Archival Science **1:** 39–55, 2001.

The impact of digital technology on archival science[1]

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Abstract. Archival science is to be regarded as a system. The properties of that system can be investigated and integrated. The methodology to do so has been tested in two research projects which are presented in this article as examples of the way in which the view of archival science as a system supports the development of new knowledge and as a demonstration of the stability of archival theory.

Keywords: archival science, diplomatics, electronic records, paradigm shift, system theory

Archival science comprises the ideas about the nature of archival material (i.e., archival theory) and the principles and methods for the control and preservation of such material (i.e., archival methodology). The analysis of archival ideas, principles and methods, the history of the way they have been applied over time (i.e., of archival practice), and the literary criticism of both archival analysis and history (i.e., archival scholarship) are also integral part of archival science. Thus, archival science can be defined as a system inclusive of theory, methodology, practice, and scholarship, which owes its integrity to its logical cohesion and to the existence of a clear purpose that rules it from the outside, determining the boundaries in which the system is designed to operate.

If we regard archival science as an organic and unitary system, we have to accept that we are dealing with a special type of discipline. A discipline encompasses the rules of procedure that discipline the search of the scholar and the knowledge so acquired. In the case of the system of archival science, however, the rules that guide the investigation of archival scholars into issues, problems or concepts are determined by archival theory and methods. This is especially noticeable when archival research aiming to develop methods,

[1] This article presupposes that the archival discipline is also a "science." Many have argued against the idea on the basis of a common perception that a science is a type of study entirely objective by virtue of the rigorous manner in which it is carried out and the restricted range of topics to which it applies. In fact, the activity of science is based upon a complex framework of assumptions that make it possible for the landscape of the scientific endeavour to be redrawn over time, and, while striving towards objectivity, considers it to be an unattainable ideal.

strategies and/or standards for the treatment of new types of material looks for a starting point, or fundamental terms of reference. In order to clarify these statements, it is first necessary to explain briefly the concept of system.

A system is any complex of interrelated parts that function in coordination towards a single effect. The essential characteristic of a system is its structure, which organizes the interactive parts and the processes enacted by them in context. The study of the structure of contextual wholes requires that analysis be followed by synthesis, simply because the notion at the heart of a system is that of organized complexity:

> The general model of organized complexity is that there exists a hierarchy of levels of organization, each more complex than the one below, a level being characterized by emergent properties, which do not exist at the lower level. Indeed, more than the fact that they "do not exist" at the lower level, emergent properties are meaningless in the language appropriate to the lower level.[2]

Besides properties that belong to certain levels within a system, there are also properties that characterize the system as a whole and do not exist other than at the level of the whole. Consequently the parts cannot be separated from the whole without deeply affecting their nature, precisely because the principles of synthesis governing the organization of parts within the context of the whole are not trivial.

The key properties of systems are:

- Systems behave as wholes. Thus, changes in any part of the system constitute a change in the system as a whole.
- Systems are more than the sum of their parts as they encompass the relationships among the parts and the processes enacted by them.
- Systems must be construed within their own context that determines the purpose of their existence.
- Over time systems move from a state of uniformity to a state of segregation and differentiation where the parts become fixed with respect to their function and operate with increasing independence from the other parts: this is indicative of increasing complexity.
- Progressive segregation leads to progressive centralization, which in turn is associated with indivisibility.
- Systems are frequently composed of sub-systems hierarchically ordered: at each level the general properties of the system will hold.

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[2] Ludwig von Bertalanffy, *General System Theory: Foundation, Development, Applications*, rev. ed. (New York: George Brazillier, Inc., 1968), p. 75.

- Systems are distinguished in open and closed systems. Closed systems do not import or export material while open systems do both.[3]
- Systems are inherently dynamic and operate in terms of process.
- A key process present in every system is that of the feedback loop, which is "a circular arrangement of causally connected elements, in which an initial cause propagates around the links of the loop, so that each element has an effect on the next, until the last "feeds back" the effect of the first elements of the cycle. . . . The consequence of this arrangement is that the first link (input) is affected by the last (output), which results in self-regulation of the entire system, as the initial effect is modified each time it travels around the cycle."[4]

To see archival science as a system requires identifying in it the three basic systems characteristics, that is, parts, structure and processes, and describe their relationships.[5] As mentioned earlier, the parts are theory, methodology, practice and scholarship, each of which is on turn comprised of parts. The structure is a hierarchical one, where each level descends from and depends on the previous one, with theory being the determinant and cohesive element. The process most relevant to us, that of feedback, is one by which new hypotheses, ideas, findings or realities are brought into the system, confronted with the theory ruling the system from the inside and with the purpose guiding it from the outside, and absorbed and integrated within the system, renewing and enriching it.

