on the users of a printed catalogue by the catalogue's physical constructs and design 'rules' (e.g., layout, product categorization, pagination, etc.). In such cases, while what is presented to the user at any moment may appear to be a document, it is instead part of the only existing document, the catalog. The full content of an online sales catalog comprises all data stored and available for presentation to a user. It includes data about the goods offered for sale, such as textual descriptions and images, as well as data about related topics, such as payment and shipment options. The fixed form of the catalog includes those aspects that are always shown as well as those that determine how selected content is presented, such as the size and position of images, and whether the catalog exhibits various categories of data in windows separate from the main display. The digital objects that enable the selection of content are digital components of the document. This qualification does not negate the necessity of fixed content of the document as a whole. It merely recognizes that interactive digital environments enable an author or writer to structure a document so as to permit variable selection of content and variable sequencing of that selection. Cases where the documentary form permits selective display of subsets of the content can satisfy the requirement for fixed content.

A document that gathers some or all of its content data from external sources and does not store them concurrently – as opposed to sequentially – within its digital components cannot be presumed to contain a fixed message. However, in some cases even documents in this category can be records. Like a musical score or script for a play, a document that delineates a fixed form in which external data are to be presented and may include some unaltered content may be an instrumental or instructive record. Myron Krueger, for example, has created artworks where the software generates geometric objects, which are projected on a screen where they move and change their size and shape; however, the specific shape, size, movement, and the sequence of changes – the specific content – depend on characteristics or actions of individual viewers. In contrast to an online sales catalog, all of whose content is concurrently stored in a digital document, in such artworks the digital document that generates the presentation does not contain all of the content data, at least not cuncurrently. This document determines what objects may appear in the artwork, their basic characteristics – for example, it defines whether one object is a closed geometric loop; it makes another look like a small animal; and presents the silhouette of a spectator captured in real time as a

third – and their possible behaviors – for example, it establishes that a ''Critter'' will seek to move to the highest point of a person's silhouette. The variable content which is manifested in a given instance may be captured in a recording of the presentation, but it is not stored in the document which enables the presentation.

There is a commonality between such artworks and online sales catalogs in that, in both contexts, the document that is kept and used for future reference is the digital object that is stored in the system. It is not the materialization of that object on a computer screen or other rendering mechanism. Provided that the other requirements for being a record are met, the record in such cases is the digital entity, not the human-perceivable form which is reproduced from it.

Applications may display pseudocs whose presentation includes both selected subsets of stored content and data obtained from external sources. For example, if a user of an online catalog inquires about the current availability of an item, the sales application may send a query to the inventory database which tracks items in the company's warehouse, or it may even query the inventory database of an independent supplier. The application would use the response from the inventory database to inform the user whether the item is currently available and how soon it could be shipped, displaying this information as if it were part of the catalog. Such external data are intentionally not stored as part of the catalog because they would quickly become outdated and misleading. Behind the variable content, the catalog document must include fixed rules that enable the system to get and present the variable data in real time. These rules are part of the stored digital document.

The description of performance art in the 'Experiential Documents' sub-section above led to the distinction between documents of performance and documents which enable performance. From the current discussion, we can see that this distinction applies to other domains. Interactive documents, with one exception, are ''enabling'' documents. They enable performance of artworks, execution of business transactions, or conduct of experiments or carrying out of programs for collection and analysis of observational data. The exception is represented by documents where changes in content data do not reflect an explicit intention of the author, but rather result from a failure to provide for the retention of data in the system and/or to compensate for system changes. This is illustrated in the case of VanMap, where data are regularly overwritten and the data model is changed on occasion. Such changes result in the inability to reproduce documents previously created in the system. This inability is due either to the fact

that some of the content of such documents is no longer available or, even when all of the original content remains available, to the fact that changes in the data model can result in the inclusion in subsequent presentations of the document of new categories of data which were not present in the original version, or in the selection, processing or presentation of the original content in a different way.

This analysis leads to a conceptualization of an electronic record which is notably different than that articulated in the first phase of InterPARES. In InterPARES 1, an electronic record was any record manifested by a computer system to a human or another system. The form of the record is that of the document manifested by the correct processing of the stored digital components. The stored components enable reproduction of the record, but are not the record. This distinction between the manifest record and its digital components is basic and essential because errors in processing the stored data could result in failure to reproduce the record or in the production of a different document and because it is possible to preserve the manifest record – that is, to maintain the ability to reproduce it – even when the digital components are altered, for example, by reformatting or migration to different digital media. In this view, all of the essential properties of the record are found in the document that is manifested, and these properties are basically independent of how the document is encoded in digital components. Thus, there is an inverse dependency between the record and its digital components: the record is produced from its digital components, but the components must be produced in such a way as to guarantee that all essential properties of the record are present and identical whenever the record is manifested.

