

Digital Preservation of Information

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Abstract

With the vast amount of information available in the world today, preservation of information for future generations to learn from our past and present experiences, knowledge, and innovations is essential. From ancient times, knowledge has been passed down through the spoken word, written on scrolls, printed in books, recorded on cassettes or audiotapes, and now through technology we can preserve our information digitally. In addition to books, most webpages, audio files, video files, and information saved on websites within schools, universities, and companies need to be preserved. Preservation techniques and software are changing rapidly with the advancement of technology. Long-term preservation techniques are still unfolding to keep up with advances in technology. There is a vast abundance of resources available to assist in the preservation of data. Choosing the right resources depends on the specific facility and that facility's goals. There is a worldwide need to preserve data and adhere to standards to ensure the data will be available for future generations.

Digital Preservation of Information

Introduction

With the vast amount of information available in the world today, preservation for future generations to learn from our present experiences, knowledge, and innovations are essential. Digital preservation has been defined as “combines policies, strategies and actions to ensure access to content that is born digital or converted to digital regardless of the challenges of file corruption, media failure and technological change. The goal of digital preservation is the most accurate rendering possible of authenticated content over time” (ALA, 2010). Data must be accessible for use regardless of the format it is preserved. There are many methods of preservation used today including environmental climate control, binding, repair and maintenance, deacidification of paper, and digitization of original materials to maintain collections to make them more accessible to users (Harris, 2006). The digitization of books, historical archives, and corporate documentation was the first wave in digital preservation. In addition to written text in books and documents, the preservation of information that was born digital is changing as the technology landscape continues to evolve, making previously used technologies obsolete. The use of digital preservation software and continual updates can hopefully keep collections up to date for long-term preservation. Additionally, when preserving information and data, facilities need to “ensure compliance with standards and best practices for responsible stewardship of digital information” (ALA, 2010). Some of these strategies and best practices described by the ALA include technical specifications, structural metadata to ensure future access, identifiers, verification mechanisms, security measures, computing and networking infrastructure, storage of files at multiple sites, refreshing, migration, emulation, and disaster prevention and recovery programs. Licensing and copyright issues must also be considered. There are many facets to preserving information whether it is converted from the written word or born digital. “The goal of digital preservation is the accurate rendering of authenticated content over time” (Gracy, 2011). In this paper I will briefly review the history of preservation, importance of preserving information, standards of digital preservation, emerging technologies, and challenges digital preservation faces.

History and Importance of Preservation

Since ancient times, preservation of knowledge has been important. It began with stories being passed down through generations and then progressed to the written word on paper. Preservation at that time consisted “primarily of protecting items from all kinds of human and natural enemies by placing them in earthenware vessels and other types of containers” (Cloonan, 1993). Preservation has progressed since ancient times, however the premise behind preservation is the same meaning “the act or process of maintaining something in its original state or maintaining safety from damage and keeping the things in perfect unaltered condition” (Yadav, 2020). Information has a life cycle, and the deterioration of information depends on the medium of that information

and the relevance of the information to the time it is produced. For example, books can deteriorate from multiple factors including the type of paper, chemicals, and methods used in manufacturing in addition to environmental conditions such as sunlight exposure, temperature and humidity. Additionally, as society progresses and thoughts and ideas change, a book's lifecycle may end as it is no longer relevant. As early as the 1900s the Library of Congress has been attempting to minimize deterioration of books by protecting them from sunlight. Also, at this time some the roles of the preservationists included, "binding, repair, and other collections maintenance activities...silking or laminating them, cleaning and matting prints and photographs, and performing similar tasks" (Harris, 2006). As information and technology progressed, preservation techniques did as well. For example, the Library of Congress performed preservation activities such as pH testing, artificial aging tests on motion picture films, and studying other methods for environmental control. Oral histories, previously written, were placed on audiotapes to preserve the information. In 1966, disaster struck Florence, Italy when the waters of the Arno River rose causing devastating flooding. Included in this devastation was mud and water damaging Florence's Biblioteca Nazionale, a public library founded in the 18th century. Numerous state archives and over 1 million books were destroyed at the library due to the flood waters. Due in part to the tragedy, new standards and changes were developed to the field of preservation. Despite copious amounts of information born digitally, books are and will continue to be present. Traditional methods of preservation still exist today to preserve written works which will be around for many years to come. The Library of Congress is building a state-of-the-art facility in Fort Meade, Maryland which will "focus on storing books and special format collection such as maps and manuscripts" (Harris, 2006).

