Archivists and Records Managers in the Information Age

by **CHARLES M. DOLLAR***

Résumé

L'auteur de cet article soutient que l'organisation et l'utilisation de l'information consignée électroniquement rend impérative la nécessité pour les archivistes et les gestionnaires de documents de comprendre que leurs disciplines respectives sont désormais engagées dans une entreprise commune. L'auteur développe son argumentation en retraçant d'abord les sources communes de l'archivistique et de la gestion des documents; il examine ensuite la réapparition de l'archivistique en Amérique du Nord dans les années 1940 ainsi que leur divergence durant les trois décennies suivantes et identifie le territoire commun de l'archivistique et de la gestion des documents quant à l'information consignée électroniquement. Ce territoire commun (qui comprend l'intégrité des dossiers, la destruction, et l'accès aux documents) est rattaché à un thème unique et unificateur par l'importance des relations contextuelles des archives électroniques. L'auteur conclut sur un appel lancé aux archivistes et aux gestionnaires de documents afin qu'ils collaborent à la conception des systèmes méta-informationnels afin de s'assurer que ces derniers contiennent l'information contextuelle nécessaire à un compréhension d'ensemble des dossiers et des systèmes de dossiers.

Abstract

In this article the author argues that the organization and use of electronically-recorded information makes it imperative that archivists and records managers understand how their disciplines are engaged in a joint enterprise. In developing this argument, he reviews the common roots of archives and records management, examines the re-emergence of archives in North America in the 1940s and their subsequent divergence over the next three decades, and identifies the common ground that archives and records management share in dealing with electronically-recorded information. This common ground, which includes records integrity, records disposition, and records accessibility over time, is linked into a single unifying theme by the importance of the contextual relations of electronic records. The article concludes with a call for archivists and records managers to participate in the design of metadata systems, in order to ensure that they contain the contextual information essential to a full understanding of records and record systems.

Introduction[1]

From a North American perspective, the remarkable convergence of information technologies and attendant developments over the last decade or so[2] compel us to review the connections between archives and records management, and to suggest a common agenda appropriate for the information age. In fact, this article argues that the changing information technology environment makes it imperative that archivists and records managers develop a vision of the future of their professions, stake out conceptually and practically what they bring to the organization and use of electronically recorded information, and initiate dialog with the larger information-handling community.

This review is organized around four themes: (1) an overview of the common historical roots of archives and records management; (2) an examination of the re-emergence of archives and records management in North America in the 1940s and their divergence over the next three decades or so; (3) a consideration of how information technologies are making it possible for archivists and records managers to engage in joint enterprise; and (4) the formulation of a common agenda for the information age.

Historical Roots of Archives and Records Management[3]

A view rather common among archivists and records managers is that the former deal with non-current records and the latter deal with current records, with the implication that the theory, methodology, and practice underlying the work of each profession differ substantially.[4] Gerald Brown captured the essence of this: "... the Records Manager is basically a business administrator and the Archivist is basically a historian."[5] This assessment loses much of its legitimacy when subjected to historical analysis. In fact, the two historical studies in English of the relationship between archives and records management—one a book by the late Ernst Posner entitled *Archives in the Ancient World*[6] and the other a two-part article by Luciana Duranti published in the *Records Management Quarterly* and entitled "The Odyssey of Records Management"[7]—clearly document the historical linkage between the two.

The term "records management" cannot be found in Posner's book, but he repeatedly describes archives and archives activities, dating back to 4,000 BC, that are linked to what today would be called "current records." For example, archaeological excavations of a royal palace at Mari (on the Euphrates River) uncovered some 20,000 clay tablets that were systematically classified for easy retrieval.[8]

In her illuminating *tour de force* summary of the history of records management, Duranti argues that record-making and record-keeping practices in ancient and medieval times were functionally similar to those of modern times. Practices associated with the creation of records, the planned selection of records for preservation (e.g., baked clay tablets *vis-à-vis* unbaked clay tablets), and their systematic arrangement for easy retrieval correspond to those activities that are inherent in the preservation of records about actions and transactions.

Duranti notes that, although the function of records manager preceded that of the archivist, the position of records-keeper had deteriorated greatly by the time of the Roman Empire, and eventually disappeared, not to reappear again until the "thirteenth-fourteenth century in the Italian City States."[9] Between the fifteenth and eighteenth centuries, a theory of record-keeping began to emerge in Spain, Italy, and France that eventually was absorbed by a new generation of historical record-keepers called archivists.[10]

Duranti concludes her sweeping survey with a discussion of how the creation and accumulation of records in North America in the nineteenth and early twentieth centuries gave rise to chaotic procedures and an ever increasing volume of records. She sums up the issue with the observation that "... to preserve everything appeared to be an impossible task. Selection was

necessary. But, how to make a selection of material about which nothing else other than the creator is known and sometimes not even that? The rest of the story is well known: North America reinvented the records manager."[11]

The Emergence of Archives and Records Management as Joint Enterprise and Their Divergence, 1940-1980[12]

Why did North Americans "reinvent" in the 1940s a function that had existed for six millennia? Part of the explanation lies in a failure at the time to understand clearly the history of archives and the European practice of the management of "current archives." Equally important was the view that there was very little of practical benefit that could be learned from European archival experience and tradition. Herman Kahn, who joined the staff of the United States National Archives in the late 1930s, summarized this assessment in 1975: " ... to have been trained in the actual techniques of the art as it was practiced at that time abroad ... would have been of small help and might even have done us harm."[13] Clearly, a knowledge of paleography, sigillography, and Latin would have been of little use in dealing with modern records, but this was a case of "throwing the baby out with the bath water." Finally, there was the sense that the massive volume of records created by the federal government dwarfed all other records-creating organizations and that this phenomenon necessitated entirely new approaches.

