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Digital Libraries: A Frontier in Library and Information Science as speculated by Vannevar Bush in 1945

Dzangare Godwin
Institute of Science and Technology Information, Jiangsu University, Zhenjiang, China

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ABSTRACT: *Introducing Digital Libraries (DLs) has contributed to developing the Library and Information Science field. As growth is inevitable, in 1945, Vannevar Bush saw and predicted technology development, including the introduction and growth of DLs. The scope of the paper is to introduce the concept of DLs, explore the current status quo of DLs, and identify the developing opportunities through a comprehensive literature assessment, discussion, and analysis.*

KEYWORDS: digital libraries, digital resources, memex.

INTRODUCTION

Over the past decade, there have been significant changes in how information services are delivered. The introduction of internet-based content and facilities has led to various points of accessing information, such as Digital Libraries (DLs). The Online Dictionary of Library and Information Science (ODLIS) (2021) defined DLs as a library where most of the resources are available in a machine-readable format and can be accessed through electronic devices with the ability to surf the internet. Digital content can now be kept locally or accessed remotely over this computer network. DL examples include the Mountain West Digital Library, founded by the Utah Academic Library Consortium.

In the practice field of Library and Information Science, the digitisation process began with catalogues. This process was implemented through journal directories, abstract services, and prominent journal and book publication reference books. The concept and research of DLs can be traced back to Europe in the mid-1990s when repositories were first established for digital texts accessible through a search service that was operating by indexing information stored in a central metadata catalogue (Castelli, 2006). As the DL grows, it continues to occupy a continuum of more physical concepts in terms of ideas, materials, and people of the library. Despite the complicated task of building the

DL content and software that facilitates functionality, the DL has continued to evolve and develop over time. However, the oldest and most notable prediction of DLs can be traced back to the discussion that the American Scientist raised, Vannevar Bush, in an article titled "As We May Think, " first published in July 1945 in Atlantic magazine. Bush describes a vision for the future of science and how it will help humans. He further speculates the future information path, exploring information overload, information organisation, and inventions to help access information. His article lays a foundation for how digital libraries have evolved over time, which will be established in this discourse.

THEORETICAL AND PRACTICAL VALUE

Various libraries have embraced and established the need for DLs as part of their information ecosystem. By embracing DLs, many advantages and value has been extracted in using and adopting this new library entity, which is explored below.

Content Variety

Due to space constraints, traditional libraries lack the flexibility to accommodate a wide range of content. However, Bush (1945) predicted that Memex's invention, likened to DL, would have a different content type. He postulated, "Most of the memex contents are purchased on microfilm ready for insertion. Hooks of all sorts, pictures, current periodicals, newspapers, are thus obtained and dropped into place." DLs have lived to this prediction as they now store a variety of content virtually, including e-books, magazines, articles, blogs, articles, videos, podcasts, and audiobooks (Astria Learning, 2021). In addition, the most recent digital libraries have developed to have their collections hosted on the cloud, making them available from any device, anytime.

Collection Development

Compared to universities and large libraries, small libraries often need more funding to acquire new resources, such as books or magazines. Organisations, on the other hand, can keep their DLs up-to-date regularly. Like many publishers, DLs make current issues and journals available to readers for each read access. By providing readers with access to the latest publications, DL attract their interest as well (Pomerantz & Marchionini, 2006).

Although physical books are arguably still more popular than eBooks, the number of users reading digital publications is steadily increasing. In addition, young readers now prefer a digital copy to a physical one because they can easily access it on mobile devices and read anytime, anywhere. DLs have drawn this much interest because they allow readers to access online digital resources using any device, such as a computer, tablet, or smartphone. (Hughes, 2004).

Search and Retrieval Ease

Visiting a traditional library requires readers to spend time and effort finding the right book. In addition, finding relevant information in physical books can be time-consuming. DLs, on the other hand, have integrated and advanced search capabilities (Rikowski, 2008). Many DLs use a similar retrieval method, such as the popular search engines -Google, Bing, and Yahoo (Astria Learning, 2021). This way, readers can quickly find the information they are looking for. The search function also retrieves and sorts digital resources when a query with relevant words and phrases is entered. This digital advancement in searching and retrieval was also predicted by Bush (1945) when he stated that "...selection by association, rather than by indexing, may yet be mechanised." DLs also have this function. They select results based on association with the initial query and the clicked results. Value can therefore is extracted from it as the association of results, which helps with better information retrieval.

