From digital archives to virtual exhibitions

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Abstract

Digital archives typically act as stand-alone digital libraries to support search and discovery by users to access its rich set of digitized materials. Additionally, content stored in these archives have been used utilized and combined to create different thematic online virtual exhibitions (VEs). Such exhibitions are important complimentary counterparts to physical exhibitions, especially in the context of cultural institutions such as museums, archives and libraries. Well constructed VEs can offer alternative experiences to the “real thing” and open up other opportunities that include education and learning, more content beyond physical exhibits, support active participation and contribution by visitors through forums and uploads, online shopping, and others.

This paper outlines a number of concepts and design considerations for the development of VEs from digital archives. When supported by the right tools and approaches, creation of VEs can be highly effective and efficient with minimal technological knowledge. By considering the important issues of metadata, system architecture design and development techniques, it becomes possible to generate a series of VEs to meet the needs of different user groups and at the same time cater to the constraints of the client computers, thereby providing the users the best possible experience in engaging with the VEs.

Introduction

The Digital Library Federation defines digital libraries as “organisations that provide the resources, including the specialised staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily available for use by a defined community or set of communities” (www.diglib.org/about/dldefinition.htm). One of the most important area of application of digital libraries is in education. Examples of early educational digital libraries that arose out from the US-led DL Initiatives are the Alexandria Digital Library which is a distributed digital library with collections of georeferenced materials (www.alexandria.ucsb.edu/), National
Science Digital Library which is an online library for education and research in Science, Technology, Engineering and Mathematics (http://nsdl.org/), and the Digital Library of Information Science and Technology which is an open source searchable archive about information literacy (http://dlist.sir.arizona.edu/; Farmer, 2007). Another important educational digital library development is JSTOR and the like. JSTOR, originally conceived as a project at The Andrew W. Mellon Foundation, is a non-profit organization with a dual mission to create and maintain a trusted archive of important scholarly journals, and to provide access to these journals as widely as possible. High-resolution scanned images of back journal issues and pages can retrieved for a very large set of titles across many disciplines. It has become a standard offering at most US universities and colleges as well as a growing number of higher education institutions beyond US (Spinella, 2007). In these digital libraries, content can already exist, or more generally, they would be sourced and populated over time.

Across the world, non-profit cultural heritage organisations that encompass museums, archives and national libraries, would generally already have accumulated a rich amount of content in the form of artefacts and documents in different forms, medium and formats that have been acquired, preserved and conserved for a long time. Many of these would now be increasingly digitised, described and stored in digital archives. They are subsequently made available directly to the public through the use of digital library technologies, either as stand-alone documents that can be searched and retrieved, or packaged or curated through other means such as virtual online exhibitions.

Beyond the heritage dimension, we also witness the creation of digital archives and digital preservation initiatives in the area of newspapers and other born-digital documents. In US, KODAK Digital Archive Services preserve 75 years of Pittsburgh Steelers history (Reuters, 2007) and a 19th century newspaper digital archive is also been developed by Thomson Gale (http://gale.cengage.com/usnewspapers/index.htm; Bruns, 2007). Similarly, UK, 19th century British Library newspaper and old books are being digitised and preserved (Ashling, 2008) by British Library. Additionally, the Library will build a secure national digital archive of 300 terabytes to store all publications born digitally like CD-ROMS and electronic journals. Alongside this development, the National Archives have been tasked with securing Whitehall’s digital legacy by preserving government information that is born digital (Griffin, 2007). Other parts of the world like Australia and Singapore are also embarking upon such initiatives.

These trends are in line with that predicted for a ten year period commencing 2006 by ACRL (Association of College & Research Libraries) Research Committee on 10 assumptions about the future that would have a significant impact on libraries (Mullins, Allen & Hufford, 2007). At the top of the list of assumptions is that there will be an increased emphasis on digitizing collections, preserving digital archives, and improving methods of data storage and retrieval. Others assumptions suggest that users and consumers expect high quality facilities and services, and free public access to information stemming from public funds.

