Highlight

OVERVIEW OF ARCHIVAL PRACTICES AND ISSUES

by Bruce Ambacher

Introduction

In the midst of preparing this overview of archival and data management issues which impact geospatial data, imagery, and remote sensing data, a trade newspaper provided a rich example of the practical utility and purpose of imagery and remote sensing data. It showed the value of applying the discipline and practice of archives, especially electronic records archival practice, to organizing and preserving images and remote sensing data. The cover story of the June 9, 1997 issue of *Federal Computer Week*, "Mapping: Marines take new IT to Sierra Leone," noted that the U.S. Marine Expeditionary Units supporting citizen evacuations in Sierra Leone and the Congo were relying on a prototype Remote Replication System developed for the National Imagery and Mapping Agency to produce tailor-made, digitally produced maps on demand. The maps were so current that information from previous flights could be incorporated before subsequent flights began. In the past, pilots relied on older maps cut up, pasted together, and annotated by hand. The new system proved so beneficial that it was used to provide "tailored evasion charts carried by individual marines going ashore to conduct the evacuation." Truly a real-time, high technology application that might even thrill Tom Clancy.

An incident which took place six years ago, while neither as technologically advanced nor as centered on imagery, also reflects the centrality of information: Shortly after the fall of the Berlin Wall an East German "mob" besieged the headquarters of the Stasi, the East German Secret Police; as dreaded a symbol of Communism as the Wall itself. Initially the mob sought to locate, ransack, and destroy the hundreds of thousands of case files accumulated during four decades of Communist rule. The investigations that the case files summarized symbolized the authoritarian state's violation of its power over its citizens. Calmer heads prevailed and the records were placed under the control of officials who would preserve them for later use as evidence against the state that created them, against the Stasi and its officials. (*New York Times*, November 15, 1991, p. A-11.) Today the German Bundesarchiv is grappling with the issues of preservation and access to both the case files and related electronic indices.

Mob action against records – a byproduct of government, corporate, or institutional activity – has occurred throughout recorded history. Records symbolize authority and power and can document abuse of that authority. An Egyptian mob in 2200 B.C. succeeded where the East German mob was held back. It attacked the kingdom's archives and destroyed property boundary records used each spring to redraw property lines after the annual Nile River floods. The mob, frustrated at the decline of central government authority and increasing food shortages, hoped the absence of valid boundary records would force land redistribution. There is no record that redistribution occurred. (Posner, 1972, p. 85-86.)

Governments also have burned books and records to prevent citizens from seeing and independently evaluating facts which do not conform with their own credo and as a way to obliterate or distort the past, denying citizens access to information and the chance to make independent judgments. Archival materials, special collections, and rare books all provide windows on the past, windows which have direct relevance and applicability to the present and the future.

Archival Practices Through Time

Man has maintained archives nearly as long as he has had writing. Prior to the written word, village elders and wisemen maintained and passed on history and legend through epic poems, song, saga, and art. With the written word came the need to preserve what was written or otherwise documented. For more than five thousand years man has relied on archives to preserve and understand the past, improve the operations of government, maintain the cultural heritage, and establish and protect the rights of the sovereign and, in the past two centuries, the citizen.

One measure of the prominence of archives in the ancient world is seen in their contents. Archives of ancient Egypt, Sumeria, Persia, Greece, and China contained laws and decrees, tax rolls and citizen registries, daybooks of the accomplishments of the ruling class, diplomatic records, maps, financial accounts, transcripts of trials, business contracts, plays and orations, lists of the winners of the Olympic games, minutes of public meetings, and official dynastic histories. Ancient archives also contained the records of private citizens. In both Egypt and Republican Rome archives are known to have contained deeds and business contracts (perhaps to insure that the state received its cut), prominent family papers, and even the records of prostitutes. Scattered portions of ancient archives have been found on clay tablets, papyrus, parchment, bamboo slips, bones, tortoise shell, leather, wooden tablets, and increasingly on paper, after its invention by the Chinese in 200 B.C. (Posner, 1972, passim.)