The view of archival science as such a system allows us to confront what has been defined by the archival profession as a "paradigm shift." This expression refers to a new way of thinking about the same things, which occurs when new observations that cannot be explained in the terms of the old framework begin to put into question its validity. The first archival thinker who referred to a paradigm shift in archives was Hugh Taylor, who, in 1987, linked it to technological change and the creation of records in electronic form.[6] A few years later, in 1993, Heather MacNeil resumed the discussion initiated by Hugh Taylor, and related the concept of paradigm shift as it affected the ideas we held about the nature of records to the theory of dissipative structures, and in the process alluded to archives as systems. She wrote:

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[3] Ibid., 66–79.

[4] Fritiof Capra, *The Web of Life* (New York: Anchor Books, Doubleday, 1996), p. 42.

[5] For this entire discussion of systems I am indebted to Diane Rogers, *Archives as Systems* (MAS thesis, University of British Columbia, 2000).

[6] Hugh Taylor discussed the concept of paradigm shift in archives in the keynote address entitled "Transformation in the Archives: Technological Adjustment or Paradigm Shift?" delivered in 1987 at the Association of Canadian Archivists annual meeting.

> Prigogine's scientific theory of dissipative structures suggests that perturbation and conflict are essential in pushing systems up into a higher order because the resultant instability increases the number of novel interactions within the system, brings elements of old patterns into contact with new patterns, and makes new connections. Eventually, the parts of the system reorganize into a new whole and the system escapes into a higher order. . . . The theory of dissipative structures describes, in short, the nature of a paradigm shift. . . . In our own small paradigm shift, our understanding of archives is shifting from a physical to a contextual paradigm. Although that shift is bringing with it an increased sense of purpose, it is also creating some uncertainty and instability as old truths are challenged and new ones resisted.[7]

In the context of MacNeil's observations, the view of archival science as a system more specifically allows us to deal effectively with the continuing change brought into the archival world by the use of ever new technologies for records' creation and storage. If, in a paradigm shift, we bring into the system a view of records based on the purpose of their creation and linked to business processes, and if we let this view guide us in the identification of the components of the records and their function, we can make comparisons with the traditional view of the records as integrated indivisible physical units deriving their meaning from a documentary context physically manifested. This comparative analysis would use the whole of the archival knowledge accumulated through the centuries, and, as a result of the new connections and of the feedback process, old archival ideas would broaden and develop into new ideas rooted in the past and consistent with the old ideas. A synthesis of the new findings and their integration among the elements of the archival system that have remained stable would ensure that all archival activities aimed at controlling the records generated by digital systems would continue to be framed within a unified structure governed by an overarching theory, and would be carried out according to standards applicable to all records types.

This methodology of investigation, discovery and integration of new archival realities within the archival system has been tested in the course of two research projects that are presented here as examples of the way in which the view of archival science as a system supports the development of new knowledge consistent with the existing one. These examples also demonstrate the stability of archival theory as the cohesive element holding the system together, and the strength of its rigor, which allows the system to absorb any number of paradigm shifts as long as the purpose ruling it

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[7] Heather MacNeil, "Archival Theory and Practice: Between Two Paradigms," *Archivaria* 37 (Spring 1994): 17.

from outside – the reason, that is, why records are generated and preserved – remains unchanged.

The first research project is entitled "The Preservation of the Integrity of Electronic Records." It was undertaken between 1994 and 1997 by archival researchers at the University of British Columbia (UBC), in collaboration with the Department of Defense (DoD) of the United States. The goal of the research project was to identify and define conceptually the nature and components of an electronic record and the conditions necessary to ensure its integrity, that is, its reliability and authenticity. In order to investigate and discover the new reality presented by electronic records, the research team decided to confront it with the fundamental concepts of archival theory. Thus, it proceeded to analyze the nature and components of electronic records on the basis of the integration of the concepts and principles of diplomatics with those of archival science that has occurred in the past century.[8]

The primary contribution of diplomatics to the understanding of electronic records consists of its identification of the attributes of a record, based on theoretical ideas that have evolved over centuries of detailed study of the documentary process. By decontextualizing and universalizing those attributes, the original diplomatists were able to recognize and evaluate records created over several centuries and across different juridical systems. On the basis of this understanding, the research team hypothesized that diplomatics would have been capable of guiding the recognition and identification of records generated within many different hardware and software environments. Archival theory contributed to the understanding of electronic records its ideas about aggregations of records and their documentary and functional relationships.

