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ABSTRACT

In this selection of papers from the conference, authors from 10 of the more than 35 countries and every continent (except Antarctica) provide discussions covering all levels of museum Web design. They brought a wide variety of experiences and backgrounds to the conference, all of which ensured new perspectives and new ideas. The meetings opened on Thursday with a plenary address, followed by a full day of sessions and two Crit Rooms. Friday featured sessions on accessibility, portals, and data interchange. This day also featured a variety of Mini-Workshops. The final day began with two groups of demonstrations that were followed by sessions on design, licensing, schools, and new technology. MW2001 ended with a closing plenary. This proceedings includes the register; schedule of workshops by leaders in the museum computing field; schedule of sessions, with links to abstracts and full text papers; a table listing speakers (identifying country, presentation title and indicating whether the paper is online); schedule of interaction sessions (Mini-Workshops and Crit Rooms), with links to abstracts of Mini-Workshops; schedule and description of demonstrations; list of exhibits with descriptions of vendors; schedule of events; "Best of the Web" awards; key dates for future meetings; links to Seattle and Puget Sound area museums and tourist information; and list of sponsors. An accompanying CD-ROM includes: a list of all the speakers at the conference and links to their abstracts, biographies, and papers (where available); an overview of the Museums and the Web 2000 conference program and links to abstracts and paper biographies; and the results of the Best of the Web 2000 conference (requires Internet connection). (AEF)

Museums and the Web 2001

Selected Papers from an International Conference

edited by
David Bearman and
Jennifer Trant

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Museums and the Web 2001

Archives & Museum Informatics

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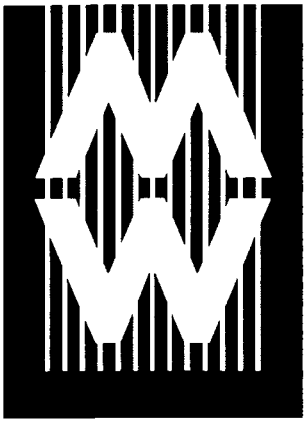

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Introduction

The Web as a Fact of Museum Life

David Bearman and Jennifer Trant, Archives & Museum Informatics, USA

The fifth year of Museums and the Web comes at a time when the use of the Web by museums – and the need of museums to take advantage of the Web – are givens. No-one questions the appropriateness of a museum Web site, only how well it achieves the goals the museum has set, and how fully those goals encompass the mission that the museum could be taking on in an age of nearly ubiquitous, increasingly broad-band, and narrow-casting. Each of us now expects to be able to use the Web to get instant information about museum offerings both in-town and around the world. In North America we imagine receiving Web content on ever larger monitors at home and the office; in Europe, with the proliferation of cell phones and wireless PDAs, the dynamics of access may soon (if only for a short time) feel very different. But the assumption of instant information, on demand, anywhere, anytime, remains.

For museums, the opportunities have never looked greater. In the wake of the bursting of the e-commerce bubble of the year 2000, there is a new focus on mission – both in the corporate and non-for-profit sectors – and a reaffirmed desire to use the medium to connect with our audience and to create something really useful.

.museum

The past year also saw the first, brave moves of ICANN, The Internet Corporation for Assigned Names and Numbers (http://www.icann.org), towards opening up the name-space of thematic Internet Top Level Domains beyond the familiar .com, .edu, .org, .gov and the two-letter country designations. The place of museums on the Web was reaffirmed when MuseDoma (The Museum Domain Management Organization – http://www.musedoma.org) was granted the right to administer a .museum top level domain. (See http://www.icann.org/tlds/mus1/ for the application, and http://www.icann.org/announcements/icann-pr16nov00.htm for the announcement.) MuseDoma, was founded by the International Council of Museums (ICOM) and the J. Paul Getty Trust purposefully to submit the .museum application to ICANN, "for the benefit of the museum community world-wide and for the Internet itself. This new TLD was intended to give museums the possibility of registering Internet addresses with a distinct museum identity and would allow the users of the Internet to recognize this as a sign of authenticity" (http://www.musedoma.org/).

MuseDoma now faces all the challenges of administering a collaboration in the open world of the Internet. As "registration in .museum will be restricted to museums and museum organizations" (http://www.musedoma.org) the refinement of the ICOM definition of museum and the development of MuseDoma operating policies and procedures that both maintain the distinct sense of museum space and encourage the inclusive and participatory philosophy of much net art and museum Web activity will be a difficult task.

We offer our collective thanks to Cary Karp, of the Swedish Museum of Natural History, and Ken Hamma of the J. Paul Getty Trust for their leadership in developing MuseDoma and the .museum domain. The Museum Web community owes it to itself and its users to stay abreast of this debate, both through the online discussions hosted by MuseDoma (http://listserv.musedoma.org/archives/musedoma-news.html) and through membership in that organization itself, when that becomes possible. Our domain will only be as good as we make it!

User Influenced Design

Awareness of the needs and requirements of users was one of the main themes of MW2001. The first four papers in this volume explore means and methods of involving users of museum Web sites in their conception, design and evaluation, and offer ideas of how we can integrate the needs of all kinds of users in to the Web presence of our museums.

Carrie Adams, Traci Cole, Christina DePaolo and Susan Edwards of the Seattle Art Museum lead the volume with an essay on "Bringing the Curatorial Process to the Web". Working with sixth-grade students from the Seattle area, their My Art Gallery Project used the curatorial metaphor to help students understand and appreciate the intricacies of museum operation. An engaging guide, Mona, personalizes the site. Designed in an iterative process with direct input from users, Mona, and the application she unveils, set the tone desired by the target audience.

Other ways of finding out what users want are equally valid, and can lead to development of appropriate applications that surprise us with their ground rules. Research conducted at the IBM T.J. Watson Research Center by John Vergo and his team over ten intensive months revealed what user-centered design might dictate for a model museum Web site. Using interviews, questionnaires, and surveys, they identified a preference in a generalist audience for "less interactive narratively structured streaming experiences with a human voice" as a way to for many users to augment their cultural experiences and attendance at cultural institutions. Is it distressing to find that users want enhanced TV like experiences? Or is it a challenge to convert them with more interactive offerings? Or is the even greater challenge for us to change the character of what we often want to deliver?

We are also charged to reach out to disabled users whom we may initially think are unable or unwilling to visit the virtual museum. Enabling access for a broad range of users is the theme of Susan Anable and Adam Alonzo's paper. They point out how easily museums can accommodate the needs of people with disabilities, with a small amount of planning and forethought. Not surprisingly, the design discipline required makes the resulting Web site better for all users.

Developing the skills to conduct rigorous user studies of museum Web activity is a challenge for many museum professionals. Ilse Harms and Werner Schweibenz, of the University of Saarland in Germany report on a research project that applied methods of usability engineering to a museum Web site. Their methods, built on foundations constructed in usability engineering and systematic qualitative human-computer interaction research, offer a model to which many museums will aspire. The partnership between computer scientists and museums is also a model to keep in mind.

Designing for (re-) Use

Effective and efficient information design remains a challenge as we struggle with the complex nature of cultural information. The second group of papers in this volume reports on projects, methods and tools to help us create information architectures that support the design of virtual exhibitions and the re-use and representation of their informational components.

The ViEx system developed by Christian Breiteneder, Hubert Platzer and Martin Hitz in Austria is one such tool to assist in the authoring and management of a virtual exhibition. Their framework of content repository, editorial tools, and Web page generator supported the creation of the complex exhibition Bhutan – Fortress of the Gods (http://www.bhutan.at) and is being generalized and tested in other applications. The approach – beginning at the end of a traditional multimedia design and reverse engineering a toolset that can make the same end product – is definitely worth further study and application. Detail sof the content and presentation choices made in presenting the Bhutan experience can also be found in a complementary paper on the accompanying CD-ROM.

Gilles Falquet, Jacques Guyot, Luka Nerima and Seongbin Park also address issues of reusability of museum information in their paper on the "Design and Analysis of Virtual Museums". Using a database publishing tool called Lazy, this group demonstrates the efficiencies in design that result from a rigorous analysis of structure, and the refinement of that structure using grammatical formalisms. If the building blocks are sufficiently solid and modular, constructing new multimedia content packages could indeed be something even the 'Lazy' could do.

Slavko Milekic explores the implications of content repurposing on interface design in his paper, which builds on his experience in creating informative and engaging user interfaces. Milekic proposes a typology for content repurposing, and points towards some of the benefits that intelligent repurposing could offer. Adaptive delivery of information content tied to user interest or ability, and effective redesign of information presentation, are two such areas where further research and exploration is required, particularly in the realm of converging media.

New Content, New Uses

Museums house and deliver a wide range of information content in many media. Much of the deep and exciting content of museums is, of course, served from databases rather than presented as static HTML pages. As a consequence, even the information that museums would like to make widely available to the public is hidden in the "Deep Web" (Bright Planet, 2001, see: http://www.completeplanet.com/Tutorials/DeepWeb/index.asp) where search engines cannot tread and most users never go.

John Perkins reports on the CIMI Consortium's work with the Open Archives Initiative as one way that museum can surface their deep content, and make it available to metadata servers that support information discovery on the Web. CIMI members are working with other partners in the international metadata community to develop methods for museum and other deep content servers to place metadata in harvestable packages for easy collection and updating of metadata servers (or search engines, as they are more popularly known).

The Cleveland Museum of Art has taken on another of the challenges of moving museums out to interested publics in trying to create the partnerships and methods needed to launch a broadband network for the delivery of museum content to seniors in assisted living residence facilities, community centers and disabled persons in their own homes. Len Steinbach reports on this unique collaboration, funded by the Technology Opportunity Program of the US Department of Commerce, that brings together museum and other cultural organizations' content expertise, the technological expertise of local ISPs and public broadcasters, and a network of community partners. These diverse players are working together to bring life-enhancing programming to under-served, and ready audiences – and it seems that they are having fun while they are doing it. (Maybe it's just too early in the project...)

Jim Spadaccini reflects on his experience in delivering streaming audio and video in a number of museum contexts, and offers some thoughts on the limitations of current technologies and implementations. After reviewing the relative experiences and evaluations of participants 'on the museum floor' and on-line, he designed modifications in the Webcast viewing environment that would greatly enhance the viewers experience – moving them from a passive recipient of pushed content to an active participant in a multi-media dialogue. Spadaccini's thought experiment cum requirement statement should inform the next generation of streaming content viewers – the 'killer app' of the users John Vergo and his colleagues at IBM interviewed.

Personal Web Experiences

Methods that enable visitors to museum Web sites to have active and relevant experiences have been the goal of museum Web designers since we began to take advantage of the Web's dynamic capabilities. The next group of papers explores methods and means for enabling the personalization of the museum Web experience.

Timoty Barbieri and Paolo Paolini continue their exploration of the nature of on-line collaboration in their paper on "Cooperation Metaphors for Virtual Museums". Building on their experience in developing the Web-Talk environments presented at previous MW conferences, they systematize and enumerate the requirements for virtual group behavior. This analysis offers a strong guidance to the designers of collaborative systems, and articulates the benefits of a group experience over a solitary visit. By making it clear how much social experience depends on shared time and space, Barbieri creates an exciting conundrum for virtual experience designers; they need to create virtual worlds in which groups of people have the same grounding they feel in the real world!

In their discussion of the "HyperMuseum Theme Generator System" Peter Stuer, Robert Meersman, and Steven De Bruyne explore another way for virtual museum visitors to gain a personalized take on museum multimedia content – in this case, it's a Take Away. Their prototype system enables the creation and extraction of 'personalized themes' from the HyperMuseum Server, and to create a their own view of that information, in a chosen information display and/or manipulation environment.

Providing Personalized Assistance is the goal of the designers of the SAGRES Virtual Museum. Brazilians Ana Carolina Bertoletti, Márcia Cristina Moraes and Antônio Carlos da Rocha Costa have developed multiple paths through their virtual collection for Visitors, Teachers and Students. Each type of visitor also has access to a software agent or Personal Assistant, represented as an animated character. Their evaluation, shows

that users are satisfied with this kind of on-line help, and would choose to have the assistant join them on their next visit.

Customizing the environment for experts working with multimedia archives is the goal of the OPALES project, reported here by Henri Betaille, Marc Nanard, and Jocelyne Nanard. Working with the French Institut National de l'Audiovisuel this group has defined authoring and reading points of view, which enable categories of annotation and viewing of specified information content within personalized workspaces. They are also defining a collaborative work environment which enables geographically and temporally separated experts to work together annotating documents and videos.

Being a Museum, Digitally

Since its inception in 1997, Museums and the Web has explored the impact of network technology on museums and museum programs. Creative use of the Web has expanded and enhanced museums' missions.

In a very few years, the Web has evolved a number of distinctive genres. Kevin Sumption of the Powerhouse Museum and Australian Museums Online takes a broad look at the models and metaphors informing presentation of content by museum Web sites in their delivery of Web-based Education. He presents a typology of learning styles and provides examples of museum Web sites that have exploited each of these approaches. While Sumption concludes that further evaluation of museum learning is required to develop consensus around when and how particular on-line educational methods are effective, his initial typologies provide much for designers to use and students of this evolving communications medium to ponder.

Sarah Kenderdine, also of the Powerhouse Museum in Australia, profiles an innately virtual exhibition created to celebrate the 2000 Olympic Games in Australia. She highlights the active interpretive choices involved in making digital archaeological reconstructions and reviews the components of this digital museum that integrates many kinds of media in a compelling manner.

C. Olivia Frost explores the changing nature of authorship through the model of the collaborative on-line exhibitions developed by the CHICO project at the University of Michigan. Uniting content specialists, educators, and information specialists in cross-disciplinary teams she explores changing professional roles and the nature of creation in a collaborative environment.

The "Unseen Discussions" that took place in conjunction with the PS 1 Contemporary Art Center Exhibition Greater New York: New Art in New York Now, changed the nature of this museum exhibition from a one-way delivery to a two-way dialog. Anthony Huberman outlines the E-Mail Project, created as a vehicle to enable direct communication between contemporary artists and the people who viewed their works in this show. By giving each artist an email address and distributing these widely (including on the exhibition labels), PS 1 enabled museum-goers and other critical publics to connect directly with the creators of challenging works of contemporary art.

Conceiving of the Web as the museum has been the logical next step for contemporary artists and curators alike. Beryl Graham and Sarah Cook of the UK have explored the issues involved in the creation and curation of this new media arts space through the

CRUMB Web site, a "Curatorial Resource for Upstart Media Bliss". Artists, Archives, Audience and Aesthetics are analyzed and the authors' experience shared in this overview of approaches to the confluence of digital media and museum reality.

Maintaining the Magic

Susan Hazan sends us off with a warning not to disregard the importance of the ethereal in aesthetic experiences. Following the requisite tour of Malraux and Benjamin, she challenges us conceive of the virtual museum as one with all of the magic and mystery of other museum spaces. Using examples from virtual (and not so real) museums around the world, her exploration reminds us of the emotive and evocative power of the arts, and the seduction of the truly beautiful. We mustn't lose sight of that which we cannot completely grasp, and we must strive to maintain the mystery of the museum experience.

In this selection of papers from the conference, authors from ten of the more than thirty-five countries represented at the meeting present a taste of the research on what is rapidly becoming a world-wide phenomenon. The creativity reflected in these papers, and in the more than 120 other presentations made at the conference (and documented on the enclosed CD-rom) demonstrate again that Museums and the Web offer a fruitful conjunction of content and a need to interpret and communicate, with a technology that thrives on rich resources and making connections possible.

