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USE OF INFORMATION TECHNOLOGY BY THE LIBRARIES IN DIGITALLY PRESERVING OF INFORMATION RESOURCES IN THE 21ST CENTURY

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Abstract

The fact that the risk of loss of data in digital formats are very much greater than any other physical form and thus is required to be addressed in greater details. We always remain in fear that the access to digital resources is threatened more by technological obsolescence and to a lesser degree it is thought to be due the fragility of digital media. The rate of change of technologies in this world of growing technologies over shorter periods of time spans is such that we always remain in fear that the information may be rendered inaccessible even within a decade. Thus we may say that preservation is an immediate challenging issue for digital resources than for traditional resources. Digital materials are different from physical materials, in particular because their content can only be delivered by computer processing. Their preservation is difficult and complex. There is need for long-term digital preservation systems and strategies that shall enable the survival of digital information. This article centers on libraries use of information technology in preserving informational resources in the 21st century. It discusses softwares used in preserving digital resources. The paper recommends that libraries must promote the adoption of appropriate technology that will facilitate access and preserve digital asset for long-term. Policies are needed on what to preserve for the long term, that is the need for appropriate preservation policies and resources which address problems of retrieval, technical obsolescence, physical deterioration, and authenticity. Solutions are required to practical and technical issues that include cataloguing digital materials, dealing with technical obsolescence and the physical deterioration of media, and to problems of authenticity.
Keywords: Information technology, preservation, libraries, digital information, 21st century

Introduction

When paper was the main medium globally adopted for storing knowledge and information, libraries were the obvious and natural places responsible for guarding, protecting and maintaining all information stored in printed formats, such as, books, papers or other. It was not until 1960's that archivists and librarians felt concerned about the preservation of electronic records (Hirtle, 2010). In the early 1990's, materials started being ported from printed formats to digital ones, being "reborn" digital. With an exponential growth observed during the 1990's, the volume of information available on the Internet expanded as well. However, unlike printed formats, its ephemeral existence and highly volatile availability were shortly noticed. Today, digital information is ubiquitous, patrons of information do not have to go into libraries to get it or to use it. They obtain and use information at home, in the office, in the classrooms, and in anywhere by making use of desktop and laptops, smartphones and tablets (Etebu & Zacchaeus, 2020).

Resources of human knowledge or expression, whether cultural, educational, scientific and administrative, or embracing technical, legal, medical and other kinds of information, are increasingly created digitally, or converted into digital form from existing analogue resources. Where resources are ‘‘born digital'', there is no other format but the digital original. Digital objects include texts, databases, still and moving images, audio, graphics, software, and web pages, among a wide and growing range of formats (Gbaje, 2011). The sheer volume of digital information to preserve is immense and will continue to grow over the years. Electronic contents are proliferating fast and libraries worldwide are racing to preserve information for the next generations before technology obsolescence, or even data loss, creep in (Li & Banach, 2011). According to Dolan-Mescalet, Farewell, Howard, Rozler and Smith, (2014), long-term digital preservation is not just about tomorrow, it is also about formulating a plan for today that will make your digital files more organized, efficient, professional, secure and useful. And this, in turn will make collections, archives and institution stronger. The panorama of information preservation has substantially changed with the advent of the digital era. This rose awareness for the need to address preservation to digital-only data. Techniques such as microfilming allowed for affordable and durable preservation of paper-based documents, the same does not apply to digital formats. Even if the base of digital formats is simple binary 0 and 1, digital encompasses a rich set of various resources such as text, audio/video, images, computer programs, just to name a few (Rosa, Olga Craveiro and Domingues, 2017).

Digital materials can be defined as information resources that have been created in digital form, i.e. their life begins in digital form (i.e. Born digital resources), and those that have been converted from print or paper-based resources (i.e. analog) to digital formats (i.e. Made digital or Digitized resources) (Digital Preservation Briefing Paper, 2006). Digital materials include texts, databases, still and moving images, audio, graphics, software, and web pages, among a wide and growing range of formats. They are frequently ephemeral, and require purposeful production, maintenance and management to be retained. Many of these resources have lasting value and significance, and therefore should be protected and preserved for current and future generations. According to Keene (2001) Digital materials are all similar, whatever kind of sensory content they represent. They consist fundamentally of binary states (on/off, positive/negative charge, etc.) stored on physical media. But though simple at this level, they are very complex, because to re-create the content they represent it is necessary to use a computer to process the physical binary states electronically as digits (hence the term ‘digital’). Eventually the content is recreated, as light waves, sound waves, pressure or scent molecules that can be perceived as text, image, sound, physical touch or smell.

Digital information is delicate and their storage facilities suffer wear and tear and are affected by technological obsolescence. These characteristics of digital information resources have made it imperative for libraries through the use of information technologies to take steps to ensure that their contents stand the test of time. Such steps are called “digital preservation” (Li and Banach, 2011). Other than this, digital publishing has created new and different categories of document types from simple analog documents to multimedia document types, with varying types of media embedded in-between. The advent of new and exciting digital formats such as graphs, audio, video has transformed the document types into very colorful, yet complex multimedia documents at times. The embedded audio, video, graphics, sound and other aids have enhanced the quality of digital documents. Digital publishing especially that of *"born digital"* materials encourages these types of new innovations.

