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Virtual archival exhibition system:
An authoring tool for developing Web-based virtual exhibitions

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Abstract

This paper describes the design and development of a Virtual Archival Exhibition System (VAES) that facilitates the authoring of web-based virtual exhibitions that can be tailored to serve the needs of various user groups. VAES is a joint collaborative project between the National Archives of Singapore (NAS) and Nanyang Technological University (NTU), Singapore. Based on an XML-based metadata database, VAES provides tools for users to create, update, extract, and search metadata of artifacts and exhibitions stored in the database. The actual digital artifacts (information objects) are reused by referencing as necessary without duplicating the artifacts. Dublin Core (DC) elements and non-DC elements with layered tags are used to describe and provide tailored information of each artifact for different users. In VAES, a virtual exhibition is created based on the pre-defined exhibition metadata and artifact metadata stored in the database. An authoring tool provides a direct manipulation work area for users to browse, display and layout the exhibition page content that is extracted from the database. XML's Extended Style Sheets (XSL) and Cascading Style Sheet (CSS) are then applied to the layout to yield the final exhibition in HTML format. By using different information layers, reusing the layout setting, and the application of different style sheets, it is easier for authors or archivists, especially those who are less proficient in information technology, to create multiple versions of the same exhibition that vary in content, layout and presentation to meet the varying information needs of a range of different user communities.

Keywords: virtual exhibitions; authoring tool; XML-based digital archive; reuse of artifacts; metadata; information layering; user requirements.

1. Introduction

Virtual exhibitions have become a common means for museums or archives to provide access to cultural heritage information resources to the public. However, using Web page authoring tools, such as Macromedia's Dreamweaver, to create online exhibitions is quite tedious and time consuming. In order to simplify the creation of virtual exhibitions and to reduce the resources spent on their development, some authoring tools or systems have been developed, especially for the creation of virtual exhibitions in multiple versions using the same content. Some of the most notable are: ViEx System (Breiteneder and Platzer, 2001), the Norfolk System (Vercoustre and Paradis, 1999), XMP-CMS (Hong et al., 2001) and ARCO (2003; Patel et al., 2005). All these systems have a common feature: they facilitate developing multiple versions of the same exhibition in different contexts by separating content and presentation. However, they have their own disadvantages: ViEx System does not support XML and metadata; the Norfolk system's descriptive language is not easy to understand and use; XMP-CMS does not support information layering, thus it cannot provide customized content of the same artifact to different users; and the ARCO

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system emphasizes creating 3D digital surrogates of artifacts on the Web, since its targeted users are museums whose main collections are 3D artifacts and not archives whose main collections are 2D artifacts.

To fill in the gap between these existing systems and the expectations of exhibition designers, especially of archivists who have minimum Web design knowledge, the Virtual Exhibition System (VES) project was developed by the National Archives of Singapore (NAS) and Nanyang Technological University (NTU) in 2002 (Lim and Foo, 2003). The system aimed to develop a user-oriented virtual exhibition authoring tool that is intuitive, easy to use, and with the facility to create multiple exhibition versions to adapt to different user profiles.

Based on an XML-based metadata database, VES provides functions for managing digital texts and photographs in the database, integrating the two kinds of digital artifacts into virtual exhibitions, and searching artifacts that are contained in the created virtual exhibitions. By using the "reuse and reference" model (Goh and Foo, 2002; Lim and Foo, 2003) and separating the content from the presentation, VES makes it possible to create multiple versions of the same exhibition with much less effort and resources.

As VES was a first prototype and largely developed to demonstrate the "proof of concept", there was some room for improvement. The current system (VAES), attempts to enhance the functionality and user-friendliness of the VES in a number of areas:

a) To establish a central repository for various types of digital artifacts (text, photograph, audio and video) that could be used in an integrated environment for various applications.

b) To provide a metadata system with layered tags to support information layering, and facilitate information retrieval and interoperability between systems.

c) To optimize the existing interfaces for archivists to manage the database effectively.

d) To replace the VES's grid-based authoring tool with a powerful direct manipulation tool to support the authoring of exhibition pages in a more intuitive and flexible way.

e) To support different user group profiles (e.g. virtual exhibitions for students, teachers and researchers) by facilitating the creation of multiple versions of the same virtual exhibition to cater to the requirements of diverse user groups.