User Influenced Design

Bringing the Curatorial Process to the Web

Carrie Adams, Traci Cole, Christina DePaolo, Susan Edwards, Seattle Art Museum, USA

Abstract

The Seattle Art Museum's *My Art Gallery* Web site was born out of an actual experiment in the galleries of the museum itself. The project was called "Growing Up With Art" and was funded by a four-year grant from the Pew Charitable Trusts. SAM invited sixth-grade classes from local schools into the museum to curate two exhibitions using the museum's permanent collection. It was a project requiring collaboration from many corners of the institution–curators, educators, and registrars–as well as teachers and students in the public schools. Achieving an actual exhibition in the museum's galleries after only a ten-week lesson was an ambitious goal. Educators and a curatorial associate developed lessons for the students that would take them step by step through a "curatorial process." This process was designed to incorporate key elements of a curator's exhibition-development process and to tie into a sixth-grade curriculum as well as Washington State learning objectives.

The very nature of this project was clearly experimental and brought up many issues within the museum about the display of art and the role of the museum in relation to its community. Because of the intense time commitment and expense required for the project, the museum was able to give this experience to only a limited group of sixth-grade students. Not wanting to retire our efforts to the archives, we turned to the Internet as a way to extend a version of the unique experience to a wider audience.

As the project was winding down, SAM had completed the transfer of its object collection data to a new system, allowing the data to be accessed through the Web. Using the Web to engage our audience with the permanent collection became a new possibility. The idea was to build a Web site where students could be introduced to the elements of the curatorial process online: a process of visual analysis that includes observation, questioning, research, comparison, and label writing. Students, specifically in grades 6-10, could create a virtual exhibition by choosing from the group of works used in the actual student-curated exhibition and writing the results of their research and observations into a database-driven notebook. The notes and images would then dynamically generate html pages displaying their work. As a reward, students could pick their own gallery backdrops for their exhibition and send "gallery opening" emails to friends and family.

This paper will explore the transformation of classroom curriculum into an engaging, Web-friendly, interactive experience, pointing out the Web-management and structural-design challenges that were faced to achieve this goal. Similar to the program that resulted in the physical exhibitions, the Web site project was ambitious; it required museum staff to work collaboratively and face new issues that were pushed to the forefront by this medium.

Introduction

Using the Web to teach the complexities of curating an art museum exhibition, with the goal of having the user complete the process in twenty minutes, is no small feat. Yet perhaps giving the user a sense of the complexities involved, from research and visual analysis to design and writing, is possible. The Seattle Art Museum developed an interactive site that allows users to interact with the museum's permanent collection in a new way and create their own online exhibition, thereby beginning to grasp the knowledge and experience required of today's museum curators.

My Art Gallery is a Web site that was developed out of a four-year grant entitled *Growing Up with Art* (see Appendix A for granting information), which brought local sixth-graders into the Seattle Art Museum to co-curate two actual exhibitions using objects from our permanent collection. In ten one-totwo-hour lessons in their classrooms, museum staff taught the sixth-graders a simplified version of the curatorial process. It was an ambitious pedagogical program for the sixth grade, introducing the students to visual analysis, research, comparison, developing interpretations, and writing explanatory labels, all within a period of six months. A central goal of the project was to find new ways to present the museum's permanent collection and improve how the public interacts with it. Another important goal was to foster collaboration both within the museum and without, working with museum departments, teachers, and students.

After the exhibitions were installed, the question remained of how to maintain the relationships forged between the public schools, the teachers, the students, and the museum, and how to use what was learned from the project to help future users engage with the permanent collection. These exhibitions were intense administrative feats made possible by a large grant and will not likely become part of the museum's regular program due to limited funding, time, and resources. In addition, though the project was a great experience for about one hundred students, we wanted to find a way to expand our reach. Thus, three years into the four-year grant, the curatorial associate involved in the project approached the Web team with an idea to transfer the curatorial process that the students underwent in the classroom on to the Web, allowing the lessons developed for the project to live beyond the grant period. It was an ambitious idea–to create a highly interactive learning environment on the Web modeled on ten classroom lessons. The site would give any users a glimpse into the world of an art museum curator and give them their own virtual "gallery" where they would choose a work of art, research it, and develop their own interpretations.

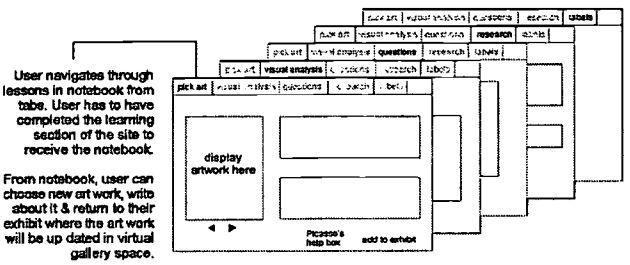
Many of the goals for the exhibitions were carried through to the Web site, though they sometimes manifested themselves in new incarnations. From the beginning, the project to create student exhibitions was envisioned as a cross-cultural one because the Seattle Art Museum's collection includes works of art from North and South America, Europe, Africa, and Asia, with particular strengths in Chinese, Japanese, African, and Northwest Coast Native American art. Development of the Web site also corresponded with the launch of our online collection database, which is accessible through the museum Web site. *My Art Gallery* would provide a structured environment in which a user of the Seattle Art Museum site could explore a portion of the permanent collection online.

In addition, the cross-cultural comparisons and themes chosen for the exhibitions came from the students' own impressions of the world around them. We hoped this approach to the exhibitions and the Web site would help to make a connection between our collection and our users' personal experiences. Finally, the Web site allowed us to continue collaboration and outreach efforts into the future by marketing the site to teachers and allowing users to experiment with our permanent collection. Theoretically, the expense and risk involved in pursuing such experimental projects in the physical space of the museum is reduced on the Web. The assumption was that the Web is more flexible and forgiving, and therefore a perfect place for the eclectic and experimental nature of these exhibitions.

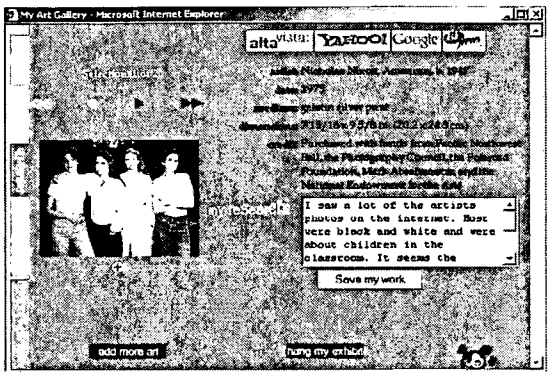
The process of developing this site was complicated, especially for a Web team of three developers (graphic designer, programmer, and manager) and one content provider (curatorial associate). What made this project such a challenge was transforming a model for teaching students in a structured classroom setting into a free-for-all Web environment. The existing process for the museum's Web site development presented a great stumbling block for this type of project–we had simply never attempted such an interactive, process-oriented Web site before. We knew we needed to build a site where graphics, images, and rollovers were used to create an interactive learning experience that would engage our users and take them through the process. Users needed to learn on the Web from doing, and the site needed to give them all the tools necessary to do this without supervision.

The idea of developing a "notebook," a place where students would do their own work and start creating their own exhibition, was essential to early site development. A vehicle was needed for students to select art images from the collection and write notes about their selections. A database had to be developed where "notebook" images and text could be saved and retrieved to create the content for the individual online exhibitions. It needed to be both a programming tool and a learning tool, giving users ownership of their process.

One early realization was that if we didn't engage our users immediately in the learning process, we would lose them. We also couldn't assume students would know who a curator is or what one does. So the first task was to introduce the idea of a curator in a fun and interesting way. Once we knew how to accomplish that, we could roll up our sleeves and build the remainder of the site.



Initial notebook concept



Final notebook

Some of the questions we needed to answer included, How do you get students to think about looking at art online? How can we get them to leave the site to research the work of art they chose and then come back to the site? What happens if they go to a search engine and can't find any information? Finally, how do we make them feel rewarded for completing the process of building their own exhibition?

It took several months of meeting, developing flow charts, drafting text, and building models to come up with a design solution to the "questions" the site posed. The key challenge was coming up with an interface design that combined all the components into one dynamic learning experience. Everything on the site had to work together. We needed to simplify a very complex set of ideas. We knew this thorough development process was necessary to avoid the pitfalls before us–possibly building a site where the components competed with each other, lacked focus, and were confusing to the user.

Throughout the months of the production process, we constantly had to redefine and lock in our established goals. This was necessary for two reasons. First, the site kept evolving and changing as we worked; we needed to produce one section of the site in order to understand how to build the next. We weren't always sure of the end result, so revisiting our goals kept us focused and on the right path. Second, each person working on the project contributed distinct expertise and brought a particular perspective to the project. This dynamic intensified when staff members from several different departments were pulled into the project at various stages of development. It took a lot of negotiating and working together to pool the necessary skills into a shared vision for the site. Unlike a traditional museum project with a clear beginning, middle, and end and clearly defined staff roles, the site development was much more dynamic and cyclical.

Over a year and a half, we worked through a process of constant redesign and rewrites of text and code. We developed new models for management, as well as site structure, design, and content. The evolution of our process grew out of the lesson we were learning about the Web: that it is a unique environment where complex concepts can become lucid in a way that is not possible in the classroom or in the gallery.

Simple Structures for a Complex Project

As various museum staff members contributed and developed content, the Web team found it necessary to establish content-organization tools which would be used both to guide the project along in a focused fashion and to guide the user along within the Web site itself. A main challenge was to restructure the original goals and materials for the actual exhibition process into content suitable for the Web environment. In order to simplify both the management of the project and the structure of the site, the Web team developed a clear mission statement and defined the target audience. Then, the graphic designer developed a storyboard, using it as a tool to create one interface to integrate all the components of the site: the introduction, the curatorial

lessons, the notebook idea, and the ability for users to create their own exhibition site. Crucial to this storyboard process was the development of an illustrated character (and eventually the development of two characters) to guide and motivate the user through the site.

A Focused Mission Statement Creates a Focused Web Experience

Defining a target audience is key in the early stages of developing a Web site, as it can often lead to the success of a site. It may be necessary to elaborate on the definition of the target audience and outline the kind of experience they should have. This can be called a "mission statement," where the target audience demographics and goals for their experience are melded into a clear statement.

Choosing a target audience for the site became an essential tool for focusing the content during early development of the site. Not only did we need a good solid understanding of the audience, but we also needed to understand how this group uses the Web. The target audience for the Web site differs in many ways from the students who participated in the physical exhibition project. One difference is that Web users can abandon the process any time they want by clicking out of the site. Another difference is that they can't ask questions or have direct dialogue with a teacher if they have difficulty understanding a step in the curatorial process. Within the Web site, the users are on their own and in control of their experience.

These limitations challenged us to further streamline the content and take several approaches that departed from the classroom experience. Initially, we assumed our target audience would be the same demographic as the students, with the exception that the target age would be expanded, focusing on grades six through ten. As we proceeded further into the Web project, it became clear that, along with retrofitting the content, we would need to create a focused "mission statement," outlining the kind of experience we wanted the user to have.

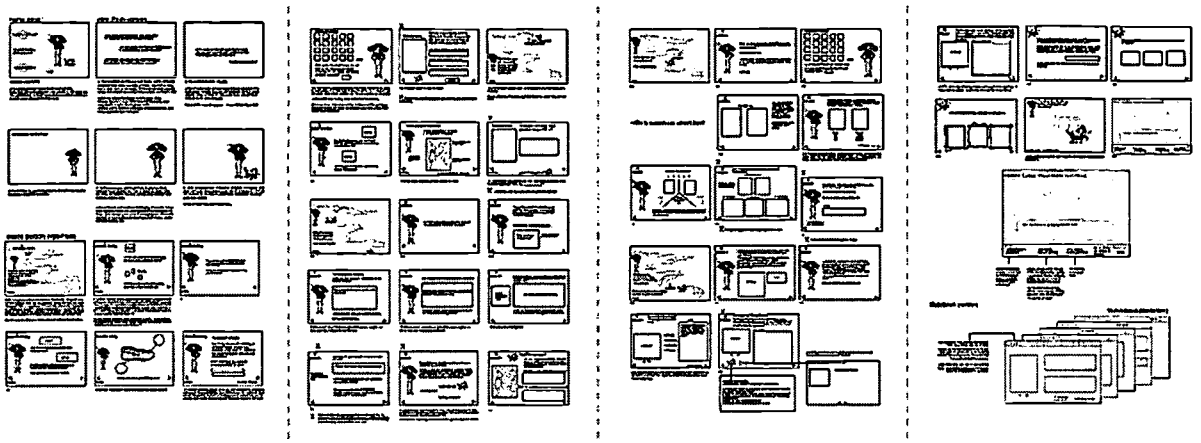
For example, we decided that the Web experience needed to be completed within a shorter period of time than originally planned. We initially thought of the notebook as a tool the users could save their work in and then log back into if they wanted to take a break. They could log in upon return and continue where they had left off in the process. On further thought, we realized that this kind of open-ended learning experience could result in confusion. Allowing the user the freedom to break the flow of learning could come at the cost of losing them all together. As a result, we decided to create a two-part Web experience.

The first portion of the site would be dedicated to introducing the users to the curatorial process, having them participate in five "lessons" as they went along. On the Web the five lessons are called learn from looking, asking questions, research, compare, and interpret. Only after the learning occurred and their online exhibit was posted did we give them free rein to work within their notebook and choose additional works of art. The mission statement was our saviour in many regards, as it helped us clarify the user goals and focus on creating a more organized Web experience. We would often refer to the mission statement as a focal point as we continued to develop the site.

Storyboards: Streamlining Content into a Web Experience Conducive to Learning

Storyboarding can be helpful if there is a lot of content to organize but design is not yet developed. The storyboards we created helped to approximate the number of pages the content would require and how much text and graphics might go on each page. Simply presenting a masked-out visual representation of each page helped the team easily grasp whether our ideas and content were working.

Originally, content for *My Art Gallery* came from various worksheets, diagrams, and notes from educators who participated in the physical experience. This content was useful in the physical experience, as it promoted two-way interaction with the students and educators. The lesson tools could be used to explain complex concepts and generate discussion. Working with this content, however, the Web team found the Web site was developing into an unfocused experience for our users. Based on the original content, many of the five lesson components repeated concepts, provided too many options, and offered intricate cross-references to other



Storyboard

lesson components. We realized that the original content and ideas generated for the site were impossible to fit into a restricted Web environment.

As a result we prioritized content, focusing on the material crucial to understanding the curatorial process. Content was streamlined into a straightforward learning approach that would work on the Web. Other ideas and components that were interesting but did not fit into this approach were discarded. The storyboard we developed illustrated to all non-Web team staff how the original content needed to be streamlined for the web. It gave everyone working on the project a visual guide that became the framework from which all content and ideas were generated.

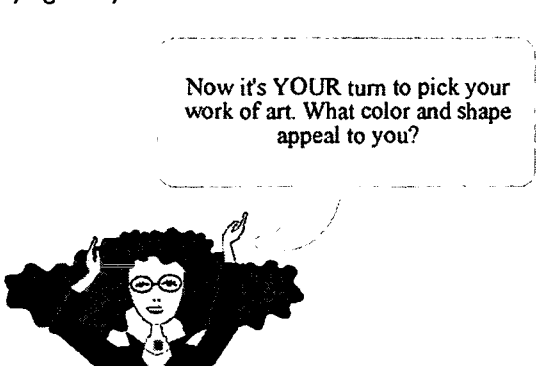
Mona, A Hip 'Learning Tool' for Kids

During the first project meetings we brainstormed the idea of having a guide to take users through the lessons. The graphic designer developed an illustrated character who would act as an anchor point within the site, add personal interest, and work with the content in a way that our target audience could relate to.