In the digital world, preservation must be concerned with entire technological systems, not one or another component such as a film or a storage disk. Digital systems are characterized by multiple subsystems (scanners and transmission devices) (Council on Library and Information Resources, 2014). Digital Preservation essentially aims at taking steps to ensure the longevity of e-documents. It applies to documents that are either born digital or stored on CD-ROM, diskettes or to the products to analog-to-digital conversion, if long-term access is intended (Sur, 2006). Digital preservation is a process by which digital data is preserved in digital form in order to ensure the usability, durability and intellectual integrity of the information contained in them. Digital preservation can be understood as the series of managed activities necessary to ensure continued access to digital materials for as long as necessary (Digital Preservation Coalition, 2008). It involves the planning, resource allocation and application of preservation methods and technologies to ensure that digital information of continuing value remains accessible and usable (Day, 2006). Musa and Safiyanu (2015) assert that digital preservation is the act of securing digitized and born-digital information resources for a long time so that they can be accessed and used again. Digital preservation is more than saving bits and bytes, but also involves the making of plans, policies and putting into use workflows with a view to making electronic information resources authentic and accessible (Baucom, Troup, Cote and Mannheimer, 2018).

The goal of digital preservation is to maintain the ability to display, retrieve, and use digital collections in the face of rapidly changing technological and organizational infrastructures and elements. Digital preservation is the ability to keep digital documents and files available for time periods that can transcend technological advances without concern for alteration or loss of readability." (The Association for Information and Image Management) (Chapman, 2001). According to Sambo, Urhefe and Ejitagha, (2017), The obstacles of software and hardware obsolescence and lack of external or secondary storage devices and laid down rules and regulations guiding digital preservation cannot be solved without digital preservation. Preserving digital content entails far more than making backup copies and storing them in disparate location. Digital preservation is to extend the usable life of machine readable files and protect them from media failure, physical loss, and hardware and software obsolescence, the activities include are:

1. Ensuring the long term maintenance of bitstream (the zeros and ones):
   - Backing up files and keeps a copy at an offsite location.
   - Running checks to track the deterioration of storage media, files and bitstreams.
2. Providing continued accessibility of the contents:
   - Viability – making sure that information is readable from the storage media ;
   - Renderability – making sure that information is viewable by humans and able to be processed by computers.
3. Understandability – making sure that information is able to be interpreted by Humans (Hixson, 2004)

Besides the main data, additional information regarding the resources – format, software environment, operating systems, etc. – is required to properly preserve and access digital data. Digital formats are very fragile and even on controlled environments, there must be an active management to assure their good shape and longevity (Hirtle, 2010). In the electronic age, Information technology has facilitated preservation of the documents, i.e. digital preservation. Texts or documents are the primary sources of information significant. Information technology is a big umbrella that covers activities connected with computer based processing, storage and transfer of information. It involves computer, electronic media, telecommunications, satellites and storage devices (Uddlin and Hassan, 2012). As noted by Etukudo and Aliu (2019), the 21st century as the millennium of information, has been seen as the era of explosion of information output and information sources. ICT is a synergic blend of digital and electronic media for creation, acquisition and dissemination and preservation of knowledge. ICT has also given birth to new formats of recording information and new tools and techniques of handling and preserving information. ICT has been conceived as a combination of computers, storage media (which provide processing, storage and retrieval capabilities) and telecommunications (which have the capabilities of transferring and communicating data or information from one workstation to another (Oyewumi, Alegbeleye and Onifade, 2015).

The information and communication technology (ICT) system has brought revolutionary changes in the organization and management of information. IT has changed the way information is organized and preserved. Books, tapes, CDs of yester year are being replaced by e-mail, video-chats and social networks. Internet is becoming more user-friendly. ICT has enabled instant access to enormous information, anywhere, any time. The new digital ICT is not a single technology but a combination of hardware and software, multimedia and delivery systems. DeWatteville and Gilbert (2000) see ICT as the acquisition, analysis, manipulation, storage and distribution of information; and the design and provision of equipment and software for these purposes.

Najar and Wani (2019) posit that throughout the lifecycle of digital content, it depends upon information technology of different kinds, including the following types of technologies:
• The software packages used for the creation, storage, management, processing, and most importantly providing access to the available digital content.
• Different file formats supported by different software packages at the time of creation and those softwares to which the digital content is converted or transferred over time as software packages and file formats are continuously evolving with updating, extensions, new trends and features.
• The digital storage media to which the digital content is stored at the time of its creation and the media to which it is copied or transferred over time.
• The combinations of operating systems, different computer programs, various security mechanisms, computer hardware, and different communication networks which support and enable the creation, management, protection, and most importantly access to digital content for use over time.
• The standards for formats and practices that develop and emerge within digital preservation, information technology and other communities which are responsible for digital content as new information technologies become more widely used and stable (Najar, and Wani, 2019).
Sauer (n.d) enumerated Six Steps of preserving digital information which includes:

- Identify the types of digital content you have.
- Select what portion of your digital content will be preserved.
- Store your selected content for the long term.
- Protect your content from everyday threats and emergency contingencies.
- Manage and implement requirements for long term management.
- Provide access to digital content over time.