Availability

Traditional libraries have specific working hours, and users can only use the library's resources within the stipulated time. On the other hand, DLs are advantageous as they allow readers to access e-books, listen to audiobooks, and watch videos 24/7 without having any access time restrictions (Astria Learning, 2021). The unrestricted availability of resources has brought more readers to DLs these days. These resources will be accessed if a patron has the credentials and authority to sign into the DL. Bush (1945) also shared a similar concept when he predicted that "…a future device for individual use, which is a sort of mechanised private file and library". Now the DL lived up to the prediction and not only sorts files but ensures that documents are accessible to a private group of users.

Unlimited Access to Multiple Resources

Traditionally libraries could not cater to multiple readers to access the same book simultaneously. Users had to wait for other readers to return the book before accessing it. However, in the digital age, multiple readers can simultaneously access the same book, video, or audiobook through DLs (Astria Learning, 2021). Many institutions have even set up a consortium for their DLs to allow them access to more resources for their patrons in different locations and to access the same resource simultaneously.

Library Management Automation

Some of the duties in the library are becoming increasingly obsolete as the automation of these routine services, such as indexing, publishing, tracking, and retention, as the DLs are absorbing them. Bush (1945) also predicted this, for instance, in the retention task. He stated that with Memex, which is likened to the DL, "frequently-used codes are mnemonic so that he seldom consults his code book". Retaining frequently retrieved documents is now a popular feature on most DLs, and some books are even flagged as most cited or used, helping them appear on top of the search results.

In addition, a simple task such as restarting a search query is also automated by returning to a DL's home page. This practical task which helps with reconfiguring a search was also predicted by Bush (1945) when he stated that "A special button transfers him immediately to the first page of the index." As a result of this value of automation, many institutions and libraries have quickly adopted the DLs.

Reduce Resource Depletion

Physical collections are vulnerable to wear and tear, requiring the library to invest in the conservation of resources. In addition, as users frequently access and reuse physical resources, the library faces the challenge of deforming books, records, or cassettes. However, with the introduction of DLs, many library users can consistently access resources without them being damaged (Astria Learning, 2021). In addition, physical storage facilities are required to store the physical collection for future generations. However, this challenge cannot be encountered when a DL is created, as it can store resources in the cloud. This idea was also predicted by Bush (1945) as he suggested that in the future, the user will have enough space "so he can be profligate and enter material freely." The advanced and secure storage methods of DL storage have ensured that collections can expand with more space and still be safe, remotely accessible and grows without any physical limitation.

CURRENT SITUATION

Khan (2021) specifies that "Bush (1945) created a vision based on experience "Digital library". The concept of the DL is a perfect depiction of what Bush had forecasted. DLs have become a growing phenomenon in the library and information science field. As part of the development, they have evolved and incorporated various elements to cater to the growing demand and serve the users' needs. The components and core functions of the DL that have since developed include centralisation, portals, integration, support and services (Allard, 2002).

Decentralisation

The DL's main characteristic is dismantling and rebuilding the library concept. Since the future is digital, it is essential to consider it the new normal. DLs are not always associated with a physical space or a single organisation, but many libraries are known for their physical foundations, collections, and services (Baker,2006). DLs have even decentralised the idea of ownership. They bring together content and services from various commercial and non-commercial providers, opening more resources for the user.

Portals

Portals are another growing feature which has been developed in DLs. No DL can contain all in information in the world. An isolated technique of facilitating access to information will not satisfy user needs. Adopting portals to integrate content and information services has become a theoretical value that can be extracted by introducing

DLs (Brophy et al., 2004). A portal system creates a single entry to a web pocket or sign-on system, giving users access to a scalable and robust system (Baker, 2006). Users may not notice that the content is not stored physically on the portal system as the look and feel of the content do not differ from other content provided by the system. This system will be able to integrate heterogeneous types of content and metadata, which gives access to the user a wide variety of information.

Support and Services

Digital libraries are effective and have attracted a good number of users. The current technical support and services are seamless, transparent, instantaneous, decisive, safe, and systematic. As part of their expanded service offerings, digital libraries now generate, customise, edit, and forge materials with greater flexibility (Baker,2006). The technical support for DL is consistent and accessible through groups and online communities. These communities provide the necessary support in the global digital environment and the availability of teams of developers prepared to fix any systemic faults.

Integration

Recurring technological components have led to integrating services based on common standards, interoperability, and open access. These aspects that most DLs have shared a similar concept and terminology (Baker,2006). Such progressive aspects of DLs have opened an integrated approach to current work as content creation expands through means such as the Open Archives Initiative (OAI). Baker (2006) suggests expanding the integrated approach to standards as soon as possible to promote interoperability.