In addition to new standards and changes to the preservation of the written word and archives, the need to preserve digitized information and digital born information and publications, for example e-books and e-journals, is the current challenge for information professionals. The lifecycle of digital media is focused on obsolescence (Cloonan, 1993) of the medium on and for which it was developed. The long-term preservation of data needs to consider the changing of technology and the reformation of software to newer versions. Beginning in the 1950s, microfilm started to be used in libraries to store newspapers and continued through the 1990s to preserve diverse types of information. Microfilm was once the gold standard for reformatting print material and ensuring long-term access (Gracy, 2011). Now, many microfilms are being digitized for easier access to the public. Additionally other technologies once used frequently are becoming obsolete such as vinyl records, audiocassettes, laser discs, VHS tapes and CDs (Austin, 2018). According to Cloonan (1993) there are concerns regarding conversion to digital formats which include fragility of the medium, rapidity of obsolescence of the operation apparatus of each medium, ease of altering documents, and proprietary rights. All these concerns must be addressed when preserving digital information. In a technologically focused society, we all want information available at our fingertips and immediately. Digitally preserving information into accessible formats is essential to providing this service to the end user.

Preservation Strategies and Standards

There are many different strategies for preserving information, no one method will fit all organizations or data types. Thibodeau (2002) describes four concepts to consider when developing a strategy: feasibility, sustainability, practicality, and appropriateness. During the process of digitization, considerations include selection of materials to preserve, valuation requirements, priorities, planning of prototypes, metadata gathering, metadata formation, formation of data assortments, presentation of digital assets to delivery systems and warehouses (Shimray, 2018). Another aspect of the process is in relation to cost-benefit analysis. Many small libraries or historical centers cannot afford to invest in higher end or commercial software, nor do they usually have the infrastructure to support high-tech data management. They must approach their strategy from a practical standpoint. For these reasons, they may choose open-source software as opposed to commercial software. For any institution considering preservation software and tools, the ability to migrate the data is essential from one version to another once the previous version is obsolete as many software programs update to a newer version every year. A facility's preservation strategy should correspond to a component of their strategic plan which involves planning for the individual organizational needs and long-term preservation of materials. For example, The National Archives 2018-2022 strategic plan “embraces a vision that ensures ongoing access to extraordinary volumes of government information to bring greater meaning to the American experience. Digital preservation is critical to this work...” (Dferrieo, 2019). An academic library will have different goals and uses for preservation than other facilities such as museums or corporations. It is important their information is available for citation for scholarly works for years to come. This focus will be different than the small historical institution or the large National Archives. Once the strategic plan is in place, a strategy for preservation can be considered. After the strategy for preservation is evaluated, then appropriate software and software tools can be chosen. These tools range from open-source vs proprietary software, limited tech support vs full support, embedded content vs nothing embedded, or lossy compression vs lossless compression, depending on the type of files or artifacts which need to be preserved. (Univ. Of Illinois, 2021). “Long term preservation encompasses indirect efforts to increase the life expectancy of the object.” (Tripathi, 2018). Digitally preserving an object requires that the object itself also be carefully preserved. These efforts include preservation techniques, metadata, and storage methods to maintain records and objects for long term use.

There must be standards for preserving digital information. These standards are in place to ensure usability, durability, and longevity of digital content and access to the content. The ALA (2008) describes the need for continual research on metadata, software, operating systems, and life cycle management technologies that can hopefully prolong digital works. Advocacy of these policies should be available to the public for transparency. This standard is displayed at the National Archives. Their preservation framework was released for public view, comment, and input. The Society of American Archivists website has multiple standards listed relating to many distinct aspects of digital preservation. Their Standards Portal is “designed to educate the archives community about the value and role of standards, enhance the application of standards

to practice, and facilitate successful partnerships with related information standards organizations with mutual concerns and interests. The portal includes SAA-approved standards, guidelines, and best practice documents” (Society of American Archivists, 2021). The Library of Congress also provides access to “sustainable practices and guidelines” in Federal Agencies Digital Guidelines Initiative (FADGI). As there are many aspects of digital preservation which vary based on the facility, there will be general standards such as presented by the ALA. But to address the various aspects of preservation, differing specific standards should be in place as found on the Society of American Archivists website and the FADGI website.