These findings were not wrong, but too limited. Given the essential memorial function of a record, the digital components might themselves constitute a record or a set of records, depending on how they are instantiated in the system. The digital components and the document reproduced from these components may constitute, that is, related but distinct records: the digitally stored record(s), and the ''manifested record,'' which can be defined as the visualization or materialization of the record in a form suitable for presentation to a person or another system. The primary purpose of keeping the stored record is to be able to reproduce the manifest record, while the manifest record is preserved to communicate information to persons or other systems. The study of interactive records in InterPARES 2 further enriches the concept of the manifested record to encompass any and all variability of form and content which is specific to the document. InterPARES 2 case studies also lead to the recognition that a digitally stored record includes not

only the data which must be processed in order to reproduce the manifest record, but also the rules for processing the data, including rules which enable variations in the content or form of the manifested record. Another reason for differentiating between the stored and manifested records is that one or more of the digital components of a manifested record may also be used in reproducing other manifested records. If a stored object is used to reproduce more than one manifested record, it cannot be the equivalent of any one of them. Moreover, if in a set of digital components which together are used to reproduce a manifested record, any one component is used in the output of multiple records independently of other members of the set, then that component should be considered a record.

The findings may seem radical, but in fact there are well established precedents. In medieval Europe, when the profession of notaries became so powerful that most transactions had to be recorded and preserved by them, they introduced efficiencies by not writing out the records of the transactions that they witnessed. Rather, they would take a parchment, fold one corner forward, and write on it the transaction type, the names of the parties, the date, the description of the transacted property or matter, and any other data specific to that transaction. Then, they would file away the blank parchment with the annotated corner, called *imbreviatura*.[58] At the end of each year, they would bind all the *imbreviaturae* of the year in a volume, and index the volume and/or keep a separate registration of the transactions bound in that volume in a book of *regesta*. If, later on, one or more of the parties to that transaction, or their descendants, wanted the complete record of the transaction, the notary would find by date the volume containing the *imbreviatura* in question, retrieve the document in it through the index or the register, take a new piece of parchment (or paper, if appropriate), and write out a complete record following formulas contained in a special book, called *formularium*, which provided clear instructions for writing out a record for each type of transaction that occurred in a specific range of years, and inserting the specific data written on the *imbreviatura* corner at the proper locations. Thus, what the notaries maintained was not the complete record of each transaction in its final form, but a record of the content of the transaction and another record of the documentary form in which that type of transaction had to be manifested. Rather than keeping transactional records per se, they maintained the ability to

[58] Sometimes, rather than on a corner, they would write the data on the back of the medium.

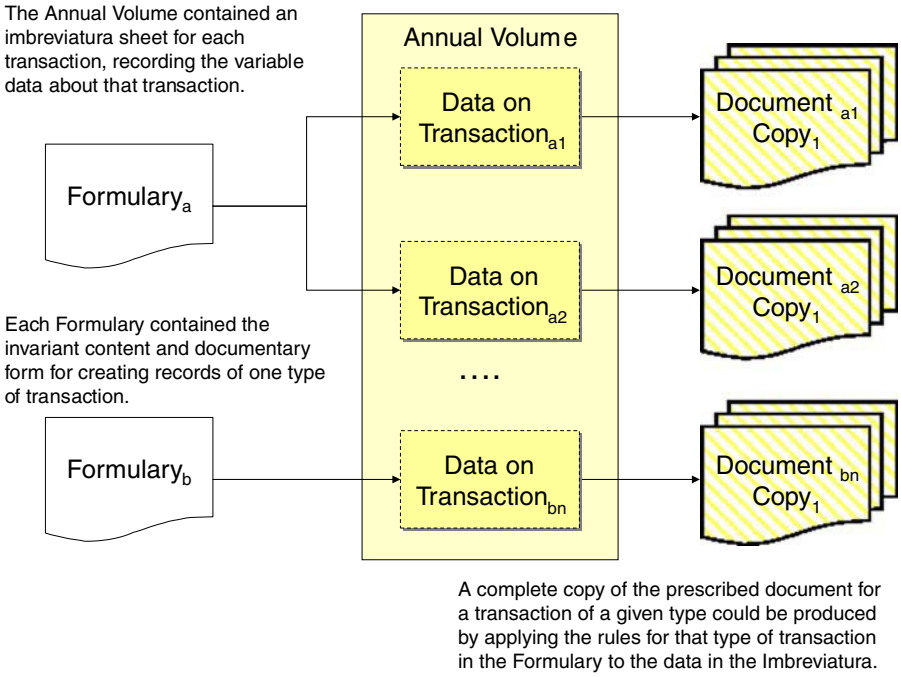

Figure 1. Keeping and Producing Records Using Formularies and Imbreviaturae.

produce an authentic copy of such a record upon request. In this system, each *imbreviatura, formularium, register, and reproduction of a transactional record is a record.*

The notaries kept a record of the fact that a transaction had occurred (register and/or index), a second record defining the documentary form for each type of transaction along with identification of the variable attributes needed in each type of records (*formularium*), and a third record containing the data values of those attributes for each transaction (*imbreviatura*). Combining the document model contained in the *formularium* with the specific values in the *imbreviatura*, they and their successors could produce the accurate and authentic record of the transaction when needed, even centuries later. Each record of the transaction produced in this manner would be an original record. However, because of the trustworthiness of this practice, the parties to a transaction, or their successors, almost never requested that a complete record be issued: the existence of the *imbreviatura* in a notary archives was sufficient evidence of the transaction.