For the purposes of the project, the research team adopted the classic archival theory definition of record, according to which a *record* is any document created, meaning made or received, and set aside, either for action or reference, by a physical or juridical person in the course of practical activity as an instrument and by-product of it. An *electronic* record was defined as a record created in electronic form. The research team was thus able to distinguish the entity *record* from other entities typically found in electronic information systems, i.e., documents, information, and data.[9]

Defining an electronic record was a necessary first step in characterizing it as a distinct species of recorded information. The next step was to identify

[8] Luciana Duranti and Heather MacNeil, "The Protection of the Integrity of Electronic Records: An Overview of the UBC-MAS Research Project," *Archivaria* 42 (1996): 46–67.

[9] Data were defined as the smallest indivisible facts. Information was defined as intelligence given, or a message meant for communication. Document was defined as recorded information. Accordingly, records are a special kind of documents: all records are documents, and contain therefore information and data, but not all documents are records.

and define the necessary and sufficient components of an electronic record so that the entities record and electronic record could be compared and assessed. The result of such comparison would indicate whether the theory ruling the archival system from inside could be readily applied to the new entity or needed to be revisited and adapted. In either case, the identification and definition of the components of an electronic records would serve archival practice by allowing for an electronic record to be recognized and captured as such by an electronic information system. The research team found that an electronic record, like its traditional counterpart, comprised eight components:

- *medium* (the physical carrier of the message)
- *content* (the message the record is intended to convey)
- *physical and intellectual form* (the rules of representation that allow for the communication of the message)
- *action* (the exercise of will that originates the record)
- *four persons* (the entities transacting business by means of the record: author, addressee, writer, creator)
- *archival bond* (the relationship that links each record to the previous and subsequent one); and
- *context* (the juridical, administrative, procedural, and documentary framework in which the record is created)

Once the components of an electronic record had been identified and found consistent with the components of any record, the research team turned its attention to determining the methods necessary to ensure its reliability and authenticity. To this purpose, it adopted the concepts developed in the context of early Roman jurisprudence, and later absorbed into diplomatic theory and archival science. Thus, *reliability* was defined as the ability of a record to stand for the facts it is about (i.e., the trustworthiness of the record as to content). *Authenticity* was defined as the characteristic of a record that is what it purports to be and has not been tampered with or otherwise corrupted since its creation (i.e., the trustworthiness of the record as a record).

Reliability was found to depend upon two factors: the degree of completeness of the record's form and the degree of control exercised over its procedure of creation. The completeness of the form of the record refers to the fact that the record possesses all the elements of intellectual form necessary for it to be capable of generating consequences. Traditionally, no record is considered complete if its intellectual form does not contain the *date*, which expresses the relationship between the record and its author, and the *signature*, which assigns responsibility for the record and its content.

With electronic records, the date given to the record by its author does not make it complete: the date and time of transmission to either an external or internal addressee, or the date and time of transmission to the dossier or class to which the record belongs are also necessary. Moreover, because a handwritten or typewritten signature can be attached to an electronic record by anyone, the function of the signature in an electronic environment is accomplished by the name contained either in the header of electronic mail messages, or in the profile of other record types, or by electronic signatures. One has to distinguish a generic electronic signature from the digital signatures, the latter being an attachment to the record with the nature and function of a seal.

The date and signature constitute necessary, but not sufficient, elements of a complete electronic record. The research team determined that for a record to be capable of generating consequences it should possess all the following elements of intellectual form: *date* (time and place of creation, transmission, and receipt), *indication of persons* (author, addressee, originator, writer, creator), *indication of action* or matter (title or subject), *classification code*, and any other element required by the creator's procedures or juridical system. Does this constitute a fundamental difference between a traditional record and an electronic record capable of affecting the basic concept of record? It does not, because the elements that need to be explicit in an electronic record exist implicitly in every traditional record. For example, the classification code in an electronic record is only a means of making explicit the archival bond between a record and the previous and subsequent one within the same archival aggregation. With traditional records, the archival bond is made evident by the physical position of a record in the aggregation of records in which it belongs.