The aforementioned examples have a common thread among them in that all have potential in education even though if they are not originally conceived as an educational service, but as repositories of information that are made accessible to users for knowledge and information discovery. In the context of this paper, we will focus on digital archives and how these contents
can be packaged and developed into virtual exhibitions which have an educational aspect beyond the exhibits.

**Virtual Exhibition Definition and Case for Support for Development**

A virtual exhibition (VE) was earlier defined as an online Web-based hyper-textual dynamic collections devoted to a specific theme, topic, concept or idea (Silver, 1997). Most virtual exhibitions are attributed to museums and archives to make visible their collections to end users, generally the public or specialized user groups (e.g. Hunt, 2005). Original artifacts are digitally captured and rendered into 2D or 3D objects which are packaged together and linked by hyperlinks to allow non-linearity or multiple-linearity by users (exhibition visitors). Virtual exhibitions are viewed as dynamic entities as they often undergo ongoing change in terms of design, activity and content, including encouraging users to contribute towards its collective memory, thereby adding to its dynamism.

Many early virtual exhibitions are undertaken as distinct projects and packaged as standalone exhibits with little regard on the reusability of objects, adoption of standards to support interoperability, extensible and scalable system architectures to support growth and pervasiveness of exhibitions.

Some examples of early VEs include *Building a National Collection: 150 Years of Print Collecting at the Smithsonian* by the National Museum of American History (americanhistory.si.edu/prints/index.htm), *American History Documents* (www.indiana.edu/~liblilly/history/history.html), *Birds: A Virtual Exhibition* by Canadian Heritage Information Network (www.virtualmuseum.ca/Exhibitions/Birds/Birds/), *Colours of the Wind* by the National Archives of Singapore (www.a2o.com.sg/a2o/public/html/online_exhibit/misas/exhibit/index2.html; Leong, Chennupati & Foo, 2002, 2003), and others.

Over the last decade, improvements to these areas have been seen and virtual exhibitions have reached a stage of sophistication although a number of fundamental challenges remain. While the basic tenets of virtual exhibition have not changed, an updated definition of virtual exhibition is proposed (Foo, 2008):

*A virtual exhibition (VE) is a Web-based hypermedia collection of captured or rendered multi-dimensional information objects, possibly stored in distributed networks, designed around a specific theme, topic concept or idea, and harnessed with state-of-art technology and architecture to deliver a user-centered and engaging experience of discovery, learning, contributing and being entertained through its nature of its dynamic product and service offerings.*

The case for investing in the design and development of VE has been well documented in literature (for example, Chennupati (2007) and Lester (2006)). First and foremost is the recognition that hosting VEs provides a gateway to showcase an institution’s collections that are not bound by time (temporal), distance (spatial) and space (spatial) constraints unlike physical exhibitions. This addresses the important issue to make valuable artifacts available to the masses while playing the role of custodianship of national and international treasures.
Users are unlikely to pay visits to these institutions unless they are aware of its collections and holdings. One way round this is to create VEs that are coupled with educational functionality to promote the institution as a centre for learning, and to further encourage users to physically access the brick-and-mortar building, or virtually access and retrieve digitized information objects. Such an approach helps to demonstrate institutional relevance and societal value through a strong public profile. In turn, high usage figures can used to help secure adequate funding and resources for survival, sustainability and growth of the institution into the future. In view of this, user outreach through VEs is seen to be an important strategic activity that needs to be properly planned and executed. Other forms of more traditional outreach activities like publications, websites, tours, talks, demonstrations and other activities can be undertaken alongside VEs to create the impact and yield the desired outcomes.

Online strategies (VEs and websites) have particular advantages: it is relatively easy to add new products and services or revamp existing ones in the form of adding new materials, updating and reusing existing materials, adding new learning and edutainment components, online shopping, online forums, users’ contributions, to name just a few.