This practice is illustrated in Figure 1 below. The Formulary includes invariant content data, articulates the essential aspects of

documentary form, and indicates the variable data elements whose values must be specified in each instance, while the Imbreviatura contains the instance data for a single transaction. Thus, the imbreviaturae for all transactions of type "a" would include the data elements specified in the formulary for transactions of that type. In the imbreviaturae system, records of various transactions, such as contracts and deeds, were kept, but not in the documentary forms which were prescribed for those transactions. The record keeping system enabled the record keepers to produce copies of the records in the required forms on demand. Any instance of a transactional record produced in this manner was an original.[59] Interestingly, the imbreviatura system was so reliable that, over time, people who needed to know what was in a transactional record were satisfied by ascertaining the data contained in the imbreviatura, and did not require the production of records in the documentary forms prescribed in the applicable formulary. Even though the imbreviatura was not the intended complete record, but only a prelude to it, it served as a reliable record of a transaction of a given type. The reliability was contingent on the fact that the system could produce an authentic complete record of the transaction on demand.

Functionally, the formularies and the imbreviaturae are the equivalents of digitally stored records described above.[60] While the imbreviaturae system physically separated content data about a specific transaction from the documentary form and the invariant content

[59] Technically, the very first was an original, while the subsequent ones, lacking primitiveness, were copies in the form of original, although they had the force of an original. However, as they were all produced directly from the imbreviatura rather than from one another, and, having a different date of transmission and, possibly, a different writer (a notary who has legitimately succeeded to the original one) and a different addressee (the addressee of the action would remain the same, but the addressee of the record could be a descendant of one of the original parties), were different records, they can be all regarded as originals.

[60] There is a subtle, yet important, distinction here that makes the correspondence to the Medieval analogy less than exact. The digital records are not being stored in documentary forms that are different than originally *intended*, rather, they are being stored in forms that are different than the forms in which they were originally *created*. The imbreviaturae (notwithstanding that they are complete records unto themselves) are, in one sense, incomplete 'stand-in' records for complete transaction records that, in most cases, were never created. This is not the same process that is occurring with the digital records, because the digital records are, in fact, created as complete records in their final form, and then saved in a form that differs from the form in which they were originally created. Thus, unlike the potential 'records to be' that are associated with the imbreviaturae system, the products of the digital systems discussed here are complete records created in their final form prior to being stored (except in those cases, as noted, where the minimum requirements for an e-record are not met).

(i.e., extrinsic and intrinsic elements of form), physical separation is but one of many possibilities in the digital environment. Digital information technology offers a variety of ways of keeping and combining data and instructions. What is essential is that the computer stores and processes the data and the instructions in a way that consistently and correctly distinguishes each type and combines the different digital components of a record.[61]

Similar practices exist in the digital environment. Figure 2, depicts in the abstract a common way of keeping records using database applications. The three elements at the top of the figure, ''Database Form,'' ''Instance Data'' and ''Document Copy,'' illustrate in summary fashion how individual documents can be generated by applying a Database Form to the data of individual instances of the types of transactions covered by the form. This process exactly parallels the medieval use of imbreviaturae. However, digital information technology offers greater variations in how this practice can be implemented. The lower part of Figure 2 presents a more detailed view of how forms are filled in with data of individual instances. In a database, not all of the data need to be kept in a single 'document' or logical object within the application. A form can be filled in with data of a single instance stored in many different locations in the database. Figure 2 illustrates this for a relational database, where the data of each individual case are spread across several tables. The database keeps track of the data of individual instances thanks to a logical data model that defines how data entries in one table are related to those in other tables. The database application fills in a form, ensuring that the right data elements of a single instance are entered in the correct locations on the form in accordance with rules that map the logical data model to the form. An additional element of complexity in the digital environment is that individual data can be combined in different ways with other data to produce different types of documents; for example, data from an online order can be used to fill out a pull list, shipping label, and invoice.

In this conceptualization of electronic records, when is a digital component of a manifested record a record itself? One example of such a situation occurs when a single digital component, such as a binary image of a printable document, comprises all of the data necessary to reproduce the manifested record: in this case there is a

[61] Future analysis of how the different types of data are mapped into digital components should address how the system recognizes and processes the different data types in different mappings.