Types of digital resources

a. The born digital and
b. Made digital resources

Born digital documents: This refers to those materials that were initially created using some form of digital technology. They are often called as Electronic Records. The "born digital" resources do not have any print or paper-based backups and some of these publications are difficult to preserve because these will only work with a specific type of hardware, software and other allied equipment (John & Marian, 2009).
Made digital/digitized resources: This refers to those materials which have been transformed from analog to digital form through some reproductive means such as rekeying the information

or scanning the document or objects etc. They are usually converted from old texts and brittle documents which were created long before the digital era. The biggest challenge with such types of material is to capture the authenticity of the original content while retaining the original source for future innovations (John & Marian, 2009).
The third type of digital materials (*born digital originally)* when printed into paper formats for wide circulation/readership or for other reasons and later reconverted into digital formats(e.g. newspapers, conference papers, etc) are relatively easy to maintain as these do not pose as many challenges as the typical *"born digital"* and *"made digital*" publications.

Strategies for digital information preservation
Emulation, Migration and Technology preservation are strategies for preservation:
Emulation: is based on the need to preserve the technological environment and therefore original functionality. An emulation strategy seeks to preserve that environment not through the preservation of original hardware/software but by using current technology to mimic the original environment. This might involve emulation of the original software or (more likely) emulation of the original hardware (in this case the original software and operating system are stored along with the digital object itself). Either way, the strategy relies on a detailed description of the original environment on which to base the emulation in future (Gbaje & Bot 2009).
Migration means copying the object to be archived and moving it to newer hardware and software as the technology changes. It is the process of transferring data from a platform that is in danger of becoming obsolete to a current platform. Migration is, of course, a more viable option if the organization is dealing with well-established commercial software such as Oracle or Microsoft Word (Saha, 2006). The aim of migration is to change the object in such a way that hardware and software developments will not affect its accessibility. This includes content migration, which transforms data from a source format into a target format, and media migration from one digital medium to another (either digital or non digital) medium (Reis and Lindley 2007). Granger (2000) points out that migration is currently the only practical strategy open to large-scale digital archives.
Technology Preservation: Technology preservation helps in preserving the integrity of the digital information during the copying process, converting the information through machine language as a stable medium, preserving the computer hardware platform that the operating system software was designed to run on, refreshing and copying of information to a new media according to requirements, hardware and software to support the application programme.] and creating and accessing the digital documents through the application programme (Das, 2003).

Software used in preserving digital information
Softwares used in preserving digital information are:
- Xena
- DSpace
- Repository of Authentic Digital Records (RODA).
- Archivematica
- Greenstone
- LOCKSS: (Lots of Copies Keep Stuff Safe)
- Fedora
- Invenio
- DAITSS
- PORTICO

- EPrints
- Archimede

Xena: Xena is an acronym meaning 'Xml Electronic Normalizing for Archives' and is also known as normalizing software which convert the format in to xml so that format to be view by xena viewer. Xena transform files into open data formats for long-term digital preservation, encodes content in Base64 and wraps in XML metadata. Formats supported include MBOX, PST, MSG, DOC, XLS, PPT, RTF, PNG, XML, PDF, JPG, TIFF, PCX, WAV, MP3 and more. The National Archives of Australia released Xena 4.0 which is open source digital preservation software. The latest version of xena version (5.0.0) was released December 9, 2009. The main function of xena is to recognize the file formats of digital data and convert them in appropriate preservation file format based on open standards and aids in long-term digital preservation (http://oxy.gnme.org/). Xena software aids digital preservation by performing two important tasks:

- Detecting the file formats of digital objects.
- Converting digital objects in open formats for preservation (Bailey, 2007).

Xena uses different plug-in to deal with various file types. Some plug-in components are: plug-in structure (http://oxy.gnome.org/). Xena type corresponds to a supported file format. Xena Guesser determines the type of a given xena input file Normalizer. It takes the xena input file and transform into an xml file. For the purpose of the file format identification there are most important plug-in of Xena, they are Guesser and Normalize. The relation between the plug-in normalizer and guesser is described by example of image plug-in and image.

- Plug-in reads unknown image format.
- Image guesser identifies the image format.
- Image plug-in normalizes image with image normalizer.

Normalization involves migrating a digital object from original software into an open source. Normalization aids to preserving electronic records. Normalization is opt as a rule for open source, no normalization format meet all the requirements of any organization therefore combination of approaches may be necessary (http://Xena.sourceforget.net/preserving). Xena Plug-in: consists of one or more components, each having specific role in the conversion process (such as the file format detection, file conversion and creation of the xena .xml file.

DSpace: DSpace one of the most used solution for libraries, educational institutions, governments, non-profit and even commercial organizations. Originally, DSpace is jointly developed by MIT Libraries and Hewlett-Packard (HP) Labs, had its first release in 2002 (Rosa, Craveiro and Domingues, 2017). DSpace is a groundbreaking digital repository system that captures, stores, indexes, preserves, and redistributes an organization's research data. DSpace software platform serves a variety of digital archiving needs (http://www.dspace.org). The objective of DSpace is to provide a repository for research data sets and educational materials. DSpace can preserve not only digital journals and digitized documents, but also 3D digital objects, research data sets, and films (Luan, Nygard, and Mestl, 2010). DSpace is a full stack web application consisting of a database, storage manager and a front end. The web applications provide interfaces for administration, deposit, ingest, search, and access to assets stored and maintained on a file system or on similar storage system. This way, it is highly customizable and configurable through a web-based interface (DURASPACE, 2016). Additionally, DSpace provides for full import/export of the repository feature for disaster recovery. It enables easy and open access to all types of digital content including text, images, video and data sets. The items submitted and archived into the DSpace digital library repository can be disseminated and accessed by the users through search and browse (Campbell-Meier, 2011). DSpace offers users the capability to search DSpace for items of interest both simple and advanced. From the DSpace home page, users can browse all items in DSpace by title, author, or issue date. Files are sent and received internally but also with external parties, and it needs to be simple. Distribution of files allows for easy share and distribution of brand, marketing and production of digital assets (Bynder, 2020). The content of these repositories generated by faculty, staff and students at an institution can be made available for integration with on–campus library and course management systems. It can also be made available to colleagues and students at other institutions, as well as to general public (Ranjan, 2015). The software serves the files and it's the choice of the user to choose appropriate tools to access the information included in the database (Campbell-Meier, 2011)