Emerging Technologies and Tools in Digital Preservation

A vast majority of information is created, communicated, and stored digitally today. Many recent technologies and tools are available for digital preservation. Choosing the right tool for a specific setting is important. Depending on the institution’s function (public library, museum, corporate, academic setting, etc.) the digital preservation software and tools may vary. These tools are designed to “enhance and enable digital preservation workflows” (Stamp, 2021). Principles of digital preservation may be universal, however actual software and applications will vary based on the setting and need of the institution. According to Stamp (2021) when considering preservation software or tools certain considerations must be examined. These include open-source vs commercial software, enterprise-level solutions vs micro-services, describing workflows, specifying clear requirements, changing and evolving requirements, sustainability of tools and community participation. Gracy (2011) lists steps for placing an object in a digital format including “identifying file formats, generation fixity values, checking for viruses, generating metadata records for objects, converting files to a preservation-ready format, and assigning persistent identifiers to files”. Preserving files in a digital format is not as simple as placing it on microfilm anymore. Due to the many diverse types of objects, software involved, technology, etc., digitizing information takes planning. Included in this planning is disaster planning and risk management planning to ensure the information is kept safe. According to Tirpathi (2018) the LOCKSS (Lots of Copies Keep Stuff Safe) and iRODS (Integrated Rule Oriented Data Systems) are systems which preserve data but also are aimed at disaster planning.

One of the earliest reasons for digital preservation was for libraries to preserve written words. Microfilm first was used for newspapers to decrease the amount of space required for storage. Libraries now create digital copies of books and non-book materials for many reasons including: to protect the original from further damage, replace originals if they are no longer able to be used, or to provide access to recent technology desired by end users (Gracy, 2011). Digital preservation is necessary so information does not disappear and can be accessed for knowledge and future use. Technology can also be used for repair and maintenance of books to preserve them. The Library of Congress uses technology and software to aid in the maintenance of and repair of books. For example, they now can download from their automated catalog, including author, title, and call number, into one of their binding automated systems, BCCD’s system LARS (Library Automated Retrieval System) to bind and label books

(Harris 2006). These methods of preservation are aimed at library projects, archives, and research to provide long term, digital access.

Digitizing information can allow researchers ways to search and access all types of materials allowing for avenues of references that were previously unavailable. Many of these resources are placed in digital libraries or digital repositories. Works placed in digital libraries or repositories need to be able to be accessed for many years in the future. A repository is used to “preserve the intellectual output irrespective of format and application used to create resources” (Madalli, 2012). Deciding on a repository, criteria should be considered. According to Madalli (2012), considerations for choosing a repository include: file features (size, format, etc.), integrity check, metadata, licensing rights, and authentication. Examples of discipline-specific repositories are *Deep Blue Data (UM)*, *Registry of Research Data Repositories*, *DataONE*, *Dataverse Project*, *Dryad*, *SPARC*, *Open Context*. Repositories should also have a preservation policy which would include a successor format available for easy migration once technology becomes obsolete (Univ. Of Michigan Library, 2021). Repositories must be able to support digital content for long term use. Gracy (2011) describes three types of repositories: distributed replication (Lots of Copies Keep Stuff Safe – LOCKSS), repository and toolkit, and formal OAIS (Open Archival Information System). Of these repositories, the formal OAIS is best designed to “support preservation from ingest to long-term storage to dissemination” (Gracy, 2011).

The use of technical and administrative metadata is also needed to preserve information digitally. Madalli (2012) describes aspects of metadata that are important when addressing preservation. These aspects include technical details of the format, structure, and use of the content; history of any changes performed on the data or object; authenticity information such as custody features; and the responsibility and rights of the document. It is important for repositories or other storage media to have the ability to present all information on the preserved object for the user to have access. This becomes especially important when discussing copyright and licensing issues of the object being preserved.