VEs, through digitization and rendering, also have the distinct advantage to create and use electronic surrogates of original fragile or sensitive records, or priceless artifacts which might otherwise be damaged in physical consultation. Established institutions such as Smithsonian Institute (www.si.edu), Auckland Art Museum (www.ackland.org/index.php), and most national heritage boards and museums around the world have a permanent and rich set of VEs hosted on their servers. Collectively, they are able to display and make available a significant amount of “treasures” held by the institution which is by far much than what physical exhibitions can display and achieve at any one time. This means of extending outreach has significant long term returns of investment once these VEs are curated and implemented for public access and use.

While VEs have been critiqued in the past for its inability to provide the experience of the “real thing”, VEs can allow users to understand, discover, learn and do far more than physical exhibitions. By adopting a carefully researched user-centered design, VEs through hyper-linking supports both linear and non-linear discovery and learning pathways, creating learning opportunities that are difficult to replicate in physical exhibitions.

The ability to engage in multiple forms of media (text, image, audio, sound, video, augmented reality and virtual reality components) on one page, having the ability to reverse, revisit, translate and read text tailored for different user groups, proficiencies and requirements, immersion in well crafted theme-games, etc., collectively helps to establish a deeper sense of understanding, awareness, and learning of contents than physical exhibits. VEs are therefore no longer viewed as passing fads but an important logical companion and extension to physical exhibitions.

While the discussion of VEs has so far being related to non-profit institutions such as museums and archives, it should be borne in mind that the ideas put forth subsequently are equally applicable to profit organizations for the marketing of its products and services. While some functionality and features are no longer slanted towards the social responsibility aspects in such organisations, these VEs still relies on similar characteristics such as the ability to deliver attractive, interesting, engaging, and intriguing “exhibits” through user-friendly interfaces to
encourage users (buyers) to visit and access the site, and ultimately become customers of the organisation. These sites typically have the common features of hyper-animated graphics, brief exhibitions and high interactivity zones to showcase products and services, online areas for mailing list sign-ups and online stores to order and make purchases. However, it should be made aware that these VEs are often characterized with biased education in an attempt to gain competitive advantage over other competitors’ VE sites which one should really expect in today’s competitive landscape. In contrast, VEs developed by non-profit organizations and government agencies are almost always constructed with different objectives in mind: archival, preservation, discovery, education, and others. They are deemed more authoritative, contain better researched and trusted resources, and higher educational value.

Nonetheless, a similar set of user-centered design paradigms, use of technological tools, well designed system architectures to high level of automation with minimal human intervention and effort to create new versions of VEs are equally applicable for all forms of organizations. At a higher abstract level, we may consider VEs as digital libraries that contain a set of information objects that can be accessed individually, or packaged together by applications supported by the DLs.

The aim of this paper is to treat VEs from this generic angle to examine a number of issues in the design and delivery of virtual exhibitions. This includes addressing the stakeholders of VEs, the important role of metadata, approaches to system architectural design and development.

**Stakeholders of Virtual Exhibitions**

Virtual exhibitions are extraordinary difficult to design and develop. One main reason is the number of stakeholders involved in the process. Patel et al. (2005) suggested that there are actually six groups of stakeholders involved in the process of creating and using the VE, with each group playing different roles:

1. **Curator** who is knowledgeable of the information objections and primarily responsible for artifact selection (i.e. identifying and selecting the artifacts for the VE).
2. **Photographer** who is responsible for digital acquisition to create the information objects to be stored in the digital repository.
3. **Cataloguer** who is responsible for data management to describe, catalogue and group individual objects together.
4. **Modeller** who is responsible for model refinement to create and describe object interpretations and/or refinements.
5. **Curator exhibition designer** who is responsible for exhibition building.
6. **End users** who are the consumers of the final VE.

The first five categories of stakeholders are typically part of the VE team, each with a different set of knowledge, expertise and skill sets and differing metadata requirements. VE teams can be large and can comprise professional writers, artists, archivists, graphic designers, multimedia technicians, technical specialists and curators. External advisory and editorial committees may also be roped in the VE design and construction to create a more balanced and effective exhibition.