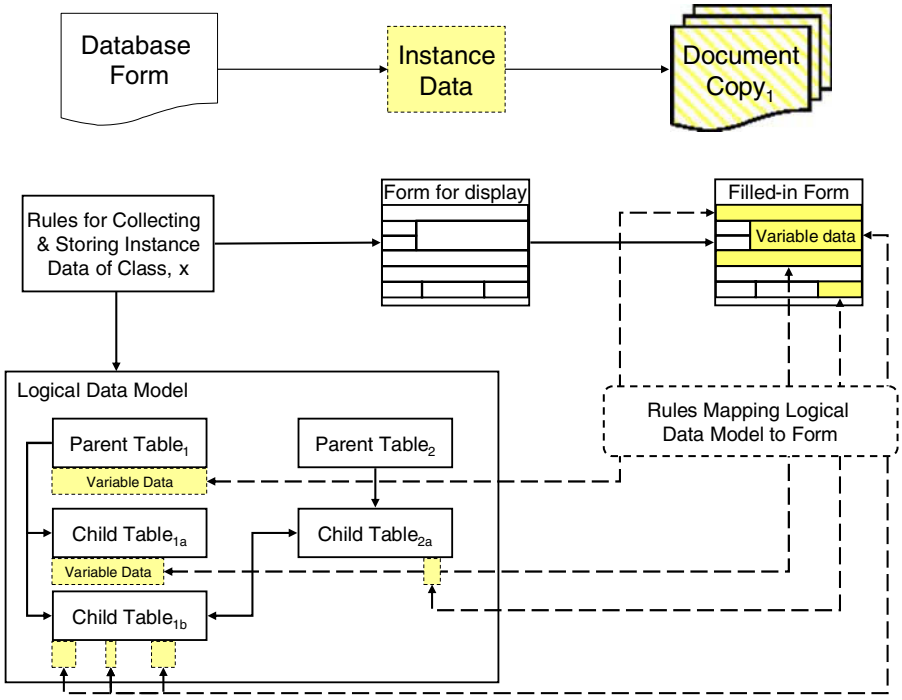

Figure 2. Producing Documents From Databases.

one-to-one correspondence between the digital component and the manifested record. Another example occurs when, in a complex database like that illustrated in Figure 2, one digital component, the "database form," has a fundamental unity, autonomy and completeness, just like a medieval formulary. This would not be the case for the digital component "instance data," because each of the data necessary to fill in the form is recognized and processed by the database application as a distinct bit stream, and is therefore meaningless by itself. It would acquire meaning only in the context of a data model. Moreover, while the application can isolate each datum, it does not store or manage it as a distinct object. Data are defined and stored as part of database tables. Thus, if properly managed, each database table, the logical model of the database, and any other model, such as one that defines a form or report, may constitute a stored record.

Figure 3 presents a generalized model summarizing the analysis of electronic records to this point. It can be applied to traditional, interactive, experiential and dynamic computing environments that produce some type of manifested document, and it can be used as an

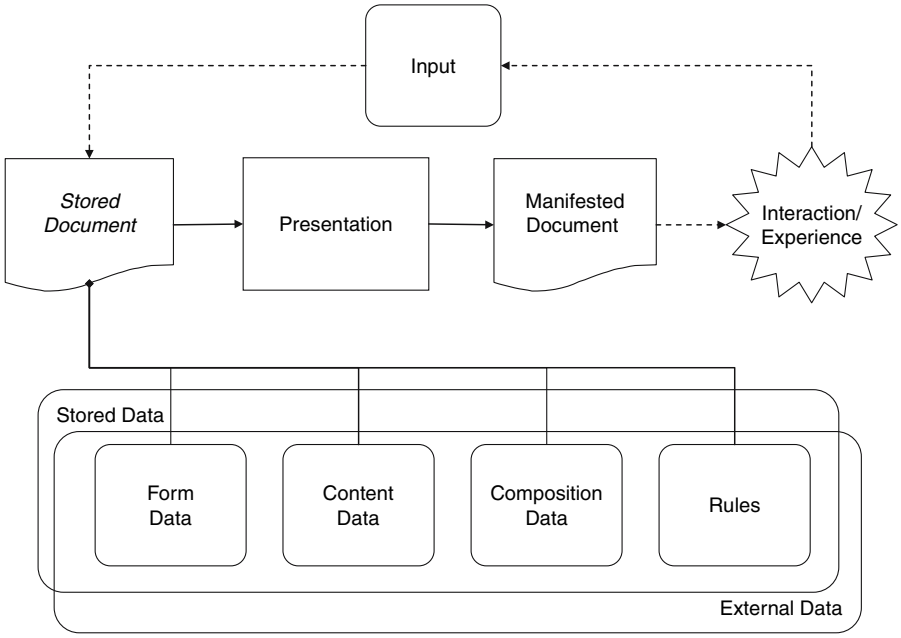

Figure 3. Generic Model of Stored and Manifested Documents.

analytic tool to determine the characteristics and nature of electronic records.[62] The first three figures, reading from the left, in the middle row of Figure 3, depict in very abstract fashion the production of a Manifested Document from a Stored Document, a process common to all these environments. In a system that does not have interactive or experiential features, the final figure in the middle row, Interaction/Experience, would not occur, hence the dotted lines connecting this figure. The Manifested Document may be presented to a person or another system. It is assumed to include all the content that could be manifested, even if only a portion of the content is manifested at one time, as in the case of audio and video recordings and pseudocs. In order for the Manifested Document to be a record it must be possible to reproduce it repeatedly as it appeared the first time. If the environment provides for Input (top row) from a user or interacting system and that input can change the content or form of the Manifested Document, then this document cannot be a record even if other

