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# Design and Development of Web-based Online Exhibitions

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**ABSTRACT**

Online exhibitions are web-based multimedia information systems, which were came into existence with technological advances in computer processes, communications, multimedia, and the introduction of internet. Never before, now there are better opportunities for various types of communities worldwide to share their cultural and heritage with one another in an easily accessible yet interactive and entertaining way. This article proves an overview of trends in the design and development of online exhibitions in the world. Along with users requirements analysis needed to any systems design and the key technologies involved for developing an online exhibition were discussed.

**Keywords:** Web-based exhibitions, virtual reality, internet, shockwave

## 1. INTRODUCTION

The majority of the cultural, art, and other related organisations in the world are moving from physical exhibitions to online exhibitions for the past two decades. Long before the words 'interactive' and 'multimedia' became buzzwords in the 1990s, museums and other archival institutions were already presenting multimedia displays and exhibitions to their visitors and encouraging interaction between the visitor and the exhibit objects[1]. Interactive multimedia and computer technology, in the form of kiosks, was recognised as a way of allowing a greater degree of public participation and involvement in the learning experience.

The current trend shifts the focus of electronic exhibitions from static kiosks on the web, where they are called as online exhibitions. Online exhibitions cover a wide range of topics, ranging from art, geography, history, literature to science in general. They are mostly of archival and library content, e.g., archival audio and video resources, print arts (classic postcards, etc.), manuscripts, etc.

## 2. ONLINE EXHIBITIONS VERSUS PHYSICAL EXHIBITIONS

Online exhibitions are basically electronic web-based versions of physical exhibitions, so it is worthwhile comparing the two types of exhibitions, in order to understand the increasing pervasiveness of the former.

Physical exhibitions suffer from their bulk and size. Although 'travelling exhibitions' offer some degree of mobility, expensive resources (manpower, time and costs) have to be expended to shift the contents from one site to the next. Being manned by humans, with their associated working hours, these exhibitions are open for public access only during certain times of the day, further limitation is their temporal reach. In addition, limitations in the size of the display area available often result in the organisers being forced to leave out much of the collections (sometimes by as much as 80 %) from being put on display. Furthermore, as the content is presented in the form of static information panels, visitors often find it difficult to obtain take-away copies of the materials for future use (e.g., teachers may wish to incorporate the materials into their learning structures). In certain remote regions, it may not be possible for the physical exhibitions to reach out to the widest possible audience, due to their locations at geographical distribution areas.

Online exhibitions can overcome these limitations in time, distance and space, by being available around the clock via the internet. Visitors, especially school-children, need not travel all the way to the exhibition site to see it: the exhibition is delivered to them through the internet. Digital storage of the artifacts helps to reduce maintenance costs. There is no longer the need to dismantle and re-build the exhibition to make it available to new audiences. New materials

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can be added relatively easily, and existing content can be upgraded in a shorter time. These factors dramatically reduce the lead-time and eliminate costly physical space needed to mount a physical exhibition.

Once an exhibition is put online, it becomes immediately available to visitors around the world with an internet connection. This helps to share the local cultural and heritage reaches to the international community, as part of the global cultural exchange. Teachers can easily download the digital resources for inclusion into their teaching syllabi. Students learn to gather information, organise it, create meaning, reach insight and present their findings online, effectively creating new information products in the process. This provides a different and dynamic kind of learning experience, as compared to conventional static classroom instruction.

It should be noted that online exhibitions are generally designed to play a complimentary (rather than competitive) role to their physical counterparts, although there are some exhibitions that exist solely in virtual form. The contents of web-based exhibitions provide background information to prepare potential visitors for their Feventual visit, and can also help to fill gaps in the visitors' information needs after their visit, by providing additional resources to augment the static information panels at the physical exhibition[2].

## 3. TRENDS IN ONLINE EXHIBITION DESIGN

With the widespread availability of internet connections worldwide, there has been an ongoing global trend in putting information online to facilitate easier access[3-7]. This trend has also been encouraged by recent technological advances in computer engineering, telecommunications and multimedia systems[8-10]. The impact of such advances and their implications in content delivery have not been lost on museum and other archival professionals. In recent times, museums and galleries have been aggressively migrating their collections on the web[11].

Over a short period of time and with improvements in web-based multimedia technology, these web-based exhibitions have progressed from being the static online versions of their physical cousins to providing an enhanced virtual experience to their web-surfing visitors[12]. Increasingly, creative applications of commercial off-the-shelf technologies such as Shockwave, multimedia Java applets, Flash animations and virtual reality authoring tools (e.g., QuickTime Virtual Reality) have enabled online exhibitions to deliver their content more effectively than their physical counter parts with fixed passive layouts.