End users, on the other hand, can evolve from a myriad of different user groups: children and adults, students and teachers, academics and researchers, novice and expert users, tourists and
casual Internet surfers, the general public and professional users (such as archivists, librarians and information professionals). The important aspect to note in this multiplicity of stakeholders is that it translates into a varying and large set of differing user requirements and expectations throughout the process of designing, developing and using the exhibition.

A “one size fits all” paradigm is almost certain to fail to meet these expectations. VEs need to be carefully curated and designed to ensure the potential for success. Typically, this encompasses a need for good metadata design and management, novel and effective ways to generate different versions of VEs at least or acceptable costs and high productivity in order to satisfy the needs of different user groups. With this, we can expect to find the requirement to tailor varying levels of content generation and online media types to cater to the needs of these different types of users. Contents would typically include multimedia elements, 2D, 3D, augmented reality (AR) and virtual reality (VR) (Lim & Foo, 2003; Gotz & Mayer-Patel, 2005).

**Metadata requirements**

Metadata has always been an extremely crucial aspect for describing and managing artifacts in the collection. When these are digitally acquired and transformed into information objects, a new set of corresponding metadata becomes necessary. When new applications such as VEs are developed, more metadata is required to describe and manage the exhibition, page contents, access information, and so on. The different stakeholder groups in the previous section provide an idea of the wide ranging metadata requirements needed by various constituents of the cultural heritage industry.

Active researches done on metadata and continuing developments of standards such as SPECTRUM, EAD, Dublin Core and other metadata schemes attest to the importance of having relevant metadata to support a variety of needs. Metadata can typically be classified as descriptive metadata, technical metadata, presentation metadata, preservation metadata, administrative metadata, and resource discovery metadata. It should be noted that while Dublin Core is an important, well-established metadata standard for descriptive and resource discovery across domains and used by almost all systems, it does not specifically deal with museum, archive and education requirements that have their own set of detailed metadata elements.

This overwhelming amount of metadata has prompted the proposal for having a system for authoring, maintaining and managing metadata to support the development of the Augmented Representation of Cultural Objects (ARCO) system for museums to create, manipulate, manage and present small to medium artifacts in VEs for both internally within museums and externally on the Web (Patel et. al., 2005). They envisaged the creation of digital artifacts providing opportunities to develop virtual learning environments (VLEs) which in turn entail creating new additional metadata such as those defined by ADL Sharable Content Object Reference Model (SCORM) or IEEE Learning Object Metadata (LOM) standards to support eLearning. Furthermore, they envisage commercial exploitation by institutions in the form of virtual loans for VEs (through information objects) that requires the support of a digital rights management system (DRMS). All this translates into more and more need for metadata.

Two issues are particularly important for metadata in the context of VEs. First is the highly recommended use of standards to support interoperability. When this becomes not possible for whatever reasons, the exchange of metadata information across systems becomes more costly.
due to the need for validation, optimization and mapping. In terms of metadata definition and storage, XML has turned out to be the de-facto emerging preferred means to manage information objects and VEs. VE exhibition pages contain a series of exhibition objects that can be neatly encapsulated in a XML-based conceptual hypermedia document model. Such a document typical includes different types of information: text, data, graphics, images, hyperlinks and other elements. Likewise, the information object’s metadata can be neatly based on the XML structure. Effectively, an XML-based solution exhibits the advantages such as platform independence, clear structuring and encapsulation, modularity, and so on.

The second issue pertains to the need to create a range of representations for one same original artifact. As an example, an image can be captured at different resolutions and sizes. They can be used as thumbnails, medium resolution for browsing, and very high resolution for zooming and detailed analysis. These different versions of content basically share the same metadata except for those entities that are distinct and different.

Figure 1 shows an example of a photograph metadata set in XML format (Lim & Foo, 2003). In this example, the Accession ID is used to uniquely identify a photograph artifact while the location element is used to define the repository directory where all the images are stored. As indicated previously, the image element can be defined more than once to cater to the different available versions of the same original photograph. These versions may contain resized, enhanced, or digitally-manipulated variations (e.g. colour, addition of borders) of the original photograph.