There is a deluge of digital born data being developed for education, entertainment, or commercial ends. Preserving digital born data is a complex task, particularly to determine what needs to be preserved and how to best preserve the information. Within the digital community, users want instant gratification when searching and retrieving information. One company that is a driving force in this arena is Google. Google’s mission statement is “Our company mission is to organize the world's information and make it universally accessible and useful” (Google, 2021). “The technological environment in which Google thrives is enabling a new digital humanities scholarship – intensely collaborative, interdisciplinary, and enable by computing tools for finding new meaning through data mining, creative visualizations, and other ways of pushing the boundaries of existing documentation and evidence” (Conway, 2021). The objective of preservation of digital data is to preserve and organize digitally born data for “future use by acquiring, maintaining, transforming, and delivering digital assets” (Conway, 2021). The OAIS (Open Archival Information System) repository model, as again described by Gacy (2011), aims to provide permanent, or indefinite long-term preservation of digital information. This is one model that can hold and organize digitally

born data. Another model is the DCC Lifecycle Model which can be implemented for all types of information.

A task force was commissioned by The Commission on Preservation and Access and the Research Libraries Group. This task force developed the *Preserving Digital Information: Report of the Task Force on Archiving of Digital Information* in 1996, which focused on the challenge of “preserving the integrity of materials already in digital form and retaining the ability of users to retrieve, display, and otherwise use these materials in the face of constantly changing technology” (Waters, 1996). This concept of retaining digital information, the methods to preserve, and the ways to ensure access to the future, despite the changes of technology, is such a principal issue a task force was developed to tackle the problem. The major findings this task force attempted to address were the underlying needs of the preservation community to be able to keep records and information secure and accessible for future use. These findings include: “[1.] The first line of defense against loss of valuable digital information rests with the creators, providers, and owners of digital information. [2]. Long-term preservation of digital information on a scale adequate for the demands of future research and scholarship will require a deep infrastructure capable of supporting a distributed system of digital archives. [3]. A critical component of the digital archiving infrastructure is the existence of a sufficient number of trusted organizations capable of storing, migrating, and providing access to digital collections. [4]. A process of certification for digital archives is needed to create an overall climate of trust about the prospects of preserving digital information. [5]. Certified digital archives must have the right and duty to exercise an aggressive rescue function as a fail-safe mechanism for preserving valuable digital information that is in jeopardy of destruction, neglect or abandonment by its current custodian” (Waters, 1996). Although this report was written over 25 years ago, their findings are just as relevant today. Disaster planning is a vital component of digital preservation. One system which is consistently mentioned is the LOCKSS (Lots of Copies Keep Stuff Safe) philosophy. By keeping data in multiple places, should disaster strike a facility, the information will be safe elsewhere. Also firewalls, data recovery, and backing up of files can help keep information safe.

There are many software applications and tools available for digital preservation. Some of these are BagIt File Packaging Format, Bagger, BagIt-Python, BMF MetaEdit, and PREMIS which were found as reference from the Library of Congress. Another tool registry is the Community Owned Digital Preservation Tool Registry (COPTR). This registry “acts primarily as a finding and evaluation tool to help practitioners find the tools they need to preserve digital data. COPTR aims to collate the knowledge of the digital preservation community...in one place” (Stamp, 2021). Digital Curation Center (DCC) offers support and advisory services. The Open Preservation Foundation is a “global not-for-profit membership organization working to advance shared standards and solutions for the long-term preservation of digital content” (Open Preservation Foundation website). These are but a few samples of tools to be used to aid in the digital preservation process. Discussion is also ongoing about using block chain technology to preserve data. During a routine Google search, one can find many software tools for digital preservation. The types of files and formats again will vary and depend on the specific institution, what they are preserving, and what their goals are. Despite the tool used, preservation of information is vitally important. So much so that

the Library of Congress has built state-of-the-art facilities for storage and special media conservation activities - The National Audio-Visual Conservation Center at Culpeper, Virginia and the High-Density Collections Storage Facility at Fort Meade, Maryland.

Digital Preservation Challenges

Despite the need to preserve diverse types of information today, the digitization of preservation continues to have challenges to overcome. Long-term preservation is at the top of the list. The storage medium on which the information is preserved or contained must be sustainable for the future to access this information. For example, many newspapers continue to be stored on microfilm. But to view the film, a microfilm reader is necessary. Not all facilities will have this reader, therefore the information is inaccessible. Advances in technology to new devices and software can render some information obsolete. A challenge is to preserve the information to a format that will be able to be accessed in the future. "A suitable, sustainable and scalable storage medium for a digital archive is required to manage vulnerability to rapidly evolving technology" (Tripathi, 2018). To help mitigate this challenge in an environment of rapidly changing technology, it is important to place the data on software or in a repository that can migrate the data to a current version of the file format. If we are talking about an object, not only do we need to be able to preserve the digitized format, but the actual object as well. Therefore, environmental controls must also be utilized. Researchers at the Library of Congress and the Smithsonian Institution have studied ways to adjust the environment to protect artifacts. Many storage facilities and renovations to buildings have taken place. This will lead to another challenge, economic sustainability.