We felt it was important that the character be a compelling peer who goes through the curatorial process on a level similar to our users, but also explains the concepts and lessons as they proceed through the site. The character developed was first called "Annie Art" but she was eventually christened "Mona." Used as a main tool for organizing the content, she became the backbone around which we worked the other elements.

Through her positioning, and the use of dialogue (called "bubble text") and rollovers, Mona operated interactively with the users, providing a context for the content and accommodating different learning styles. Some users have found they read Mona's bubble text while others find they learn better relying solely on the visuals.

Mona



Mona with bubble text

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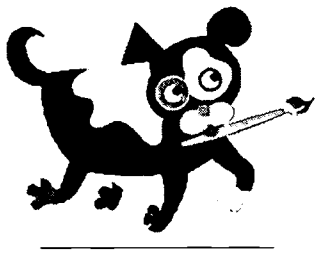
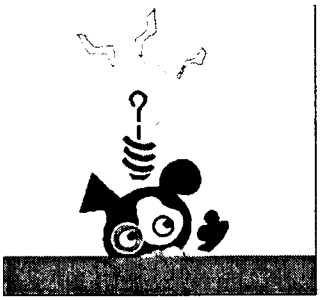


Pablo



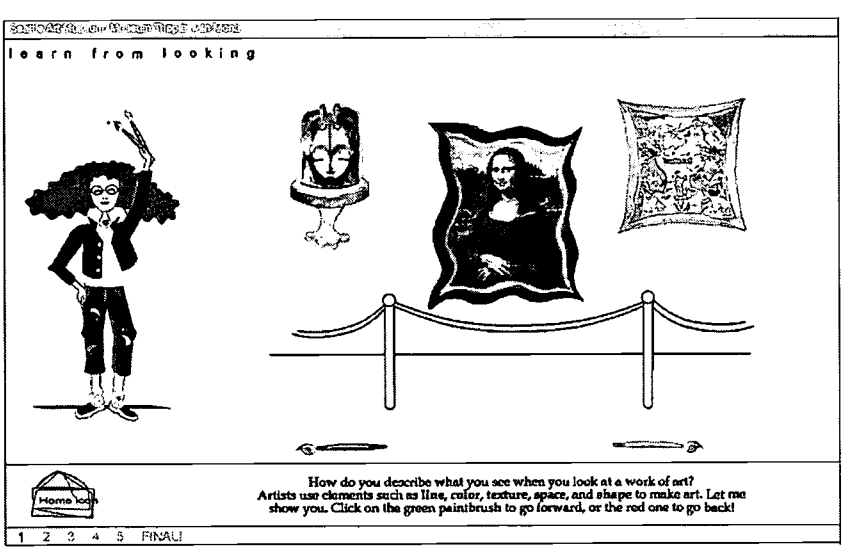
Help box icon

In addition to Mona, we developed a second character, her dog Pablo, to keep students motivated, guide them through help screens, and chart their progress throughout the site. Pablo became the icon giving a consistent presence to the help function.

Evolution of the Character and Script

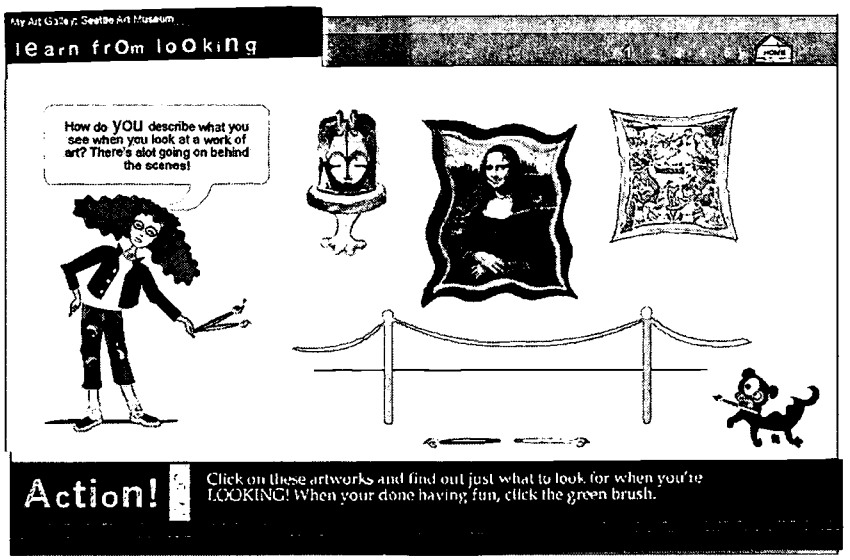
The original text for the Web followed the course of the lesson plans despite the fact that in the classroom the lessons were presented for one to two hours over a period of ten weeks. The resulting text was cumbersome, repetitive, and dry. Part of the problem was lack of experience. The curatorial associate who helped write the original lessons and taught them in the classroom was also writing the copy for the site. Her task was formidable; she had to write for a format she had little experience working with and for an interactive framework that did not yet exist. Likewise, the Web team understood the technical and design possibilities of the Web, but did not have the experience of creating an exhibition with the students, nor were they experts on the curatorial process. Clearly, the linear model that worked on simpler site projects "first copy, then design, then post" was not going to work here.

Initially, we felt that Mona would appear intermittently throughout the Web site, appearing only when necessary to add visual focus and help explain a complex lesson. As the lesson sections were laid out graphically with the first draft of text, it became apparent that the text and our character seemed disjointed. In fact, in early testing, our user was not reading the text at all. This was partially a design issue, but the illustrative examples that came out of the classroom were detracting from the visual and interactive nature of the Web experience.



Round I Design: Mona with no "bubble" text - lesson text at bottom

23



Final Design: Lesson text integrated with Mona

During the next redesign Mona became the unifying structure for the site, and text was streamlined to work with her. We added a text bubble above her head and drastically cut the script to fit comfortably within it. We were able to move much of the longer explanatory text into Pablo's help screens, assuming that those who needed this extra information would seek it out. Finally, text that did not have a direct visual relationship to what was going on in that page was eliminated.

Placing all of the instructional text in Mona's bubble intensified the interactive quality that she now embodied. As users rolled over the various interactives, Mona's position and bubble text changed accordingly. A once static page was now full of action.

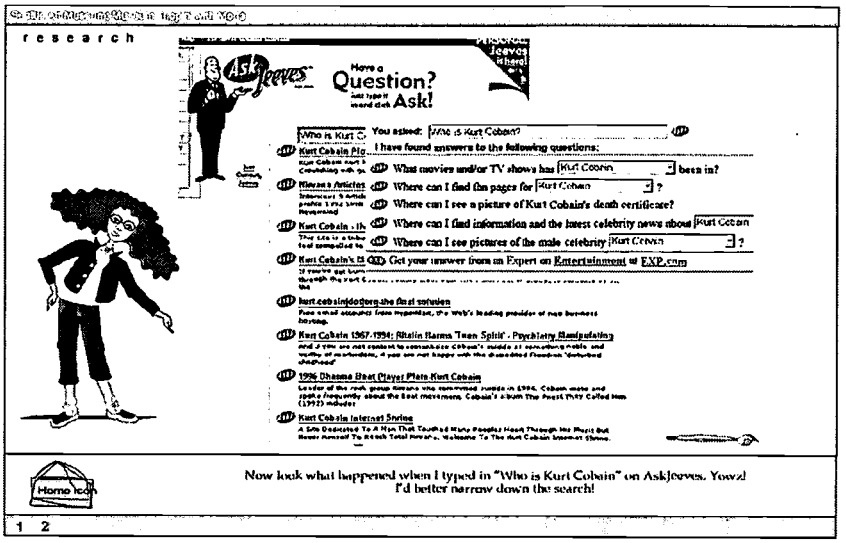
With Mona and Pablo established as our tour guides, the text for the site shifted from a descriptive lecture into a narrative dialogue. The curatorial associate and Web manager had many two-hour writing sessions that were more like drama workshops. The graphic designer also rewrote much of Mona's text; perhaps because the design is so central to a site of this nature, she clearly understood what Mona should say.

Much of the narrative couldn't be written until the basic design of each section of the site had been sketched out. We needed an idea of what Mona would be doing and how the user to the site would be interacting with her before we could write carefully focused text. This back-and-forth exchange between design and copy writing allowed us to make use of the unique abilities of the Web to illustrate complex ideas (especially visual ones), and to streamline the text as we went. As the programmer noted, there was one point where she realized that one rollover allowed us to get rid of a whole page of text.

Project staff had decided to write Mona in the youth vernacular in order to appeal to the target audience. We did not want her to "talk down" to the user but be an equal, someone they could feel comfortable with when learning about the complexities of art. Internally there was some concern about this language. We wondered if using words such as "dude" and "rock on" could potentially alienate the students and trivialize the process. We were sensitive to the fact that, as writers, we are much older than our target audience. We didn't want to assume we knew what would work for them. We also didn't want the site to become out of date by using trendy language.

Testing Our Audience

During the writing process we struggled to keep our users in mind. We realized that we were really working in the dark and were plagued by the question, "Will kids really do this?" The next step was to



Round I Design: Research section with search engine screen shots

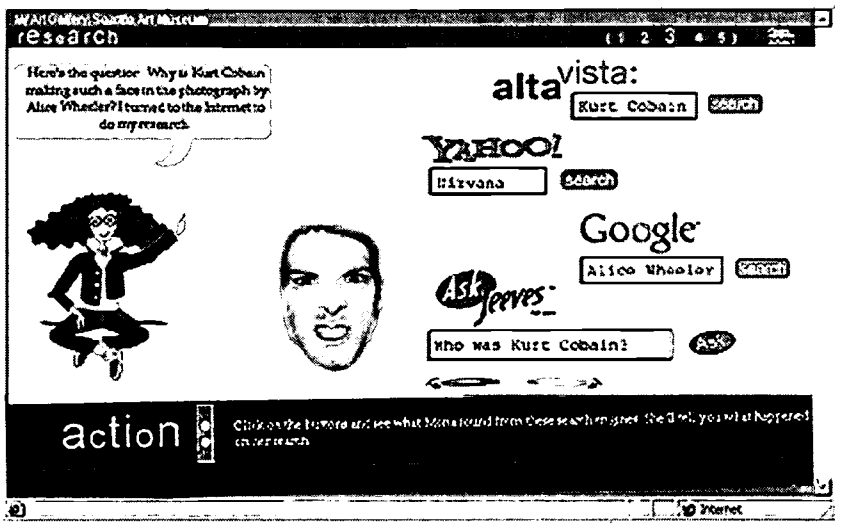
have both students and teachers review our materials to let us know if we were on the right track. It was important to get feedback on what we were building and also to get a sense of whether or not our target audience would be interested in using the site.

Through informal testing we evaluated the site with three different groups of users that we knew would be invaluable to our development process: teacher consultants, students in the target age group, and museum staff. The graphic designer created two questionnaires —one for the students and one for the teachers. She also created design boards featuring Mona and Pablo, the site layout, and text. We scheduled several one-hour testing sessions and recorded them. These sessions kept us focused on the needs of our user throughout the rest of the development process.

What we found is that each student and teacher had contrasting opinions of the Web, based on both level of interest and access to technology resources. Regardless, each person responded with genuine interest in learning what a curator does and in building their own exhibition site on the Web. In fact, everyone seemed excited and interested in the concepts of the site and the direction it was going. Reaction to the character illustrations was positive, as was reaction to the text.

Teachers were among the first testers of the site. They encouraged a youth-oriented dialogue and alleviated our initial concerns about the text. This core group of teachers became vital consultants whose feedback proved invaluable throughout the development of the site. Because much of the site's content had to be reshaped from the original classroom lessons for the web, we also wanted to verify that the content was still solid from a pedagogical point of view. We also got their advice on the logistics and feasibility of using an interactive Web site in a classroom. The teachers supported our decision to make the site a personalized process for the students, pointing out that the tools to let them pick their own works of art and write their own notes were important motivators.

As part of the testing process, we also interviewed a group of middle school students. We were curious to see how they would respond to Mona and the language in the script, as well as what interest they would have in creating an art exhibition online. The graphics and text were generally well received, with requests from various students to "tone down" the use of the vernacular. We learned that they mainly use sites targeted to adults, feeling strongly that education sites developed for their age group were "cookie cutter" and that the language used was often "too cute." They encouraged us to create a Web site that gave them the ability to make choices and trusted their intelligence.



Final Design: Research section with search engine logo portal

It was important to schedule constant review into the many phases of the production process. Project staff, often consisting of more that the central group of four, had long review meetings going over each page of the site both during the initial design and throughout the various redesign phases. We asked other museum staff to walk through the site at several key points during production. These feedback sessions were instrumental in fine-tuning the flow and troubleshooting technical problems.

Redesigning the Curatorial Process Online

A good illustration of the development process for *My Art Gallery* is the evolution of the research lesson design, which was the most challenging to build. This section needed redesigning three times, managed to dodge several deadlines, and caused widespread panic among the Web team. The problem with this section was threefold: 1.) We invited our users to leave our site to conduct research; 2.) We couldn't assume they knew how to do this; and 3.) We had to acknowledge that researching works of art could be an ambiguous and open-ended process.

When we decided to encourage users to leave the site and use search engines, we feared we would lose them. We worried that there would not be enough incentive for them to return to our site even if we used all the limited programming tools available to make coming back effortless. As a result of our concern, Pablo was engineered to eagerly await their return to the site.

Another concern was how to explain the complex process of conducting research online. Similar to how we first approached the original text, we started with classroom technique and tried to model the process by example. We took screen shots of some popular search engine sites that Mona "used" to research the work of art she chose, hoping visuals would effectively explain how to use search engines to some one who may have never done it. However, we had problems securing permission from several of the search engines to capture screen shots, so we had to abandon this first design concept.

This turned out to be a mixed blessing. We were trying to balance the need to guide novice researchers while providing a more streamlined presentation that would not bore those with more online experience. In the end, we broke with the narrative script and replaced it with a central research portal.

Using various search engine logos, users can link to several examples of search results and explore them

in detail if they wish, before moving on to do their own research. This simple design provides a needed structure without being too didactic.

Research is a vital step to the curatorial process, including understanding that there isn't necessarily one right answer to a question raised. Sometimes finding an answer at all can be challenging, especially for some of our collection's works that the students can chose from. To prepare for this eventuality, we used Mona to explain that there can be many different opinions about one work of art, and they are not necessarily right or wrong. She lets the user know that it is ok if they can't find specific information about a chosen work of art. Mona selects a photograph as an example, but fails to find explicit details about it. However, after more research, she finds information about the photographer and the subject of the photo, allowing her to hypothesize what the answer to her question might be.

Realistically, our concerns about this section could not be dispelled easily since the actual process of research is, in and of itself, inconclusive at times. There was also little we could do other than hope the site was compelling enough to draw users back in to finish their exhibit.

Use

During our testing phase we asked the teachers what they thought the best way to market the Web site to Seattle-area educators would be. Each teacher said an attractive postcard would stand out among the multitude of solicitations they receive. Our Web designer produced a postcard that was mailed in conjunction with the launch of the site in September 2000. We used our own mailing list of Puget Sound-area schools and education-related institutions that represented our target audience. Our press department also sent out a release that generated national coverage in education and art-related publications.

The postcard mailing was very successful in reaching a local audience, and several area teachers have integrated the site into their curriculum. Some teachers have contacted us to discuss the site and provided informative feedback. Most reviews have been favorable, but we ran into an unforeseen roadblock: notebook identification. Following protocol adopted by other Web sites, we had chosen the users' email addresses as the unique identifier for the notebooks. This identifier has the advantage of allowing us to email forgotten passwords to users—important in ensuring continued use of the site. However, we learned that many students do not have their own email addresses. In one instance, a resourceful teacher allowed her students to use her email address; unfortunately, this meant that all the students were actually writing to the same notebook, resulting in quite a mess. In other instances, the students mistyped their email address in the initial setup, rendering their notebook inaccessible when returning to the site. The programmer and Web manager worked with affected teachers to come up with short-term solutions so their students could continue to work on the site.