The reinvention of the records manager in North America in the 1940s initially was driven by the urgent necessity to reduce the burgeoning volume of records that organizations—both government and the private sector—were creating. The National Archives of the United States, which had been established in 1934, played a major role in this endeavour.[14] The National Archives statute authorized the Archivist to conduct inspections of the records of federal agencies and submit to Congress annually a list of records that had no permanent value or historical interest. The first Archivist of the United States, historian R.D.W. Connor, established a small group of "Deputy Examiners" to conduct these inspections. The overwhelming mass of records, many of which suffered from poor, or no filing systems, in which valueless records were intermixed with valuable ones, seemed to defy any rational process of selection. As one veteran Deputy Examiner put it, "We were confronted with masses of material and something had to be done about them. Either they [the records] were going to survive or we were. And a great many of us were just tossed in the middle and had to swim or else, and to one degree or another we did swim."[15]

What these "swimming archivists" did was to call for the identification and selection of records of permanent value, while they were still in active agency use. Although several archivists participated in what was called "records administration," two people played a particularly critical role in this activity. In 1940, Philip C. Brooks, who had been a Deputy Examiner, prepared a paper entitled, "What Records Shall We Preserve?"[16], in which he introduced the concept of the "life history" of records, a concept later generally called the "life cycle of records."[17] Brooks argued that archivists have a legitimate interest in records at their creation, because it is at this point that the selection of records can be made, and archivists should participate in the design of classification systems that segregate records according to their final disposition. Brooks maintained that this would make the work of archivists much easier, as well as facilitate the use and routine disposal of current records.

The second key person in this development of a new approach to records control was another National Archives staff member, Solon J. Buck, who became the second Archivist of the United States in late 1941. Ernst Posner, who worked with Buck in developing and teaching a course on the history and administration of archives at American University in Washington, DC in 1939, wrote that Buck believed that the most effective way to select records of enduring value "... lay in action taken within the agencies of origin, at the time when the documents are filed...."[18] Buck argued that there had to be an integrated programme of records control that focused upon

the entire life cycle of records from their creation until their destruction or transfer to the National Archives.[19] Although the National Archives had no statutory authority for such an integrated programme, Buck obtained funding from Congress "to persuade and assist the operating agencies ... to give adequate attention to the problems of records management."[20]

The programme that Buck initiated became the basis for an extraordinarily successful records management programme during the war years, 1942-1945.[21] Concepts such as general schedules, retention and disposition, continuing authorization for disposal, and low-cost intermediate records centres began to be considered. Central to this records management programme was the definition of "record" in the *Records Disposal Act* of 1943.[22] By 1945, the National Archives was poised to move forward with a comprehensive records management programme.

Usually, when these early years of records management experimentation are discussed, the National Archives receives most of the credit and accolades. However, an equally important sphere in which records management flourished was the private sector, where a strong movement developed to control business costs by reducing the costs of record-keeping. Proponents of this activity argued that the soaring costs associated with paperwork dictated that it be managed and controlled in the same way as manufacturing processes were controlled. Techniques were developed to handle in the most efficient way the process whereby paper records were created, used, and disposed of—probably the most notable being records scheduling. During the 1920s and 1930s, the American Management Association promoted a vigorous records disposal programme through its publication, *Office Management Series*. For example, in 1935, an issue entitled "Office Machines and Methods" included two articles that dealt with the retention of business records.[23] The two articles focused largely on procedures and approaches for expediting the destruction of records no longer required for current business.

It is more than a matter of passing interest to note that only one of the articles mentioned, very briefly, the need to retain "permanent records." The exclusive focus was on how, in the name of economy and efficiency, to dispose of paper records no longer needed. The solution was systematic records disposal. Getting rid of unnecessary records through a systematic disposal programme, without paying adequate attention to archival concerns, represents—as it were—the darker side of records management.

Despite its successful records management efforts during World War II, in the immediate post-war years the National Archives was not able to sustain the momentum of its records management programme. Instead, its integrated programme—emphasizing that archivists and records managers were engaged in a joint enterprise—fell victim to a stronger and more powerful movement for economy and efficiency across the government.

In 1947, former American President Herbert Hoover chaired the Commission on the Organization of the Executive Department of the Government, which examined ways to improve the economy and efficiency of the federal government.[24] Staff reports generated by the Commission declared that hundreds of millions of dollars were being wasted through the unnecessary retention of records.[25] Building upon this platform, the proponents of economy and efficiency in records management gained the ascendancy.[26] In 1950, Congress enacted the *Federal Records Act*, which mandated a government-wide records management programme.[27] This legislation required the heads of all federal agencies to establish records management programmes that would ensure both the economical and efficient management of federal records and the creation and preservation of "records containing adequate and proper documentation of the organization, functions, policies, decisions, and procedures and essential transactions of the agency...."[28] Archivists welcomed both objectives, but especially the latter, because it guaranteed good record-keeping, which would improve the quality of records destined for preservation in the National Archives.[29]

Subsequent events, however, turned this optimism to disappointment as federal records management programmes, responding to Congressional pressure and private-sector records management programmes, increasingly focused upon economy and efficiency, neglecting the equally important function of ensuring the creation and maintenance of adequate and proper documentation. The National Records Management Council, which Emmett J. Leahy had helped organize in 1947, was very successful in promoting records management in the private sector as a powerful technique for cutting costs through a reduction in the volume of records retained.[30] During the 1960s and 1970s, the Records Management Office of the National Archives[31] issued numerous reports listing savings of millions of dollars, largely through cost avoidance. This same office, however, failed to pay sufficient attention to ensuring that records management programmes also adequately documented the organization, functions, policies, decisions, procedures, and essential transactions of federal agencies. Thus, the gap between archives and records management once again widened.[32]

Information Technologies and the Re-emergence of Archives and Records Management As a Joint Enterprise[33]

Over the last decade or so, the development of information technologies that greatly facilitate information capture, processing, storage, and sharing has unleashed forces causing enormous changes[34] in the way that people work, play, socialize, organize, teach, and even make war. At this point, we have an incomplete assessment of the ultimate impact that information technologies will have on archivists' work. Nonetheless, there are at least two dimensions that are evident. The first is retrospective, in that ten years after the fact features of that impact are discernible. The second is a prospective dimension in which the outlines of an information technology-oriented society are beginning to emerge.

A major consequence of the convergence of information technologies was the emergence of a new interdisciplinary profession called Information Resource Management (IRM). The immediate impetus was the development of computer processing, telecommunications, and office-automation technologies in the 1960s and 1970s.[35] The managers of these new technologies seldom took into account policies and procedures developed for paperwork management functions. Compounding these problems was the fact that technical personnel acted as intermediaries between creators and users in defining and implementing applications of the technologies. Eventually, this led to communication gaps between users of information and providers of information services; the information management function became fragmented and uncoordinated.