Another measure of the prominence of archives throughout history is seen in their location. Ancient archives are known to have existed in royal palaces, in special purpose buildings in the government square, and in various temples including the Metroon – the temple of the mother of the gods – in fifth century B.C. Greece. The ruins of some purpose built archives have shelv-

ing for up to 20,000 clay tablets from the different creating agencies. The organization of the tablets reflects filing and retrieval systems which could still be recognized and utilized today. Many were located in the basements of palaces and temples to achieve better temperature and humidity control. At least one archives is known to have had running water as a means to achieve better humidity control. (Posner, 1972, passim.)

Archives are also known to have existed in the tents of world conquerors. In 330 B.C. Alexander the Great was in the process of conquering his known world when a fire in the tent of his Chief of Chancery destroyed his records. Well aware of the role archival records played in his successful governing of conquered lands, Alexander ordered his Chancellor to contact all satraps and military commanders and instruct them to provide copies of all records they had previously forwarded to Alexander. (Posner, 1972, p.127.) Perhaps the highest praise for the role of archives came from Aristotle when he proclaimed archives to be one of the "indispensable" institutions of government. This perception is still valid today.

With the fall of the Roman Empire and the rise of the Roman Catholic Church as the symbol of stability, authority and continuity, the most significant archives existed within the church. Prior to the emergence of the nation-state, the semi-nomadic rulers deposited extant government records with the churches and monasteries for safekeeping. Official records were maintained along with hymnals, religious texts, and correspondence. (Posner, 1972, passim.)

The traditional perception of archives and archival records existing to document and protect the rights of the sovereign gradually shifted to a view in which records were considered property of the state, not the ruler, and as symbols of the power and prestige of the emerging nation-state. The most significant event to advance this emerging view was the French Revolution. In 1789, the "Citizen" replaced the King as the ruler of France. This concept carried over into records as the Republicans debated what to do with the records in more than 1600 archives across France. In 1790 the Assembly established the Archives Nationale to care for the records of new France and to take custody of the records of old France in order to establish and protect the rights of the citizens. Four years later the National Assembly passed one of the most far-reaching pieces of archival legislation when it decreed: "every citizen is entitled to ask in every depository." Many archivists hail this as the roots of the contemporary freedom of information and sunshine legislation on the state and national levels.

The Archives Nationale's early policies established the modern state's responsibility to care for the records of the past and confirmed the concept of an independent, neutral national archival institution housing the state's records. It also clearly enunciated two basic principles of modern archival theory which endure – respect des fonds and respect pour l'ordre primitif. Restated by the Prussians a half century later as Provenance and Original Order, these concepts provide for separating the records of one creator from any other creator and for maintaining the creator's arrangement pattern for the records whenever it can be identified and maintained (Posner, 1940). Examining records in the order the creator established provides insight into the records, their use, and their interrelationships.

Archival Practice in the United States

Archival concepts in America have evolved since colonial times. British colonial governments had "records managers" as part of the bureaucratic structure. Thomas Jefferson even included records among the "long train of abuses and usurpations" listed in the Declaration of Independence as justifications for independence from Great Britain: "He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records. .

The new nation was both present and future oriented. Further, British colonial records sent back to Great Britain during the war for safekeeping, were not returned. While the elite citizenry of several communities established historical societies, beginning with the Massachusetts Historical Society in 1791, to house manuscripts and books, and facilitate genealogical research, public archives and record keeping suffered. The prevailing concept of limited government did not include archives as an essential core function. Individuals such as Charles Thompson and James Madison performed yeoman service as recording secretaries (and *de facto* archivists) of the Continental Congress and the Constitutional Convention; their official papers provide revealing insight into those deliberative bodies. Letterpress editions of notable public papers, such as Ebenezer Hazard's 1778 letterpress collection of state papers, Gales and Seaton's *American State Papers: Documents, Legislative and Executive*, and Peter Force's *American Archives . . . A Documentary History of . . . North America*, fostered a false sense of confidence that our records were being preserved. Periodic major fires, such as those which destroyed the War Department in 1800, several government buildings in 1814, and the Treasury Department in 1833, prompted calls for a federal "hall of records." The first century and a half of federal government was marked by nearly 300 major and minor fires involving government records which occurred with increasing frequency throughout the nineteenth century. Fires, coupled with the growth in government activity and the corresponding growth of records, prompted repeated calls for a hall of records or a national archives. Rutherford B. Hayes was the first president to formally call for a hall of records in his Annual Messages of 1877 and 1878. He appointed a Records Commission which issued the first of more than 40 bills for a national archives.