DSpace recognizes and manages a large number of file format and MIME types, such as the most common formats PDF, Word, JPEG, MPEG and TIFF files. Although out-of-the-box DSpace only recognizes common file formats, other formats can be managed through a simple file format registry. This way, it is possible to register any unrecognized format, so that it can be identified in the future (DURASPACE, 2016). It collaborates with academic, scientific, cultural, and technology communities by supporting projects and creating services to help the preservation of the collective digital heritage. DSpace configures file storage, either local file system or cloud-based service and also browse, search as well as fulltext search capabilities (DURASPACE, 2016).

DSpace functions based on three layers namely (a) Storage Layer (b) Business Layer and (c) Application Layer. The storage layer manages the physical storage of content and its metadata. The business layer manages the content of the archive, different e-people (users), and authorization of item/collection/community and workflow of DSpace. The application layer is responsible for containing the components that communicates with the world. Web user interface and the Open Archives Initiative protocol for metadata harvesting service is the best example of the same (Tripathi, 2018). DSpace uses a popular and robust search engine namely 'Lucene' that is open source in nature. The challenges may be in configuration and may require the support of programmer in some cases.

Saha (2006) asserts that research institutions worldwide use DSpace to meet a variety of digital archiving needs, such as: Institutional Repositories (IRs), Learning Object Repositories (LORs), eTheses, Electronic Records Management (ERM), Digital Preservation and Publishing.

Repository of Authentic Digital Records (RODA): It is developed by Keep Solutions, a Portuguese company, in cooperation with University of Minho, and its research community. RODA supports several main standards and is capable of ingesting information, normalize objects for data preservation and allow to browse the repository. It also provides advanced search over the entire repository contents, previews of stored digital objects for text based objects, images, audio or video files and downloading the preserved information (Keep Solutions, "RODA, 2013). RODA is built on top of a plethora of technologies, they are Fedora Linux for data services, OpenOffice, JOD Converter, SoundConverter and ImageMagick responsible for migration and conversion, JAVA is responsible for programming language and implementation, and DROID (Digital Record Object Identification) responsible for automatic validation and characterization. Repository of Authentic Digital Records is a full open source software that is freely available to download, build on fedora and support existing extensible mark-up language (XML) metadata schemas such as Encoded Archival Description (EAD), METS and PREMIS. In terms of digital preservation actions, RODA supports normalization, ingestion of digital data, format conversion and checksum verification (Bountouri, 2017).

RODA built-in preservation strategy is migration. It features all the steps this strategy encompasses, i.e., normalization, conversion, replication and preservation. It also supports other strategies, such as emulation or encapsulation through its extendibility and configuration capabilities. RODA supports several main standards and is capable of ingesting information, normalize objects for data preservation and allow to browse the repository. It also provides advanced search over the entire repository contents, previews of stored digital objects for text based objects, images, audio or video files and downloading the preserved information (Rosa, Craveiro and Domingues, 2017).

RODA provides for access control and permission management, with flexible configuration and tracking of user actions, it is vendor independent, being able to use the most convenient hardware and operating system, it has multilingual support, it has extensibility capabilities and provides support for 3rd party systems integration through the exposure of functionality via web services. This allows other systems to easily communicate with RODA and let them add more functionality to the system, RODA has embedded preservation actions such as format conversions, normalization steps (Keep Solutions, "RODA, 2013).

Archivematica: Archivematica is an integrated suite of open-source software tools that allow users to process digital objects from ingest to access in compliance with the ISO-OAIS functional models. Archivematica automates standard digital preservation activities such as ingestion, checksum generation, format identification, format validation, metadata extraction, format conversion and placement in archival storage that is self-documenting Archival Information Packages for long-term storage. Content can be re-ingested and new workflows initiated to accommodate new format migrations, metadata updates or other preservation actions. The user can interact with the system via a web-based dashboard, but configuration options can be used to fully automate all aspects of the workflow (Archivematica digital preservation system, 2019). Users monitor and control ingest and preservation micro-services via a web-based dashboard. Archivematica uses METS, PREMIS, Dublin-Core, The Library of Congress, Bagit specification and other recognized standard to generate trustworthy, authentic, reliable and system independent Archival Information Packages (AIPs) for storage in your preferred repository (Bountouri, 2017).

Software systems are written in one or more specific programming languages and sometimes a framework for those languages. The core structures of Archivematica is written in Django, which is a framework for writing web applications in Python (Blewer, Romkey & Spencer, 2019). Archivematica's goal was introduced at the iPres 2010 conference which was stated as to "reduce the cost and technical complexity of deploying a comprehensive, interoperable digital curation solution that is compliant with standards and best practices (Garderen, 2010). In a few years, the software grew to encompass "system scalability, customization, digital repository interfaces, format policy implementation, and a business plan that stays true to the ideals of the free software community"(Mumma & Garderen, 2013). Archivematica typically runs by itself on a dedicated server or virtual machine, and between Archivematica and hardware is the Linux operating system.