During the 1970s, information technologies such as distributed processing, computer telecommunications that integrate voice and data, and intelligent work-stations were converging,[36] thereby bridging the gap between users and providers of information. At the same time, the potential for chaotic use of new and emerging information technologies spurred efforts to coordinate their use. As organizations became increasingly dependent upon information technologies, greater attention was given to incorporating information technology planning into overall organizational business or mission strategies. The cumulative impact of these information technologies was the creation of an environment that gave rise to an interdisciplinary or—perhaps more appropriately—a multidisciplinary perspective. Finally, the enormous investment in the creation of information and the supporting technologies forced managers to begin to look at information as an asset or resource, to be managed (planned, costed, budgeted, and evaluated) like any other business asset. Thus, the new profession of Information Resource Management (IRM) came into being.[37]

What is Information Resource Management? One very useful definition states,

> Information resource management is not a specific function or a set of procedures; rather, it is an umbrella concept which embraces a number of related yet discrete functions .... Put very simply, information resource management is the totality of planned and directed activities within an organization which result in usable, accessible, timely, secure, integral, economical, and accurate information for that organization.[38]

At least three key concepts in this definition merit further elaboration. First is the concept of quality of information, which refers to its accuracy, reliability, and timeliness. The second concept is that of the usability of information, which refers to the degree to which the information is easily accessible to current and future users. The third concept is that of a systems approach, in which all information-related processes and resources are inter-dependent and the life cycle of information is the unifying theme. A systems approach implies that, prior to the creation of a system or a body of information, consideration should be given to all the potential uses that might be made of the information. Clearly, determination of potential use is an information or records disposition activity, which archivists and records managers have in common.

As noted earlier, a second effect of information technologies was the emergence of the outlines of an information-oriented society. One dimension of this outline is the growing displacement of paper-based information technologies by electronic information technologies.[39]

Despite the fact that paper-based information technologies and products still dominate the workplace, there is growing evidence of a major transformation underway in the United States. For example, ten years ago electronic formats accounted for only ten per cent of the business of *Chemical Abstracts*, the remainder being paper formats. By the end of 1990, electronic formats accounted for forty-eight per cent of its business. Given this growth rate, the next decade will see electronic format information accounting for as much as ninety-five per cent of the business of *Chemical Abstracts*.[40] At the federal government level, digital imaging technology applications increasingly are displacing paper.[41] At least two factors help to account for this increase. First, digital imaging technologies can relieve agencies of the labour-intensive burden of dealing with paper. Second, the use of digital imaging technologies will permit agencies to deliver better public service.

A second dimension of our information technology-driven environment is the changing character of work. Increasingly, many archivists will find that the way in which we work is being changed by the information technology tools available to us.[42] Electronic communication networks are breaking down the barriers of time and space that traditionally have made it difficult for people widely dispersed to participate meaningfully in work activities. Distributed databases and electronic networks are promoting organizational decentralization, while at the same time they are bringing people and resources together across time and space, thereby allowing them to work productively in ways not previously possible.[43]

A third dimension of this outline of an information technology-based society is the emergence of information technology standards—generally described as "open systems"—that facilitate connectivity and interoperability between and among different computer systems and information application systems platforms.[44] In the long run, this may be the most important development because it gives users enormous flexibility in choosing software and hardware, and ensures the relatively easy transfer of data across different computer systems—a factor of some consequence when usability and access to electronic records over time are significant.

The Common Ground Shared by Archivists and Records Managers

The fact that electronic records being produced today lack the physical attributes that archivists and records managers traditionally have relied upon to do their work is a cause for concern but not despair. In fact, the cumulative impact of converging information technologies and their related side effects (e.g., Information Resource Management) is the "rediscovery" of the common ground that archives and records management share.[45] This common ground can best be understood in terms of three fundamental concepts: records integrity, records disposition, and records accessibility.[46]

Ensuring that records as evidence of actions and transactions have not been altered during the course of current use and preservation for future users (i.e., records integrity) should be a matter of great concern to both records managers and archivists. Ensuring records integrity is fundamental to records management because it is the basis on which information resource management can deliver timely access to relevant and reliable records.[47] Unfortunately, many people approach electronic information with what can be described as presumptive authenticity or integrity: information is in a database and a slick information retrieval system delivers it to users, so therefore it must be reliable. Neither databases nor information retrieval systems as such, however, can distinguish between reliable and questionable or unreliable information. Records managers can ensure that electronic information systems deliver reliable information and that the information delivered to users is in fact what it purports to be, by focusing upon the maintenance of records integrity.

For archivists, ensuring records integrity is another way of maintaining the principle of provenance, which is the foundation on which modern "archival science" rests, and which is crucial to the preservation and communication of all records—especially electronic records. Preserving the provenance of records means ensuring that the context (including the relations of documents with their creators, with the facts and acts that they are evidence of, and with other documents) in which records were created and used is preserved. Protecting the provenance of electronic records presents difficult challenges for archivists, because electronic records do not exist as physical entities and much of the contextual information about them is not visible to users or may not be routinely captured.[48] Archivists, therefore, can no longer rely upon maintaining the original physical order of electronic records as a means of protecting their provenance and authenticity.[49]

Ubiquitous electronic archives and multiple copies of electronic records are certain to come into existence increasingly as electronic network communications become more pervasive. Multiple copies of electronic text will be uploaded and downloaded routinely. Other copies will be made when electronic records are transferred to new digital storage media. What guarantees do archivists and users have that no changes have occurred, either intentionally or accidentally? Furthermore, other traditional indicators of the authenticity of documents, such as signatures, watermarks, marginalia, and the like are not captured in many electronic documents.[50]

The traditional device for ensuring that records remain authentic or "uncorrupted"[51] is the notion of their unbroken custody in a dedicated place—which superficially, at least, seems very difficult to do, given the ubiquity of electronic records. Ironically, three potential solutions for protecting the authenticity of electronic records rely upon electronic information technology itself. The first employs what is called a "secure client-server architecture,"[53] which blocks user access to the database or electronic archives. In a client-server architecture, a user queries a database or issues retrieval instructions for a specific electronic document(s) at a work-station which are passed on to a server device, which, after appropriate translation, passes them directly to the database. The system that supports the database receives and processes the

queries and retrieval instructions, and the results are passed back to the server and then to the user. Because original electronic documents are never directly accessible to users in a client-server architecture, electronically-speaking there is unbroken electronic custody of the records.