The growing movement within the government for better facilities for its historical records coupled with the rise of academic professionalism as symbolized by graduate education and the emergence

of discipline based doctoral degree programs. Historical and political science programs, especially, rely upon widely available, systematically organized manuscript collections, archival records, and other primary and secondary sources. By the turn of the century the American Historical Association, established in 1884, set up first a Historical Manuscript Commission and then a Public Archives Commission, as part of a three decade effort to establish a national archives. Both were headed by J. Franklin Jameson who worked diligently with scholars, politicians, congressmen, journalists, and related professionals to push the need for a "national archive depository." In 1913, Congress authorized study of archival buildings in Europe and development of building plans; in 1926, it finally appropriated funds to construct the building. The National Archives Building, begun in 1930, was occupied in 1935, and completed in 1938 at a total cost of $12,250,794. The long struggle was over. (Cox, 1983; McCoy, 1985; Gondos, 1981; Walch, 1985; Bradsher, 1988)

Today the National Archives and Records Administration (NARA) has more than 2,500 employees in 40 buildings across the continental United States including federal records centers, regional archives, presidential libraries, and two headquarters buildings in the Washington, DC area. NARA has responsibility for more than 21,500,000 cubic feet of records from the congressional, judicial, and executive branches of government spanning nearly 250 years of American history. The physical media of the information ranges from ink on parchment to contemporary images encoded on magnetic media. (http://www.nara.gov)

Contemporary Records Issues

All creators and disseminators of contemporary information, including geospatial data, imagery, and remote sensing data, face the same core issues of the explosive growth in the volume of information they create and hold; an increasing dependency on technology; decisions on what to keep, how to keep it, and where to keep it; and ensuring access to what is retained across time.

VOLUME

The growth in the volume and the variety of formats for records in the last half of the twentieth century has been unprecedented. This phenomenon is evident not only in government records but also in the records documenting most other aspects of human activity across the globe including academia, business, religion, philanthropy, and leisure. One example of the volume growth on the federal level is seen in the U.S. courts where one-half of all extant cases have been created since 1980. A second example is the growth of archival electronic records. While NARA accessioned its first electronic records in 1974, three-fourths of its electronic records collection has been transferred in the last five years. Some government officials claim that virtually every government record is electronic for some or all of its life cycle. This requires a quantum shift in archival structure, procedures and allocation of resources.

APPRAISAL

The large volume of federal records which NARA has deemed archival and moved into its physical custody, or allowed creating agencies to retain for varying periods of time, represents only a tiny fraction of all federal records created and routinely destroyed every year. NARA estimates it retains less than five percent of all paper records and less than one percent of all electronic records created and used in federal agencies. NARA's appraisal standards are rigorous. The percentage of information retained varies between agencies and between programs within one agency. Generally more information is retained from programs which focus on collecting and analyzing information, whether involved in research and development, policy support, or scientific research. Certain media types, such as photographs and cartographic materials, also have higher percentages of retained information due to the specialized uses of those media.

Archival records are appraised for their enduring values. Some records provide evidence of the routine conduct of official business and demonstrate how and why the creator performed its duties. Other records are retained because they document legal rights for the creator or another party. The vast bulk of archival records, however, are retained for their informational value. The secondary uses of archival records are varied and often quite unique. Archival records can be used to educate and entertain as well as inform and enrich. Maps, photographs, remote sensing data, permits, and unrelated reports can be used to document climatic change, locate toxic sites, and inform scientific predictions. (NARA, 1996)

ELECTRONIC RECORDS

Archival repositories and data centers now have over a quarter century of experience with preserving and providing access to electronic records. Electronic records are the first type of archival record to separate the information from the physical medium upon which it is recorded. They also are the first records in which the copy can be equal to or better than the original due to the recording process and to media refreshment procedures.