Technology Standardisation

The technology around DLs has developed over the last decade. Fall (2002) postulated that the most important technical components that should be recognised include the standardisation efforts made for DLs. Some standards are found in metadata and metalanguages, such as extensible Markup Language (XML) and Resource Description Framework (RDF) (Fall, 2002). These standards are regarded as the more important as they can answer many challenges facing DLs in areas such as digital object description, user interfaces, architecture for collection organisation, and scaling.

Metadata is defined as machine-understandable information about web resources and other things. Metadata is important for the DL because it can be used effectively to convey descriptive cataloguing information. In contrast, the RDF is defined as a syntax-independent model for describing internet resources, thus enabling far more intelligent searches (Fall, 2002). In addition, these tools have provided the technological capabilities for more efficient search and retrieval, extensibility, and desktop delivery of multimedia documents. These aspects have made DLs as influential as they are now.

Evaluation and Acquisition

A core function of a DL is to purchase and evaluate material that should be of great use to the user (Baker, 2006). These processes ensure high-quality service and continuous library supply and use. As a result, the material in the DL has continued to diversify and is being accessed. Therefore, control measures must be implemented to facilitate a rigorous assessment process. Quality control is a reliable mechanism that has levelled up content, repository escrow, or access to the collection.

DEVELOPMENT PROSPECTS

DL's future growth and development will be operational, with tasks expanding beyond what physical libraries and archives are currently carrying out (Castelli, 2006). The development will also include diversity and variety, expanding to include information object types for several multimedia components and unlimited formats. These include text, scientific data tables, images, 3D images, annotations, video and NFTs. These new information objects will provide innovative and more powerful tools that researchers can use to share and discuss the results of their work (Castelli, 2006). One is left to believe and question the possibility of a content explosion. In order to support these various formats, the DL functionality will need to be extended far beyond its current functionality. Hence, as they manipulate and support these objects, they can generate new information with excellent processing power to perform these tasks.

DLs will become one of the critical instruments in libraries and information service delivery. As most libraries now host their servers and have adopted different software to support their system, every institution will host or own its own DL (Krottmaier,2004). With the widespread growth in DLs, the development of this service has become inevitable. Some prospects to look out for include; resource sharing, Non-Fungible Tokens (NFTs) management, engagement and embeddedness.

Resource Sharing

The cost of a DL subscription will continue to increase. To curb the growing expenses, one of the developing prospects in the DLs is expanding consortiums for resource sharing (ODLIS, 2021). Beyond consortiums for DLs, there will be a need to include applications, computers, and even human resource sharing to help with the necessary skills for supporting DL development and maintenance (Castelli, 2006).

Non-Fungible Tokens

Another developing prospect DLs can cater for is the storage for NFTs. Fernandez (2021) defines an NFT as a unique digital token and identifier developed off existing properties designed to be non-fungible (Fernandez, 2021). It can be given or sold to another person, like an original copy of a painting or a creative piece. Each NFT is a unique digital object that another cannot replace, this ensures that the internet or

technology reduces the barrier to mass distribution, especially without consent (Fernandez, 2021).

With the value of NFTs being forecasted for growth and NFTs still remaining volatile to disappear, proper maintenance will be service required that will rise very soon. Preservation as relevant expertise that libraries offer will be a service that will be a developing prospect when NFTs continue to grow. Fernandez (2021) states that "NFTs do require ongoing maintenance for their continued existence," therefore, it will be a meaningful service for libraries to engage in this growing field to offer preservation services for the maintenance of NFTs. Some platforms developed in this service include the InterPlanetary File System, which stores the file with additional identifying information on multiple computers (Fernandez, 2021).

In addition, the library NFTs will become the new and growing technology that intersects many of the same concepts at the core of library science. For example, while libraries initially specialised in storing and distributing exchangeable materials, NFTs will surely need these services.

Engagement and Embeddedness

Like any new or growing technology, DLs must optimise the users' ability to ensure further uptake and use. Baker (2006) suggests that the great potential in DLs has yet to be fully utilised, possibly because of change management. In addition, cultural issues arise in migration and integration of ideas, affecting technology adoption. Therefore, training programs need to be implemented to create an environment that propels the use of DLs.

Another form of engagement that will change will be how users turn from consumers to producers of information (Baker, 2006). After assessing and engaging the information in the DL, the users will use the information to create more information. The DL will have to create a facility that will enable self-publishing, and this will also enrich the content.

CONCLUSION

The development of DLs in the growing digital age is essential to note. Delivering digital content will ensure that users' growing needs are met. DLs offer many opportunities these include the ability to provide new and creative library services to users, guarantee long-term storage, use of artificial intelligence in research, adding more digital content, e-document management system and exploring the best ways to manage digital content. These services were chief amongst what Vannevar Bush had predicted in 1945 with clear association to Memex which can be regarded as the initial conceptualisation of DLs.

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