2. Design of VAES

VAES is based on a metadata database that includes four types of artifacts (text, photograph, audio and video) metadata and exhibition metadata. According to many previous researchers, a virtual exhibition is made up of several parts, with each part containing one or more pages, and each page containing different types of artifacts, navigation links to the other pages and local information like web banners and navigational buttons. Virtual exhibitions are created based on the pre-defined exhibition metadata and artifacts' metadata that are stored in the database.

To accommodate the diversity of users, functionality of supporting customized information and adaptive presentations are expected in this system (Paterno & Mancini, 1999; Harms & Schweibenz, 2001). The end users of virtual exhibitions can be broadly classified into three levels based on their information needs: casual visitors, intentional visitors and specialists (Paterno & Bucca, 1997; DiSilvestro, Garzotto and Paolini, 1999; Callery and Thibadeau, 2000; Schaller and Allison-Bunnell, 2002). To study the virtual exhibition's role in education, VAES focuses on three user groups, namely, students, teachers and researchers.

VAES provides three ways to create virtual exhibitions for these three user groups: a) layered information of each artifact, that is described by layered tags in the artifact metadata, is produced to provide tailored information for various user groups; b) the exhibition page content can be laid out in various ways to cater to users' appreciation, and c) several pre-defined format templates are provided to present the content in adaptive presentation styles. Separating the contents, layout, and templates, this system facilitates the creation of multiple versions for the same content

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that vary in content size, layout and templates. The data flow of creating a virtual exhibition with different versions is shown in FIG.1.
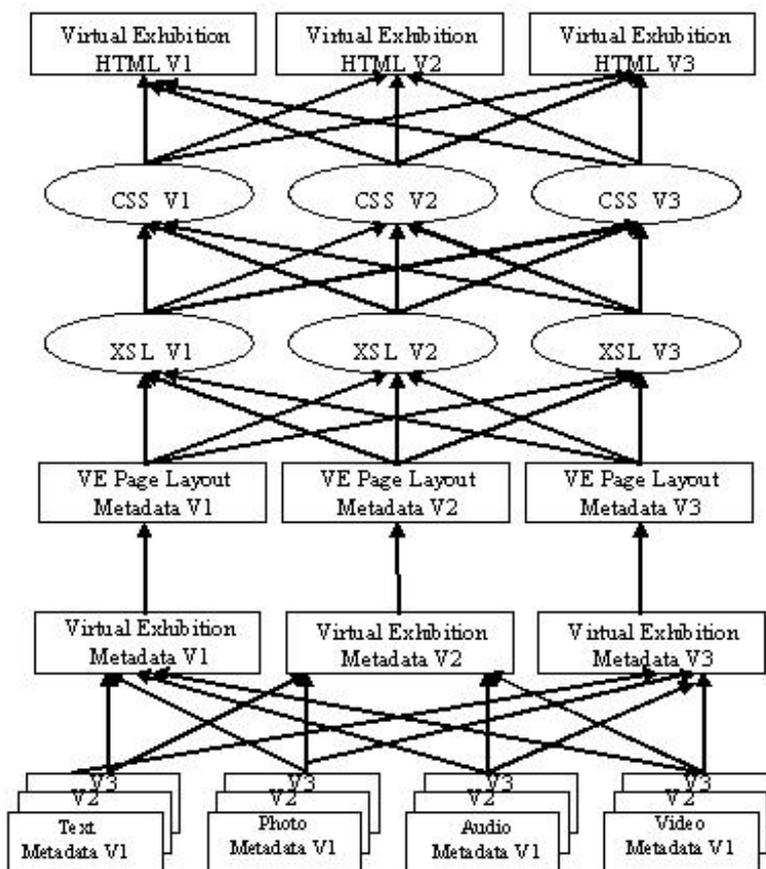

FIG.1. Data flow of creating a virtual exhibition page with different versions (V for version).