The second electronic technique for ensuring the authenticity of electronic documents involves the use of a two-stage digital signature standard, under development by the National Institute of Standards and Technology.[53] The first stage of this process involves the creation of a 160-bit digest of a document of any length, which is appended to an electronic document (text, image, or drawing). This is called a "one-way hash digest" because it cannot be reversed in order to regenerate the original document. The second stage of this authentication process encrypts this hash digest, using a unique "private signing key" that is protected from disclosure, and appends it to the unencrypted "original" electronic document. Later, a "public signing key" is used to open the encrypted hash digest for comparison with a hash digest of the electronic document generated for this purpose. The failure of the two hash digests to match perfectly is clear evidence that the electronic document has been altered, because a change of only one bit in an electronic document can modify more than one-half of the bits in its hash-digest. Although this approach makes electronic documents tamper-resistant, its effectiveness depends upon protecting "private signing keys" from disclosure and the ready availability of public signing keys, each of which may be difficult to achieve.

A third technique called "digital time-stamping," under development by BelCore, is a variation of the digital signature.[54] Both techniques employ a document hash digest linked to a mathematically unique number, but the process of "digital time-stamping" links this unique number to the "digital time-stamps" of two other documents. The underlying expectation of "digital time-stamping" is that documents will be submitted to a time-stamping service that will utilize the numbers of the preceding and the following documents to create a non-repeatable 160-bit number. which is then appended to the electronic document in question. A recipient of the document either next week or a hundred years from now could validate its authenticity by using a public verification key to generate a second hash-digest of the document and to compare it with the one appended to the electronic document. There are at least two very attractive benefits of using "digital time-stamping" to ensure the authenticity of electronic documents. The first is that the public verification key, which is published weekly in the New York *Times*, will be widely known and available to any users. The second advantage is that the unique identification number of an electronic document is inextricably linked to the unique identification numbers of two unrelated electronic documents. These combined numbers can be linked to other numbers in a tree-like structure that make the "digital time-stamp" virtually immune to recomputation, at least for the foreseeable future. There is no inherent reason why "digital time-stamping" could not be adapted to record creation and record-keeping programmes and activities in order to ensure the authenticity of electronic documents.

To sum up, protecting the provenancial information about electronic records is the foundation on which archivists and records managers can build programmes that ensure the preservation of record integrity. Records managers can ensure that electronic information systems deliver reliable information, that the information delivered to users is in fact what it purports to be, by relying upon provenance, which has been enriched by the use of a variety of techniques, including digital signatures and hashing/time-stamping of documents. What works for electronic archival material, moreover will also work for electronic records in the domain of information resource management.[55]

The second area of common ground that archives and records management share concerns the disposition of electronic records, which must be done as early in the life cycle as possible. The difficulties in the 1970s and early 1980s of trying to develop disposition instructions for computer tapes ten and twenty years after their creation convinced many archivists that appraisal of electronic records had to be done as early in the life cycle as possible.[56] One effective way to accomplish this was the incorporation of appraisal and retention functionalities in the design of information systems supporting records creation and use applications.

Archivists must recognize that records management is an important component of Information Resource Management, which, among other things, focuses upon system processes. Hence, there is a natural community of interest between archivists and records managers that disposition considerations be addressed in the design of new information application systems. In this context, disposition instructions also include the criteria whereby the value of information is determined.

Traditionally, in North America, disposition criteria have been subsumed under two themes—evidential value and informational value. In the 1970s and 1980s, the latter dominated the appraisal of machine-readable records.[57] However, a growing number of archivists are now urging that archival appraisal return to basics and pay more attention to the documentation of programme accountability, which suggests that the informational value of information application systems may be eclipsed by their evidential value.[58] A related consideration is the likelihood that, under prevailing archival practice, the volume of electronic records likely to be retained as archival will increase geometrically and drive archives into bankruptcy unless informational value considerations are dramatically minimized. Sometimes, one hears the counter-argument that, because storage media costs are so cheap for electronic records, archivists can afford to keep everything and recopy the records onto steadily less expensive storage media. This assessment fails to take into account substantial "hidden costs" of information technology dependence.

To sum up the disposition common ground, archivists and records managers can and should work together in order to ensure that information systems applications incorporate records disposition functionalities. In addition, the ever-increasing cost of maintaining electronic records and transferring them from old computer technology generations to newer ones necessitates that archivists and records managers refocus retention criteria on evidential value considerations.

The third area of common ground between archives and records management is the accessibility of electronic records over time. Because the single most important impediment to the accessibility of electronic records over time is technological obsolescence, the traditional archival preservation focus on the support or carrier of information (e.g., paper, microfilm, and magnetic tape) offers little useful guidance. In order to deal with technological obsolescence we must shift the emphasis from preservation of the information carrier or physical storage medium to the maintenance of accessibility over time.[59] This shift in emphasis, which is already under way in the archives and library communities, involves a fundamental reorientation of preservation approaches, methodologies, and practices.

Maintaining the accessibility of digital records over time is a question of readability, retrievability, and intelligibility. Readability means that the information can be processed on a computer system or device other than the one that initially created the digital information or on which it is currently stored. Typically, non-readability involves some aspect of an older storage device (a tape or disk) that makes it physically incompatible with existing equipment. This is generally called hardware obsolescence and occurs when storage devices and media used today become incompatible with those developed in the future. An example of this is the 556 BPI tapes used in the 1960s which cannot be read by current tape drives. Of course, as long as a tape or disk drive continues to function properly and there are spare parts available for repair, its usable life can be extended for a time. Similarly, the usable life of media can be extended through proper maintenance.

Retrievability, which assumes readability as just defined, means that identifiable records or parts of records can be selected and retrieved. Accurate retrieval requires keys or pointers that link the logical structure of records (e.g., data fields or text strings) to the physical storage locations of the data on a disk—which, depending upon the media and format involved, may have little relationship to the logical structure. Usually, this linkage information is found in a

file header or label containing the information required to locate the beginning of a file, to indicate the number of bytes each record contains and where these bytes are physically located, and to distinguish among the various informational units of fields that form records. Typically, the interpretation of the logical structure of records is a function of an operating system (MS-DOS) or a device driver. Ensuring the retrievability of records requires the functionalities of the original operating system or device driver—which also are likely to become obsolescent.

A further layer of complexity may arise with the way a storage and retrieval systems writes index pointer information to disks. Furthermore, the searching and retrieval software associated with a particular application system usually requires a specific operating system platform, such as MS-DOS. Typically, a retrieval software application will add pointers to both the logical and physical structures of the records. The retrievability of these records is, therefore, inextricably linked to the software application. Unless there are built-in migration paths, or newer generations of the software offer backward compatibility to older versions of the software, access to the records will be impossible.