This operating system also requires regular system updates for maintaining the security and integrity of the platform on which Archivematica and all of its dependencies run. Falling behind on these updates can affect how the software performs in the greater computing environment, whether on the web or in a locally installed application. Software, programming languages, and operating systems all often have an "end of life" or "end of support" date for given versions, and it is important to heed those dates and perform appropriate updates (Blewer, Romkey & Spencer, 2019).

Greenstone: Greenstone is a suite of software for building and distributing digital library collections (Witten and Bainbridge, 2003). Greenstone is produced by the New Zealand Digital

Library Project at the University of Waikato. It is developed and distributed in cooperation with UNESCO and the Human Info NGO in Belgium. It is a suite of software for building and distributing digital library collections that provides a way of organizing information and publishing it on the Internet and or on removable media i.e. (CD-ROM/DVD). The aim of the Greenstone is to empower users, particularly universities, libraries and other public service institutions throughout the world, to build their own digital library collections in the field of education, science and culture (Rajawat, 2017). Greenstone can be run as a web server, with full search capabilities and metadata-driven digital resources. Alternatively, it can be run on a non-networked environment as a standalone application, being installed on a computer or operating from removable media. Greenstone also has a server version for the Android platform with the digital library self-contained on an Android device (Greenstone, 2016). Greenstone have built-in advanced search with customization possibilities, built-in librarian interface that can manage its installations and multilingual support. It provides a flexible way of organizing information and publishing it on the Internet in the form of a fully-searchable, metadata-driven digital library. Using it, a rich set of different types of collections can be formed that reflect the nature of the source documents and metadata available. In spite of being digital repository software, Greenstone does not follow the OAIS reference model or implement explicitly any data preservation strategy (Greenstone, 2016).

The software has interoperability capabilities with other systems through the implementation of contemporary standards like OAI-PMH or METS for metadata. Technology-wise, Greenstone relies mostly on Java for implementation and user interface. The authentication and authorization is performed through JASS (Java Authentication and Authorization Service).

LOCKSS: (Lots of Copies Keep Stuff Safe) is an automated, decentralized preservation system developed to protect libraries against loss of accesses to digital materials. It is a program founded in 1999 by Dr. David S.H Resnthal and Victoria Reich under the sponsorship of Stanford University, develops and supports free and open source software for digital preservation (www.lismcqspractice.com>2020/05). LOCKSS is a distributed, peer-to-peer preservation system that is able to manage multiple copies at remote data repositories. The system was released in 2004 and had been tested at more than 50 libraries Worldwide (Luan, Nygard, and Mestl, 2010). LOCKSS provides libraries with digital preservation tools and support to easily and inexpensively collect and preserve their own copies of authorized E-content. LOCKSS program is led and supported by libraries and librarians internationally, works on the principles and practices like replication, format migration and repair through a polling mechanism. LOCKSS also possesses the feature of format migration i.e. if the information is available in the format which is no longer valid; LOCKSS automatically changes it to the usable or current format. (UGC-NET, 2014). Requests for material are sent to the publisher through LOCKSS and if the content is not retrieved for any reason, the LOCKSS copy is provided with one exception of dynamic content i.e advertisements or graphics that change with each screen display, remains static". There are near about fifty publishers who are currently participating in LOCKSS program, and most of these have agreed to allow their subscribers to use LOCKSS as a backup system (Rutgers University Libraries, 2007).

LOCKSS provides a web-based administrative interface that allows the library staff to target new journals for preservation, monitor the state of the journals being preserved, and control access to the preserved journals, acts as a web proxy or cache, providing browsers in the library's community with access to the publisher's content or the preserved content as appropriate, preserves the original state of the content, right down to publisher branding. With LOCKSS, the content is preserved at its original URL -- exactly as it looks on the publisher's site today and continually compares the content it has collected with the same content collected by other lockss boxes and repairs any differences (Bhattacharjya, 2017). LOCKSS is regarded as a "light Archive" i.e. it provides access to archived information even in case of temporary loss of access to publisher or publishers website (Swoger, 2014).

Fedora: Fedora is a repository software suite that provides management and dissemination of digital content. Fedora is an acronym that stands for Flexible Extensible Digital Object Repository Architecture. Fedora was originally developed by researchers at Cornell University and the University of Virginia Library as architecture for storing, managing and processing digital content in the form of digital objects inspired by Kahn and Wilensky Framework (Kahn and Wilensky, 2006). Fedora supports ingest and export of digital objects in a variety of XML formats. This enables interchange between fedora and other XML-based applications and facilitates archiving tasks.

Digital Object Model: The FEDORA digital object model allows tight management of metadata and digital content, regardless of format. The system is scalable and flexible allowing for fedora to associate objects with external or distributed repositories. Objects and behavior are separated making it possible to change the required behaviors by altering the mechanisms without changing the objects themselves.

Server architecture: is based upon four main Application Programming Interfaces (APIs): manage, access, search and the Open Archival Initiative Service (for metadata harvesting). Fedora supports two types of access services: a management client for ingest, maintenance and export of objects; or via API hooks for customized web-based access services built on either HTTP or SOAP. A fedora repository provides a general-purpose management layer for digital objects, and containers that aggregate mime-typed datastreams(e.g., digital images, XML files, metadata). Out-of-the-box fedora includes the necessary software tools to ingest, manage and provide delivery of objects with few or no custom disseminators, or can be used as a backend to a more monolithic user interface.