3. Data Model of VAES

The metadata database of VAES is implemented using XML and Document Type Definition (DTD). In this database, each type of artifact has its own set of metadata. Layered tags are used to describe different information layers of each artifact with a unique version ID to distinguish one from the others. The 15 Dublin Core (DC) elements, along with qualifiers, are used to describe the general features of an artifact, and non-DC elements are specifically used to further describe an artifact or the exhibition. The use of DC elements facilitate information retrieval and information exchange between different systems, and the use of non-DC elements with layered tags provide a richer and more complete metadata description for each artifact version. Layered information described by layered tags provides customized information of the same artifact for different users. An example of a photograph's metadata is shown in FIG.2. In this example, the image element, with its children, is used to describe specific information regarding the existence of each manipulated image version. The element img_id is used to identify each image version. The other elements, as implied by their name, are used to describe the image attributes respectively.

```
<photograph>
    <photo_id>phg00000001</photo_id>
    <title>A commemorative ball held in the Assembly Rooms, 1854.</title>
    <creator>Mr Heng</creator>
    <subject>Social event, historic site-- Singapore </subject>
    <description>A commemorative ball held in the Assembly Rooms in celebration of
anniversary of the settlements, 1854.</description>
    <publisher>National Archives of Singapore</publisher>
    <contributor>National Archives of Singapore</contributor>
    <date>1854</date>
    <type>Image</type>
    <format>jpg</format>
    <identifier.photoCD>19980007379-8105-3181-0351/0012</identifier.photoCD>
    <identifier.negative_no>S22327</identifier.negative_no>
    <source>National Archives of Singapore</source>
    <language>EN-SG</language>
    <relation>virtual_archive_exhibit/images/phg00000003_3.jpg</relation>
    <coverage>1854</coverage>
    <rights>National Archives of Singapore 2001.  All Rights Reserved</rights>
    <location>virtual_archive_exhibit/images</location>
    <image>
        <img_id>1</img_id>
        <img_width>1000</img_width>
        <img_height>754</img_height>
        <img_file_size>603kb</img_file_size>
        <img_resolution>200dpi</img_resolution>
        <img_description>large resolution for broadband</img_description>
        <reproduction_date>1999-10-01</reproduction_date>
    </image>
    <image>
        <img_id>2</img_id>
        <img_width>638</img_width>
        <img_height>481</img_height>
        <img_file_size>235kb</img_file_size>
        <img_resolution>120dpi</img_resolution>
        <img_description>Medium size </img_description>
        <reproduction_date>1999-10-01</reproduction_date>
    </image>
</photograph>
```

FIG.2. An example of a photograph's metadata.

The exhibition metadata describes the entire exhibition's content. In the exhibit_id element, a user_type attribute is used to identify the different versions for different user groups. Each version is unique with different artifacts information layers and different local information. For example, the exhibition version for students includes text artifacts with the shortest length, and all the icons are colorful and in cartoon style, but the text for researchers is the most comprehensive, and the icon images are in black and write. An example of the exhibition metadata is shown in FIG.3.

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```
<exhibit>
    <exhibit_id user_type="teacher">exh00000001</exhibit_id>
    <title>Colours in the Wind: Old Hill Street Police Station in Retrospect</title>
    <creator>NAS and NTU</creator>
    <subject>Historical sites - Singapore</subject>
    <description>Old Hill Street Police Station in Retrospect</description>
    <publisher>National Archives of Singapore</publisher>
    <contributor>Ministry of Information Communication and the Arts</contributor>
    <date>2001-11-30</date>
    <type>Interactive Resource</type>
    <format>text/html</format>
    <source>National Archives of Singapore</source>
    <language>EN-SG</language>
    <relation>MITA Building</relation>
    <coverage>1880's till present</coverage>
    <rights>National Archives of Singapore 2001.  All Rights Reserved</rights>
    <part ID="1">
        <part_title>A Time and A Place: History of the Site</part_title>
        <page ID="1">
            <page_title>A Time and A Place: Introduction</page_title>
            <text>
                <text_id>txt00000001</text_id>
                <content_id>3</content_id>
            </text>
            <photograph width="250" height="175">
                <photo_id>phg00000001</photo_id>
                <img_id>3</img_id>
            </photograph>
            <homepage>nas_ve_index.htm</homepage>
            <homebutton>virtual_archive_exhibit/images/indexb3.gif</homebutton>
            <nextpage>exh00000001_1_2s.htm</nextpage>
            <nextbutton>virtual_archive_exhibit/images/nextb3.gif</nextbutton>
        </page>
        ...
    </part>
    ...
</exhibit>
```

FIG.3. An example of an exhibition's metadata.

Based on the pre-defined exhibition metadata, the individual exhibition page metadata are extracted from the database, and it describes the content of each individual exhibition page. The exhibition format page metadata, slightly different from the exhibition page metadata, contain the layout information of each page. The layout information indicates the exact coordinates and size of each contained artifact in the authoring tool work area, which works as a spatial metaphor for a desktop, thus the artifact will be located accordingly in the final HTML page. The exhibition page metadata and exhibition format page metadata is generated by the system to facilitate the creation of each exhibition page. A section of an exhibition format page metadata is shown in FIG.4.