The third aspect of maintaining accessibility over time is that of ensuring intelligibility so that it is comprehensible to users. Intelligibility may occur at three levels. At the simplest level, it operates when two computer systems either use or understand the same digital representation of the information and this representation is translated into a form that humans recognize and understand. An ASCII text file is the best example of this level of intelligibility. The second level occurs when two computer systems can use or understand the same representation of the information (ASCII), but when the representation is presented to users it does not carry sufficient information (i.e., it is not self-referential) for a human to comprehend its content. Usually this problem is associated with both coded and numeric data, and the intelligibility of such information can be assured only by the use of documentation defining the values represented by the numbers and codes. The third level of intelligibility occurs when two different software applications functioning in different computing environments can process the same digital data with the same results. This is particularly difficult for digital images, where proprietary image file headers and compression techniques are used. Digital data, and in particular digital images, that can only be processed within a specific proprietary environment are especially vulnerable as this environment becomes obsolete.

Addressing hardware and software dependence, which eventually leads to technological obsolescence, involves two activities: periodic recopying, and migration to new generations of technology. Periodic recopying of digital information in order to stay current with existing technology (e.g., from 6250 BPI tape to 3480/90 Class Tape Cartridges) offers an absolute guarantee of readability. As long as the volume of digital information is relatively small and the time between copying remains ten years or so, this option is very attractive. However, periodic recopying every ten years or less can become a major financial burden, even when storage media costs are extremely cheap.[60] Data exchange standards, which support upward migration paths that bridge computer generations, potentially can extend the time between recopying from, for example, ten years to twenty.

Because maintaining the readability of electronic records over time does not guarantee retrievability and intelligibility, a more robust alternative must be developed. This alternative includes a planned strategy for bridging technology generations, relying upon international standards that support interoperability and upward migration paths across technology generations. One example would be a standard for interactive electronic documentation, such as the Information Resource Dictionary System (IRDS)—which when linked to the Structure Query Language, can provide a bridge between otherwise incompatible software systems,[61] thereby extending both the retrievability and intelligibility of electronic records. Other international standards under development have the potential to address other significant impediments to maintaining accessibility over time.

The international information standards development arena involves techniques and tools that are substantially different from those with which most archivists and records managers are familiar. Nevertheless, it is an arena in which the viewpoints and concerns of archivists and records managers will be welcomed—if they are articulated in terms that database administrators understand. Among other things, this means linking archival and records management concerns to business processes and functions.

Where does records management fit into the accessibility of digital information? A major premise of Information Resource Management is that information, especially digital information, is a corporate asset that represents a substantial investment of resources and must be treated as such. To the extent that electronic documents and data are exchanged across an organization in which there are heterogeneous computing environments, or the electronic documents and data are to be exchanged over time and the target computing environment is not known, attention to facilitating access over time and its attendant techniques and practices should be of great concern and benefit to records management. Thus, records managers have as much to gain as do archivists from the development of open systems standards that ensure connectivity and interoperability.

Conclusion

The critical issue for archivists and records managers is ensuring that international standards address three crucial information-handling requirements: maintaining records integrity, incorporating records disposition into information system application design, and facilitating access over time. Consequently, we must understand how the process of standards development and implementation operates, identify and concentrate on those standards of greatest relevance for our programmes, and become actively involved in the development and implementation process. It is not enough that archivists and records managers agree upon a joint agenda and talk about it. There must also be aggressive activities that carry archivists and records managers into the main stream of the information management community.

Because protecting provenance of electronic records is so important to all users, archivists and records managers must do at least two things. They must participate in the design of information resource directories or metadata systems, and ensure that in fact these systems contain all of the contextual information essential to a full understanding of the records in question. They must also become involved in the development of the Information Resource Dictionary Standard (IRDS), in order to ensure that provenance-related functionalities are incorporated into the standard.

Equally important is the inclusion of appraisal and retention functionalities in the design of new information system applications, and reexamination of the fundamental basis for the appraisal and retention of records in electronic form.

Finally, ensuring the accessibility of electronic records over time in the face of technology obsolescence requires an on-going commitment to international information technology standards. Archivists and records managers increasingly must play an active role in sharing with other users, standards developers, and information technology vendors the importance of supporting technology tools that facilitate access to records over time.

As archivists and records managers accept the common ground they share that results from new and emerging technologies, and stake out clearly for the rest of the information-handling community their concerns and objectives, there will be a new day of shared endeavour. Under this banner of mutual endeavour, archivists and records managers can play a crucial role in shaping Information Resource Management in the future, as new technologies and new management tools, such as enterprise-wide management, are implemented in the workplace.

Notes

* This article is a substantial enlargement and revision of several ideas developed for papers and lectures delivered over the last year at Oxford University, the University of British Columbia, and the New England Archivists Meeting (1 May 1993). An earlier version of this paper was translated into Catalan and published in *Ponències De Les Quartes, Jornades D'Arxivística De Catalunya: Informatica i arxius* (Sabadell, 13-15 May 1993), pp. 13-24. The views presented in this article should not be construed as representing the official position of the United States National Archives and Records Administration.

1 I am very grateful to the staff of the National Archives Library, who processed numerous interlibrary loan requests and tracked down obscure citations on my behalf.

2 See, for example, Charles Dollar, *The Impact of Information Technologies on Archival Theory and Practice* (Macerata, 1992), pp. 21-34.

3 I shall not dwell on the distinctions frequently made by North American and European archivists between records and archives, other than to observe that there is a substantial literature on the subject. See, for example, Ernst Posner, *Archives in the Ancient World* (Cambridge, Mass., 1972), p. 4; and *Proceedings of the European Archival Conference on the Creation and Organization of Contemporary Records* (Budapest, 23-26 April 1985).