The same approach can be adopted for textual artifact metadata to incorporate the standard DC elements plus text specific elements. For example, the “content_version” element can be used the support layering of information through different descriptive layers of a textual artifact. These text descriptions can range from summarised abstract information to detailed information, or specially text written for children or adults, and so on. Likewise we can adopt the same approach for different audio, video and other artifacts to cater for different network conditions, resolutions, and the like. In doing so, we have one associated metadata record across different content versions that can be drawn by the VE to create a series of VEs for different users.
Creation of Multiple Versions of VEs Effectively and Efficiently

By using this approach of layering metadata and use of style-sheets, Lim & Foo (2003) developed a VE authoring system to interface with the National Archives of Singapore digital archive to support the creation of VEs. The XML-based digital archive provides different artifact types that form the contents in the exhibition through the reference and reuse model. This means that only one copy of information object resides in the repository which is in turn referenced and used by more than one VE as necessary. Information objects and exhibitions are endowed with rich metadata that include the Dublin Core elements and other new attributes to support enhanced search support for field and free text searches. An authoring tool using a grid-layout approach is used to define and layout the exhibition contents. XML’s Cascading Style Sheet and Extended Style Sheets are then selected from a range of predefined templates and applied to the XML documents to yield the final VE in HTML format. By adopting the notion of information layering in the descriptors or different editions of the information objects, and the application of different style sheets, it becomes possible to create multiple versions of the same exhibition that varies in content, layout and interface to create different versions of VEs for different user groups. The use of style sheets is particularly useful as it allows content and structure to be separated cleanly so that the information can rendered to yield different look-and-feel interface versions of VEs, thereby enhancing the productivity of creating VEs and updating
existing VEs. A second version of this system was subsequently developed (Yang, Chennupati & Foo, 2007) to enhance the authoring aspect by supporting a WYSIWYG interface for VE content layout and addition of different information objects types.

A similar approach was also adopted by Cruz-Lara et. al. (2002) in the development of a distributed content management framework for digital museums based on XML and XSL techniques. Using this framework, they developed a Lanyu Digital Museum for the Lanyu Island and its Yami inhabitants, and a Lanyu Virtual Exhibition Hall. In a related article by Hong et. al. (2004), they proposed an intelligent styling system to help museums efficiently and effectively produce and publish attractive VEs through the use of loosely coupled fine-grained style modules (FGSM) to present specific content fragments coupled with a hypermedia authoring system.

**Generic System Architecture for Developing Virtual Exhibitions**

At the formative stages of VE development, we witness the emergence of different stand-alone proprietary systems as one would expect. Over a period of time, there is a growing emergence of acceptance of standards and techniques, notably in the areas of metadata definition for VE artifacts, XML for storing metadata and exhibition data, utilization of style templates for generating versions of VEs, and inclusion of eLearning functionality in VEs.

Examples of different system architectures have been report in literature. These include the Virtual Exhibition System (VES) by Lim & Foo (2003), Virtual Archive Exhibition System (VAES) by Yang, Chennupati & Foo (2007), the Lanyu Digital Museum architecture and proposed framework for an integrated digital museum system by Hong, et. al. (2005). The salient features and approaches of these systems have also been described previously.

Although these and other current VE applications have adopted different system architecture for their systems, they tend to share a number of basic components to support VE functionality. Figure 2 attempts to encapsulate a generic system architecture that can be used as a useful platform for the development of VE systems in future. The architecture aims to support effectiveness and efficiency in generating, maintaining and managing VEs. It attempts to provide VE exhibition teams useful tool sets to generate different versions of the same VEs for end users’ consumption, taking into account user needs and system constraints of the client’s setup in accessing the exhibition.
Figure 2. Generic system architecture for VE development
The primitive data level contains all the information objects that can be used for VEs: text, image, audio, video, 3D graphics, interactive media, and so on. These information objects can be different versions of digitized artifacts or born digital objects. When eLearning is considered, this can also include questions for quizzes for assessment, and other learning activities. These primitive learning and information objects can be combined to form larger learning entities through the Learning Management System (LMS) or eLearning authoring system (which can either be stand-alone or an integral part of the LMS) to generate stand-alone learning objects which in turn can be aggregated to form larger learning modules. These variations of learning content can be incorporated into VEs as necessary.