Many universities, CEOs, museums, and board of directors are under tight budgets these days. Many preservation and conservation funds are being cut. Those facilities with newer environmental control spaces, it is more cost effective to keep the original artifact/information within that facility. "While short-term digital projects often have been well-funded by granting agencies.... long-term digital preservation programs have had significant difficulty in sustainability..." (Gracy, 2011). Gracy goes on to describe interviews from suppliers and vendors from the digital preservation market who noted that legal obligations, either for business requirements or to fulfill part of the company's mission, was the key reason for preserving information (2011). Despite the reasoning for digital preservation, failure to embrace the technology for access for the end user can spell disaster and obsolescence for the organization.

Proprietary and copyright issues are also challenging in the digital world. Mass digitization of works calls into question who owns the publication? Are they in the public domain? How do libraries and universities navigate copyright laws when forming a digital library and developing a circulation of books and resources? "Creative Commons is a nonprofit organization that promotes the sharing of creative works and knowledge" (Minnow, 2018) This organization provides licensing to writers to keep their copyright status while allowing the public access to their works. In the academic arena, researchers are publishing their studies electronically, allowing more people to view and build on their research. Considering this, proprietary issues arise for the journals. Many journals charge fees to access their works. If a researcher publishes his study in a

journal charging a fee, the number of people who can access it is lessened. This brings in an accessibility issue. In 2012, Harvard University sent a memo to its faculty stating that due to the rising costs of subscriptions, at that time up 145% from the previous 6 years, subscribing to these journals was no longer financially feasible (Joseph, 2018).

Another challenge is preserving the authenticity and quality of the objects. “One of the thorniest problems that digital preservationists face in creating and maintaining trusted digital repositories is how to guarantee that authenticity of digital materials over time” (Gracy, 2011). Particularly data born digitally, either videos, music, art, or other objects, preserving these without disturbing the quality of the object is essential to preserving the actual artifact. Conway (2010) states “for conservators, treatment quality is a core goal of the profession’s code of ethics”. As technology advances and the need to update systems to maintain access to information, will some of the quality diminish? These challenges are not alone. Others include risk management and disaster prevention methods, and the training of new preservationists with the use of previous and modern technologies. As technology advances and as the amount of information available continues to multiply, there will continue to be ongoing challenges for the digital preservation community.

Conclusion

The vast amount of information today from physical objects, artifacts, music, art, books, and information that is digitally born such as e-books, e-journals and social media sites is astounding. Preserving not only today’s information, but information from our past into a digital format to provide quick, easy access to the user is challenging. The principles of preservation “need to be compared to recent technological advances in the formation and storing of texts...” (Cloonan, 1993). Ever-changing technological advancements, long-term methods of preservation, budget cuts, and licensing issues are only a few of the challenges facing digital preservationists. Additionally, preservation of original objects, books, manuscripts, and archives continues as well, splitting budgets even further. This paper only touches on the surface of digital preservation and the emerging technologies. The future of digital preservation lies in using technologies effectively to preserve information, build digital collections with open access to reach most users, maintaining best practices and standards for preservation, and keeping up to date with the latest technology and migration procedures to continually be able to access information. Keeping abreast of copyright and licensing laws is vital to providing appropriate digital access to authors of various works and scholarly communication. Leaders of institutions need to have a grasp of the preservation process, including knowing what to preserve and how to budget for the preservation to keep within their strategic planning goals. “Whether working with born-digital data or digitized copies of physical objects, [we] must understand how to identify the best means of describing, storing, and providing access to that content today, and evolve those processes to maintain the integrity of content over time” (Gregory, 2018). Digitally preserving our works and our lives for future generations, as generations before us have done, is essential to help gain knowledge, foster new innovations, and ensure the information does not disappear.

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