Reliability is also established in relation to a record's procedure of creation, which refers to the body of rules governing the making, receiving and setting aside of records. Some of these rules determine who is competent for compiling, modifying, or annotating records; others refer to how records will be handled in the course of their compilation; and others still refer to how records will be routed and filed. The more rigorous and detailed the rules, the more established the routine, the more reliable the records will be. The research team identified a number of methods in electronic systems for ensuring the respect of such rules.[10] None of these methods were

[10] Among them were (1) embedding access privileges, that is, assigning to each person who has access to the electronic system, on the basis of his or her specific competence, the authority to compile, classify, annotate, read, retrieve, transfer, or destroy only specific groups of records; (2) embedding in the system "workflow rules" according to which the system will present only the person competent for each action with the related records and will solicit the making of the appropriate record at the proper time in the automatic development of the

found in contrast with the traditional methodology of record creation and control that derives from the theory of the record. In a way, they represent a different manifestation of the same ideas on how to treat records to ensure the trustworthiness of their content.

Reliability and the methods for ensuring it are linked exclusively to record creation. Authenticity is instead linked to the record's mode, form and state of transmission, and to the manner of its preservation and custody. It is protected through the adoption of methods that ensure that the record is not manipulated, altered, or otherwise falsified after its creation. It follows that an authentic electronic record is one the identity and integrity of which can be verified, that is, a record whose provenance and authorship are known at every time, and for which the security and state of transmission can be ascertained, and the method of preservation accounted for.

Methods of ensuring the security of an electronic record's transmission include maintaining an audit trail of every transmission, encrypting records, and establishing the state of transmission of each record, i.e., its status as a draft, original, or copy – again different manifestations of the same methodological ideas. Generally speaking, the research team found that ensuring the authenticity of electronic records by the manner of their preservation and custody requires nothing different from what was required to guarantee the authenticity of traditional records, that is, the preservation of semi-active records in a climactically suitable and physically secure environment, self-authenticating and well-documented procedures for reproduction and migration, and an uninterrupted line of physical custody.

The main difference between electronic and non-electronic records is that non-electronic records are kept authentic by maintaining them in the same form and state of transmission in which they were when made or received and set aside, while electronic records are kept authentic by continuous refreshing and periodic migration. This is because idiosyncratic software systems generate, manage, and store digital information using technologies and media subject to the dynamism of the computer industry. This digital information gets lost in a self-perpetuating and expensive cycle of obsolescence and incompatibility. As a result of media fragility and technological obsolescence, the term preservation as applied to electronic records no longer refers to the protection of the medium of the records, but to that of their meaning and trustworthiness as records.

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procedure; (3) limiting physical access to the technology or to parts of it by means of magnetic cards, passwords, finger prints, etc.; (4) designing within the electronic system an "audit trail", so that any access to the system can be documented as it occurs, whether it is a modification made to a record, a deletion, an addition or a simple viewing of a record.

Refreshing and migration have different consequences for a record's authenticity. Refreshing generates a complete reproduction of both the content and the formal elements of the records, therefore, the resulting records may be considered faithful copies of the original ones. Migration, on the contrary, generates a reproduction of the content of the record, with changes in configuration and format, often having a ripple effect on other elements of the record. Thus, migration always involves some measure of loss. These are not new concepts. Refreshed records are what diplomatists have traditionally called "imitative copies," whereas migrated records correspond to "vidimus" or "inspeximus," simple transcripts of records preceded by a declaration of conformity of the record to the original. Other examples of migrated records are photographs or microfilms of paper records. Migration has always involved loss of information and the amount of acceptable loss used to be quite clearly defined by type of record.[11]

However, in the majority of the cases, with traditional records, refreshing or migration did not imply the destruction of the original and the trustworthiness of the copies could be verified by comparison with the original and, often, with previous copies of the same records. With electronic records, the originals only last for as long as they are accessible by the current technology. What survives and is brought forward is a copy of the electronic records. Thus, the efforts aimed at the preservation of electronic records must be directed to the production of "authentic copies" of records that, when first reproduced, could be and were proven authentic. These efforts should respect the fundamental principle governing the authenticity of records since antiquity: if the records are still needed by the record creator for the usual and ordinary conduct of its business, the continuing reliance of the creator on them authenticates them. By extension, the reliance of the creator on the products of a migration process internally conducted and/or controlled would authenticate them. However, once the records are no longer needed by the records creator to conduct its business, the migration process will need to be carried out by a neutral party and its products verified and authenticated:

[11] According to traditional methods, there are elements of the record that can be lost without compromising its substance and the ability to verify its authenticity overtime, and others the loss of which would be equivalent to the loss of the record. These elements, as already pointed out, vary from a type of record to another. For example, color is a meaningful part of the message in a map or a chart, columns in a table, highlight in a hypertext, etc. This accumulated knowledge is not readily applicable to electronic records. Thus, it is essential, first, to identify for each type of electronic record the components that allow to verify its authenticity over time; second, to assess whether those that are not visible to the user can be made visible by adding them to the presentation features of the record; third, to determine whether, in the cases in which this operation were not doable, it would be possible and advisable to move the records in question to a non-digital form (e.g., microfilm).

the resulting records would thus become authentic copies of the obsolescent records.

The research team's analysis resulted in four major findings concerning the best methods for ensuring the reliability and authenticity of electronic records.

The first finding was that the reliability and authenticity of electronic records are best ensured by embedding procedural rules in an agency-wide records system and by integrating business and documentary procedures. The *records system*, as defined for the purposes of the project, comprises the creator's records, along with the procedural rules of its recordkeeping and record-preservation systems. Both systems are controlled by the creator's records management function. The rules of the recordkeeping and record-preservation system establish agency-wide control over the creation, handling and preservation of both electronic and non-electronic records. The integration of business procedures with documentary procedures strengthens this control, thereby enhancing reliability, by embedding it within specific business processes.

The second finding was that the reliability and authenticity of electronic records are best ensured by instituting procedures that tighten the archival bond, such as classification, registration, and profiling. The archival bond, that is, the relationship that links each record to the previous and subsequent one and to all those which participate in the same activity is an essential component of the record, in keeping with our understanding that records are necessarily composed of documents and the complex of their relationships.

While the need for classification and registration is self-explanatory, the identification of the need to create a record profile for each electronic record that is set aside is based on the research team's discovery that what distinguishes electronic records from their traditional counterparts is not their components, which remain the same, but the fact that the record's elements through which they are manifested are not inextricably joined to one another, as in traditional records. They exist separately as metadata, and can be managed separately, unless they are consciously tied together for the purpose of creating and maintaining reliable and authentic records. The record profile, therefore, is the means by which all the elements expressing the components of the record are brought together.

The third finding is that the reliability and authenticity of electronic records is best preserved if the management of the electronic and non-electronic components of the records system is integrated. This integration reinforces the archival bond between records and completes their documentary context. Integration is accomplished by instituting procedures for creating an electronic record profile for every non-electronic record that is

consigned to the central records system as well as for every electronic record that is set aside, and by establishing a repository of those record profiles. The idea behind the electronic repository is to allow users of the records system a complete view of all the profiles of the records belonging to the same dossier or class, regardless of their media.

The research team's final finding concerns the best means of protecting the authenticity of inactive electronic records. Strictly speaking, this issue did not fall within the scope of the research project. However, on the basis of its analysis, the research team drew the preliminary conclusion that the integrity of electronic records is likely best preserved over the long term by entrusting the creating body with primary responsibility for their reliability and authenticity while they are needed for business purposes, and a separate preserving body with responsibility for their authenticity over the long term. The conclusion was based on the team's belief that the custody of inactive electronic records by a trusted recordkeeper is a necessary precondition for safeguarding their authenticity in general and the integrity of the authentication procedures in particular. Such body would be an autonomous office within an agency (if it maintains its own historical records, as is usually the case with private bodies); or an external body (if records are routinely transferred to a central archival depository, as is usually the case with public bodies).