Each primitive information object is defined by a set of appropriate metadata which is created, updated and maintained through a Database Management System (DMS). If necessary, a Metadata Management System (MMS) can be used to provide an interface to the DMS to support various metadata operations. This system is not confined to managing primitive information objects: it can also be used to manage metadata for the exhibition, presentation templates and other metadata which the system uses.

The Exhibition Authoring System forms the crux of VEs authoring. The VE exhibition team uses the system to define the exhibition framework, select information objects (including learning objects if these are present in the VE) for page contents, and create the layout and look-and-feel of the exhibition pages. This functionality can be integrated as one system, or split into different modules for exhibition page definition, page element selection and presentation definition. This latter approach attempts to clearly separate data from structure and layout. Using an Information Object Manager, exhibition pages can incorporate background music or background image, use a specific layer of information, select different layout setting, font setting during the authoring stage.

As mentioned previously, different presentations are usually achieved through different presentation or style templates selected during this authoring stage. These templates can be predefined for selection, or created and managed by a more sophisticated Presentation Template Manager. The Exhibition Manager defines and manages the whole exhibition and combines these various pages together to form the exhibition whose metadata can be stored in the exhibition repository for future reference, editing or updates. The internally generated VE definition can be stored in a suitable data exchange format that is used by the Presentation Manager, whose role is to render and generate the VE into its final form for use by users.

Depending on the way the Exhibition Authoring System is designed, all the necessary information can be made available for the Presentation Manager to complete the work so that VEs can be generated offline. Alternatively, VEs can be generated on-the-fly to take into account client system characteristics and end-users characteristics or preferences. As such, the Presentation Manager may be interfaced with a User Profile Manager to manage these aspects of system and user requirements.

System requirements would typically consider client computer processing capability, network bandwidth, and so on, in order for the content to be adapted as necessary. For example, different resolution image, sound and video may be used as necessary to attain an acceptable quality of service for the VEs with different constraints; and resource intensive 3D graphics may be eliminated if they cannot be adequately by the client computer. User characteristics would
typically consider age, literacy level, motive for using VE, kind of experience desired, and so on in order for the VE to be adapted as necessary. As such, the User Profile Manager may require some form of interaction and inputs from the user to complete the information necessary for the VEs to be generated.

Another component that might be interfaced to the Presentation Manager might be a Digital Rights Manager to support a Digital Rights Management System in the case where VEs are loaned out to other institutions and where constraints are placed on the information objects’ use. Such a system may allow other VEs from other institutions to have access to the primitive information objects as content for these VEs. Such an attempt to either provide free or fee-paying access can help promote reusability and sharing, and potentially enhance the quality of the final VEs.

Through the Presentation Manager and these other interfaces, a stand-alone single or many different versions of the same exhibition may be generated at one pass. Ultimately, the aim is to generate different versions of VEs to meet the needs of different user groups, and to user technology to support VE authoring efficiently and effectively, thereby minimizing human effort and intervention.

In terms of implementation, a number of common data types, standards and techniques have been utilized in most systems for VEs as shown in Table 1. The table also shows the desirable contents, characteristics and features that have been suggested in literature for successful VEs.

<table>
<thead>
<tr>
<th>Information Objects</th>
<th>VE Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text: ASCII, Unicode</td>
<td>Comprehensive and well organized contents</td>
</tr>
<tr>
<td>Image: GIF, JPEG, PNG, SVG, BMP, TIFF</td>
<td>Contextual information to ensure understandability by web visitors</td>
</tr>
<tr>
<td>Audio: MP3, MP4, MIDI, SND, WMA, WAV</td>
<td>Online courses (eLearning)</td>
</tr>
<tr>
<td>Video: MPEG, AVI, MOV, WMD, QT</td>
<td>Educative interactional games</td>
</tr>
<tr>
<td>Interactive Media: Java applets, Flash, Shockwave, X3D, VRML</td>
<td>Engaging multimedia</td>
</tr>
<tr>
<td>Metadata: Dublin Core, SPECTRUM</td>
<td>Frequently asked questions</td>
</tr>
<tr>
<td>Learning Object Metadata: LOM, SCORM</td>
<td>Guest book</td>
</tr>
<tr>
<td>Style/Presentation Templates: XSL</td>
<td>User forums (for ideas, comments, critiques, suggestions)</td>
</tr>
<tr>
<td>Database Management System: XML database</td>
<td>Across server access and information exchange: SOAP (Simple Object Access Protocol)</td>
</tr>
</tbody>
</table>