Many of the teachers who contacted us did so specifically to discuss technical difficulties, but this also gave us the opportunity to interview them to understand how the site was being used. It is interesting to highlight one teacher's experience with the site. She had an ongoing discussion with her students about attitudes toward works of art. Her students argued that all artworks could be judged equally, that merely by being art they were "all the same." She wanted to find a way to prove to them that works of art are held up to standards and that each work of art had to be understood within its own context. After receiving our postcard, she thought the *My Art Gallery* Web site would be a good tool to use to prove her point. Along with using the site, she also required the students to hand in a paper. She did feel that the students' assumptions about art were being tested as a result of using the site. Through their exploration of the five interactive lessons, they were discovering the complexities involved in researching art. As a result, they had many questions about the works they chose, and some students came to her for guidance when they could not find adequate research to explain them. This feedback supported our initial fears about developing the research section. However, with this teacher's guidance, the students did not give up and learned a valuable lesson about the process of research itself and also the intricacies of researching two very different works of art.

Another indication of use is the online exhibitions that are created after the users go through the les-

sons. As of this publication, 254 users have logged on and 64 exhibitions have been created. Many of the exhibitions submitted are similar; the majority include two works of art and one paragraph describing and/or comparing the works. This may indicate that our user expectations were too high, since we were hoping the submissions would be more extensive and dissimilar. We knew from the beginning that our goals were ambitious, expecting users to go through the five lessons to launch their online exhibition. After going through all of that, it may be unrealistic to expect the students to go back to their notebook to continue to choose, research, and write about additional works of art.

In the spring of 2001, we will evaluate the use of the site to determine what further enhancements should be made. We will review a wide range of issues: long-term solutions for the technical problems, analysis of the quality of the exhibition submissions, limitations of the research section, and whether or not we should provide more information about the works of art from our collection that are on the site for users to select. Important to this discussion is what amount of museum resources is available to further market, maintain, and enhance the site.

Conclusion

The Seattle Art Museum staff working on this project learned several invaluable lessons. First, we learned that the organization of a complex Web site has to come from the Web site producers in the form of a storyboard, mission statement, and production timeline. Staff with Web expertise understand how a project idea can be best translated into a successful online experience. Second, a level of trust in the Web team is needed from all staff participants in order to do this. Staff members need to trust that their goals and expertise will not be lost or misinterpreted through the Web development process. This trust is built when all project participants gain an understanding of how the Web works. Also, positive working relationships among staff can be further established if all participants on a project have a clear understanding of their roles and responsibilities and are kept informed. Third, effective project coordination and communication is difficult to implement with new initiatives such as the *My Art Gallery* Web site, but it is one of the most important factors in its success. We encountered many stumbling blocks in this area, but came out of it with clear communication models that we are now using, making current Web site projects much easier.

Interestingly, the Web site ignited many of the contentious issues raised as a result of the *Growing Up with Art* project. This project sparked discussion within the institution about the role of the curator in a museum and whether a sixth-grader could be a substitute for a real curator. Our efforts to highlight this experience and put it on the web, in a very public format, brought this issue back into the spotlight.

The management challenges of a Web project with this level of complexity seemed daunting at times because protocol was lacking within the museum to guide us through the unique issues that arose. Many of these issues demanded attention, and meetings were held to explore and create new guidelines. Some of the questions raised included, Do we need to review the online exhibitions users created? Or is it acceptable to post them automatically to the site? Since this was a project of complex collaboration across museum departments, who was ultimately responsible for it? The meetings convened to answer these questions resulted in innovative problem solving, but also led to more questions that we are confident will be answered over time. Eventually, we started to see *My Art Gallery* as one pioneering answer to meeting the museum's important initiatives and as an exciting pilot project to lay groundwork for future Web projects.

Acknowledgements

The *Documents International* exhibitions at the Seattle Art Museum are part of a four-year project called *Growing Up with Art* which has been generously funded by The Pew Charitable Trusts; M. J. Murdock Charitable Trust; Microsoft Corporation; the National Endowment for the Arts with the H.J. Heinz Company Foundation; The Coca-Cola Foundation; the Discuren Charitable Foundation; the King County Arts Commission Hotel/Motel Tax Revenues; PONCHO; and the Washington State Arts Commission. The Corporate Council for the Arts provides support for this exhibition through its generous annual funding of the Seattle Art Museum.

"Less Clicking, More Watching": Results from the User-Centered Design of a Multi-Institutional Web Site for Art and Culture

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Abstract

This paper summarizes a 10-month long research project conducted at the IBM T.J. Watson Research Center aimed at developing the design concept of a multi-institutional art and culture web site. The work followed a user-centered design (UCD) approach, where interaction with prototypes and feedback from potential users of the web site were sought throughout all the phases of the design process. In the first phase of the research, we conducted interviews with museum curators, issued questionnaires to brick and mortar museum visitors, performed on-line surveys with users of museum web sites, ran focus groups, and performed usability walk-throughs of best-of-breed museum web sites and of our new web site design ideas.

The results showed a surprisingly strong interest in streaming multimedia, TV-like experiences where users watched experts and artists talk about art and culture, augmented by links to additional and in-depth information. Such a design strategy was clearly favored by our subjects over more interactive experiences such as chat rooms, information search systems, or user-curated tours. In other words, when users go to a web site of arts and culture looking for entertaining and educational content, they seem to be less interested in clicking to find information than in watching people, especially experts and celebrities, present and discuss artistic works from their perspective.

Based on the results of the first phase, we developed a prototype of a web site based on the concept of "tours" — 5-10 minute streaming multimedia experiences led by experts and artists, accessible by users with normal telephone connections (56Kbps modems). The tours resemble a slide show enhanced by narration, music, occasional video clips, and hot spots for extra information. Two pilot tours were fully produced and tested with users who reported great satisfaction with the tours in terms of their entertainment, engagement, and educational values. We also observed that the most satisfied users were those who interacted and explored the least during a tour.

The research described in this paper suggests that people interested in art and culture have an affinity for web sites where they can have entertaining, curated experiences in many ways similar to short TV-like documentaries. Yet there are many other occasions when they are looking for engaging educational and entertaining experiences. In such situations, less interactive but narratively structured streaming experiences with a human voice seem to be a very appealing format to engage and satisfy such users. Importantly, they do not see such experiences as a substitute for actual visits to museums or attendance at live performances, but as an enriching and highly accessible way to augment the cultural experiences and performances they enjoy in brick and mortar cultural institutions around the world. People are often looking for specific information about artists and art works.

Introduction

In the summer of 1999, IBM decided to investigate the possibility of sponsoring and creating a multi-institutional web site for art and culture. The goal of this web site is to give users around the world ways to increase their appreciation of artistic works, cultural treasures and performances by providing information and learning opportunities about art and culture.

User centered design

User-centered design (UCD) is a design approach in which multidisciplinary development teams create useful, usable and satisfying user experiences. Central to UCD is the notion that the design process is iterative, and is accomplished by nearly continual input from users. As user input is collected and analyzed, it is fed back into the design process, resulting in progressive refinement and improvement of the system under design.

We followed six general UCD (IBM, 2000) principles which guided our activities:

1. Set goals for the project. This early phase of the project is also the right point to spell out any competitive goals, along with an identification of the primary competitors.

2. Understand users. Define the intended user population and the context of use. The context of use includes the physical context and the social context, if both are relevant.

3. Assess the competitiveness of the system under design. If the goal is to design a system that breaks new ground, it is risky to attempt such a design without a thorough understanding of the competitive landscape. Having clearly stated goals for the intended user allows testing of the system against competitive alternatives and comparing the results.

4. Design every aspect of the user experience. Everything a user sees and touches is designed together by a multidisciplinary team. In the case of the design of a web site for art and culture, the user experience goes well beyond the content to include navigating the site, interacting with virtual exhibits, and even downloading and installing browser plug-ins.

5. Create and evaluate designs iteratively with representative samples of the targeted user population. User feedback is gathered early and often, and this feedback drives design and development. In the early phases of design, lower fidelity prototypes are presented to and tested with the users. As the design team's understanding of the effectiveness of various design alternatives and design elements is clarified, higher fidelity prototypes are developed and tested. This allows inexpensive testing of many ideas early in the design process. Once a design idea (or set of design ideas) tests well with a low fidelity prototype, it is less risky to commit development dollars and resources in pursuit of the idea(s).

6. Manage the project through continual user observation and testing. Throughout the life of the project, continue to monitor and listen to your target user group, and let the feedback inform any modifications to the system design.

These guidelines are a set of heuristics that we typically follow on any project. They provide tremendous flexibility with respect to the precise activities a project team might employ and include a wide range of established user research methods and participatory design methods in use today. The next section explains the specific techniques we employed on our project, along with the rationale for our choices. After each UCD activity is presented, we report some of the most significant findings resulting from the activity. Each activity yielded a wealth of data not presented in this paper but publicly available (Karat 2001, Pinhanez 2001). Those findings that support our ultimate design choices are presented, along with findings of general interest to the Museums and the Web community.

Our UCD Approach

Project goals

The initial requirements for the project were extremely broad and open. We set out to create on the Web a major cultural destination (not a portal) that would attract a large number of visitors. The site had to provide access to content supplied by 5-10 of the largest and best-known cultural institutions around the world. The institutions were chosen to represent different areas of art and culture, including various performing arts, fine arts, natural history and science. Finally, each exhibit on the site needed to combine content from multiple institutions, to leverage the powerful institutional partnerships and to ensure the uniqueness of the site.

An additional goal was that the web site must not be a database of cultural artefacts or knowledge, but instead it must attract users by enabling entertaining and educational experiences similar to those provided by visiting a museum, attending a performance, or watching a cultural TV program. The success of the web site would be measured by its popularity and, specifically, by its rate of return visits. Given the openness of the initial specifications of the project and the strong requirement of users' satisfaction, we adopted a user-centered-design (UCD) approach to the development of this web site.

We ran five major user research activities in the discovery phase of the project. We conducted interviews with museum curators, issued questionnaires to brick and mortar museum visitors, performed on-line surveys with users of museum web sites, ran focus groups, and performed usability walkthroughs of best-of-breed museum web sites and of our new web site design ideas. Before engaging in any of the user research activities, we took the time to define our target user population.

Defining the target user population

Our definition of the target users for our project was initially shaped by the project business goals. The sponsoring organization within IBM came to us with some initial parameters. We eventually defined our target users to include members of several different population segments:

1. Adults 21-34 years old
2. Adults 35-50 years old, with and without children
3. Adults 50 - 70 years old, and
4. Children 9-15 years old, typically accompanied by adults from segment "2", above

While we did not target people 16-20 years old, we did not explicitly exclude them from our user population.

We assumed that our typical users spend an average of 10 or more hours a week on a computer, and of that time, five or more hours are spent on the Internet. They find out about sites from search engines, advertisements, friends and family, and web surfing. They think that having cultural events as a part of their lives is somewhat to very important. We also anticipated that visitors see the site as a way of enriching their experience at the brick and mortar center, not as a substitute for it.

Focus groups

Our first project activity was to run a series of six focus group sessions, which were conducted on the east coast (New Jersey), mid-west (Michigan) and west coast (California). Each group consisted of eight individuals, gender balanced. Two groups of age groups 21-35, 35-50 and 50-70 were conducted. An independent, objective third party moderated the sessions.

Some of the initial ideas that were explored during the focus group session were:

- Giving users the ability to create their own exhibit
- Live virtual tours where artists or curators are available on-line, in real time, to conduct a tour
- A cultural community center allowing users to meet, talk and exchange ideas on a wide rage of cultural topics
- A site that could be personalized to an individual's cultural interests, so that an individual visiting the site any time sees cultural content that is more likely to have personal interest

During the focus group sessions, participants were presented with verbal descriptions and simple visual representations of the new design ideas, and were asked a wide range of questions with the following objectives:

- Gaining a better understanding of the target audiences' use of cultural resources.
- Uncovering consumers' experiences with existing cultural web sites.
- Understanding current web site usage and behaviour.
- Assessing reactions to the proposed web site features/activities.
- "Brainstorm" potential features for inclusion on the web site.
- Determining relevance of and interest in the web site concept.
- Understanding the receptivity to various payment methods (i.e. advertising, sponsorship, subscriptions/memberships, etc).

Focus group results

Overall, the newly proposed web site features sparked favorable reactions from consumers. "Live" tours were overwhelmingly considered one of the most compelling and unique ideas proposed. They particularly liked the opportunity to interact with artists and tour guides.

Respondents were adamant that they should not be charged a fee to use the features offered on the web site. Advertising banners and third-party sponsorships were deemed the most acceptable means of funding the site. However, it must be noted that the use of advertising banners was a forced choice response. In the usability walkthroughs, people were clear in their disdain for advertising banners.

Most respondents viewed the newly proposed web site as a supplemental source of information and/or enhancement to the actual live cultural activity or event. While east-coast participants usually use ticketing and venue web sites to gather logistical information regarding a cultural activity, mid-west and west-coast respondents also venture to cul-

tural "home sites" for background information relating to the activity or event. Most respondents conduct some form of preparatory research before attending a cultural activity or event.

Time, geographic limitations and financial constraints are the primary factors that hinder respondents from attending cultural events as often as they would like.

Curator interviews

We conducted a series of interviews with curators from two partner institutions. Five curators were interviewed, with each session lasting between one and two hours.

The interviews were conducted with a specific set of goals but did not follow a rigid script. We queried curators to understand the design criteria for exhibits. We were interested in understanding if there are differences between institutions on how design criteria are created and implemented. We asked them how the design criteria affect the final exhibit. We wanted to know if curators go through the explicit step of defining the target audience for each exhibit. Finally, we asked the curators how they (or their management) measure the success of their work.

Curator interview results

Curators at both partner institutions stated that most individual exhibits are attractive to narrow audiences, and that many different types of target audiences exist. Curators from both institutions expressed an interest in drawing new people (i.e. new visitor segments) to the institution. Curators at an institution indicated they specifically target 20-30 year old visitors on a regular basis with the goal of establishing a satisfied clientele that will engage in repeat visits to the institution for many decades to come. Both institutions consider "families with children" a target audience.

All institutions have "dead zones", times when visitation is slow, and they try to draw people in to the museum by putting on exhibits that have appeal to a wide audience. The curators reported that their institutions perceive a strong need to keep exhibits "fresh", in order to attract repeat visitors.

No institution employs a quantitative approach in measuring success other than simply counting visitors. The institutions use ad hoc observational techniques in the museums. They also gauge reactions through published reviews in magazines and periodicals.

Usability walkthroughs

The usability walk-throughs were run in 12 sessions with a total of 70 participants who were screened for cultural interest and basic familiarity with the web. Subjects were first shown excerpts of existing web sites related to culture. Groups of approximately six subjects each were assembled in the TJ Watson Usability Lab in Hawthorne, NY. As much as possible, the groups were composed of 50% women, 50% men, and represented the diversity in income, education, background, race, and ethnicity in the tri-state area.

Each group was shown sections of two existing cultural web sites (children were shown only one site), followed by two new design ideas for the proposed site. After each demo, a facilitator led a group discussion of their opinions of the content in the demo. Then participants recorded their individual thoughts about the demo content (children had no written part). Then the next demo was shown. At the end of the adult session, participants were asked to answer several summary questions (children did not do this part). Over the course of all the walkthroughs, five existing web sites were shown and five new design ideas were presented.

In the first part of the session, we showed existing web sites where users could navigate through 3D replicas of exhibitions, interact with panoramic images, visually explore paintings and 3D sculptures, write and publish stories about the content, and obtain information about different layers of a painting.