## 4. IMPACT OF TECHNOLOGICAL INNOVATIONS

Over the last few years, higher-speed internet connectivity speeds have been made commercially available using cable modems (which use optical fiber cables to transmit data as light waves) and digital subscriber loop (DSL) modems (which use normal telephone lines to transmit data at faster rates using efficient compression and transmission techniques). While cable connections require the installation of special lines and modems, DSL connections typically make use of existing telephone lines which helps the subscriber to save costs, at the same time web-surfing can proceed with telephone conversation concurrently on the same line.

Demand for such broadband connections is spurred by the trend towards more multimedia content on the web. The average size of files transferred across the internet is now in tens of kilobytes (KB), nearly 20 times bigger than what it used to be when the web was still basically a text-based communications medium. Such large file-sizes render dial-up modem connections increasingly inadequate, even for 56 kbps connections, which represents the upper limit for modem communications over ordinary telephone lines. The current drawback of broadband connections is the high recurrent costs of subscription, although this is expected to drop as competition between service providers intensifies; this could help to make such connections more affordable to the masses, but is driven by market conditions and can differ significantly between country to country.

Great strides have been made in the development of microprocessors – the 'brains' of computers. While the earliest Zilog Z80 microprocessor ran at 2.5 MHz, the Pentium IV and PowerPC G4 chips of today blaze above 3 GHz: a 1200-folds speed improvement over a short period of 20 years. While such high processing speeds may seem extravagant for users who typically do word processing, they are absolutely essential for delivering multimedia content over the internet. The integration of native multimedia instructions support into the microprocessor core architecture, as well as more efficient instruction execution design, are the essential process improvements that make microprocessors the key hardware enablers of web-based multimedia information systems, together with advances in modem technology.

The release of QuickTime, the world's first digital video and animation system in 1990 was followed by the development of the world wide web (www) at CERN in Switzerland. In 1995, these two technologies converged when QuickTime movies first appeared on the web. This was quickly followed by the appearance of RealAudio, the world's first streaming media (audio) format. Since then, digital movies have become commonplace on the web, and the major web multimedia formats (QuickTime, RealMedia and Windows Media) are now delivered in streaming format. Streaming audio and video files

mean that web users need not wait for the entire file (which can be very large in the case of digital video) to finish downloading – the first few frames can usually be sent in seconds after the page is loaded. Such streaming media technologies are the software enablers of web-based information systems.

## 5. KEY TECHNOLOGIES

Although the internet started off as a text-based communication medium, the introduction of the Mosaic graphical browser has enriched the web browsing experience. Initially only simple images were available. Later on, with the incorporation of audio and video support by web browsers, the web became a full multimedia communication channel. The following are the key technologies for the developing of online exhibitions:

### 5.1 Images

Web image formats can be generally divided into two main categories: raster and vector graphics. Raster graphics describe a picture by its image composition information (in terms of pixel location and colour), while vector graphics are represented by mathematical equations. By far, raster images are more popularly supported, but vector graphics are also emerging in importance due to the fact that they take up less space on disk (thus making them faster to download and render). Raster graphics are mainly in GIF, JPG and PNG formats, while vector graphics are exemplified by the Flash format.

### 5.2 Audio

Audio files come in many formats, but only a few are practical for use on the internet. The WAV (waveform) sound file format is playable across many computer platforms, but its use is limited to very short clips on the web due to its large file size. MIDI (Musical Instruments Digital Interface) sound files are generated using a series of sound notes information, similar to the way vector graphics are drawn. MIDI files are very small in size, but the output is artificial machine-like tones. MP3 and MP4 are other forms of popular web audio formats – they can compress CD-quality audio up to 10–20 times smaller than the WAV format. The major problem with WAV, MIDI and MP3 is their download-and-play delivery model, which means that the listener has to save the entire audio file to disk before the file can be played. This can result in an unacceptably longer waiting time for the user, besides the additional issue of copyright enforcement.

### 5.3 Video

Web-based video come mainly in three formats: AVI, QuickTime and MPEG. Like WAV file, the Intel AVI (Audio Video Interleave) video file format can be played across many platforms, but its use is limited to very short clips due to its large file size. QuickTime is the most widely used digital video format and is widely supported in the industry, making it ideal for use on the web. MPEG (Moving Pictures Expert Group) has good compression and image quality, but playback on the major web browsers is not consistent. Both AVI and MPEG are based on the download-and-play delivery model.