The bulk of the early digital collections of institutions such as NARA, the Roper Center, the Inter-University Consortium for Political and Social Science Research, and the National Archives of Canada are data bases – surveys, questionnaire responses, voter tabulations, and simple data bases. Even with the experience with, and emphasis upon, data bases the richness and variety of digital collections can be seen by examining the repositories' inventories of holdings. NARA's digital holdings, for example, include anonymized statistical samples of tax returns, decennial census responses, public opinion surveys conducted around the world, fertility studies, retirement history studies, demographic data, scientific research studies, stock ownership reporting, Vietnam era military data, and educational testing results. (NARA, 1995; http://www.nara.gov/nara/electronic)

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Most data bases were created as flat files using ASCII or EBCDIC coding and processed on main frame computers in dedicated computing centers. Long term preservation of the information consisted of maintaining copies of the data offline in a controlled environment, periodically sampling the data to ensure its continued readability, and refreshing the physical media to prevent loss of data through deteriorating media. Since the information was usually maintained in a format that was not dependent on any specific computer system or software package these procedures are sufficient to provide long term access to the information. While these procedures are still viable for flat files more is required to preserve contemporary digital information.

Increasingly computers are used to create, modify, and store textual electronic records, object-oriented data bases, digital photography, scanned documents, geospatial data, and computer-assisted designs. Increasingly computer systems function as data warehouses and dynamic web sites providing online access to both metadata and data through customized searches. Future use of many newer types of digital information depend upon preserving and conveying the "look and feel" as well as the content of the information. This requires retaining, or emulating, the hardware and the software in which the information was created. Preserving the information over time requires migration of the information in addition to refreshment of the media. Providing future researcher access to the information entails more than just making a copy of the data available; it may require providing access to a computer that will perform as if it was the original system used to create the information. It also may require providing online access to your information, conducting much of your reference work through the Internet, and providing researchers the opportunity to download a copy of the data they wish to acquire. Indeed, many specialized data centers function this way already.

Ultimately there is a correlation between the complexity of the storage requirements and the costs of preserving that information. Archives and data centers must increase their funding base to ensure appropriate preservation and access. Researchers may have to bear some of those increased costs.

ARCHIVAL CUSTODY

When an archives will gain custody of the records which have been appraised as permanent and scheduled for transfer is a more important consideration with electronic records than with other physical media types due to the fragility of the media. Federal law, for example, requires federal agencies to transfer most permanent records when they are 30 years old, although earlier transfers are encouraged (44 USC 2107(2)). Electronic records archivists encourage and negotiate the earliest possible transfer. If an electronic records archives waited up to 30 years for permanent electronic records to be transferred, given the technological changes that occurred over the past three decades in the computer arena and the increasing pace of change, it is quite conceivable that the media would have deteriorated and the information on it would be unprocessable on any extant computer.

Archives rarely are on the "cutting edge" of the electronic records technology curve. Indeed, an archival program for electronic records is more correctly identified as "trailing edge." Many of the archival issues surrounding various hardware and software applications, such as backward compatibility between applications versions and exchange ability between competing softwares, and offline storage and retrieval, will arise first as current business issues. Contemporary users require vendors to address these and other issues and to incorporate solutions in mature versions of the hardware and software applications. Hence some archival needs are met at no additional expense before the electronic records are transferred.

Electronic records archives also can derive short term benefits from being on the trailing edge as current users might be more willing to transfer the applications and systems as well as the data. This permits the custodian to provide researcher access while developing long term migration and preservation strategies.

Timely transfer of electronic records to archival facilities also is affected by their continuing utility to the creating agency, by their compactness, and by the specialized staffs often required to provide full access to the information. Continuing utility is reflected in time series replacing annual reports; in reports including reference to, and full analysis of, older data; and in multiple analyses of master data bases. Unlike paper records, physical volume is not a consideration; records managers are not "pushing" the paper out the door to make room for this year's files. The falling price of computer storage also works against timely transfer; too often it is easier to add disk storage than it is to download and transfer the data.

GIS AND REMOTE SENSING DATA

The kinds of records ASPRS members create and use illustrate the transition underway in the records and information of many specialized disciplines. The past two decades have seen imagery move from a film base to magnetic media, and analog cartography evolve into geospatial data displayed in geographic information systems. This same time period has witnessed exponential growth of holdings. One recent accession of images NARA received from the Central Intelligence Agency, images from the CORONA, ARGON, and LANYARD satellite systems, contained more than 800,000 images with 17,000 cans of original negative film and an equal number of duplicate positive film, plus 225 cubic feet of related collateral data (unpublished NARA fact sheet, 1997). Other imagery repositories, such as the National Satellite Land Remote Sensing Data Archive of the EROS Data Center, also are responsible formillions of images on both film and magnetic media.