Thus, an assessment of the findings of the first research project on electronic records can only conclude that, as a result of the feedback process, archival science as a system was enriched by the broadening of concepts and the development of methods that are intrinsically consistent with archival theory and methodology as they were developed for traditional records. This enrichment did not alter the system in any way, every theoretical and methodological idea being preserved in its integrity and in its cohesive relationship with all the other entities in the system, in the context of the same structure. Such preservation of a dynamically coherent and cohesive system is of course due in large part to the already stated assumption that the purpose ruling the archival system from the outside is still the same, notwithstanding the advent of a new technology that has changed the way of working of the office. In other words, the constructs of archival science still derive from the need of records creators to carry out their business by means of records they can trust and from the need of society to preserve such records to maintain, protect and perpetuate itself. All the ideas and activities involved in fulfilling such needs are controlled by the juridical system in the context of which they occur and must therefore be consistent with it.

The second research project on electronic records is based on the same assumption. The International Research on Permanent Authentic Records in Electronic Systems (InterPARES) aims to formulate principles and criteria

for the development of international, national and organizational policies, strategies, and standards for the long-term preservation of authentic electronic records.[12] It is directed by this author and carried out by national and multinational research teams from various countries, including among others Canada, the United States, England, Ireland, Sweden, The Netherlands, France, Portugal, Italy, Australia, Hong Kong, and China.[13] A global industry team includes multinational companies in the pharmaceutical, biochemical, health and computer fields.

The research project is divided in four domains. The first domain aims to identify the requirements for preserving authentic electronic records. The second domain aims to establish whether, in order to satisfy the requirements for authenticity identified in domain one, the selection criteria and methods for electronic records need to be revised or even radically changed. The third domain aims to develop methods, procedures and rules for the preservation of electronic records according to the requirements identified in domain one, and to define the responsibilities for implementing them. The fourth domain aims to develop a framework for the formulation of strategies, policies and standards.

The basic concepts that constitute the theoretical framework of the project are those adopted and/or developed in the course of the previous project on the preservation of the integrity of electronic records while they are still necessary to the creator for carrying out its business. They are the concepts of authenticity and reliability and the concepts of record and electronic record, as defined earlier. Each of these concepts subsume many other concepts, such as those related to the components of a record (e.g., the concepts of documentary form, author, addressee, writer, action, procedure, context, archival bond, etc.).

One significant change was the abandonment of the terms "physical form" and "intellectual form" in favour of a return to the original diplomatic terms "extrinsic elements of form" and "intrinsic elements of form." This derived by the practical difficulty of distinguishing in an electronic entity what is

[12] The direction of the research and its infrastructure are funded by the Social Sciences and Humanities Research Council of Canada (SSHRCC), and by the Hampton Fund of the University of British Columbia (UBC) and the UBC Vice President Research Fund and Dean of Arts Fund. The national and multinational research teams are funded by national granting agencies and institutional and organizational contributions. For example, the Canadian team is funded by SSHRCC and the American team by the National Historical Publication and Records Commission (NHPRC). See the project web site http://www.interpares.org/.

[13] The national teams are the Canadian, American, Australian and Italian research teams. The multinational teams are the European, Asian and Global Industry research teams. In the course of this first year of the research, multinational teams are still open to the participation of additional members. For example, the Asian team may be joined by Japan and Korea.

physical from what is intellectual. The conceptual definition of the traditional terms was found easier to associate with electronic entities and to use. Another change was to consider the "annotations" to the records a separate part of its form, rather than extrinsic elements, as in traditional diplomatics, or intrinsic elements, as in modern archival diplomatics.[14]

The research team found necessary also to define the concept of authentication, which is often confused with that of authenticity by legislators and decision makers. Although that of authentication is not a concept of archival theory, it is important that it be brought into it, as increasingly the need for it affects the records' creation, maintenance and preservation requirements and processes. European archival science has traditionally absorbed fundamental concepts from jurisprudence, thus consistence between the legal concept of authentication and the other concepts of archival theory was to be expected.[15] Thus, it was established that, while authenticity is a quality of the record, authentication is only a means of proving that a record is what it purports to be at a given moment in time. *Authentication*, in other words, is a *declaration of authenticity in time resulting either by the insertion or the addition of an element or a statement to a record*, and the rules governing it are established by legislation. The requirements for the continuing verifiable authenticity of records go much beyond legislated means of authentication and juridical principles and structures; they derive from the historical stratification of traditions, uses, attitudes, and perceptions that each culture brings to bear on what it treats as an authentic record. This is the reason why contextualization of the requirements identified for the authenticity of electronic records is essential to the success of the research project.