The mockups of our new design ideas shown in the second part of the usability walk-throughs included five different possibilities for exploring cultural content:

1. A filtering system based on direct manipulation of large databases with visual feedback (such as in Alberg & Shneiderman, 1994)

2. A set of lenses (tools) to manipulate the way content could be viewed (such as in Stone, Fishkin, and Bier, 1994)

3. A chat system where people could talk about a particular artwork (Viegas and Donath, 1999)

4. A notebook system where the user collects and comments on artistic content, and later publishes the notebook for public/private viewing

5. A multimedia system where the user watches guided multimedia tours, interacting whenever interested in related information

Usability walkthrough results

A major finding of the usability walk-throughs was that most of the participants did not express interest in web sites that involved active interaction with the content or other people, such as when using a filtering system, creating a notebook, or chatting. The multimedia prototype was clearly the best received among the design ideas. Among the existing web sites, there was a preference for sites where the user was guided through an experience or discovery process, and in this case, participants strongly suggested the replacement of text by audio.

We summarize those findings by hypothesizing that in this kind of entertaining web experience, users want *less clicking, more watching*. Users seem to be very comfortable with the idea of a streaming web experience that leads them through artistic and cultural artefacts where, unlike television, the stream can be paused, replayed, or interrupted for further exploration. In fact, we found a strong desire for availability of additional information through hypermedia links and in-depth analysis of the works of art. Interestingly, some of the participants viewed the more interactive design concepts and existing web sites as work, not entertainment.

The idea of more passive experiences was further reinforced by many complaints about the difficulty of 3D interfaces, the excess of textual information, and the amount of work required to find information. The streaming multimedia concept seems to address this major concern by neither requiring the user to learn and exercise a large set of new skills nor requiring a large amount of attention and decision-making.

The usability walk-through also detected a desire for a "human voice" behind the multimedia experience; that is, a personal viewpoint in the exposition of the content. However, this voice needs to have the authority of an expert in the field or the human interest of a celebrity. In fact, a major complaint identified with chat systems was precisely the lack of trust and perceived value in the information provided by generic chatters.

We explicitly asked the usability walkthrough participants what factors would be important in their decision to re-visit the site on multiple occasions. The most frequent responses to this question were:

- The quality of the content
- The ease of use of the site
- Having a cultural calendar that would send them reminders
- The quality of the images, video and audio
- Having new exhibits
- Access to archived old exhibits.

The modal response to the question "How often should the site be updated with new material" was one month, but there was considerable variance in the data.

Web site surveys

The web surveys were conducted by using a questionnaire that automatically popped up, in a separate window, whenever users accessed the home page of two partner art museums. Answering the 17 questions was optional, but throughout the month the survey was conducted, 830 and 1417 users answered the survey on each of the museum web sites. The survey was centered on questions about how the respondents use the web to obtain art and culture-related information and entertainment.

Web site survey results

About 81% of the surveyed visitors were visiting the web sites for the first time. About half of them

(45%) got to the site through search engines and 17% through links from related sites. An estimated 10% came directly from other web pages.

About 25% were researching information on specific content, while 32% were interested in specific information about the museum (schedules, access, etc.). About 12% were looking for fun-like activities and only 2.4% declared interest specifically in shopping.

The absolute majority of the visitors (90%) were alone while visiting the sites. The most important aspects in the visit were the "content" (46%) and the ability to pre-visit the museum (31%). Only 14% ranked "usability" as their major concern.

About half of the visitors considered the sites "interesting", 21% saw them as "educational", and only 4% thought of the sites as "entertaining". This, in some ways, correlates with the objectives of the visitors as described above.

Visitors considered actually getting the information they wanted as the most engaging part of the experience of the site (39%). Similarly, when asked what part of the experience could not be replicated, 50% of the visitors mentioned the facility of getting information, and 35% mentioned the convenience of visiting the museum from home. The biggest frustrations with the web sites were

- The inaccessibility of the full content of the museum (35%)
- Not finding the sought-for information (16%)
- The inability to access the schedule (9%)
- The inability to ask questions of the curators (5%)

There was a slight predominance of males (58%) among visitors to the site. The age distribution was quite homogeneous, with a strong participation of people in their forties (22%) and fifties (11%).

Most of the visitors (58%) belonged to families having more than 5 hours/week of web usage and only 22% used the web less than 2 hours/week. As for connection time, 76% had a connection equal to, or faster than, 56Kbps, and 99% have a 28.8Kbps or better connection available.

To the users who answered the survey, the most popular education web sites were Discovery (6%), Yahoo, PBS, and the New York Times. The most popular entertainment web sites were Yahoo (6%), the Internet movie database, ESPN, and the onion.

Brick and mortar visitor surveys

A total of 99 visitor surveys were conducted at two of our partner institutions. The surveys at each institution were conducted on multiple days in order to get information from weekend and weekday visitors, as well as to survey individuals who might be visiting to attend a special event at the institution.

Brick and mortar visitor survey results

People enjoy integrating cultural experiences into their activities in order to create a rewarding social, entertainment, and educational experience - also, visitors to the institution are interested in learning and enriching themselves and their friends and families.

Many people selected the institution they were visiting because it provided an event that would satisfy both social and educational goals. A visit could also be integrated with other social events (visitors appeared to schedule a trip to the institution along with other activities such as a walk in the park, shopping, and dining). A majority of visitors visited to enrich themselves by viewing exhibits and special events. Many visitors indicated that the use of different presentation techniques (e.g., kiosks, films, human guides, lighting effects, etc.) greatly enhanced the learning experience.

The nature of the content dictates whether people are more focused on entertainment than education, and is primarily responsible for shaping the experience. As for the design of the web site, these surveys point out that there should be different treatments and different goals for different kinds of content. For instance, scientific content asks for an experience designed to be more educational than entertaining, while content related to comedy and drama should be entertaining and emotionally engaging.

There is a significant difference between the normal visitors and the audience for special events. Special events are less "social" than regular visits. In terms of the design of the site, this data should inform the number of community-related features (for instance, chatting) available for regular browsing visitors versus the audience for special events.

Conclusions of the Discovery Phase UCD Activities

From the responses of the web surveys, we found that only a minority of people (4 to 5%) label the experience they have at museum web sites as "entertaining". In many ways, the participants in our research seem to lean towards defining an entertaining web experience as something closer to traditional TV, but enriched by the opportunity to explore and find extra information. However, our research also indicated that to access the majority of our targeted audience today, such web experiences must be available to users sporting modems of 56Kbits/second or more.

Based on the results of the discovery phase, we developed a design concept for the cultural web site based on the idea of multimedia *tours* guided by experts and artists. In our design, a tour presents information to the user continuously, from beginning to end, unless the user signals a desire to explore extra material or to exercise control. During the tour, opportunities to obtain additional information are presented as hot spots on the screen. All of the extra information is also available for exploration at the end of the tour.

The proposed web site consists of a collection of tours covering different areas of art and culture, such as painting, music, theater, and sculpture. In order to satisfy a large number of users, it seems to be necessary to provide a large number of tours and to add new ones regularly. Some of the design decisions presented below are, therefore, the result of the need to reduce production costs.

To cope with the requirement of maximum 56K bandwidth, we decided to explore multimedia experiences primarily based on still pictures and sound, instead of low quality video. At 56Kbits/second, video tends to become small and blurry, while at that speed it is possible to download audio with reasonable quality and reasonably good-looking pictures. Dealing mainly with stills also serves to reduce production costs, since shooting video is normally quite a bit more expensive than just audio recording and picture taking.

In our design, the main multimedia experience, or simply *main tour*, is enriched by the addition of user controls such as pause/resume/rewind/forward and by the inclusion of hot spots for two kinds of extra content: side tours and branches. A *side tour* is an extra, self-contained segment of multimedia, normally focusing on more specific aspects of the tour subject, which can be "inserted" into the main tour. A *branch* is a static web page with text, pictures, and links to extra information on a specific subject. The decision to create a side tour instead of a branch is based on the expected reach of the content. Since side tours are much more costly to produce than branches, we tend to produce side tours only for highly desirable extra information.

Figure 1 shows a snapshot of a tour. Most of the area is used by the content being presented by the tour (pictures, text, occasionally very short segments of video). On the bottom left side, a pictorial map gives the user a basic idea of the duration of the different scenes of the tour and the elapsed time. Rolling the mouse over the map brings extra textual information about each scene, while clicking on the picture of a scene interrupts the current scene and immediately starts the scene corresponding to the clicked image.

As the tour progresses, hot spots indicating side tours and branches appear on the screen. When a side tour is selected, the main tour is interrupted and the side tour is played. When the side tour finishes, the main tour automatically resumes from the point where it was left. A click on a branch pauses the tour and opens a new window on the browser, displaying the web page associated with the branch. To resume the playing of the main tour, the user is required to click on the pause/resume marker above the map.

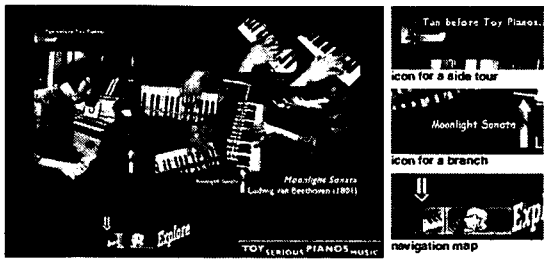

Figure 1. Typical scene of a tour with its navigation map, including links to a side tour and two branches

When the tour finishes, all the content - main tour, side tours, branches - of the tour becomes easily available on the *explore page*. Figure 2 depicts the explore page associated with the tour offig. 1. Clicking on the tour map restarts the tour from the beginning of the scene that was clicked. Similarly, clicking on side tours and branches immediately starts them. The explore page is automatically presented to the user at the end of the main tour. However, during any moment of the main tour, the user can access the explore page by clicking on the corresponding hot spot on the right of the map (fig. 2).

The Two Pilot Tours

The design concept described above instructed the development of two pilot tours that are the main instruments used in the evaluation methods later described by Pinhanez and Karat (Pinhanez 2001, Karat C. 2001, Pinhanez 2001).

The first tour features the work of a toy pianist, Margaret Leng Tan. In the tour, the pianist talks about her involvement with toy pianos, how music is arranged for a toy piano, and her connections to Schröeder, the famous cartoon character created by Charles Schulz. Two side tours describe the history and functioning of toy pianos and the work of Margaret Leng Tan before becoming a toy pianist. The main tour lasts 4m15s, and the side tours take 1m18s and 50s, respectively. The tour also includes five branches.

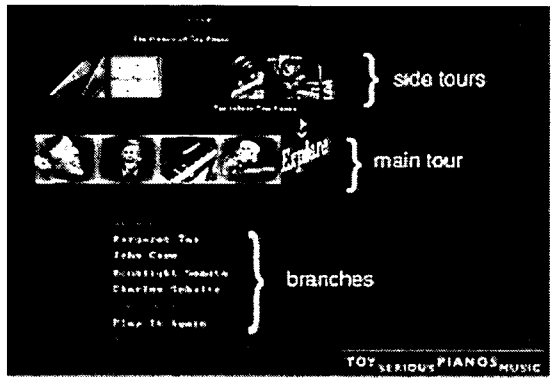

Figure 2. Exploration page that allows access to the main tour and all side tours and branches

The second tour talks about Ludwig van Beethoven and his Ninth Symphony. In this tour, a narrator leads the user through aspects of Beethoven's life and work, with comments also by a maestro and a concert pianist. Three side tours are provided, one about Beethoven's deafness and two others that let the user explore Beethoven's scores and his famous Heiligenstaden testament. Beethoven's main tour lasts 10m10s and the first side tour 2m00s. The other side tours, since they incorporate interactive elements, have no fixed duration, although their exploration usually takes around 60s each. There are also 5 branches available for user exploration.

After completing the development of the prototypes, we again engaged a sample of our target user population in a usability study to assess the success and value of our designs. The prototypes were tested with men and women from 21-55 years old. Test results indicate high user satisfaction with the tours. Users interacted relatively infrequently with the tours, and the less they interacted, the more they reported feeling engaged and entertained by the experience. This supports our initial hypothesis that the tours are most entertaining when they are experienced as they were designed to be; that is, watched as a TV-like experience. The results of the usability study give support to the contrarian "less clicking, more watching" design approach identified in the discovery phase.

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Accessibility Techniques for Museum Web Sites

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Abstract

Like other public institutions, museums strive to make their facilities accessible to people with disabilities, yet these same patrons may be hindered in their use of museum Web sites by electronic accessibility barriers. This presentation will demonstrate that access was a primary design factor in the Virtual Museum Tour, part of the Web site of The Dayton Art Institute. Developed in collaboration with Wright State University, planners of the Virtual Museum Tour faced the challenge of making a variety of Internet technologies accessible to people with visual or hearing impairment or mobility limitations. By adopting a set of Web accessibility guidelines and utilizing them in creative ways, the Virtual Museum Tour provides an enlightening art experience for all visitors.

Introduction

The Dayton Art Institute has served residents of southwestern Ohio since 1919. The museum operates on the premise that art is for everyone, and provides the community with free general admission 365 days a year. In addition, the Art Institute's physical facility is free of architectural barriers that might prevent people with disabilities from accessing exhibitions or participating in programs. Rated "superb in quality" by the American Association of Museums, The Dayton Art Institute has one of the finest mid-size museum collections in the country. As the Art Institute began to make this Collection available on the World Wide Web, the same commitment to barrier-free access was demonstrated.

The Virtual Museum Tour is an interactive learning environment for Web visitors to explore The Dayton Art Institute (http://www.daytonartinstitute.org/). The Tour came about through a collaboration between the Art Institute and Wright State University (http://www.wright.edu/), located in Dayton and known for its outstanding support program for students with disabilities. One of the primary goals of this project was to provide Web visitors with an informative and absorbing experience equal to or better than what they might have in the Museum's actual galleries. This naturally implied the inclusion of visual and auditory technologies to enhance the visitor's examination of works of art. Yet the Tour also needed to be as accessible as possible for everyone, including people with disabilities, as prescribed by the U. S. Department of Education grant that funded the development of the Tour. Although the idea of accessibility may seem incongruous to a Web site enriched with images and sounds, it is not impossible. Through cooperation and creativity, the project partners were able to achieve both objectives.

One important factor that had to be determined early in the project was the definition of accessibility as it pertains to a Web site. There is a great deal of information about the topic available from books, Web sites and conferences, but the recommendations given by these sources do not always concur. Fortunately, a single authoritative source has emerged from the World Wide Web Consortium, the international body that leads the development of the Web. The Web Accessibility Initiative (WAI) within that organization has published a set of fourteen Web Content Accessibility Guidelines (http://www.w3.org/TR/WAI-WEBCONTENT/) to help designers create accessible sites. Developed through a process of extensive research and review by a team of experts, the WAI Guidelines were adopted as the accessibility standard for the Virtual Museum Tour project.

Because the WAI Guidelines are designed to be universal in scope, they do not specifically address the needs of unique audiences such as museums. As a result, they often require interpretation or simplification in order to be applied. This paper documents how the Guidelines were implemented in practical ways on the Virtual Museum Tour, thereby creating a type of accessibility style guide suitable for other museum Web site designers. Due to the limitations of this paper, only a few of the fourteen Guidelines

can be addressed, but more extensive information about accessibility techniques will be available on the Virtual Museum Tour site itself.

Accessibility Techniques

Among the fourteen WAI Guidelines, there are a few which have particular relevance to museum Web sites. These are listed in the sections below, along with the techniques used to implement them on the Virtual Museum Tour.

Guideline 1. Provide equivalent alternatives to auditory and visual content

Provide content that, when presented to the user, has conveys essentially the same function or purpose as auditory or visual content.