Reluctance to transfer electronic records is especially prelevant in more specialized, more scientifically oriented research disciplines which rely

upon observational data such as space data, remote sensing data, seismic recordings, meteorological and climatic tabulations, and clinical studies. Researchers depend on vast amounts of information to obtain sufficient observations, to determine patterns, and to establish trends. Researchers also are reluctant to part with any potentially useful information and exhibit disdain for any process such as organized appraisal which destroys any portion of the information available for their research. Finally, researchers are just that. They are not trained in the care and preservation of records. They do not want to dilute their research focus by paying attention to such routine housekeeping matters.

Searching for Solutions

Information managers, data managers, and archivists supporting the geospatial and scientific research communities are addressing issues relating to creation, appraisal, volume, and preservation. They also are benefitting from investigations into these issues by the broader research community and archivists and information managers.

FEDERAL GEOGRAPHIC DATA COMMITTEE

The premier activities for geospatial data are being directed by the Federal Geographic Data Committee (FGDC). This federal interagency committee, organized under Office of Management and Budget Circular A-16, had its authority enhanced by Executive Order 12906, signed by President Bill Clinton (April 11, 1994). With representatives from 14 executive branch agencies, the FGDC is providing a forum for coordinating the federal government's more than six billion dollars in annual expenditures for geospatial data. It is working on several fronts to develop the National Spatial Data Infrastructure: The National Geospatial Data Clearinghouse has been established to reduce or eliminate creation of duplicate data, provide access to extant geospatial data and metadata, and establish priorities for data creation. The FGDC developed and promotes the Content Standards for Digital Geopsatial Metadata describing geospatial data, and the Spatial Data Transfer Standard to standardize description of geospatial data and to facilitate exchange of geospatial data.

Through its structure of theme-based subcommittees and cross-cutting working groups the FGDC has developed and issued thematic standards for specific geospatial data themes of Metadata, Spatial Data Transfer, Wetlands and Deep Water Habitats, and Cadastral. Final public review is underway for Soils, Geodetic Point Profile, Digital Orthoimagery, and Digital Elevation. Seven additional standards are in early draft stages. The FGDC is encouraging data sharing between agencies and with state and local governments through the Clearinghouse. It is addressing data management through its Clearinghouse, Standards, and Historical Data working groups.

The Historical Data working group is responsible for raising FGDC member awareness of the continuing research value of geospatial data, promoting data management, and assisting records and information managers within FGDC member agencies in determining which geospatial data have enduring value. The working group has produced *Managing Historical Geospatial Data Records: Guide for Federal Agencies* (May 1996). This fact sheet explains relevant federal law and regulations, provides a series of questions to assist geospatial data creators in determining the enduring value of their data, and includes sources for further assistance and information. Many of the concepts are developed more fully on the working group's home page. The working group also assisted NARA in incorporating the Content Standards for Digital Geospatial Metadata and the Spatial Data Transfer Standards into NARA's regulations on transferring records with enduring value to NARA. More recently the group developed generic series descriptions for geospatial data to improve agency records management of geospatial data. Currently the group is accumulating information on costs of geospatial data creation, acquisition and maintenance to assist the geospatial community in understanding and budgeting for appropriate data management costs. (http://www.fgdc.er.usgs.gov/fgdc.html)

Within the last three years, the FGDC has encouraged nonfederal geospatial data creators and users to participate through cooperating groups such as 16 state GIS councils, the National Association of Counties (NACo), the National States Geographic Information Council (NSGIC), and related professional societies, and through direct discussions with geospatial data creators at the state and local government levels. (FGDC Newsletter, March 1997)

GEOGRAPHIC INFORMATION SYSTEMS STUDY

In 1996, four FGDC member agencies, the U.S. Geologic Survey (USGS), the Bureau of Land Management (BLM), the U.S. Forest Service (USFS) and the National Oceanic and Atmospheric Administration (NOAA), jointly funded the National Academy of Public Administration (NAPA) to study surveying and mapping activities of civilian agencies. The study is assessing their geospatial activities, determining current and future trends in geospatial data collection by public and private entities, and cataloging current best practices. NAPA was instructed to pay special attention to the role of geospatial data in keeping the United States competitive in a global economy, the appropriate role for the federal government in surveying and mapping, which (if any) federal roles could or should be privatized, and whether any consolidation could or should occur among federal agencies. The study's final report is expected late in 1997. (NAPA "Work-in-Progress," "Study of U.S. Geographic Information Resources," November 7, 1996; USGS briefings to FGDC Coordination Committee, November 12, 1996, May 6, 1997, July 1, 1997.)