The research methodologies used are as varied as the disciplines involved in the research, which range from archival science to computer engineering to music theory. Surveys, case studies, diplomatic analysis, and modeling are some of them. Diplomatics is especially useful for identifying commonalities between and among types of records and records systems where they are not readily apparent, and for developing standards. Modeling methodology is used to represent graphically the activities involved in each hypothesis and their relationships, and the entities involved in each activity and their attributes. To support the modeling process, every activity, entity, attribute,

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[14] "Archival diplomatics" is a term used in the Master of Archival Studies program at the University of British Columbia to refer to a diplomatics that is integrated with the theory and the methods of archival science, but the focus of which is still the individual record.

[15] See Elio Lodolini, *Lineamenti di Storia dell'Archivistica Italiana* (Roma: La Nuova Italia Scientifica, 1991), p. 44.

and relationship named in the models are consistently and rigorously defined in an interdisciplinary international glossary.

The first product of the research conducted within the first domain is an electronic records typology with conceptual requirements for authenticity for each record type which are additional to baseline requirements. To populate the electronic records typology, the researchers perform an analysis of the empirical data gathered during case studies of electronic systems containing or having the potential for containing records. The primary instrument used to analyze case study data is the *Template For Analysis*, created using the diplomatic elements of electronic records identified in the findings of the already discussed previous research project. The template elements were then refined and expanded by utilizing the InterPARES International Team's combined interdisciplinary knowledge and experience with types of electronic records and electronic systems. To further refine the template as well as to construct the electronic records typology, a form of grounded theory is being used. Grounded theory is a method for discovering concepts and hypotheses and developing theory directly from the data under observation.[16] Cases are selected for study "according to their potential for helping to expand on or refine the concepts or theory that have already been developed. Data collection and analysis proceed together."[17] Because a grounded theory is used, theoretical, rather than statistical sampling is applied in the selection of the case studies, that is, the analysis of the data determines each time "what data to collect next and where to find them, in order to develop . . . theory as it emerges."[18] Accordingly, criteria for selection have been developed, which will evolve as case study data are analysed.

The work conducted in the context of the first domain and aimed to define the authenticity requirements for the reproduction of electronic record shows that the research team operates on the assumption that investigation of new archival realities can use productively methodologies and concepts that are outside the realm of archival science, as long as the purpose, the questions and the theory guiding such investigation are archival in nature. The work conducted in the context of the fourth domain and aimed to determine procedural and technological methods of preservation capable of respecting authenticity requirements is consistently based on the same assumption. This appears very clearly from the articulation of a basic fact, on which the work in the preservation domain had to be grounded, that it is not possible to preserve

16 Glaser, Barney G. and Anselm L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research* (Chicago: Aldine Atherton, 1997), pp. 6–7, 46.

17 Taylor, Steven J., and Robert Bogden, *Introduction to Qualitative Research Methods: The Search For Meanings*, 2nd ed. (New York: Wiley, 1984), p. 126.

18 Glaser and Strauss, p. 45.

an electronic record or even a copy of an electronic record. It is only possible to preserve the ability to reproduce an electronic record:

> It is always necessary to retrieve from storage the binary digits that make up the record and process them through some software for delivery or presentation. Analogously, a musical score does not actually store music. It stores a symbolic notation which, when processed by a musician on a suitable instrument, can produce music. Presuming the process is the right process and it is executed correctly, it is the output of such processing that is the record, not the stored bits that are subject to processing. . . .
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> Starting from the inevitable requirement to reproduce an electronic record, we can stipulate that demonstrating the authenticity of electronic records depends on verifying that (1) the right data was put into storage properly, (2) either nothing happened in storage to change these data or alternatively any changes in the data over time are insignificant, (3) all the right data and only the right data were retrieved from storage, (4) the retrieved data were subjected to an appropriate process, and (5) the processing was executed correctly to output an authentic reproduction of the record. Verifying that these technical requirements were satisfied is necessary, but not sufficient, to demonstrate the authenticity of an electronic record. It is obviously necessary because if any of these conditions is not satisfied, the result of the processing of retrieved data cannot be (asserted to be) the same as the electronic record from which the stored data were produced. It is not sufficient because there is nothing in it that applies specifically to a record. It would be accurate, then, to say that this technical verification is a method for demonstrating that a digital object produced from stored digital data is an authentic reproduction of a digital object that was stored. To be precise, we should not even refer to 'a digital object that was stored,' but to the digital object that was the source of the stored data.[19]