Table 1. Data types, desirable content and features of VEs
User resource contributions (e.g. users’ own photographs, stories, oral history)
Online shopping (e.g. souvenirs)
Downloadable content (e.g. wallpaper, screen-savers, free content)
Educational resource center for teacher classroom teaching
List of useful resources for further research
Help (e.g. How to Navigate, Technical support)

**Features**
Different versions for different user groups
High aesthetics and appealing
User-centered styles and interactivity
Good navigation design (including possible automatic navigation)
Good browsing and searching capability
Use of standards to support interoperability
Metadata details upon users request (for research)

**Conclusion**

Digital archives, as a stand-alone digital library, can be endowed with added functionality to create applications such as virtual exhibitions that will not only enhance the value of digital objects in the archives being used by users through browsing or searching, but allow well designed virtual exhibitions to be curated, designed and developed to support discovery, learning, and other opportunities beyond what physical exhibitions and stand-alone digital objects can offer.

This paper has presented the case for VEs, surfaced the myriad of stakeholders of VEs, and demonstrated the need for good metadata. Using a generic system architecture, the various components and approaches widely adopted in VE system design and development are highlighted. A list of desirable VE contents and features are also articulated to aid future VE development. The continuing developments of Web 2.0 and Library 2.0 work, VE researches, wireless and other technological advances are likely to change the form and capability of future VEs, and perhaps change how users would view and use such applications in future.

We believe that virtual exhibitions can, and are expected to, survive and grow as they stand to yield a rich set of both tangible and intangible for institutions that fully embrace the idea of both the physical and virtual operating environment in this Internet age. The key is to keep close watch on the trends which at this time of writing seems to raging on social networking sites (such as Friendster, Facebook, mySpace, Flickr, and many others), where developers have embraced Web 2.0 technology offerings to allow users create ownership, have their personal “voice/face” in these applications, ability to contribute, discuss and engage other users in the community virtually. By endowing virtual exhibitions with such attributes, and making the contents searchable in such social spaces can help to land users on board to use, learn and contribute to these exhibitions (that contain trusted authoritative contents) and the physical institutions.
References


Key Terms and Their Definitions

Digital archives

An information retrieval system that stores digitized primary sources of information and accessible by computers for browsing, search and retrieval. The digital content, generally grouped by provenance and original order, may be stored locally, or accessed remotely via computer networks. The content is usually unique and one-of-a-kind and cannot be found or consulted at any other location except at the archive that holds them.

Virtual exhibitions

A Web-based hypermedia collection of captured or rendered multi-dimensional information objects, possibly stored in distributed networks, designed around a specific theme, topic concept or idea, and harnessed with state-of-art technology and architecture to deliver a user-centered and engaging experience of discovery, learning, contributing and being entertained through its nature of its dynamic product and service offerings.

Metadata

Metadata is data about data, or information about information. Metadata is documentation about documents and objects; they describe resources, indicate where they are located, and outline what is required in order to use them successfully. Metadata is data associated with objects which relieves their potential users of having to have full advanced knowledge of their existence or characteristics. Metadata is data that describes attributes of a resource, characterise its relationships, support its discovery and effective use, and exists in an electronic environment.

System Architecture

The design and representation of a system in which there is a mapping of functionality onto hardware and software components, a mapping of software architecture onto the hardware architecture and the human interaction with these components to form a software or information retrieval system.