CURRENT SPACE DATA INITIATIVES

No single effort in the area of space and scientific data is as large as that of FGDC for geospatial data. Recent activities illustrate some of the efforts to address long term preservation issues for large data collec-

tions: National Aeronautics and Space Administration's (NASA) National Space Science Data Center (NSSDC) sponsors an ongoing series of annual conferences on mass storage systems and technologies. The conferences concentrate both on the technical properties of magnetic storage media and on data management, data preservation, data archives, and access. (NASA, 1991)

For the past three years NSSDC staff have facilitated and led an International Standards Organization's (ISO) Consultative Committee for Space Data Systems (CCSDS) effort to develop a *Reference Model for an Open Archival Information System (ISO, 1997)*. Designated as a draft ISO White Book in March 1997, the model provides guidance to any large scale data creator or custodian on the responsibilities, services, and preservation activities associated with acting as a data archives. Several "annexes" provide scenarios of existing archives and discussions of migration issues. The working group expects to finalize the document in 1998. (http://bolero.gsfc.nasa.gov/nost/isoas/overview.html)

In 1995, the National Academy of Science's National Research Council produced *Preserving Scientific Data on Our Physical Universe: A New Strategy for Archiving the Nation's Scientific Information Resources (NRC, 1995)*. Sponsored by NARA, NOAA, and NASA, the study examined the current status of archiving observational and experimental data in the physical sciences, sought to establish principles and criteria for appraisal of such data, and suggested mechanisms and processes for appraisal and preservation of scientific data. The panel found data under utilized due to lack of knowledge about its existence, difficulty of access, and lack of funding for appropriate preservation, use, and dissemination. It recommended developing data management procedures coupled with enhanced interest and funding from policy makers to ensure that extant data are used broadly to advance science and benefit society.

PRESERVING DIGITAL INFORMATION

The Research Libraries Group and the Commission on Preservation and Access jointly sponsored a 1996 study, *Preserving Digital Information*, (RLG, 1996) which examined preservation and access issues related to "ensuring continuing access to electronic digital records indefinitely into the future." This task force focused on issues surrounding migration of information already in digital form and developed a cost model to provide some sense of financial implications for preserving large amounts of digital data. It found costs for storing one volume of printed material in a depository library running between $4.40 and $6.27 per year. The estimated corresponding costs for a digital volume in a hypothetical digital archives model ranged from $0.82 to $2.58 annually for storage and $2.79 to $6.72 annually for access. The task force endorsed the concept of distributed archives to provide both some redundancy in data preservation and to distribute the costs over a larger number of institutions.

Archival Electronic Records Costs

Finding actual cost information for various aspects of a digital archives program is difficult. Analyzing available cost data is surely the proverbial case of comparing apples and oranges. NARA first examined its costs relating to electronic records in 1977. The Center for Electronic Records' most recent cost analysis spans three fiscal years (October 1, 1993, through September 30, 1996) for accessioning and preserving its electronic records collection which is largely flat files, i.e. numeric data stored in ASCII or EBCDIC. The average cost of accessioning one data file was $186. Most of this cost was staff time to gain intellectual understanding of the file, prepare standard descriptions and documentation (finding aids), make a new master copy and a new backup copy, verify the contents, and prepare preservation reports. Less than $25 of the $186 cost are related to computer system and media acquisition and processing. Other costs directly related to preserving electronic records include annual sampling of the collection to ensure continued readability of the information, costing about $3,200 each year, and periodic media refreshment, cost about $40 every five or ten years depending on media life expectancy. These costs seem so reasonable because they are based on prorating the costs of computer systems and staff time across the entire accessioned collection of nearly 30,000 data files. They do not include costs associated with administrative overhead, appraisal, or reference. (NARA Center for Electronic Records, unpublished cost study, 1997)