4 In 1955 Robert Bahmer, Assistant Archivist of the United States, summed up this view: "The further records management has moved into the field of current records maintenance and handling and in the more uncertain field of record creation, the less the professional archivist, as an archivist, can contribute": "The National Archives After 20 Years," *American Archivist* 18, no. 3 (July 1955), p. 202. In much the same vein, Theodore R. Schellenberg wrote, "The distinctions between archival and records management activities are basic, not artificial. Record management techniques, taken as a whole, are quite as different from archival techniques as are those of a librarian or a museum curator." *The Management of Archives* (New York, 1965), p. 72. Records managers also share this view. See Gerald Brown, "The Archivist and the Records Manager: A Record Manager's Viewpoint," *Records Management Quarterly* 5 (January 1971), pp. 21-22, 38; T. M. Campbell, "Archives and Information Management," *Archivaria* 28 (Summer 1989), pp. 148-49. For a contrary view, see Morris Radoff, "What Should Bind Us Together," *American Archivist* 19, no. 1 (January 1956), pp. 3-9; Robert A. Shiff, "The Archivist's Role in Records Management," *American Archivist* 19, no. 2 (April 1956), pp. 111-20; Frank B. Evans, "Archivists and Records Managers: Variations on a Theme," *American Archivist* 30, no. 1 (January 1967), pp. 45-68; Christopher L. Hives, "Records Management, Information and Archival Management in Business," *Records Management Quarterly* 20, no. 1 (January 1986), pp. 3-8, 17.

5 Brown, "The Archivist and the Records Manager," p. 21.

6 Cambridge, Mass.: Harvard University Press, 1972.

7 "The Odyssey of Records Management. Part I: From the Dawn of Civilization to the Fall of the Roman Empire," *Records Management Quarterly* (July 1989), pp. 3-11; "The Odyssey of Records management. Part II: From the Middle Ages to Modern Times," *Records Management Quarterly* (October 1989), pp. 3-11.

8 Posner, *Archives in the Ancient World*, pp. 29-31.

9 "From the Dawn of Civilization to the Fall of the Roman Empire," p. 10.

10 In this regard it is worth noting that in 1558 King Philip II of Spain issued regulations for the management of records created under the authority of the Council of the Indies that bear a remarkable resemblance to twentieth-century records management regulations. The text of the regulations can be found in José Luis Rodriguez de Diego, ed., *Instrución para el gobierno del Archivo de Simancas (Año 1588)* (Madrid, 1989). I am grateful to Margarita Vazques de Parga, Director of the State Archives of Spain, and Pedro Gonzales, Director of the Archivos General de Indias, for bringing this material to my attention.

11 "From the Middle Ages to Modern Times," p. 9.

12 The historical context of some of the forces driving records management, of course, extends back into the nineteenth century. As JoAnne Yates demonstrated in *Control Through Communication: The Rise of System in American Management* (Baltimore, 1989), evolving organizational structure and the introduction of new information technologies had a profound impact on the ways in which offices created and maintained records. This historical context also includes the United States federal government. See Bess Glenn, "Search for Efficiency in Federal Records Management: Introduction," *American Archivist* 21, no. 2 (April 1958), pp. 157-59; Harold T. Pinkett, "Investigation of Federal Recordkeeping, 1877-1906," *American Archivist* 21, no. 2 (April 1958), pp. 163-92; Bess Glenn, "The Taft Commission and the Government's Recordkeeping Practices," *American Archivist* 21, no. 3 (July 1958), pp. 277-303.

13 Herman Kahn, "The First Generation: The Autodidact," *American Archivist* 38, no. 2 (April 1975), p. 150.

14 JoAnne Yates's description of how business corporations developed filing systems, forms control, and scheduling of records that were part of improved managerial efficiency can be characterized as primitive records management. Although these innovations predated organized programmes at the national level, some of these record-keeping practices were being implemented in federal agencies. One of the more noteworthy examples was the work of General Fred C. Ainsworth, Adjutant General of the War Department. See Mabel E. Deutrich, *The Struggle for Supremacy: The Career of General Fred C. Ainsworth* (Washington, DC, 1962).

15 National Archives and Records Service Oral History Project, Transcript of interview with Herbert E. Angel, 12 February 1973, (Record Group 64, National Archives and Records Administration, Washington, DC). See also the assessment of Oliver W. Holmes, "The National Archives At a Turn in the Road," *American Archivist* 12, no. 3 (October 1949), pp. 344-46.

16 The paper was read at a luncheon attended by Washington members of the Society of American Archivists on 13 April 1940. Subsequently, it was issued by the National Archives as a Staff Information Circular.

17 For a useful review of Brook's concept, as well as a schematic drawing he prepared that delineates the various stages of the "life history of records," see Kenneth J. House, "The Development of Records Disposition Procedures and Legislation at the United States National Archives, 1934 - 1945," M.A. Thesis, Western Washington University, 1990, pp. 123-26.

18 Ernst Posner, "Solon Justus Buck and the National Archives," in Ken Munden, ed., *Archives & the Public Interest: Selected Essays by Ernst Posner* (Washington, DC, 1967), p. 144.

19 In the summer of 1938 Buck was in Europe, where he visited archival agencies in several countries and obtained firsthand information about how agencies handled their records. Ernst Posner noted that Buck was impressed by the "...fact that in Germany and certain other countries the functioning of archival agencies was facilitated by the existence of a good system of pre-archival record keeping in the agencies": National Archives and Records Administration, Record Group 64, National Archives Oral History Project, Statement dictated and written By Ernst Posner, December 1973, p. 11. In a 19 January 1939 letter to Emmett J. Leahy, Buck noted that American archivists could benefit from the European archives experience, especially with regard to the principle of provenance and the need for archival material to be properly filed, organized, and cared for in the office of origin before transfer to the archives: Buck to Leahy, 19 January 1939, Buck Papers, Manuscript Division, Library of Congress.

20 *Eighth Annual Report of the Archivist of the United States, 1941-42* (Washington, DC, 1942), p. 4; Quoted in Posner, "Solon Justus Buck and the National Archives," p. 144.

21 In 1944 Buck proposed a Public Records Act, which would have established the statutory basis for a comprehensive records management and archives programme for the federal government. Senior National Archives staff prepared several draft bills, but in late 1944 the proposed legislation was abandoned. Some of the key provisions of the proposed 1944 legislation were later incorporated into Executive Order 9784 establishing a records management programme in federal agencies, which President Harry Truman issued in 1946. Of even more interest is the fact that language in the proposed Public Records Act of 1944 was included in the *Federal Records Act* of 1950.

22 Prior to this, the National Archives Statute did not define the term "record." The impetus for this legislation, as well as the new definition of records, came largely from Solon J. Buck. See House, "The Development of Records Disposition Procedures and Legislation," pp. 209, 227-30. The actual language of the definition of records was drafted by senior National Archives staff: Ibid., p. 289.

23 Harold C. Pennick, "Retention of Records," *Office Machines and Methods, Office Management Series* 69 (New York, 1935), pp. 6-10; Harry P. Snow, "Discussion," Ibid., pp. 10-12.