```
<layout>
    <title>Colours in the Wind: Old Hill Street Police Station in Retrospect</title>
    <creator>NAS and NTU</creator>
    <subject>Historical sites - Singapore</subject>
    <description>Old Hill Street Police Station in Retrospect</description>
    <publisher>National Archives of Singapore</publisher>
    <contributor>Ministry of Information Communication and the Arts</contributor>
    <date>2001-11-30</date>
    <type>Interactive Resource</type>
    <format>text/html</format>
    <source>National Archives of Singapore</source>
    <language>EN-SG</language>
    <relation>MITA Building</relation>
    <coverage>1880's till present</coverage>
    <rights>National Archives of Singapore 2001.  All Rights Reserved</rights>
    <page_title>A Time and A Place: Introduction</page_title>
    <homepage>nas_ve_index.htm</homepage>
    <homebutton>virtual_archive_exhibit/images/indexb3.gif</homebutton>
    <nextpage>exh00000001_1_2s.htm</nextpage>
    <nextbutton>virtual_archive_exhibit/images/nextb3.gif</nextbutton>
    <text x="49" y="237" width="200" height="200" number="1">
        <text_id>txt00000001_3</text_id>
        <content_id>3</content_id>
        <content_source>c:/virtual_archive_exhibit/text/txt00000001_3.txt</content_source>
        <text_link/>
        <content>Ministry of Information, Communications and the Arts, MITA, building used
to be the Old Hill Street Police Station.</content>
    </text>
    <photogragh x="274" y="236" width="250" height="175" number="1">
        <photo_id>phg00000001_3</photo_id>
        <img_id>3</img_id>
        <img_source>c:/virtual_archive_exhibit/images/phg00000001_3.jpg</img_source>
        <img_link>phg00000001_3.htm</img_link>
    </photogragh>
</layout>
```

FIG.4. An example of a metadata section of an exhibition format page.

4. Implementation of VAES

VAES is implemented using Java and XML-based technologies. A Tamino XML server is used to store, index and retrieve the metadata. Tamino APIs are used to create the gateways for communicating with the database. JSP and Servlet are used to create a few tools for users to manage the database. An Apache Tomcat Web Server (with servlet engine) is used to run these interfaces. Java Swing and XML-based APIs are used to develop the authoring tool with a direct manipulation graphic user interface. XSL and CSS are used to convert XML files to HTML files that are ready for use by end-user browsers.

To create a virtual exhibition in VAES, firstly the exhibition's metadata is created in the metadata creation tool and then saved to the database; secondly, each exhibition page metadata is extracted from the database by using the extracting tool; thirdly, the exhibition page metadata file is imported into the authoring tool for setting the layout of the page content and then saved as an exhibition page layout XML file; and finally the XSL and CSS style templates are applied to the layout XML file to make it ready for the end-user browser.