[62] Such analysis, however, would only be partial. It is also necessary to determine, through additional analysis, whether the requirements related to context, action, persons, archival bond, and intrinsic elements of form are satisfied.

requirements for being a record are satisfied. Regardless of its record nature, though, there may be one or more digitally stored records used to produce the Manifested Document. If the system stores an object that is the internal representation of the Manifested Document, that object may be a stored record. In the case of a static Manifested Document, the Stored Document should contain all of the Content and the Form Data and Rules that determine the extrinsic elements of the form of the Manifested Document. Where there is a one-to-one correspondence between the Stored and Manifested Document, there would be no Composition Data because the Stored Document is already composed. The Stored Document would include provisions for modifying the content and/or form of the Manifested Document, but the Stored Document might still be a record, analogous to the medieval formulary, if it presents all the other necessary characteristics of a record. However, if the Stored Document is itself modifiable as a result of Input or External Data, it cannot be a record. If the system does not store a single representation of the Manifested Document, it is necessary to determine how it composes that document from Form Data, Content Data, Composition Data, and related Rules and whether the digital components which make up those types of data are stored entirely within the system or derived in whole or in part from one or more external sources, in order to identify any stored records.

A record is whatever the creator treats as its record, but that ''whatever'' must be something that the creator can in fact keep, associate with other records, and subsequently recall. There are two different modes in which a record can serve a memorial function. In most cases, the memorial function of a record is retroactive: it is the means through which its creator remembers what was done, happened, or was described or said, and through which others may learn about the past. For example, the record of a performance of an artistic work is retrospective: it enables the audience to remember – or more accurately in most cases to experience – how the artwork was executed in that specific performance. But, there are also records whose principal function is prospective. A musical score or the script for a play may be considered a record of the artist's career or genius. It can be examined for what it reveals of the evolution of the artist's abilities and leanings, of the impact of biographical events on artistic output, etc. However, the driving intent in the creation of the play or piece of music is that it be performed. The script or score serves a prospective function: it is a set of instructions on actions to be carried out afterwards.

The distinction between retrospective and prospective records can help us come to grips with records in interactive, experiential and dynamic environments. *Interactions* between humans and computer systems, *experiences* enabled or mediated by experiential systems, and *processes* which are composed and carried out with at least some degree of spontaneity by dynamic systems are not the residues of action. They are not means of remembering either what was done or what is to be done. In short, they are not records. But, they can be captured in documentary form and some of these documents could be treated and used as records of interactions, experiences, or dynamic processes, that is, they may become records of those activities. In addition, interactions, experiences and processes are enabled by documents within such systems and these documents can serve as prospective records. Both retrospective and prospective documents can be found in all three-focus areas examined by InterPARES 2. In the arts, there are recordings of performances and documents that enable performances. In government, documents created in the execution of governmental transactions can be retrospective records. In science, documentation of the conduct and results of experiments and observations are retrospective. In government, laws, regulations, and directives and, in science, research plans and protocols are created with the primary intention of guiding, controlling, or perhaps prohibiting subsequent actions.[63] In sum, retrospective records capture, while prospective records enable or at least inform interactions, experiences, or dynamic processes.

Within the class of prospective records, there are two subclasses. One simply contains instructions about executing an action or process. The other subclass is actively involved in carrying out the action or process. Examples of ''instructive'' records include musical scores, regulations, manuals of procedures, and instructions for filling out forms. Examples of ''enabling'' records include software patches that enable a musical instrument to interact with a computer, software in online marketing sites that interprets data about a visitor's actions on the site to determine what elements of content should be presented next to that visitor, and software agents that enable interacting business applications to execute transactions autonomously. Although software is not commonly considered a record, rather it is to be

[63] Prospective records still retain the basic function of remembrance: they enable subsequent actions and actors to remember what to do and/or how to do it in accordance with prior decisions.

regarded as a digital component of records, this type of software is created and serves as a record in the specific contexts presented here, as it is generated and used as a means for carrying out the specific activity in which it participates and stands as the instrument, byproduct and residue of that one activity.

In addition to the differences in how they are involved in the actions or processes that they inform or control, there are differences in the way instructive and enabling records are materialized to achieve the purpose for which they are created. Instructive records are intended to be read by humans and, therefore, are materialized by being reproduced from stored digital components into a human readable form. In contrast, enabling records achieve their purpose in the digital form in which they are stored[64] and, conversely, cannot achieve that effect if transformed into human readable format. Moreover, as long as they remain active, enabling records must be maintained in the systems in which they were created – or in systems with identical functionality. Otherwise, they will not produce or enable the interactions, experiences, performances or other processes they were intended to generate.[65]

Keeping Interactive, Experiential, and Dynamic Records

Digitally stored records are kept in order to be able to reproduce manifested records. There are three broad possibilities for keeping stored records: (i) keeping instructive records in the system in which they are generated, together with all the instantiations generated from them, (ii) keeping instructive records in another system, and (iii) keeping enabling records and the record instantiations produced from

[64] Strictly speaking, computer code is not stored in the form in which it controls or shapes processes. It needs to be translated into machine code at the time of execution, but that translation is analogous to the translation of a musical score into signals processed by the human brain during performance of the work.