This is perhaps the most basic of the fourteen Guidelines, but it is also the most important. The Web in general, and museum sites in particular, rely heavily upon images to convey information; audio content is also found on many Web sites. But people with visual or hearing impairments may be unable to perceive multimedia features such as images, sounds or video. If a Web page includes equivalent alternatives, however, all Web visitors will be able to experience to some degree the content conveyed by these visual and auditory elements. Equivalent alternatives frequently take the form of text, which is the most broadly accessible type of content available on the Web. It is important to note that Guideline 1 does not prohibit the use of multimedia such as images and sounds, but rather suggests how to convey that content in different ways so all users can understand its meaning.

Audio

The Virtual Museum Tour contains a large number of audio clips, spoken by various commentators, containing information about works. In order to implement Guideline 1, each narration is accompanied by a text transcript. All of the recordings were carefully transcribed to ensure that the speaker's exact words were accurately rendered into text (including sentence fragments and grammatical errors), and to ensure that names, places and terms were spelled correctly.

A typical audio segment on the Tour contains the comments of Alexander Lee Nyerges, Director of The Dayton Art Institute, recounting how the Museum acquired the painting *Waterlilies* by Claude Monet (Fig. 1). The excerpt below shows how the transcript captures the conversational style of the narration, and also demonstrates the need for accuracy in transcribing names and places.

> It really isn't 'til you get to Monet's highest points, his series which include his series of *Waterlilies*, that we find the fully developed and fully mature essence of what we now regard as classical Impressionism. This was done in his garden in 1903, and probably represents the highest point of his entire *Waterlilies* series. This work was given to the Art Institute by a gentleman by the name of Mr. Joseph Rubin, who ran a company in New York City called the Loma Dress Corporation. And sometime before 1953, Dr. Esther Seaver, who was the Director of The Dayton Art Institute in the first part of the 1950s, had encountered this picture and was acquainted with a dealer in New York by the name of Silberman . . .

Fig. 1: Claude Monet (1840-1926) French, Waterlilies, 1903, Oil on canvas, 32 x 40 inches, Gift of Mr. Joseph Rubin, 1953.11

When incorporated within the Virtual Museum Tour, text transcripts are provided alongside the audio clip itself, so Web visitors can choose the format that is appropriate for them. They can select either a link that plays the recording or a link that leads to

the transcript on another page. In this manner, the two formats appear truly equivalent, since one is not presented as subordinate to the other.

Although not applicable to the Virtual Museum Tour, it may be necessary to expand text transcripts if there is meaning conveyed by more than just the words themselves. For instance, if an audio clip contains music or sound effects, these should be briefly described in the transcript. In addition, if the tone of voice is significant, or the speaker is portraying a particular character, this may also be alluded to in the transcript

Images

In addition to audio, Guideline 1 also applies to visual content such as images, certainly the most common medium found on the Web. In the context of a museum Web site, images can be roughly categorized into two types: simple graphics such as logos, and complex pictures of artwork. Depending upon their type, two different approaches may be used to provide equivalent alternatives to images.

Simple graphics can be dealt with relatively easily by taking advantage of a feature of Hypertext Markup Language (HTML), the language that controls the format and function of Web pages. To place an image on a Web page, a designer inserts a particular HTML element into the document; this element is referred to as an "image tag" and appears as a three-letter abbreviation between brackets.

```
<img>
```

In addition to this term, another statement (called an "attribute") must be placed inside the brackets. This attribute indicates the filename or "source" of the image; it too is abbreviated.

```
<img src = "filename">
```

While no further information is required to produce a visible image on the page, there are several optional attributes that may be used to control properties of the image such as its size and its relation to surrounding screen elements. One such optional attribute can be added to provide a text alternative that briefly describes what the image is. The alternative attribute is also abbreviated, and is used alongside the source attribute within the same image tag.

```
<img src = "filename" alt =
"description">
```

Text alternatives are not captions that appear alongside the image, and in most cases they will not even be visible on the page. However, there are several ways in which they benefit visitors, particularly those with visual impairments. Web visitors who are blind typically use specialized computer software and hardware that reads pages aloud to them. If a Web page includes text alternatives, they too will be vocalized, informing users about the images found on the page. Without text alternatives, users will not know what the images are or why they are there. Further information on the use of text alternatives is available from the World Wide Web Consortium (http://www.w3.org/TR/html4/struct/objects.html#adef-alt).

Every image on the Virtual Museum Tour is accompanied by a text alternative that is generally no more than a few words in length. Because of their brevity, text alternatives are not used to describe the appearance of images, but simply to identify what they are. For example, the following line of HTML code could be used to identify the Art Institute's logo (Fig. 2):

```
<img src = "logo.gif" alt = "The
Dayton Art Institute logo">
```

Fig. 2: The Dayton Art Institute logo

For simple graphics such as a logo, a brief text alternative may be adequate, but pictures that show works of art require a more detailed visual description. Visual descriptions are short paragraphs that verbally describe the appearance of images for the benefit of Web visitors who are unable to see them. They serve the same role in the visual arts as audio descriptions do for the performing arts, since both provide participants with a verbal impression of things they cannot see. The Virtual Museum Tour provides a visual description for every piece of artwork presented.

The WAI Guidelines suggest different techniques for including visual descriptions with complex images (http://www.w3.org/TR/WCAG10-HTML-TECHS/#long-descriptions), but there is currently no standard practice in use. The Virtual Museum Tour uses visual descriptions to supplement rather than replace text alternatives: a text alternative gives the title of a work while a visual description tells what it looks like. Links to visual descriptions are prominently placed on a navigation menu alongside links leading to other sources of information about the artwork, thereby presenting them as simply another resource for everyone, not just people with disabilities.

Developing quality visual descriptions is a time-consuming task that should be done thoughtfully by individuals with excellent writing and editing skills. No instructions for doing so were available during the creation of the Virtual Museum Tour, but in the course of preparing approximately 100 visual descriptions, a standard process was developed. This process is summarized in the following six Recommendations which can be applied to other Web projects that involve images of artwork.

Recommendation One: Be Objective

The sole function of a visual description is to describe the appearance of a work of art. In brief, it should simply answer the question, "What does the object look like?" Descriptions should avoid analytical interpretations or emotional responses. In other words, they should not explore questions like, "What does it mean?" or "How does it make you feel?" Descriptions help visitors to visualize an object, thereby providing a context for other information about the work found elsewhere, such as historical background, the artist's style, or critical commentary. By combining this factual information with an objective description, Web visitors are sufficiently informed to make a personal analysis or achieve their own emotional response.

Objectivity should also be exercised when referring to characters portrayed in a painting or other work of art. Though it is appropriate to describe their appearance, clothing and actions, visual descriptions should not attempt to explain their motivations or feelings, even if these are implied by gestures or context. If the emotions of the characters are obvious in the artwork, then they will likely be apparent in the visual description as well.

Fig. 3: William Adolphe Bouguereau (1825-1905) French, The Song of the Nightingale, 1895, Oil on canvas, 55 x 35 inches, Gift of Mr. Robert Badenhop, 1954.12

In this example (Fig. 3), the description was written without references to emotion, although the mood implied by the painting may still be perceived.

> ...The girl's body is turned partially to her left while her head is turned to look to her right. Her brown hair is parted in the middle and pulled to the back of her head. She has heavy eyebrows, dark eyes and reddish cheeks. Her mouth is small and her red lips are closed. Both arms are extended and her hands rest on her knees with their fingers intertwined ...

Finally, because artistic taste varies according to the individual, visual descriptions should not contain value judgements on the quality of the art object, nor on the skill of the artist who created it.

Recommendation Two: Be Brief

Although length will vary according to the piece of artwork being described, visual descriptions should be as brief as possible. In some settings, visual descriptions are presented as audio recordings read by a narrator. Other times they are provided as text that visitors have to read by themselves. In either case, since extremely long descriptions are tiresome, they should be limited to 250 to 300 words. Depending on the context, visual descriptions may be accompanied by catalogue data about the artwork (such as the artist's name and life span, title, medium and dimensions). If so, this information need not be included in the overall word count.

For better word economy, exclude redundant phrases like "rectangular in shape" or "blue in color." Simply use "rectangular" or "blue" instead. Likewise, avoid obvious statements such as "she wears a necklace around the neck" or "gloves on her hands."

Recommendation Three: Be Descriptive

Visual descriptions should utilize a broad vocabulary of vivid terminology to describe various features of art objects. Some common terms are categorized below.

Shapes can be described as square, cubed, rectangular, flat, straight, circular, spherical, cylindrical, curved, rounded, triangular, conical, pyramidal, angular, irregular, jagged, sloped, diagonal, horizontal and vertical. These words can be used not only to identify the overall shape of the object, but also to describe geometric patterns within it. Avoid words that imply action unless the object actually does move; for instance, "curved" is preferable to "curving." Also, colloquial terms such as "squiggle" or "zigzag" should not be used.

Size can be described as small, tiny, short, miniature, large, tall, monumental, thick, thin, narrow, wide, life-size, true to size, large scale and small scale. The object's dimensions, provided with the catalogue data, will inform visitors of its actual size.

Texture can be described as smooth, glossy, coarse, grainy, rough, worn, weathered, scratched, cracked, broken, rippled, grooved, patterned, striped, dotted and perforated.

Color can be described as intense, vivid, bright, light, dark, dull, pale, faint, solid or blended. There is no need to avoid references to color on the assumption that they will be meaningless to visitors who are blind. First of all, descriptions will be used by people without visual disabilities. Second, many people who are now blind were able to see in the past and are able to recall colors. Third, colors sometimes have symbolic meaning in works of art (although interpretive phrases like "warm gold" or "angry red" should not be used).

Composition (or the arrangement of elements in a work) can be described as low, high, above, below, parallel, perpendicular, in the foreground (or background), and to the left (or right). When referring to relative locations, describe objects from the viewer's perspective, unless referring to the left or right of a character portrayed in the work.

Artistic technique can be described as realistic, abstract, unnatural, simplified, detailed, precise, imprecise, sharply defined, blurred, splashed, brushed or stroked.

Recommendation Four: Be Logical

In order to be easily understood, visual descriptions must describe objects according to a logical sequence. Descriptions should begin with a general overview of what the object is and what it portrays. Depending upon what type of object it is, it may be appropriate at the outset to mention its

color and surface texture, and perhaps its construction. Following the overview, the various portions of the object should be described in detail, in some orderly fashion such as left to right or top to bottom. After one portion of the work has been described, an explicit transition should be used to identify the next area and its spatial relationship to the last. If part of the object is extremely complex, it is best to describe each segment separately, perhaps in a numbered sequence.

In the following example (Fig. 4), the location of objects in a painting are described in relation to other elements, providing the reader with an understanding of the overall composition of the work.

> ...To the left of the barn is an area of criss-crossed black strokes like a shadow. Below the barn is a red and gray machine placed awkwardly on its side. Its large wheels and gears give it the appearance of a piece of farm machinery. To the right of the machine are two brown and angular tree branches that rise upward from the bottom edge of the picture. Between the branches, several small scenes are crudely rendered one above another...

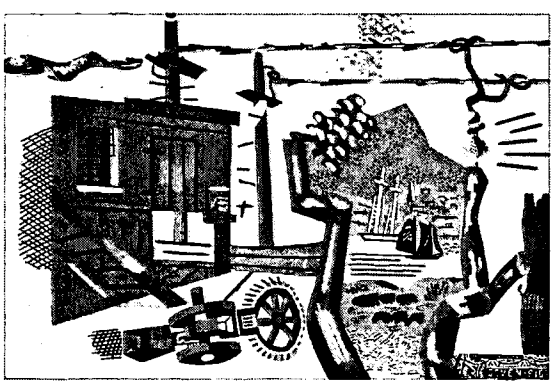

Fig. 4: Stuart Davis (1894-1964) American, Landscape with Broken Machine, 1935, Gouache on paper, 15 1/4 x 22 1/8 inches, Bequest of Virginia Rike Haswell, 1977.39

Depending on their design, sculptures or other three-dimensional works will likely need to be described from more than one angle. A logical sequence should be used when doing so, as if the viewer was moving in a circle around the object.

When using descriptive words such as adjectives, it is often best to place them after the word they modify, so visitors know what the object is before they are told what it looks like. For example, use "his fingers are long and thin" instead of "he has long, thin fingers."

Recommendation Five: Be Accurate

Because visual descriptions are part of the overall learning experience of art patrons, they should be factual and consistent with other sources of information about the artwork. Background research may be necessary to correctly identify historical figures, religious personalities, geographical locations, types of clothing, breeds of animals, architectural elements and so on. However, descriptions should avoid jargon or specialized terminology that may be unfamiliar to most visitors. For example, the stylistic terms "abstract" and "realistic" are likely to be understood, but "Geometric Abstractionist" and "French Academic" are not.

It is strongly recommended that a describer look at the actual object when making initial notes, because color and small details are most accurately observed in person. When these notes are refined into the actual description, slides or photographs may be used as a reminder of the object's appearance and composition.

Recommendation Six: Miscellaneous

Because visitors on a virtual tour may access works of art in any order, writers of visual descriptions should not assume that readers have followed a particular sequence. References to other artwork should not be made within a visual description, not even to works by the same artist or from the same gallery.

For the benefit of Web visitors using screen reading software, numbers should be spelled out as words, as in "nineteenth century" rather than "19th century," and "two and a half" instead of "2 1/2."

Descriptions ought not to assign gender to animals, such as "the dog stands on his hind legs."

When describing the clothing of characters in a work, monotony can be minimized by using varied phrases like "dressed in," "is wearing" and "has on."

Once visual descriptions have been written and edited, several reviewers (including people with visual disabilities) should provide suggestions for improvement. As a final check, descriptions should be compared, by a team member, in person, to the actual works of art in the galleries.

Video

Although the Virtual Museum Tour currently does not contain video clips, the principle of equivalent alternatives also applies to video. In general, it is necessary to provide synchronized captions for all spoken words, as well as descriptions for sound effects, music and visuals. Further details and examples are available at the National Center for Accessible Media (http://main.wgbh.org/wgbh/pages/ncam/richmedia/index.html).

Guideline 4. Clarify natural language usage

Use markup that facilitates pronunciation or interpretation of abbreviated or foreign text.

The purpose of this guideline is to make it easier for people using adaptive computer equipment to understand the content of Web documents, particularly those that contain periodic language changes. For example, a Web visitor who is blind will probably utilize a certain type of adaptive software called a screen reader to vocalize the words on a page. By identifying the language of the text, the screen reader may be able to respond with the proper pronunciation and accent. This technique can also benefit people who read Web pages with the aid of a Braille device, since words or characters may be displayed differently depending upon the language in use.

For a museum Web site this Guideline is crucial due to the frequent use of terminology from a variety of languages. As the Virtual Museum Tour was being developed, a large number of new documents were written, and existing documents were adapted for the site. In both cases, these catalogue entries and commentaries were closely checked, and variations in language were noted. This process was also applied to all visual descriptions and text transcripts of audio segments, which are accommodations themselves.

In order to implement Guideline 4, the primary language of a document must first be identified,; then any subsequent changes in language must be indicated. The initial step is accomplished by adding the language attribute to the opening HTML tag found at the top of the document. Instead of using the full name of a language (such as English), a two-letter abbreviation is used.

```
<html lang = "en">
```

A lengthy list of these two-letter language codes is available from the Organization for the Advancement of Structured Information Standards (http://www.oasis-open.org/cover/iso639a.html).

Once the primary language of a document is identified, changes in language that occur within the text also need to be declared. This can be done by using a pair of span container tags with the language attribute. The opening span tag marks the beginning of a new language segment while the closing tag indicates the end. After the closing span tag, the document reverts to the primary language previously declared. The following example is an excerpt from commentary written by Clarence W. Kelley about a pair of Japanese screen paintings (Fig. 5).