The explosive growth of the Internet and resulting internal and external pressures to develop and populate world wide web sites has resulted in an overwhelming amount of information which must be uploaded, maintained, and refreshed. Many organizations have rushed to create web sites utilizing the latest imagery and interactive technologies. Too often, in their haste, they fail to consider the long terms costs for maintenance and refreshment. Recent informal queries to federal agencies regarding costs of creating and maintaining websites indicate it costs $15 to $25 to mount each image and up to $175 per image additional to properly maintain that image on that website for ten years. The latter figure includes estimated costs for maintaining appropriate backup copies, software and hardware upgrades, sampling, and media refreshment and migration.

Conclusion

The application of technology and enhanced research techniques to cartography, imagery, and space has advanced productivity and knowledge and improved the quality of life across a broad spectrum of activities. Advancing technology also has produced problems, especially in preserving data and information over time. Archivists, records managers, and researchers must work together to understand contemporary records and contemporary record keep-

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ing, to identify and adapt to the technological challenges, and to develop strategies to ensure that contemporary information is available to assist future researchers as they continue to advance man's knowledge and understanding of his world.■

REFERENCES

Brewin, Bob and Tillett, L. Scott, "Marines Take New IT to Sierra Leone" *Federal Computer Week*, June 9, 1997.

Bradsher, James G., "An Administrative History of the Disposal of Federal Records, 1789-1949," Provenance, vol. 3, no. 2, Fall 1985, 1-21.

Bradsher, James G., "An Administrative History of the Disposal of Federal Records, 1950-1985," Provenance, vol. 4, no. 2, Fall 1986, 49-73.

Bradsher, James G. ed., *Managing Archives and Archival Institutions*, London, 1988.

Commission on Preservation and Access and the Research Libraries Group, *Preserving Digital Information: Report of the Task Force on Archiving Digital Information*, Washington, DC, May 1, 1996.

Consultative Committee for Space Data Systems, *Reference Model for an Open Archival Information System*, Washington, DC, 1997.

Cox, Richard J., "American Archival History: Its Development, Needs, and Opportunities," *American Archivist*, vol. 46, no. 1, Winter 1983, 31-41.

Executive Order 12906, April 11, 1994.

Federal Geographic Data Committee, *Managing Historical Geospatial Data Records: Guide for Federal Agencies*, May 1996.

Federal Geographic Data Committee, *Newsletter*, March 1997.

Gondos, Victor, *J. Franklin Jameson and the Birth of the National Archives, 1906-1926*, Philadelphia, 1981.

http://bolero.gsfc.nasa.gov/nost/isoas.html

http://www.fgdc.er.usgs.gov/fgdc.html

http://www.nara.gov

Jones, H.G., *The Records of a Nation: Their Management, Preservation, and Use*, New York, 1969.

McCoy, Donald R. *The National Archives: America's Ministry of Documents, 1934-1968*, Chapel Hill, NC, 1978. Washington, DC, 1985.

National Academy for Public Administration, Work-in-Progress, *Study of U.S. Geographic Information Resources*, November 7, 1996.

National Aeronautics and Space Administration, *NSSDC Conference on Mass Storage Systems and Technologies for Space and Earth Science Applications*, 1991 (and subsequent years).

National Archives and Records Administration, *Information About Electronic Records in the National Archives for Potential Researchers*, Washington, 1995.

National Archives and Records Administration, *Information About the Center for Electronic Records*, Washington, 1996.

National Research Council, *Preserving Scientific Data on Our Physical Universe*, Washington, DC, 1995.

Posner, Ernst, "Some Aspects of Archival Development Since the French Revolution," *American Archivist*, vol. 3, no. 3, July 1940, 159-172.

Posner, Ernst, *Archives in the Ancient World*, Cambridge, MA, 1972.

United States Code, Title 44.

Walch, Timothy, ed. *Guardian of Heritage*, Washington, DC, 1985.

ABOUT THE AUTHOR

Bruce Ambacher is Special Assistant to the Director, Center for Electronic Records, National Archives and Records Administration, 8601 Adelphi Road, College Park, MD. He serves as NARA's representative to the Federal Geographic Data Committee's Coordination Group and as chair of the FGDC Historical Data Working Group.

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