[65] The situation is reversed when such records become inactive. In order for a human to understand what these records did in their original technological, documentary and administrative contexts, it is necessary to convert them from the form in which they were stored and functioned as records to a form that humans can read; for example, instructions must be converted from the binary form in which they were executable to a textual form. In most cases, this conversion will involve translation from machine language to a humanly readable one.

them in the system in which they are used.[66] Of course, the possibility of keeping records does not entail that records actually are kept. Individual cases need to be examined to determine if and how records are kept.

The first possibility for keeping digitally stored records is to retain them in the interactive, experiential, or dynamic systems in which they are generated. Given that a system has the ability to produce the manifested records in the first place, it could be designed to reproduce them subsequently from stored records. An example of an instructive record kept in an interactive system is that of the script for Waking Dream, which is kept on the website for the work. The Alsace-Moselle Land Registry is an example of a system which is used both to carry out transactions and to keep the records of those transactions.

The possibility of reproducing a record using the same functionality that produced it in the first plase does not exist in cases where some of the content is not stored in the system. In the case of record instantiations, even if the system has the capability to produce the same document in response to the same input over and over again in a reliable way, this does not necessarily mean that the system keeps the document instantiation as a record. This difficulty can be seen in an InterPARES 2 case study in the scientific focus, the CyberCartographic Atlas of Antarctica. D.R.F. Taylor defines cybercartography as ''the organization, presentation, analysis and communication of spatially referenced information on a wide variety of topics of interest and use to society in an interactive, dynamic, multimedia, multimodal and multidisciplinary format.'' The CyberCartographic Atlas of Antarctica incorporates scientific and environmental data into ''an online atlas portraying, exploring and communicating the complexities of the Antarctic continent for education, research and policy purposes.''[67]

[66] The InterPARES 1 report suggested another possibility, that of trading the record characteristics of stability of content and fixity of form (including completeness of content and form with respect to the first and to any subsequent instantiations of the record) with the ability of the system containing it to track and preserve any change to the record. See http://www.interpares.org/book/interpares_book_d_part1.pdf, p.24. In other words, the researchers were inclined to shift the requirements of stability and fixity from the record to the log of the changes to the record once the record was no longer active; in this context, the object identified as the record and to be kept intact would then be the last instantiation of the fluid object, plus the complete log of changes, and the metadata of both. This option is conceptually sound only if the creator uses this set of objects as its record, but this scenario is very unlikely because it would be highly impractical.

[67] Tracey P. Lauriault, Peter Pulsifer and D.R. Fraser Taylor. The Cybercartographic Atlas of Antarctica Project. See http://www.carleton.ca/gcrc/caap.

The Atlas organizes heterogeneous data on physical, biological and human influenced characteristics and their interactions into content modules along thematic lines, and supports a variety of discovery, visualization and access functions. Projected data volumes are large and expected to grow over time. Data values in the Atlas are in stable and basic formats defined to support different presentations appropriate to experts, the general public and policy makers. However, these formats are essentially starting points enabling users to explore and access the contents interactively. The Atlas user can select among a rich and diverse, but still finite set of tools for searching, visualizing, hearing or otherwise accessing heterogeneous data about topics of interest. Hence, the forms in which the data are presented are not immutable but, as with works of performance art, their variability is within parameters established by the author. In principle, every user of the Atlas making the same selection of content and form of presentation would see an identical document; therefore, the Atlas virtually keeps such documents. However, they do not qualify as record instantiations because the system does not retain any data about their production. There is no chronological date, no identification of the addressee, nor any information about the activity in which the document is first produced.

A stored dynamic document, such as one which stores user inputs and uses them in subsequent manifestations or one which processes and presents, but does not store, data from users or from other external sources, might be said to be always in the process of creating, but never completing a manifested record. The manifested document might be a record if the processes which cause it to be forever in progress were terminated, or if it were removed from the dynamic environment and kept in some frozen form. However, the final state of a document somehow isolated from or rendered immune to dynamic processes would be static. But producing a static document in either way would amount to creating a different document. It might serve as a record *of* the dynamic process or its state at the moment it was frozen, but it would not be able to serve the dynamic purpose of producing variable output in response to a variety of different inputs or stimuli. In some cases, the stored dynamic document might be kept as a record, but that would not be possible in the case of documents covered by class 2.2.4 of Table I.

The difficulty of keeping dynamic documents as records is found in the VanMap case study. VanMap does not keep records, but could be modified to do so. As long as data are overwritten by updates, their aggregation as it appears at any given time will never reach the state of

a document, let alone a record. The combination of data layers, sets of data, and set of instructions which produce displays used in any business process can be described as an enabling document of that process. The system may preserve these documents for some time: it could reproduce the information used in a particular action, in the same form and with the same content as when the action was carried out, but only as long as there is no modification of either the data or the instructions which control the form of display. It should be possible to modify the design and operation of VanMap either to output records or store a stratification of the data variations over time.