Digital objects can encapsulate locally-managed content or make reference to remote content. Dynamic views are possible by associating web services with objects. Digital objects exist within a repository architecture that supports a variety of management functions. All functions of Fedora, both at the object and repository level, are exposed as web services (Saha, 2006). Fedora repository system consists of three layers: the web services exposure layer, the core subsystem layer and the storage layer. The Web Services Exposure is comprised of three related web services described using Web Services Definition Language (WSDL).

- Management Service (API-M) – Defines an open interface for administering the repository. It includes operations necessary for clients to create and maintain digital objects and their components.
- Access Service (API-A)- Defines an open interface for accessing digital objects stored in the repository. It includes operations necessary for clients to perform disseminations on objects in the repository (i.e to access an object content) and to discover information about an object using object reflection.
- Access Lite Service (API-A-Lite)- Defines a streamlined version of the Fedora Access Service that is implemented as an HTTP-enabled web service (Staples, Wayland and Payette, 2003).

Some examples of applications that are built upon Fedora include library collections management, multimedia authoring systems, archival repositories, institutional repositories, and digital libraries for education.

Invenio: The software is typically used for open access repositories for scholarly and/or published digital content and as a digital library. Invenio is a free suite of software that can manage its own digital library or the documents referenced on the web. The technology provided by the software covers all aspects of managing digital library, acquisition of material to its release through classification, indexing and preservation. Invenio is compatible with standards such as protocol for collecting metadata Open Archives Initiative (OAI-PMH) the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) and uses MARC 21 as the basic format of bibliographic data. The flexibility of invenio makes a complete solution for managing document repositories of moderate size or large (up to several million records). Invenio was originally developed at CERN to be the document server of the institution, the management of over 1,000,000 bibliographic records in high energy physics since 2002, covering articles, books, journals, photos, videos etc, currently one of the largest institutional repositories worldwide. It was started over 15 years ago and has been matured through many release cycles (*The Invenio Development Team, 2010).*

Data and Meta-data can enter into Invenio by manually deposited by an author (or someone delegated to this action), through custom and fully configurable web interfaces, backed by an equally configurable work-flow architecture, that lets the submission administrator set up any kind of procedure triggered by a deposition. Data can also be input into the system from any non-standard format by writing ad-hoc conversion scripts either in XSLT or in the proprietary BibConvert's language (www.biecoll.ub.uni-bielefeld.de>article).

DAITSS: DAITSS which stands for Dark Archive in the Sunshine State is a digital preservation repository application developed by the Florida Center for Library Automation (FCLA) with some support from Institute of Museum and Library Services (IMLS). DAITSS is locally-developed software by the Florida Digital Archive, a long-term preservation repository service provided by FCLA for the use of the libraries of the eleven publicly-funded universities in Florida (http://daitss.fcla.edu). DAITSS was designed to perform the major functions of Ingest, Archival Storage, Access, Data Management and Dissemination in the OAIS reference model. DAITSS implements format-specific preservation strategies including normalization, migration and localization. (Caplan, 2007).

DAITSS first went into production in 2005, it was recently re-architected and rewritten to improve ease of implementation and maintenance, scalability and extensibility. In DAITSS, data that was once written to archival storage cannot be altered; modified objects are in effect new objects; original versions of archived files must be retained unaltered and the archived data store be self-defining, so that if the DAITSS system were lost, all known information about archived objects could be recovered from the data store itself. The basic unit of storage and processing is an Information Package. Each Information Package consists of an XML descriptor and all of the content files required to assemble one (and possibly more) representations of an information object (Fischer, Chou & Lazzarino, n.d).

In DAITSS, files are modified only during the Ingest process as the SIP is transformed into the AIP. DAITSS relies upon format normalization and migration as preservation strategies, and these are implemented as part of Ingest. All files in the SIP as originally submitted are retained unaltered in perpetuity, but other versions may be derived and added to the AIP. The Information Package is the only unit of input and output; that is, even if only a single file in an AIP is needed, the entire IP must be disseminated (Fischer, Chou & Lazzarino, n.d).

PORTICO: Portico started in 2002 as a project by JSTOR, with a grant from The Andrew W. Mellon Foundation. Initially, the project was focused on designing and prototyping content handling and archival systems, crafting potential archive service models, testing possible models with libraries and publishers, and a drafting business model able to support a long-term archival effort**).** In 2004, the project was undertaken by Ithaka- the U.S based not-for-profit organization whose aim is to help the academic community use digital technologies to preserve the scholarly content (e-journals, e-books, digitized collections) accessible to researchers, scholars, and students in the future. Ithaka brought librarians and publishers together and discussed various issues and challenges which come across while developing an archive.

Finally after a lot of discussions and cooperation Portico was shaped and launched in 2005 (Fenton, 2006).

Portico is a digital preservation service for electronic journals, books, and other content. Portico receives the source files in the form of publishers' proprietary XML and SGML format and it normalizes them to format which Portico and other digital preservators have adopted, then both the original as well as the normalized content is preserved in the archive. Portico receives the source file from the publisher passes it through its content-normalization process **(**Morrissey, Meyer, Bhattarai, Kurdikar, Ling, Stoeffler, & Thanneeru, 2010). PORTICO serves as an archive for 11,954 electronic journal titles, 65,986 ebook titles, and 39 digitized historical collections.