> ... By the end of the 17th century, a distinctive association had developed between classical literature and a type of screen painting known as byobu-uta (poems for screens), as seen in this pair of screen paintings ...

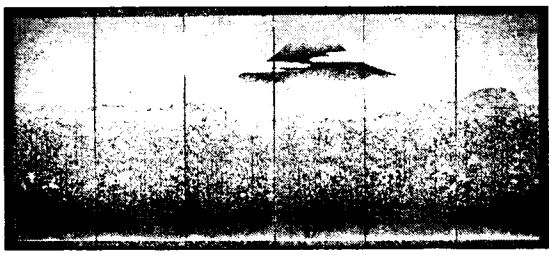

Fig. 5: Japan, Edo period (1615 - 1868) Muashi Plain, late 17th - early 18th century, Pair of six-fold screens: ink, colors and gold on paper, Each panel 66 1/2 x 24 1/4 inches, Museum purchase, 1960.24a-b

In addition to language changes, Guideline 4 also applies to the use of abbreviations and acronyms within Web documents. Further details are available from the Web Accessibility Initiative (http://www.w3.org/TR/WCAG10-HTML-TECHS/#text-abbr).

Guideline 8. Ensure direct accessibility of embedded user interfaces

Ensure that the user interface follows principles of accessible design: device-independent access to functionality, keyboard operability, self-voicing, etc.

This Guideline refers to various Web site features that present users with some sort of onscreen controls besides the typical buttons and menus found in a browser. It is important that these controls be operable through different methods, to accommodate as many people as possible. Computer users with disabilities frequently utilize input devices other than a mouse, since using a mouse requires both sight and manual dexterity. A person who is blind, for instance, might rely upon the keyboard, while someone with a mobility impairment might use a head-mounted pointing device. While Web browsers themselves can be controlled through these methods, additional interfaces may not have the same functionality. A common example found on museum Web sites is an image enlargement system that allows visitors to view works of art in detail. Depending upon the technology, users may be required to click the mouse on the image itself to zoom in. If so, this feature may be difficult for people with certain disabilities to use.

In the process of selecting an image enlargement system for the Virtual Museum Tour, keyboard operability was a primary concern. Many popular technologies failed in this respect, but a suitable product was found in the EyeSpy™ Image Server from AXS Technologies (http://www.axs-tech.com/). It allows visitors to use a mouse to click on the image, but it also provides a keyboard-accessible interface (Figs. 6 and 7).

Conclusions

When considering the topic of Web accessibility, it is beneficial to note how the addition of ramps and automatic doors have made access to museum buildings easier not only for people with disabilities, but also for all visitors. A similar phenomenon is likely

Fig. 6: Frans Geubels (1535 - 1590) Flemish, Kink Abimelech Restores Sarah to her Husband, Abraham, around 1560 - 1570, Tapestry: dyed wool and silk, 166 x 185 inches, Gift of Mr. Robert Badenhop, 1952.10

Fig. 7: Frans Geubels (1535 - 1590) Flemish, King Abimelech Restores Sarah to her Husband, Abraham. (detail)

to take place as museums improve the accessibility of their Web sites. By observing the WAI Guidelines, designers will make their pages more usable by everyone. For instance, text transcripts and described videos can be used by those who do not have the computer hardware or software to play multimedia, and by people with a slow Internet connection. Likewise, visual descriptions may be appreciated even by people with normal eyesight, since the descriptions point out details that they might not have noticed. By incorporating the WAI Guidelines into their design procedures, museums will take a major step toward accomplishing the goal of making art accessible to everyone.

Acknowledgements

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Evaluating the Usability of a Museum Web Site

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Abstract

The paper presents a research project conducted by the Department of Information Science in cooperation with the Saarland Museum, the art museum of the Federal State of Saarland, Germany. The study had two aims. The first was to evaluate some methods of usability engineering for the Web, and the second was to evaluate the usability of the Saarland Museum's Web site and improve it. The applied usability engineering methods were an expert-judgment-focused evaluation using heuristic evaluation with the *Heuristics for Web Communication* and a user-focused evaluation conducting a laboratory test with actual users and the thinking-aloud method. The combination of heuristic evaluation and laboratory testing provided interesting results. The heuristic evaluation detected a vast number of usability problems. The laboratory test confirmed most of these findings as usability problems and added some usability problems that experts did not discover because actual users often have a different perspective. The evaluation led to a re-design of the Web site.

1. Usability Engineering for Museum Web Sites

The World Wide Web offers museums the possibility to disseminate information about their collections to a world wide public. Therefore, one can state that "museums are in the communication business" (Silverstone 1988, 231) and that there are interesting parallels between museums and the mass media (Schweibenz 1998, 187). When attributing communicative and interactive functions to a museum Web site, it is especially important to keep in mind the users and their needs for easy interaction. Therefore it is essential that "the Web is a domain which must be instantly usable" (Rajani & Rosenberg 1999). This statement evokes the question of what usability means for museum Web sites. According to Garzotto, Matera & Paolini (1998), usability is "the visitor's ability to use these sites and to access their content in the most effective way. As a consequence, it has become compelling to provide both quality criteria that WWW sites must satisfy in order to be usable, and systematic methods for evaluating such criteria." Therefore Web usability and Web usability engineering methods have become an important issue (Garzotto, Matera & Paolini 1998, Teather 1999, Cleary 2000).

The usability of Web sites can be tested and improved in a process which is called usability engineering. According to Krömker (1999, 25), usability engineering is a set of methods to design user-friendly products and enhance the quality of the product. The methods of usability engineering can be categorized in expert-focused and user-focused methods. Expert-focused methods like heuristic evaluation and user-focused evaluation methods like laboratory testing with actual users can be used in combination (Nielsen, 1997a, 1543). Undisputedly, the combination of heuristic evaluation and laboratory testing achieves the greatest value from each method (Kantner & Rosenbaum 1997, 160; Nielsen, 1993, 225). Therefore, the Department of Information Science at the University of Saarland, Germany, developed a usability engineering process (Harms & Schweibenz, 2000, 19-20) and tested it in a usability study evaluating a museum Web site. This paper presents the experiences from the study which was conducted with an expert-judgment-focused evaluation using heuristic evaluation based on the *Heuristics for Web Communication* and a user-focused evaluation using laboratory tests with actual users and the thinking-aloud method.

2. A Survey of Methods for Usability Engineering

The methods of usability engineering can be categorized into expert-focused and user-focused methods. Among the expert-focused methods are several variations of heuristic evaluation. According to Nielsen (1997a, 1543) "heuristic evaluation is a way of finding usability problems in a design by contrasting it with a list of established usability prin-

ciples". The established usability principles are listed in guidelines or checklists like Keevil's *Usability Index* (Keevil, 1998) or Molich & Nielsen's nine principles for human-computer dialogue (Molich & Nielsen, 1990) or the *Heuristics for Web Communication*. In the evaluation process, experts compare the product with these guidelines and judge the compliance of the interface with recognized usability problems. The advantage of expert-focused evaluation is that it is a relatively simple and fast process. A comparatively small number of five evaluators can find some 75 per cent of the usability problems of a product in a relatively short time (for details see Levi & Conrad, 1996). The disadvantages are that experts have to do the evaluation and that experts cannot ignore their own knowledge of the subject, i.e. they cannot "step back behind what they already know." So they will always be surrogate users, i.e. expert evaluators who emulate users.

In contrast to expert-focused methods, user-focused methods rely on actual users to test the usability of a product. This process is called user testing, and according to Nielsen (1997a, 1543) it "is the most fundamental usability method and is in some sense irreplaceable, since it provides direct information about how people use computers and what their exact problems are with the concrete interface being tested." There are various methods for user testing. One of the most popular and most effective methods is the laboratory test with the thinking aloud method (Nielsen 1993, 195) which was used in our case study. The advantage of user-focused evaluation is that the tests supply a huge amount of qualitative data that show how actual users handle the product. The disadvantages are that the tests take place in a laboratory situation and that a lot of equipment and coordination is necessary to conduct the test, making it labor-intensive.

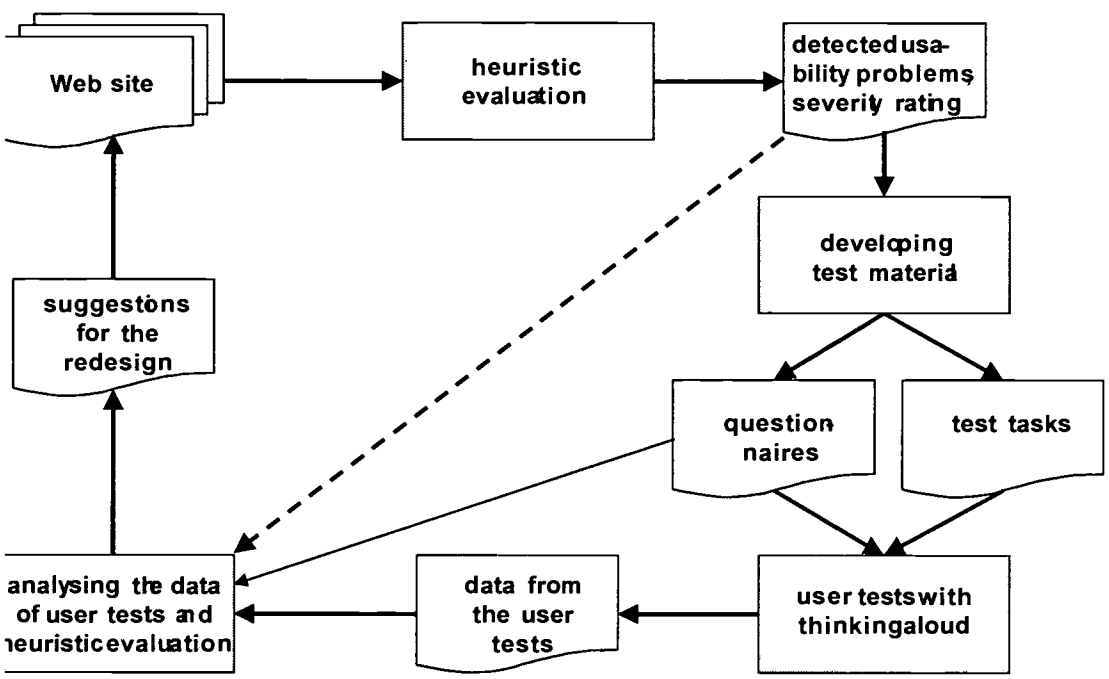

Figure 1: The evaluation process of the usability study

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3. Description of the Usability Study

3.1 The Process

In cooperation with the Saarland Museum - Stiftung Saarländischer Kulturbesitz, the art museum of the federal state of Saarland, the Department of Information Science at the University of Saarland evaluated the museum's Web site (http://www.saarlandmuseum.de). The site is a graphically designed Web site of the third generation (Siegel, 1997) and went online in summer 1999. The evaluation project was carried out by sixteen graduate students who had received training in usability engineering in a research class, and two lecturers as coordinators. The study had two aims. The first aim was to evaluate some evaluation methods, especially the *Heuristics for Web Communication*; the second was to improve the usability of the Web site of the Saarland Museum. Therefore we decided to use a combination of heuristic evaluation and user testing as suggested in the research literature. Figure 1 illustrates the process.

3.2 Heuristic Evaluation With the Heuristics for Web Communication

The first step was an heuristic evaluation. As mentioned above, there is a multitude of heuristics. Heuristics can be specific for a certain domain or generally applicable. They can be design-oriented or evaluation-oriented or both. They can be based on research or on experience of practitioners. Therefore, heuristics vary in extent and quality. In our case study we used the *Heuristics for Web Communication*, developed by the faculty of the Departments of Technical Communication of the University of Washington, Seattle, and the University of Twente, the Netherlands. The heuristics are based on research findings in technical writing and cognitive psychology and were evaluated in a workshop with 40 participants, both students and lecturers of technical communication, and professional Web developers from various Web design companies in the Seattle area. The heuristics were revised according to the feedback of the participants of the workshop and the Web developers and were published in a special issue of the Journal of Technical Communication in August 2000.

The *Heuristics for Web Communication* consist of five different heuristics. The five heuristics deal with all important aspects of Web sites: displaying information, navigation, text comprehension, role playing (i.e. author-reader relationship), and data collection for analyzing interaction. The content of the heuristics can be summed up as follows:

The heuristic *Displaying information on the Web* consists of guidelines for visuals, e.g.

- how to design and arrange display elements
- how to ensure that text is readable
- how to use pictures, illustrations, icons and motion

The *Heuristic for Web Navigation* deals with hypertext theory and offers guidelines for navigation and orientation, e.g.

- how to design orientation information on each page
- how to coordinate navigation devices
- how to design site-level orientation information

The heuristic *Text Comprehension and the Web: Heuristics for Writing Understandable Web Pages* focuses on text comprehension and issues of text quality, e.g.

- how to select, design, and organize content
- what style to use
- what makes Web pages credible and trustworthy

The heuristic *Role Playing on the Web* discusses the typical rhetorical roles of the implied author and reader of the Web pages and their rhetorical roles, e.g.

- how rhetoric is used to describe author roles and reader roles, and
- what kind of relationship exists between author roles and reader roles

The heuristics *Web Data Collection for Analyzing and Interacting with Your Users* focuses on analyzing the audience of a Web site and building a relationship either between you and your users or among the users themselves, using for example

- server log data for analyzing the use of Web pages and their audience, and
- means to build a relationship and create a sense of community with the audience.

The four content-oriented heuristics (the heuristics on *Web Data Collection* was not applied due to access restrictions to log files) were applied according to Kantner & Rosenbaum (1997, 155). The graduate students, who had received an introduction to the heuristics, worked in teams of four. Each team conducted an evaluation of the same selected number of pages from the chosen Web site. In a two-hour session of individual evaluation, the team members applied one of the four heuristics to the Web site. During the evaluation process they took notes of usability problems according to the various points listed in the heuristics. Then the team members gathered and discussed their findings. The usability problems detected in the heuristic evaluation were graded in a severity rating according to Nielsen (1997b) by each team. The rating ranged from 0 (no usability problem) to 4 (usability catastrophe) (cf. Table 1) and was conducted with respect to the frequency and persistence of the problems and the impact they have on users. At the end of the evaluation, the four teams presented their findings in a plenary meeting. The evaluation process took about five hours.

0	I don't agree that this is a usability problem at all
1	Cosmetic problem only: need not be fixed unless extra time is available on project
2	Minor usability problem: fixing this should be given low priority
3	Major usability problem: important to fix, so should be given high priority
4	Usability catastrophe: imperative to fix this before product can be released

Table 1: Severity rating according to Nielsen

The most frequent usability problems were navigational and orientation problems as described in the *Heuristic for Web Navigation*, followed by general design problems as named in the heuristic *Displaying information on the Web*. After the rating the two lecturers collected the written findings of the team members and compiled a list of all usability problems for a re-design of the Web site. The findings were also used to design tasks for a user test in the laboratory.

3.3 User Testing in the Usability Laboratory With The Thinking Aloud Method

The next step of the evaluation was a user test in the usability laboratory. Figure 2 shows a sketch of the laboratory in which the tests took place.

In the lab, real users have to work on tasks while thinking aloud, i.e. they verbalize their thoughts and comment on their actions while they handle the computer. This "allows a very direct understanding of what parts of the dialogue cause the most problems" (Nielsen 1993, 195). During the test, users work on standardized test tasks and are supervised by a test manager. The tests are recorded on video by a technical assistant who operates two video cameras. One of the cameras is focused on the face and hands of the participant, the other one on the computer screen. The recordings of the two cameras are blended together on one screen and recorded on video. In order to catch the details of interaction, a digital screencam records the actions on the screen. In a labor-intensive process, the findings of the tests are transcribed and categorized.