24 For an overview of the work of the Hoover Commission see Robert W. Krauskopf, "The Hoover Commission and Federal Recordkeeping," *American Archivist* 21, no. 4 (October 1958), pp. 371-99.

25 *Records Management in the United States Government: A Report With Recommendations. Task Force Report on Records Management (Appendix C). Prepared for the Commission on the Organization of The Executive Branch of the Government* (Washington, 1949), pp. 39-40. In an unfavourable review of this report, Martin P. Claussen asserted that it had a serious deficiency because it neglected the "need for what might be called better 'quality controls' for the improvement of record making and record keeping." Instead, the Report "... has taken a narrow view of the records function as a management tool...": *American Archivist* 12, no. 3 (July 1949), p. 287.

26 The Task Force Report recommended replacing the National Archives with a Federal Records Administration. Among the reasons given for this recommendation were the following:

> The essential specialized function of the National Archives is limited to only 5 percent of Federal records.... The 95 percent of Federal records outside the national Archives present primarily a management rather than an archival problem.... The development and promotion of a programme for Government-wide improvements and economies in records management require modern management techniques rather than archival science:

Records Management in the United States Government: A Report With Recommendations, p. 24.

27 The previous year, Congress established the General Services Administration and placed the National Archives there. Its new title was the National Archives and Records Service. It was not until 1985 that the National Archives regained its status as an independent agency.

28 Eighty-first Congress, First Session, *U.S. Senate Report No. 2140* (24 July 1950), pp. 35-36. The actual language quoted above can be found in the draft Public Records Act of 1944.

29 As Archivist of the United States Wayne Grover put it, "... we have every prosect of bringing order and intelligence into the management of Federal records, improving their quality as well as decreasing their quantity ...": "Recent Developments in Federal Archival Activities," *American Archivist* 14, no. 1 (January 1951), p. 9.

30 Christopher L. Hives, "History, Business Records, and Corporate Archives in North America," *Archivaria* 23 (Winter 1986-87), p. 46; Christopher L. Hives, "Business Archives: Historical Developments and Future Prospects," MAS Thesis, University of British Columbia, 1985, pp. 29-33.

31 The records management programme of the National Archives initially had Division status. As a result of a reorganization in 1956, which reflected recommendations of the Second Hoover Commission, the programme was elevated to Office status.

32 In "Accountability and Archival Theory," Jane Parkinson argues that Theodore Schellenberg's distinction between primary and secondary users (i.e., scholars), with the latter having an exclusive concern for the evidential and informational value of records, gave primacy to the needs of historians and further separated archivists and records managers: MAS Thesis, University of British Columbia, 1993, pp. 55-58. The issue is much more complicated than this, however. In his presidential address to the Society of American Archivists in 1954, Archivist of the United States Wayne Grover came down strongly on the side of scholarship: "There is no country in the world, I believe, where you will find archivists more dedicated to the service of scholarship than in the United States": "Archives: Society and Profession," *American Archivist* 18, no. 1 (January 1955), p. 4.

33 Ira Penn, Editor of the *Records Management Quarterly*, does not share the optimism implied by this title. See his "Federal Records Management in the 1980s - Is Just Like It Was in the 1780s," *Records Management Quarterly* 18, no. 2 (July 1984), pp. 5-6, 8, 10-15.

34 For a general discussion, from an historical perspective, that is not sanguine about the future of archives and records management, see Frank G. Burke, "Chaos Through Communications: Archivists, Records Managers, and the Communications Phenomenon," in Barbara L. Craig, ed., *The Archival Imagination: Essays in Honour of Hugh A. Taylor* (Ottawa, 1992), pp. 154-77.

35 For a detailed discussion see Forest W. Horton, Jr. and Donald Marchand, *Infotrends: Profiting from Your Information Resources* (New York, 1986), pp. 115-27.

36 Information technology convergence is the coming together, or the logical integration, of technologies that provide common and easy-to-use tools for creating and using disparate information sources and objects, such as images, graphics, text, databases, and audio. One result is the increasing availability of user-friendly application tools for accessing a variety of information objects and sources and invoking telecommunication services such as local area and wide area networks, including Internet. In a very prescient article in 1982, Michael K. Buckland noted this development. "Records Management in Its Intellectual Context: Experience at Berkeley," *Records Management Quarterly* 16, no. 4 (October 1982), p. 27.

37 The Commission on Federal Paperwork, which played a key role in formalizing and legitimizing information resource management, published a number of reports on various aspects of "paperwork management," a term that suggests a very narrow and traditional view. However, it is abundantly clear that the Commission viewed information resource management as including traditional paperwork management programmes, statistical programmes and statistical data service, computer data banks and automated information systems, libraries and information centres, printing and reprographic programmes, word processing equipment and centers, microfilm programmes, and "other information-related activities": *A Report of the Commission on Federal Paperwork: Information Resources Management* (Washington, 1977), pp. 14-15, 67.

38 T. M. Campbell, "Archives and Information Management," *Archivaria* 28 (Summer 1989), p. 146. For an overall review of the development of Information Resource Management (IRM), see Richard H. Lytle, "Information Resource Management: 1981-1986," in Martha E. Williams, ed., *Annual Review of*

Information Science and Technology (New York, 1986), pp. 309-26. See also Paul D. Condiff, *Principles of Information Resource Management: A Foundation for the Future* (Maxwell Air Force Base, 1992).

39 This does not mean that paper will disappear. Rather, it suggests that for reasons of convenience people are likely to make temporary paper copies of electronic records that are page analogues, because their physical presentation on a monitor or a printer is in the format of traditional paper records (e.g., a letter or a memorandum).

40 Statement made on 1 December 1990 at a conference on the National Research and Education Network at the Harvard Kennedy School. Cited by Henry Perritt in "Electronic Publishing Formats," *Proceedings, Conference on Electronic Publishing Standards and Formats in the Fields of Law and Accounting* (National Center for Automated Information Retrieval, May 1991), p. 3.

41 Yvonne Kidd, "Federal Imaging in 1993: Electronic Images Comes [*sic*] of Age - Part I," *Inform* (March 1993), pp. 14-27, 59; *Digital Imaging and Optical Media Guidelines for the Federal Government With Recommendations, A Draft Report of the Technology Research Staff* (Washington, DC, 1993).