The architecture of VAES is shown in FIG.5. The infrastructure layer holds the repositories, Tamino XML server and repository gateway. The application layer comprises five tools: a) the Metadata Creation Tool, b) the Metadata Editing Tool that allows users to create, modify and

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maintain the metadata in the database and in the Web server's local directory; c) the Metadata Extract Tool that allows users to extract each exhibition's page content and corresponding information from the related repositories; d) the VE Authoring Tool that allows users to create and modify the virtual exhibition's pages, ready for the Web browser; and e) the VE Search Tool for querying and retrieving artifacts stored in the database and exhibitions. The end-user layer is for exhibition visitors to view the created virtual exhibition.
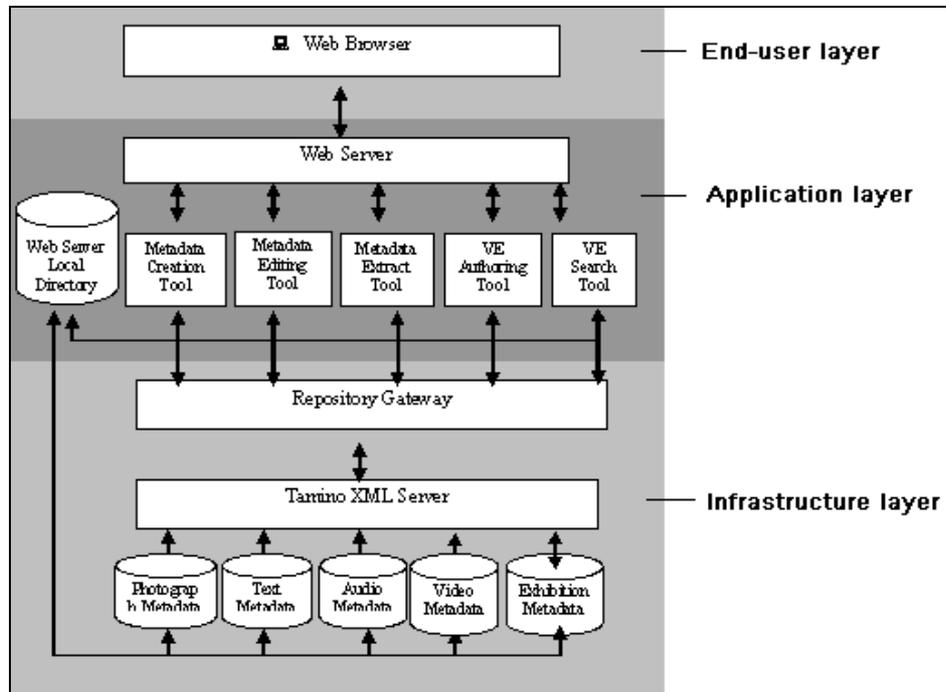

FIG. 5. Architecture of VAES.

VAES has inherited all the features and provisions of VES. However, it also provides a number of improvements and new features as shown below:

a) Handling audio and video for Web presentation and information retrieval. To accommodate various types of Internet connections and available bandwidths, the content of each audio/video is stored in three versions with varying compression rates. The inclusion of audio-visual capability enables the virtual exhibition to render a more realistic and engaging experience to its users.

b) An optimized metadata creation tool that allows the user to define and save the exhibition metadata into the database through a few entry forms. A user-type element is used to identify the unique version for different user groups. With minimized text field input, users can fill in the form in a more effective way.

c) A direct manipulation authoring tool has several provisions in its interface, as shown in direct manipulation environment in FIG.6. The authoring tool uses a WYSIWYG approach for users to browse, display, directly manipulate and locate the content on the exhibition page in an intuitive way.

d) Support for different user profiles and accommodation for diverse user groups, VAES facilitates the creation of multiple versions of the same exhibition with customized information and in adaptive presentations for specified user groups.

VAES was used to create a virtual exhibition called "*Colours in the Wind: Old Hill Street Police Station in Retrospect*", for a historical site in Singapore. FIG.7 shows the different

versions of the same page, with customized information and with different layout and style sheet, for three types of users: student, teacher and researcher.
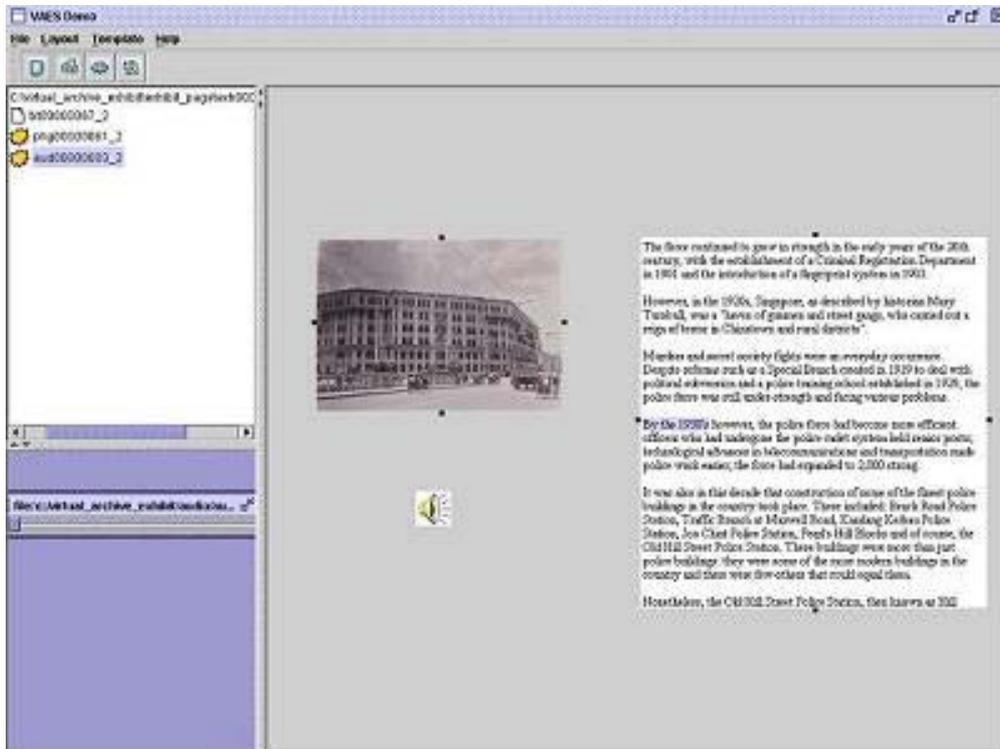

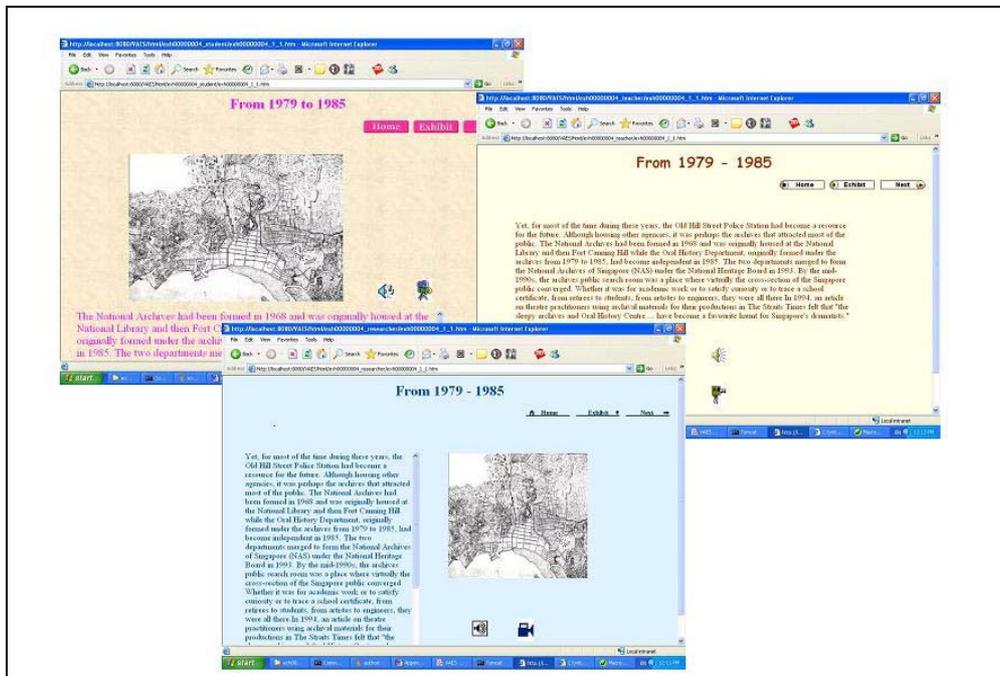FIG.6. GUI of virtual exhibition authoring tool.

FIG.7. Different versions of the same page in the virtual exhibition created by VAES.

5. Evaluation and Assessment