To move beyond the general class of digital objects to the more specific class of electronic records, we must apply criteria that specifically relate to authentic copies of authentic records. These criteria, that is, the requirements for ensuring the authenticity of electronic records, are the result of the work on the first domain, but it is also important to study and represent by means of models situations that present identifiable risks of changing the records or their copies. These situations can be described as *boundary conditions*: "A boundary condition is a state from which a record cannot be moved without

[19] From the preliminary report to the research project's Director by the Chair of the Preservation Task Force, Ken Thibodeau, March 31, 2000.

either changing the record itself or taking some action either to prevent the threatened change or to counteract or to compensate for it."[20] There are categories of boundary conditions: for example, the conditions generated by the processing of records, when the activities involved in it entail some risk that the records be altered; the conditions created by the technology dependencies of the records, when the activities involved in altering the dependency or the technology, or removing the records from them, imply changes in the records; and the conditions that derive from the transfer of the physical and legal custody of the records from the creator to the preserver. Although the methodology and the concept of boundary condition come from information science, this does not create the risk of introducing in the archival system an element that can produce instability and consequent loss of balance and cohesion, because the entire outlook of the work of inquiry is determined by archival science. Therefore, it will not be difficult to import in the archival science system the findings of this part of the research.

What will certainly facilitate the integration within the system of archival science of the concepts, principles and methods either adapted from existing ones or developed anew in the first and fourth domains of research,[21] is the building of the glossary of all terms used in the context of the research project. The major issues raised by international interdisciplinary collaboration derive from the different use made of the same term in the various disciplines and by the use of different terms to refer to the same entity or activity within the same discipline among the various countries. These are both scientific and cultural issues that need to be brought forward and dealt with in a scholarly analytical way, so that they may be overcome by a profound understanding of all concepts and traditions involved. Thus, every proposed term and related definition is researched through time and across disciplines, and then the outcome is subjected to discussion by representative members of the international research team, whose approval must be unanimous. To ensure internal consistency of the Glossary, terms and definitions already included in it are revisited in light of new terms and definitions proposed and developed in the course of the research work.

As demonstrated by the two examples of research presented above, the development of the system of archival science in light of new realities is at its heart a scientific undertaking capable of absorbing new paradigms and renewing itself without losing coherence and cohesiveness. However, when

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[20] Ibidem.

[21] I am not mentioning here either the second domain, appraisal, because the research in it is especially focused on archival science, notwithstanding the use of modeling, or the fourth domain, policies, strategies, and standards, because its findings will derive directly from the analysis of the findings of the three domains of research.

political and economical interests are touched by the outcome of the research aimed to this development, it may become a moral issue. Thus, it is essential to make the scientific undertaking as independent as possible of the whims of governments and the interests of the industry if we want to have any hope that the generations to come will receive a trustworthy record of their past. Any research result must have a strong conceptual basis, include a clear definition of terms derived from archival theory and comprise consistent sets of decontextualized procedures with an explanation of their purpose and function. As shown by describing the research methodology of the projects discussed above, this does not mean that archival science must be the only discipline supporting its own growth and development. As von Bertalanffy stated more than three decades ago,

> [Often] similar concepts, models and laws have ... appeared in widely different fields, independently and based upon totally different facts. There are many instances where identical principles were discovered several times because the workers in one field were unaware that the theoretical structure required was already well developed in some other field.[22]

We must study concepts, laws and models from various fields to foster useful transfers to our field, to encourage the development of archival theory in emerging areas of endeavour and investigation, to eliminate the duplication of theoretical efforts in different fields, and to promote consistency of scientific knowledge.[23] However, in order to develop the body of knowledge of archival science, we must bring those extraneous concepts, laws and models into its system, make them consistent with the characteristics of its parts (i.e., confront them with archival theory, methods, practice and scholarship), subject them to the feedback process, and insert them into the fundamental structure of the system. Only so will we be able to maintain the integrity and continuity of our discipline and science while at the same time fostering its enrichment and growth, an integrity and a continuity that are vital to our ability to preserve all records, regardless of medium.

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[22] Von Bertalanffy, Ludwig, *General System Theory*, pp. 33–34.

[23] See Checkland, Peter, *System Thinking. Systems Practice* (Toronto: John Wiley & Sons, 1981), p. 93.