Being able to keep records in the system used to carry out transactions is a necessity in cases where the transactions involve multiple successive steps and where the interacting systems support multiple transactions in which records of earlier transactions are needed in subsequent ones. An interacting system could not proceed to the next step or the next transaction if it did not contain records of the previous step or transaction.[68] That is not to say that the system must be able to reproduce the records using the same functionality that it used to produce them in the first place. The system could be designed to include a record keeping subsystem in addition to the subsystem or module used to produce the records.

The second possibility for keeping records generated in interactive, experiential, or dynamic systems is to retain them in a system specifically designed for record keeping. This could be achieved either by taking them out of the original system and retaining them in another system suitable for record keeping, or by adding record keeping functionality to the original system. Given that record instantiations and instructive records are outputs of such systems, they could be kept in some appropriate digital format as either static records or records with bounded variability. As that the InterPARES 2 project has examined interactive, experiential and dynamic systems, but not record keeping systems, there are no case studies of separate systems for keeping electronic records. The VanMap system does output record instantiations to other systems, but they are hard copy outputs.

Keeping electronic records in a separate system or subsystem designed specifically for this purpose is necessary in any case where the

[68] It might be argued that such a system does not necessarily need to maintain records of earlier steps in a process or earlier transactions, but that it would suffice if the system kept the data about those steps or transactions. However, if such a system does not demonstrably satisfy requirements for keeping records, it should not be relied upon to carry out business over time.

system which produces the records does not have the capability to reproduce the manifested records reliably using the original functionality which produced them. But a document set aside and kept as a record in this way may have some differences in both content and form compared to the original output. This record would not be identical to the actual system product, precisely because it has lost whatever interactive, experiential or dynamic properties the product had. However, one should consider that all records are substitutes: they stand for or take the place of acts or facts. The ability to reproduce what the system presented in a particular instance, without the interactive, experiential, or dynamic attributes of the environment in which it was produced, may be sufficient for some record keeping needs.

One method of keeping records in this way would be to take a snapshot or otherwise freeze a presentation by a dynamic, experiential, or interactive system. This is done, for example, with a static audio recording of a performance of music or audio/visual recording of other performance art. In such cases, the static record would represent, but not identically repeat the original performance.

Static, durable objects may in fact be necessary to satisfy the creator's needs for records. An example of an interactive system which creates static records as it interacts with users to meet the creator's record keeping needs is that of an online sales application which accumulates the data it needs to produce purchase orders from user selections and inputs. Another example might be a dynamic system used to execute a manufacturing process. It may record the variations – including both different values of data and different processes executed – which occur in each instance of execution, and output that information in a report. In these examples, the static records are records of transactions the system is designed to support. Given that the CyberCartographic Atlas of Antarctica is designed to provide information rather than to support transaction of business, any document output from the Atlas cannot be a record with respect to the system, but it could subsequently be used by the recipient in its own business. A user could create a record by collecting and acquiring content elements which could be exported from the Atlas to the user's environment or, if applicable, printed.

A single system may employ both possibilities for keeping records described thus far, regardless of whether it supports interactions with other systems or with human users. For example, while a system executing transactions through interactions with other systems will retain copies of the sent documents as records, and set aside received documents as records, thereby ensuring that all records are in the system in which they are created, the Alsace-Moselle Land Registry makes use of both

the first two possibilities for keeping records. It reproduces records of active entries using the same XML and database capabilities used to create new real property entries, and it has been extended to keep and retrieve the scanned image records of inactive entries.

The third possibility for keeping electronic records applies to enabling records. Given that such records are instrumental in achieving the outcomes or producing the outputs intended by a system or application, it is likely that an enabling record will be maintained in the system for as long as the system itself is maintained.

As a whole, the CyberCartographic Atlas can be described as an interactive and experiential enabling record of the Geomatics and Cartographic Research Centre at Carleton University, made in the course of a research project funded by the Social Sciences and Humanities Research Council of Canada, that shares an archival bond with the project's administrative records.

However, interactive, experiential, or dynamic systems do not necessarily contain enabling records. In dynamic systems, even in cases where it is possible to identify a set of digital components which might appear to be an enabling record, if the system has the capability of adapting its software autonomously, the object comprising those digital components will not satisfy the basic requirements of fixed content and form. In such cases, there is no way to recall what was the process which produced a given outcome or output. Thus, the system in question needs to be modified.

In VanMap, objects that exist in the system might be maintained to provide records reflecting the situation observed by the decision makers at any given time. Following well established database management methods, a history file of the data in the system could be created and set aside before any update, along with a detailed description of each business process in which VanMap is involved and of the way in which VanMap is used in each of them, in addition to the instructions used to create the records supporting each type of transaction. The description would reveal the archival bond between the records of each business process and VanMap and the instructions would reveal the specific relationship between each process and the data which supported it. This approach would follow a centuries-long tradition of embedding in a code of administrative procedure the function of a record that serves multiple activities and procedures, but of which only one original exists (see for example the series of the maps of the cadastre, which were and are used as records in several procedures having different purposes). However, as currently designed and operated, VanMap does not preserve records of any business transactions.