A preliminary evaluation was conducted in January 2005 to assess all the aspects of VAES such as functionality, user interface and potential application in January 2005. Twenty subjects with diverse education and professional backgrounds from NTU were selected for this system evaluation. The evaluation procedure comprised of demonstrations and "hands-on" exercises, followed by a survey questionnaire to collect feedback on the various functions and features of the system. The feedback from the respondents about the system was positive: most of the subjects found the system useful. The features, including visualization, artifact reference and reusing, information layering, and direct manipulation user interface, were deemed as novel characteristics of VAES.

The subjects also pointed out a few problems that are related to the usability and functionality of the system. Based on their feedback, the system's interface was modified, and this improved its usability. Some of the subjects commented that VAES was not very easy to understand and operate. The comments made included: "*How come the creation of virtual exhibition starts with creating its metadata*? *How come the content of a virtual exhibition is pre-defined by its metadata?*" It is a common problem in any system that if the developers or users do not have a minimum basic knowledge of XML, XSL and CSS, they need some orientation or short training to get to know about these technologies and the architecture of the system for better understanding. While that is also the case with VAES, it does not require days or months training, like for Dreamweaver or any other Web designing tool.

Due to time constraint, the system evaluation had its limitation: the subjects were not chosen from the targeted users of the system to include archivists or museum professionals. To improve the validity of this evaluation, real users of the system and professional evaluators are needed to improve its quality further.

6. Conclusion and Future Work

In this paper we have described the VAES system that provides a user-friendly interface with rich features and functionalities to create multiple versions of virtual exhibitions from a digital collection to cater to different user profiles. Building upon its earlier version, VAES has improved considerably in terms of functionality, including audiovisual information support, artifact referencing and reusing, user-tailored information layering, direct manipulation authoring tool with WYSIWYG user interface, separating and reusing the content, provision of layout and style templates. All these new features have also effectively eliminated the shortcomings of the four virtual exhibition authoring tools mentioned in Section 1. VAES serves as a handy tool for archivists and exhibition designers, especially those who are less proficient in information technology, to provide cultural and heritage information online to users of varying information requirements or needs.

In the future, VAES can be further developed to support adaptive navigation and multilingual support to meet the demands of archivists and museum specialists. VAES can also be used in a wider context of applications, such as virtual learning environments, distributed repositories of archives, and others.