42 Tom Finholt, "The Erosion of Time, Geography, and Hierarchy: Sharing Information Through An Electronic Archive," in Angelika Menne-Haritz, ed., *Information Handling in Offices and Archives* (Paris, 1992), pp. 67-90; Martha Feldman, "Electronic Mail and Weak Ties in Organizations," *Office: Technology and People* 3 (1987), pp. 83-101.

43 One example of this is clearly evident in humanities scholarship. See Avra Michelson and Jeff Rothenberg, "Scholarly Communication and Information Technologies: Exploring the Impact of Changes in the Research Process on Archives," *American Archivist* 55 (Spring 1992), pp. 236-315.

44 For a review and assessment of standards relevant to archives and records management see Charles M. Dollar and Thomas E. Weir, Jr., "Archival Administration, Records Management and Computer Data Exchange Standards: An Intersection of Practices," in Stephen M. Spivak and Keith A. Winsell, eds., *A Sourcebook of Standards Information: Education, Access and Development* (Boston, 1991), pp. 191-212.

45 This discussion builds upon the basic connection between traditional archives and records management that Luciana Duranti made in "Is There A Records Management Theory?" *Proceedings of the ARMA International 35th Annual Conference* (5-8 November 1990, San Francisco), pp. 814-22.

46 I am indebted to Frank Evans for suggesting these three terms that are discipline-neutral, that is, they are not oriented specifically to records management or to archival science *per se*.

47 Morton F. Meltzer, *Information: The Utlimate Management Resource* (New York, 1981), pp. 23-24.

48 For an insightful summary of problems connected with assessing electronic "archival databases," see M. Anne MacDermaid, "The Essence of Archival Communication," in Barbara L. Craig, ed., *The Archival Imagination: Essays in Honour of Hugh A. Taylor* (Ottawa, 1992), pp. 238-39.

49 This, of course, highlights the importance of contextual data, frequently referred to as "metadata," containing reference codes that provide intellectual links to, or logical relations with, other records. Maintenance of the intellectual order of electronic records, not their physical order, is crucial to the preservation of the provenance of electronic records.

50 Signatures and other handwritten marginalia are captured on raster, bit-mapped images. However, it is relatively easy to substitute or transfer a raster signature from one document to another with no visible trace of this activity.

51 The notion of "uncorrupted" is taken from Lester K. Born, who in turn quoted Emperor Justinian. "The De Archivis Commentarius of Albertino Barisoni (1587-1667)," *Archivalische Zeitscrift* no. 50-51 (1955), p. 21.

52 For a useful discussion of client-server architecture, see Ellen Ullman, "Client/Server Frees Data," *Byte* 18, no. 7 (June 1993), pp. 96-106.

53 Federal Information Processing Standards Publication (Draft), "Specifications for a Digital Signature Standard (DSS)" (National Institute for Standards and Technology, Gaithersburg, MD). For a useful discussion of this standard see the unpublished paper by Shimshon Berkovits, "Digital Signatures: A Tutorial" (The Mitre Corporation, Bedford, MA). A similar approach for authenticating engineering documents has been developed by the Canadian Council of Professional Engineers. See William Jackson, Stephen Gorgas, and Bryan Morris, "Framework for an Electronic Seal for Professional Engineering Documents in Electronic Form" (Cybit Corporation, Ontario, 1992).

54 For an informative discussion of "digital time stamping," see Peter Graham, "Intellectual Preservation in the Electronic Environment," in Arnold Hirshon, ed., *After the Revolution, Will You Be The First To Go?* (Chicago, 1993), pp. 24-33. A good non-technical discussion is available in Barry Cipra, "Electronic Time-Stamping: The Notary Public Goes Digital," *Science* 261 (July 1993), pp. 162-63.

55 Some records managers clearly have a flawed understanding of the principle of provenance and its crucial role in establishing the reliability of records. Contrary to the assertion of Robert L. Sanders, the maintenance of the principle of provenance helps to ensure that records are what they purport to be: reliable evidence of actions and transactions. Relying upon the principle of provenance in order to ensure that records are reliable serves the interests of both the creators and subsequent users. See Robert L. Sanders, "Archivists and Records Managers: Another Marriage in Trouble?" *Records Management Quarterly* 20, no. 2 (April 1989), p. 13. An equally important aspect is programme accountability. For an insightful review of this issue, see Edward F. Barrese, "Adequacy of Documentation in the Federal Government: Accountability Through the Record," *Information Management Review* 5, no. 4 (1990), pp. 53-58.

56 Charles M. Dollar, "Appraising Machine-Readable Records," *American Archivist* 41 (October, 1978), pp. 423-30; Harold Naugler, *The Archival Appraisal of Machine-readable Records: A RAMP Study with Guidelines* (Paris, 1984).

57 In the 1970s and early 1980s I supported this approach. After a more careful consideration of the basic archival issues involved in appraisal for "informational value," however, I have concluded that evidential considerations must be elevated. In fact, a full understanding of the role of provenance in establishing both the evidential and the informational value of records presumes that records derive their initial value from serving the needs of the organization. Loss of the evidential aspects of records would mean that they "would have little more validity than what could be found in a random heap of newspaper clippings": Richard Carter Davis, "Getting the Lead Out: The Appraisal of Silver-Lead Mining Records at the University of Idaho," *American Archivist* 55, no. 3 (Summer 1992), p. 463.

58 Luciana Duranti has developed the very persuasive argument that archival theory dictates an emphasis upon evidentiary considerations: "The Concept of Appraisal and Archival Theory," forthcoming in *The American Archivist*.

59 In 1986, at a seminar at OCLC in Columbus, Ohio, I defined preservation of electronic records as maintaining access over time. A better way of expressing this idea is the term "continuous processing," advanced by Douglas van Houweling. See M. Stuart Lynn and the Technology Assessment Advisory Committee to the Commission on Preservation and Access, *Preservation and Access Technology, The Relationship Between Digital and Other Media Conversion Processes: A Structured Glossary of Technical Terms* (August 1990), p. 3.

60 While the per byte storage cost for electronic media continues to decline, the volume of digital information that requires periodic recopying will grow dramatically; the key challenge will be the relatively slow data transfer rate of available devices, particularly those produced for the mass consumer market (e.g., DAT or QIC tape-drives and cassettes), where price, not performance, is critical. Given a substantial increase in the volume of digital information, slow transfer rates may make it very difficult financially, or time wise, to copy the information to the next generation of technology.

61 Incompatible software systems also include software that has become obsolescent.