### 5.4 Media Delivery

Streaming media technologies represent advances made in audio and video file formats that are previously based on the download-and-play delivery model. Streaming is the process of transmitting media over a network for real-time viewing. The media file is not downloaded into the user's computer and it is played back by the specific media player or plug-in as the file is being received on the user's hard-disk. This solves the issue of copyright enforcement. Another advantage comes from the buffering of the media data – the viewer can start playing the clip as soon as sufficient data has been received. They do not have to wait for the entire media to complete downloading. Examples of streaming media are QuickTime, RealMedia, and Windows Media.

### 5.5 Web Technologies

Dynamic HTML (DHTML) refers to techniques used to extend the current set of standard HTML elements (tags), by allowing them to be accessed and modified by a scripting language, e.g., JavaScript or VBScript. Using the Document Object Model (DOM), a scripting language can be used to modify the attributes and behaviours of individual HTML tags, e.g., change the colour of the background. Such dynamic facilities allow web pages to come alive with movement and interactivity. Unfortunately, due to the slightly differently implementation for DHTML scripting support in the major web browsers, DHTML elements must be carefully coded if cross-browser support is required. For example

### 5.6 Programming Tools

Java is an object-oriented programming language targeted for cross-platform applications development. On the internet, Java is used to create applets (mini applications) that run within the browser environment itself. The use of Java applets to deliver streaming content is attractive because there is no plug-in to install or update[13]. In addition, due to the Java-based implementation, users can receive content developed on nearly any platform. For example

### 5.7 Virtual Reality (VR)

This environment allow the viewer to rotate an object around an axis and see it in three dimensions, e.g., when exploring a small artifact[14]. The user may

also be placed in the middle of a virtual sphere. This lets the user pan in any direction, creating a pseudo-reality experience in a panoramic space. Hotspots can also be embedded inside the VR environment to link to other pages, or provide a different view (e.g., zoomed view). QuickTime Virtual Reality (QTVR) is used to create such virtual space for the users to move around in virtual mode. For example Smithsonian museum

### 5.8 Shockwave

It is a popular plug-in for delivering complex animations created using Director or Flash software. Director is a multimedia authoring tool used to create complex animation, interactive presentations, games, and multimedia applications. Sound effects can be synchronised with video and animation, buttons can be used to trigger events, etc. Flash is another similar product used for creating vector-based animated user interfaces for web-sites. The Shockwave engine is used to compress Director and Flash applications to smaller sizes suitable for web delivery. For example

### 5.9 Database Technology

This is needed for the effective and efficient indexing and retrieval of the many resources in an online exhibition, via a search engine. This is especially important for multimedia resources, to facilitate searching along both the spatial and temporal dimensions – a problem that has yet to be addressed adequately with the major industry-standard database technologies available today. Active research is being carried out on the methods of describing multimedia resources so that they can be retrieved using conventional search engine interfaces.

## 6. USER REQUIREMENTS ANALYSIS

In collecting the user requirements for an online exhibition, it is important to understand the general demographics of the survey population. The survey participants should be chosen to be representatives of the potential visitors of the online exhibition. This is because different groups have different expectations, e.g., the younger generation (with their shorter attention span) seeks dynamic content presented in short snippets, while more mature audiences are generally interested in full details of the content rather than its presentation. Having a large survey population, together with an even distribution of the professions targeted for the intended audience, will help to ensure that sufficient relevant feedback is gathered to meet the user requirements.

In general, when profiling the demographics of the survey population, the specific areas of interests are: the age groupings, gender distribution, educational qualifications, profession, domain knowledge, work experience, subject background and areas of work. Often, these factors will in turn determine the systems design based on the results obtained in the study of users' requirements analysis.

When gathering data on the users' computer usage skills, the areas of concern are their computer usage experience, the types of computers they are familiar with, the operating system they are most familiar with, the size of their displays and their internet connection, etc. The first three factors will determine the complexity of the help system to be implemented, because a highly computer-literate user population would require a less extensive help system. However, computer literacy should not be used as an absolute measure and must never be taken an excuse to provide a sloppy help system or, worse yet, to do away with the help system entirely. The fourth factor is the screen resolution selected for the online exhibition. The final factor is the best techniques used to deliver high-quality multimedia content to the users, over the limited shared bandwidth of the internet. This involves a delicate balance between information compression and content quality, which has only recently been addressed to a certain extent with such technologies as streaming media (e.g., RealVideo) and web vector graphics (e.g., Flash).