EPrints: EPrints is a free and open-source software package originally developed by researchers at the University of Southampton School of Electronics and Computer Science in 2000 (making it the oldest of the platforms in this report). It was designed specifically for archiving research papers, theses and teaching materials, though it can accept any content. EPrints initiative is designed to manage disciplinary or institutional print collections, rather than digital collections. Eprints software is Open Archives Initiative (OAI) compliant and freely available under a GNU license (General Public License) and is in use at California Institute of Technology, the University of Queensland, and other institutions. EPrints follows a "turn-key" approach and some institutions have reported that the installation process is fairly straightforward (Beazley, 2010). EPrints supports controlled vocabulary and has provision of authority list that helps to manage high quality metadata. By default, EPrints has support for internal metadata standard Dublin Core and it can export to many numbers of formats such as METS, MODS etc (Tripathi, 2019). EPrints enables the submitter to restrict the access of content by embargo feature that restrict the content date wise. It also supports metadata and repository preservation and allows downloading all the files and metadata. EPrints accepts any kind of file in any format such as text, audio, video, etc. However, to support research datasets, customization is required in order to extent EPrints. Compared to other repository software, EPrints requires additional knowledge of Perl scripting for batch importing. EPrints has a user-friendly interface that allows the submitter to submit and manage files easily. The best part of EPrints is that it allows easy modification of workflow.

EPrints considers its key preservations actions to be: "recording changes to a repository object by updating its 'preservation metadata'; "enabling the service provider to download all the files and metadata comprising an object (METS and DIDL export plugins)"; and "notifying the service provider of any rights it has to copy and act on the content of an object". The default, built-in search engine can search all metadata fields; sort results by issue date, author name and title; and supports Boolean operators. Full-text indexing is available for some formats (PDF, Word and HTML) when the appropriate tools are installed. Searches are executed through the plug-ins layer and EPrints has support for the Xapian engine, which allows sorting results by relevance (Singh, 2009). The main attractions of EPrints seem to be its user-friendly interface and ease-of-implementation. However, these features might not be enough of an advantage to warrant a migration from another system.

Archimede: Archimede project was designed to accommodate electronic preprints and post-prints from the institution's faculty and research staff. Archimede was developed by Laval University Library in Quebec City, Canada. Archimede institutional repository system complements two system components previously released by Laval. The first manages the university's electronic theses and dissertations; the second provides a production platform for electronic journals and monographs. Archimede organizes the content submission process around a network of locally-managed research communities.

Archimede was specifically designed to support multilingual international implementations. The text for the system's user interface is independent of the software code, facilitating the development of an interface in the local language. Archimede uses UTF-8 encoding and thus can accommodate any language. English, French, and Spanish language user interfaces are already implemented. Archimede uses an indexing process, developed at Laval University, that integrates in a single occurrence two types of documents: a) a Dublin Core metadata record in XML; and b) the full text of the document(s) described by the metadata. These documents can be of any type, including HTML, PDF, MS Word, MS Excel, TXT, RTF, and others. Archimede supports the import and export of multiple types of metadata based on XSLT transformations. Developed on a variety of Java Open Source technologies, Archimede runs on many operating systems (Windows, Linux, etc.) and can be used with several types of relational databases compatible with JDBC. This allows an institution flexibility in installing the software on an existing technical infrastructure.

Challenges faced in preserving digital information

It is important that future users will be able to access the information, be able to tell whether the information is accurate and preserved as it was intended to be, and use it in their intended way (Gladney, 2009). Although the act of digitizing analogue materials, and the ensuring preservation of those materials has many benefits and much to offer, it is not without challenges. Some of the main concerns include issues involving human error, data loss, fading memory, lack of effective education, and technological obsolescence (Kastellec, 2012). Despite the ready availability of mobile technology and hardware devices, digital resources are both human and machine dependant, which is perhaps one of their greatest limitations (Moghaddam, 2010). Knowing what to preserve, and the best method to use, is a major concern for professionals, and one that requires specialized training. Therefore, the professional skills needed include technical proficiency in areas such as encryption, metadata schema coding, and authentication, as well as traditional archiving skills, which include cataloguing and classification (Sanett, 2013). Photographic and audio-visual collections are especially prone to deterioration, and require specialists and an often large budget to care for them properly (Gracy and Kahn, 2012). In addition, the problems associated with digital preservation are often too great for one organization alone to handle, and the cost can be prohibitive. Today, preservation management of digital resources pose a great challenge for libraries and other heritage institutions. Drijhout (2001) posited that digital documents are different from traditional paper documents in the way they are generated, captured, transmitted, stored, maintained, accessed and managed.

Digital assets either digital born or digitized are stored and preserved on storage media. The most popular digital storage mediums available today include, hard drive, optical storage media (CDROMs, DVD, Magnetic tapes), and zip drive**.** These storage medium are vulnerable to deterioration in *addition to* the problem of obsolescence in retrieval and playback technologies. Beagrie (2004), and Rosenthal (2005), over the years have identified the following as major threats to digital information:

i. Storage medium deteriorate overtime;

ii. the hardware that reads particular carriers wears out and cannot be replaced when it has become obsolete;

iii. file formats become obsolete in the course of software evolution, as backward compatibility is lost over a succession of versions;

iv. older versions of software, even when these are available, may not work on new hardware or operating systems. These are the listed challenges:

Media Problem/Technological obsolescence: The genesis of digital resources itself is complex, the format in which they are made available can also pose a challenge. Different digital materials are available or stored in different physical formats such as computer files, compact discs, microfilms, cassettes, and other upcoming storage media. Storage media transform and evolve into different and new types of media almost every year; for example, over the years, cassettes have advanced from simple audio cassettes, to video cassettes, to compact disks (CD-ROM) and now to DVD's. The continuous innovation in the technological front poses a major threat to the digital preservation initiatives media (Hedstrom, cited in John and Mirian, 2009).