A fixed form and a stable content are only two of the characteristics that an electronic entity must present in order to be considered a record. Entities that are records must also have explicit linkages to other records, an identifiable administrative context; an author, an addressee, and a writer; and an action, in which the record participates or which the record supports either procedurally or as part of the decision making process. But, this an area of analysis and discussion for another article.

Conclusion

The InterPARES project has examined a panoply of topics concerning the preservation of authentic records in electronic systems. Among these topics are the characteristics of electronic records. Applying and testing traditional concepts drawn from diplomatics and archival science to a considerable number of case studies, the project has studied how records in electronic systems – when they exist – resemble and differ from traditional records in hard copy. In the first phase of the project, the case studies focused on the digital counterpart of traditional records. The most salient empirical characteristics of such records are that their digital encoding does not manifest the documentary form of the record and that, therefore, they are not preserved as physical objects, but as one or more bit streams that must be correctly processed by computers to be rendered in the proper documentary form. In its second phase, InterPARES is examining interactive, experiential and dynamic systems that do not necessarily produce or keep anything that corresponds to traditional records.

The analysis of interactive, experiential and dynamic systems requires clear distinctions among the systems themselves, the interactions, experiences, performances and other outputs, and the objects generated and/or kept in them. In many cases, interactive, experiential and dynamic systems produce objects that have the appearance of documents, but, after their first manifestation, cannot be re-produced with the same content and in the same form. Given the essential memorial function of a record – a record is a residue of activity retained by its creator for reference or use in later activity – such cases appear to fail the basic requirement of a fixed form and stable content.

However, cases discussed in this article show that interactive, experiential and dynamic systems can produce documents capable of being kept as records. Furthermore, a closer examination of these systems shows that they may contain documents which exhibit some

variability in form and content, but, because their variability is appropriately bounded, can be considered records, as when the variability is due to technology rather than to the intention of the author or writer of the document. In addition, authors or writers can generate digital records that embed intentional variability. This includes the construction of documentary forms that enable users to select subsets of content and control both the sequencing and presentation features, such as image magnification.

There are also cases, most notably in the arts, but also in government and science, where interactive, experiential and dynamic systems contain documents whose presentation or rendering always shows some unique or spontaneous variation in content or form. In such cases, one must distinguish between what is output by the system and the document(s) that enable the system to produce its output. Such documents are 'enabling:' they enable the interactions, experiences or processes the system executes. Provided they are properly maintained and managed as intellectually interrelated parts of records aggregations, enabling documents can be considered records. On first encounter, this conclusion seems to contradict the finding of InterPARES 1 that an electronic record is not something kept in a system, but something reproduced by processing data objects stored in the system, but, as demonstrated, this conclusion broadens, rather than contradicts, the finding of InterPARES 1.

Of course, defining the concept of record in the context of interactive, experiential and dynamic systems is a very tall order, primarily because it depends on the perspective (i.e., whether one looks at the digital entities from the point of view of the author/writer, the user, the creator, or the preserver) and on the particular level of abstraction in question (i.e., whether at the entire-object-as-record level, on down to the individual-object-interactions-as-record level). However, the purpose of this article was to present the work done by InterPARES in this respect and to initiate a theoretical discussion. In spite of its length, this article is only a beginning of that discussion. The concept of a record here articulated needs to be tested in other environments. The practical possibilities of preserving such records needs to be explored, notably in the context of the major contributions to digital preservation outside of the InterPARES project, such as the OAIS model, the CEDARS and the CAMiLEON[69] projects, the METS standard,[70] and PREMIS metadata. There is an undoubted

[69] See http://www.si.umich.edu/CAMILEON/.

[70] See: http://www.loc.gov/standards/mets/.

need to explore the great practical implications and legal consequences for all the parties directly involved, and all the stakeholders. It is the hope of these authors that such discussion will continue well beyond the conclusion of the InterPARES project.

Appendix

Appendix: Glossary of Key Terms

Term	Definition
Composition data	One of the three types of stored digital data used to produce or reproduce a digital document, they tell the system what form and content data belong to which document.
Content data	One of the three types of stored digital data used to produce or reproduce a digital document, they constitute the content of a document.
Digital component	A bit stream that is necessary to reproduce the document. It may comprise composition, content or form data, or some combination of such data.
Form data	One of the three types of stored digital data used to produce or reproduce a digital document, they enable the system to reproduce the document in correct form.
Manifested record	The visualization or materialization of the record that is produced from the stored digital component(s) in a form suitable for presentation to a person or another system.
Presentation features	A set of perceivable features (graphic, aural, visual) generated by means of encoding and program instructions, and capable, when used individually or in combination, to present a message to our senses.
Stored record	A digitally encoded object which is managed as a record.