Online exhibitions are broadly web-based information systems, so the potential users' web usage skills should be investigated as well. Users are surveyed on their frequency of web surfing, the average amount of time spent on web surfing, the types of browsers being used, and the types of web-sites they would prefer to visit. Similar to the computer usage skills, the first two factors will determine the depth of coverage of the help information to be made available to the users. The third factor (type of browser) has a major impact on the design of the online exhibition, particularly in the scripting of dynamic content, because the two major web browsers on the market (Internet Explorer and Communicator/Navigator) offer different levels of support for such content. It should also be noted that in some parts of the world, users only have access to text-only browsers, e.g., Lynx, so it helps to extend the reach of the online exhibition to these users by providing a text-only version of the exhibition. Without doubt, the requirement to accommodate users who use different browsers complicates the task of delivering the content, but catering to these users' needs will ensure that the content is distributed to the widest possible population.

Finally, the expectations of the users about the online exhibition should be examined. Users are surveyed on whether they have visited online exhibitions, their experiences of such exhibitions, the

types of media suitable for use in online exhibitions, the level of detail of the content, the appropriate length of the multimedia elements, requirements for search facilities, and a general section to gather feedback on other user requirements, e.g., any other essential features not covered in the survey. This important section is where the content and format of presentation of the online exhibition will be determined.

## 7. EVALUATION CRITERIA

Fundamentally, online exhibitions are web-based information delivery systems, and they are evaluated in six major areas of interests. These are: (a) design, (b) content and organisation of information, (c) navigation structure, (d) help information, (e) evaluation of multimedia elements (if any), and (f) total exhibition in general.

In design evaluation, an online exhibition is examined on its effectiveness as a web-site. Points to note are text readability (font type, size, colour and style), appropriate use of colours, appropriate use of icons and buttons, visual consistency, site attractiveness and user friendliness. For content and organisation of information, factors to look out for are information organisation, content coverage (detail), ease of finding information, and appropriate links to related sites.

When evaluating the navigability of an online exhibition, the hypertext structure of the site is analysed. Navigation aids (e.g., buttons) are measured in terms of helping in the users' exploration of the site, e.g., ease of navigation from one screen to another, ease of returning to the page last visited, etc. Problems surfaced by the users while using the system are to be addressed quickly in the next version of the online exhibition. This is because the hypertext nature of the web, while being representative of humans' natural way of seeking information, may lead to disorientation if not designed carefully.

In terms of help information, an online exhibition is reviewed on the usefulness of its help system, if one is available. At the minimum, a help system consists of a few web pages obtaining information organised into a Help section. A 'Help Section' should contain sufficient details for the users to locate the information of their interests within the site is in the shortest possible time. Ideally, an online exhibition should be designed to be intuitive enough for first-time visitors to use without ever looking at the 'Help Section'. However, owing to the disparate level of computer literacy among the potential visitors to the site, as well as the increasing sophistication of multimedia technologies and web-based information systems, it is still recommended that a help section be available for users to fall back on if they need some guidance along the way.

Today, commercial multimedia technology (e.g., digital movies, computer animations, three-dimensional graphics) is being increasingly incorporated into online exhibitions. Whether or not the users are able to enjoy the enhanced experience provided by the multimedia elements depends on the internet connection, the client computer used to access the site, and the server hosting the site. Factors such as the quality and length of the multimedia elements, and their window size, should be evaluated for their usefulness in reinforcing the visitors' understanding of the topics being presented. If possible, audio clips should be accompanied by text transcripts, e.g., in case the visitor's computer does not have sound playback, or the visitor is aurally challenged. Such user-oriented features can go a long way towards extending the reach of online exhibitions beyond the limits of their multimedia elements.

Finally, in the general evaluation of the online exhibition system, the site should be evaluated on whether it has met the users' expectations as gathered in the initial user requirements study. Visitors should be polled on the features found to both sufficient and lacking in the site, and encouraged to share other observations and recommendations. Feedback gathered from this kind of open-response section then become part of the new user requirements used to further refine the online exhibition to increase its effectiveness in meeting the users' needs.

## 8. CONCLUSIONS

While online exhibitions can be viewed as web-based multimedia information systems, they have an important educational role to play as well. The design of effective online exhibition is a compromise of the application of technology versus the users' needs and expectations. A hypertext-based information organisation for non-linear access to the resources provides alternative navigation paths to the resources, mimicking the natural human way of finding information. This must be carefully designed so that it will lead to disorientation in the users' search for information within the site, e.g., there must be means for the user to return to the previously visited page at any point of time. Dynamic animation elements have an aesthetic purpose and are often well-received by users, although they may not have any educational value. Therefore, there should be a balanced mix of animated interactive interfaces to attract and retain the attention of the visitors, especially the younger generation. The web presents an active learning environment where users can make decisions about the tasks, content, navigation, presentation and assessment activities that they make in the course of learning. Riding on such a rich communications medium, online exhibitions offer an exciting environment where

visitors can 'take back' portions of an exhibition, and return for more information or new features and updates in the future.

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