According to Jones and Beagrie (2001), Rapid obsolescence is a consequence of rapid technical development. When greater storage and processing capacities are available in market at lower cost, slowly old product's market will be down. So Devices, processes, and software for recording and storing information are being replaced with new products and methods on a regular three- to five-year cycle. Even those documents are created as a digital form, all are equally vulnerable to technological obsolescence. For example, the short life times media are eight-inch floppy disks, tape cartridges and reels, hard-sectored disks, and seven-track tapes those storage formats are inaccessible and more durable storage media are CD_ROM and optical WORM. (Das, 2003).

Shorter life span of digital media: The greatest concern of digital preservation is short life span of digital media and higher rate of obsolescence of the hardware and software used for accessing these digital records. Fast changes in the IT industry and the move from science-based developments to commercial development of software and hardware systems, has resulted in media becoming inaccessible at a rapid pace. Magnetic tapes, optical storage disks (e.g. CDs and DVDs) are produced for short-term storage of digital resources and thus cannot be used for long-term archival retention (Najar, and Wani, 2019). Digital materials are very short life comparatively in traditional format. Recording media for digital materials are vulnerable to deterioration and catastrophic loss. Librarian and archivists are trying to preserve acid-based papers, thermo-fax, nitrate film, and other fragile media for decades. In this situation magnetic and optical media are qualitatively different. They are the reusable Media (Das, 2003). According to technological environment digital documents are different from traditional documents by the way they are generated, captured, transmitted, stored, maintained, accessed and managed.

Copyrights and intellectual property rights (IPR): The greatest obstacle to making works available to the public in digital form is not related to technology, but rather to copyright issues. A digital library which makes its collection available over the Internet is not only a place where one gathers, preserves and lends what others have produced; by virtue of its digital presentation, one creates new copies which have the same status as the digital original. (Velmurugan, 2013).

Intellectual property rights is a big barrier for preserving the digital documents. Digitization of documents are involved with complex method for resolving the legal and practical questions of migrating intellectual property, that includes the creators and owners of intellectual property, managers of digital archives, and actual and potential users of intellectual property. In addition, the parties who represent, different kinds of intellectual property such as text and other document-like objects, photographs, film, software, multimedia objects, impose their rights in different ways (Das, 2003).

Physical deterioration/Fragility of the Media: The media used for storing digital contents are inherently highly fragile and unstable because of problems inherent to magnetic and optical media that deteriorate quickly and can fail suddenly due to exposure to heat, humidity, airborne contaminants, or while faulty reading and writing on devices (Najar &Wani, 2019). Different claims are made for the longevity of the various digital storage media. This may be because longevity is affected not just by the use or storage environment, but by the particular manufacturing specification and manufacturer. Digital media may also suffer scratches, breakage and so on. More inherently durable media are being developed, but it is clearly hard to manufacture materials that last anywhere near as long as those used historically, such as vellum and rag paper, that have survived for centuries often in less than optimum conditions (Keene, 2001). The digital materials are stored on is inherently unstable and without suitable storage conditions and management can deteriorate very quickly even though it may not appear to be damaged externally (Velmurugan, 2013).

Magnetic storage media are highly sensitive to dust, heat, humidity and other climatic conditions. Most of the storage devices, may deteriorate very quickly without displaying any physical characteristics of external damage because of lack of suitable storage conditions and proper management. Deterioration of storage media may lead to corrupted digital files in such a fashion that it may not be easy to identify the corrupted portion of digital contents. (Najar & Wani, 2019).

Conclusion

The growth of digital resources in libraries of all kinds summons a new era in their development. Historically, libraries have always been concerned with the management and preservation of 'atoms', today they must be increasingly concerned with preservation of 'bits'. The advent of technology has gradually ushered the world into what we now call digital or information era. This has paved the way for several ways of storing, preserving and disseminating knowledge for human consumption to come into existence just like the traditional ways but this time in a technological manner. Digital preservation is the numbers of actions and interventions required to ensure continued and reliable access to authentic digital objects for as long as they are deemed to be of value. This encompasses not just technical activities, but also all of the strategic and organizational considerations that relate to the survival and management of digital material. Digital objects will cease to be accessible without active management and intervention. The Digital preservation has to guarantee the integrity, understandability, originality, authenticity, and accessibility of digital records and data over long term. To enable this preservation file formats have to fulfill a number of requirements.

Recommendations

Libraries should make provision for long term planning for the digital preservation barriers, since many librarians do not have training on digital preservation management techniques and digital collation keeps growing and maturing. Only the digital library environment can establish architecture, policy or standards for creating, accessing and preserving digital content.

A digital preservation management policy needs to be formulated. This may be done by adopting digital preservation policy of IFLA or having a home grown policy. There should be an annual budget allocation for digital preservation of libraries materials. Also, government and parent organizations should make adequate financial provision for hardware and software technology that are obsolete.

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