References

ARCO. (2003). *Augmented representation of cultural objects*. Retrieved March 11, 2007, from http://www.arco-web.org/TextVersion/Description/intro.html.

Breiteneder, Christian, and Hubert Platzer. (2001). A re-usable software framework for authoring and managing web exhibitions. *Museums and the Web 2001*. Retrieved January 10, 2003, from http://www.archimuse.com/mw2001/papers/breiteneder/breiteneder2.html.

Callery, Bernadette G., and Robert Thibadeau. (2000). On beyond label copy: Museum-library collaboration in the development of a smart Web exhibit. *Museums and the Web 2000*. Retrieved November 11, 2003, from http://www.archimuse.com/mw2000/papers/callery/callery.html.

DiSilvestro, Alessandra, Franca Garzotto, and Paolo Paolini. (1999). User requirements acquisition for museum hypermedia. *International Cultural Heritage Informatics Meeting (ICHIM)*, 1999. Retrieved February 20, 2003, from http://www.archimuse.com/ichim99/abstracts/prg_30000056.html.

Goh, Dion, and Schubert Foo. (2002). Developing a digital library of reusable historical artifacts. *Proceedings of the Second ACM+IEEE Joint Conference on Digital Libraries, Portland, Oregon* (p. 393).

Harms, Ilse., and Werner Schweibenz. (2001). *Evaluating the usability of a museum Web site*. Retrieved August 15, 2002, from http://www.archimuse.com.

Hong, Jen-Shin, Bai-Hsuen Chen, and Jieh Hsiang. (2001). XSL-based content management for multi-presentation digital museum exhibitions. *Research and Advanced Technology for Digital Libraries, 5th European Conference (ECDL 2001)* (pp. 378-389). Darmstadt, Germany: Springer.

Lim, Joanna. C., and Schubert Foo. (2003). Creating virtual exhibitions from an XML-based digital archive. *Journal of Information Science, 29*(3), 143-158.

Patel, Manjula, Martin White, Nicholaos Mourkoussis, Krzysztof Walczak, Rafal Wojciechowski, and Jacek Chmielewski. (2005). Metadata requirements for digital museum environments. *International Journal on Digital Libraries, 5*, 179-192.

Paterno, Fabio and Cristiano Mancini. (1999). Designing Web user interfaces adaptable to "Different types of use". *Museums and the Web*, 1999. Retrieved February 20, 2003, from http://www.archimuse.com/mw99/papers/paterno/paterno.html.

Paterno, Fabio, and Maria Francesca Bucca. (1997). Task-oriented design for interactive user interfaces of museum systems. *International Cultural Heritage Informatics Meeting (ICHIM)*, 1997 (pp. 23-31).

Schaller, David T., and Steven Allison-Bunnell. (2002). How do you like to learn? Comparing user preferences and visit length of educational websites. *Museums and the Web*, 2002. Retrieved February 20, 2003, from http://www.archimuse.com/mw2002/papers/schaller/schaller.html.

Vercoustre, Anne-Marie, and François Paradis. (1999). *Metadata for photographs: From digital library to multimedia application*. Retrieved February 20, 2003, from http://www-rocq.inria.fr/~vercoust/DOCS/ECDL99/.