As we evaluated an art museum Web site, recruiting participants with an interest in art was suggested. Therefore we asked students of the Arts and Science department and art teachers to participate in our experiments. The teachers were chosen to increase the average age. The number of participants was decided according to Virzi (1992, 468), who suggests at least 15 participants. In our study, 17 users participated. Five of them were teachers; 12 were students of the Arts and Science department. Seven participants were male, ten female. The youngest user was 19, the oldest 48, the average age being 27.

It takes some time and effort to design the test task scenario for the user test of a large informational Web site (cf. Kantner & Rosenbaum 1997, 154). The test tasks should be as representative as possible of the use to which the system will be put in the field and at the same time small enough to be completed in a reasonable time frame, but not so small eas to be trivial (Nielsen 1993, 185f). The test scenario, which had been discussed with the client of our case study, consisted of nine tasks that represented potential usability problems. Table 2 shows a selection of the potential problems and the test tasks.

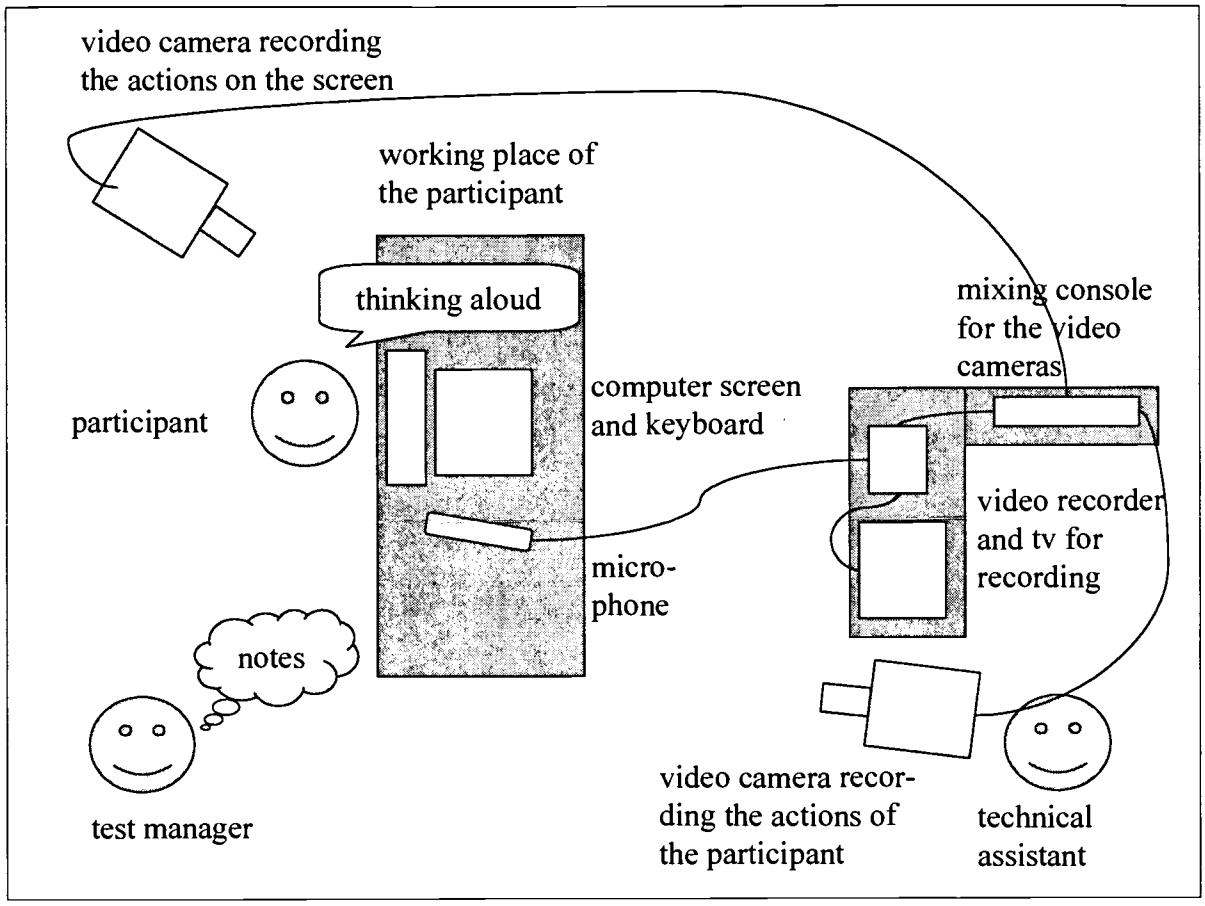

Figure 2: A sketch of the usability lab

Potential Usability Problem	Selection of the test tasks (abbreviated)
Links are hidden in graphical design (images).	1) Go from the splash screen to the core page.
Insufficiently linked information, the exhibition is not linked to the opening hours.	3) Look for the opening hours of a future exhibition.
Insufficiently linked information, the exhibition is not linked to the service section where tours are offered.	4) Look for guided tours to the current exhibition.
All pages are titled the same. There are no individual title-tags on the different pages.	7) Use bookmarks to go back to certain page.

Table 2: A selection from the test tasks of the user tests

The user tests revealed that all assumed problems were usability problems for test users. The findings were grouped into several categories, e.g. problems handling the splash screen (task 1), insufficient use of links between related information (tasks 3 and 4) etc., and illustrated by lively quotes taken from the test protocols. For example, after finishing task 1 a participant stated: "The first screen only shows a headline, a picture and an address but no link. (break) I click on the picture. It works!" Another remarked: "As an Internet beginner I honestly have a problem to get to the next page. I'm a little helpless because I prefer big arrows and buttons that say 'next page.' But I made it." While struggling with task 4, the patience of a participant snapped and he said: "Now I would try to get in touch with someone and write an email, if they offer a guided tour, because all the searching takes far too long." Trying to use the bookmarks in task 7, a participant said: "Usually I would use the bookmarks. (clicks on bookmarks) Well, now I see that all the bookmarks have the same name." Another participant used sarcasm: "That's really funny, because I have five bookmarks all named Saarland Museum Saarbrücken. That helps a lot. Great! (laughs)."

Quotes like these make usability problems come alive and show the reactions of actual users in real situations. From our experience, these reactions are much more convincing than dry statements of experts no matter how profound these statements might be and no matter on what kind of theory they are based.

The test time and performance of the users was influenced by their computer literacy, measured by data collected in a questionnaire. The average test time was about 20 minutes and corresponds with the expected test time derived from three pre-tests. The duration of the test shows some connection between the computer literacy level and the amount of time needed to complete the tasks. The shortest test of 14 minutes was conducted with a user who had used the Web for two years or longer and several times a week. The longest test of 30 minutes was conducted with a participant with little computer literacy. Further analysis did not seem necessary to us because the duration of a test is also influenced by other factors like interest in the subject and the medium and the method of thinking aloud.

4. Practical Experiences With the Different Methods

In our case study the theoretical foundations of the heuristic evaluation were the *Heuristics for Web Communication*. At the time of our evaluation, these heuristics were brand new. Only a little practical experience existed in applying these heuristics. Therefore we thought it useful to contrast the *Heuristics for Web Communication* with another heuristic evaluation tool, Keevil's *Usability Index*. According to Keevil (1998, 271), the usability index is a "measure, expressed as a per cent, of how closely the features of a Web site match generally accepted usability guidelines." The Usability Index consists of five categories (Keevil 1998, 273):

- Finding the information: Can you find the information you want?
- Understanding the information: After you find the information, can you understand it?
- Supporting user tasks: Does the information help you perform a task?
- Evaluating the technical accuracy: Is the technical information complete?
- Presenting the information: Does the information look like a quality product?

Judging from the 203 questions, Keevil's *Usability Index* seems focused on commercial Web sites. But it seemed adequate to use it for the Web site of a cultural heritage institution, because Keevil (1998, 275) points out that the *Usability Index* is generally applicable: "Information Developers can use the checklist to measure how easy it is to find, understand, and use information displayed on a Web site."

In our case study, fifteen students (one of the sixteen didn't hand in the index) used the *Usability Index* to evaluate the Web site of the Saarland Museum. The following table (Table 3) shows the results with the categories 'N/A' (not applicable), 'Yes', 'No', the sum and the usability in percent, which is calculated from the total number of 'Yes' answers divided by the total numbers of 'Yes' and 'No' answers.

Table 3 shows a wide range of usability for the Saarland Museum expressed in per cent. The results reached from 29% to 55%, the arithmetic mean being 47%. The deviation in the percentage of us-

Usability Index	N/A	Yes	No	Sum	Usability in percent
Evaluator 1	96	57	47	200	55 %
Evaluator 2	134	19	47	200	29 %
Evaluator 3	71	67	62	200	52 %
Evaluator 4	71	67	62	200	52 %
Evaluator 5	81	51	68	200	43 %
Evaluator 6	62	69	69	200	50 %
Evaluator 7	96	48	53	197	48 %
Evaluator 8	64	61	74	199	45 %
Evaluator 9	77	60	62	199	49 %
Evaluator 10	77	60	62	199	49 %
Evaluator 11	77	60	62	199	49 %
Evaluator 12	81	61	58	200	51 %
Evaluator 13	66	57	53	176	52 %
Evaluator 14	69	53	81	203	40 %
Evaluator 15	88	40	72	200	36 %

Table 3: Results of Keevil's Usability Index for the Saarland Museum Web Site

ability is remarkable. It is due to the bias of the evaluators in interpreting the questions. One reason is that certain sets of questions from the *Usability Index* did not fit for the Web site under evaluation. In this case, some evaluators chose to vote for 'N/A', while others voted for 'No'. This explains the big differences between the 'N/A' votes and the 'No' votes and in the overall usability because the usability is calculated from the total number of yes answers divided by the total numbers of yes and no answers. Another reason is that the checklist, like every checklist, is open to interpretation. Keevil (1998, 275) was aware of this problem and tried to reduce it by only allowing the answers 'N/A', 'Yes', and 'No'. But still, there is considerable room for interpretation. Apart from the problem of interpretation, the *Usability Index* has another disadvantage. It gives a number in per cent that indicates the usability and some hints on usability problems that can be derived from the 203 questions, but it hardly identifies concrete usability problems.

The identification of concrete usability problems and suggestions on how to improve usability are the practical advantages of the *Heuristics for Web Communication*. The heuristics are not simply checklists that can be answered by 'N/A', 'Yes', and 'No'. They are guidelines designed as statements and questions that guide the evaluator to identify concrete usability problems by asking guiding questions like, "Can you decipher all of the elements in the display easily? If not, consider making them larger," or "Which of the organization's values should be emphasized?" or giving hints like, "Make sure the most important links appear high enough on the page to be visible without scrolling, regardless of the resolution of the user's monitor. When pages must scroll, provide visual cues to encourage users to scroll down to links that are below the scroll line." By contrasting these established usability principles with the Web site under evaluation, the evaluator or information designer can decide if usability problems exist, what kind they are, and how they can be removed. This is the big advantage of the heuristics.

The disadvantage of the *Heuristics for Web Communication* is that they are very detailed and complicated compared with general heuristics like the ones of Molich & Nielsen. Molich & Nielsen suggest nine basic items of usability (Molich & Nielsen 1990, 338) (Table 4).

1	Use simple and natural language
2	Speak the user's language
3	Minimize the user's memory load
4	Be consistent
5	Provide feedback
6	Provide clearly marked exits
7	Provide shortcuts
8	Provide helpful error messages
9	Prevent errors

Table 4: Molich & Nielsen's nine basic items of usability

Although it is possible to do a successful evaluation with these nine basic items of usability, evaluators might need more guidance in the evaluation process, as is offered by the *Heuristics for Web Communication*. These heuristics support the evaluators by providing a structured "guided tour" for the evaluation process that takes into account both the big picture and important details. They help the evaluators to consider all substantial usability issues and to focus on the important points. Moreover they generate a profound impression of the overall quality of a Web site. This makes the *Heuristics for Web Communication* a valuable tool for Web usability engineering.

The four content-oriented heuristics (the fifth heuristic was not applied due to access restrictions to

log files) are very different as far as their ease of application and the level of background knowledge are concerned. We found that the heuristic *Displaying information on the Web*, the *Heuristic for Web Navigation*, and the heuristic *Text Comprehension and the Web* can be successfully applied if the evaluators have an average level of knowledge in information design and Web design. The evaluators in our case study, all graduate students of information science, had no difficulties in applying them. The heuristic *Role Playing on the Web* requires some special knowledge of hypertext theory as it is based on the quite complicated author-reader relationship in hypertext (Michalak & Coney 1993). Although it is very interesting and provides promising results, the evaluators in our case study had some difficulties in applying it.

As expected from the research literature (Nielsen 1992, 378f), the heuristics detected a great number of so-called minor usability problems- no disadvantage at all because user testing is not an adequate means to identify such minor problems. Minor problems were, for example, inconsistent use of link colors, no text messages for graphic links, complicated sentences, deficits in page structure and organization, lack of informative titles, meaningless animation, flaws in the author-reader relationship, etc. Although real usability problems, such minor problems are not observable in user testing, because average users do not realize that these kinds of deficiencies cause problems because they lack the background knowledge in information design and Web design.

The user tests in the usability lab were very labor-intensive for several reasons: the technical equipment had to be arranged, the test scenario had to be designed and tested, participants had to be recruited, and tests had to be conducted with two experimenters who had to be present all the time to supervise the participants and the technical equipment. The analysis and evaluation of the test data was also time-consuming because the data had to be transcribed and categorized. The big advantage of this method was that the recordings, especially the screencam files, showed cursor movements that help to identify problems in navigation and orientation. This is especially helpful when discussing the findings and suggestions for the redesign with the client. A simplified method of thinking aloud testing, in which the experimenters simply take notes of their observations, is less labor-intensive than videotaping and transcribing the tests. But from our experience, it is difficult for one or two experimenters to follow the course of the test and take notes at the same time if the test consists of more than some basic functions. Therefore video taping or screencam recording is essential. An alternative to transcribing whole test sessions would be to transcribe only the most important sequences of a test.

An important point we noticed when comparing answers in the questionnaires with courses of the tests is that answers about the test experience are often not very reliable. The answers about the satisfaction with the Web site often did not correspond with the actual experience of the participants who were observed during the test. For example, several participants stated that they had no problems with navigation and orientation although they had had serious problems during the test. The reasons for this gap between behaviour and statements cannot be discussed here. From our experience it is important to remark that a questionnaire alone cannot provide reliable results. This is not new but confirms the phenomenon that impressions of their own behaviour and the behaviour in the situation of social reality show a certain deviation. Despite this fact, from our experience questionnaires or interviews are necessary to give the participants the opportunity to comment on the course of the test. Test users appreciate this opportunity, and the results can be used to derive additional information about the acceptance of the Web site.

5. Conclusion

The evaluation method used in usability engineering depends on the subject that is evaluated and the goals of the evaluation. Although the combination of heuristic evaluation and user testing provides good results, it is costly as far as time and resources are concerned. With respect to the cost-benefit ration, in many cases the heuristic evaluation is sufficient to detect a reasonable number of minor and major usability problems.

In our case study, the *Heuristics for Web Communication* proved to be applicable tools for heuristic evaluation. The heuristics support a structured evaluation and help both to find and to solve usability

problems. In contrast to checklists, they give the evaluators some scope for interpretation while offering guidance at the same time. The drawback of the heuristics is that they cannot be successfully applied by novice evaluators. The evaluators need some background knowledge in Web design and evaluation. The heuristics were helpful in pointing out critical points in the Web site that were evaluated in the user test. Compared to user testing, the heuristic evaluation was less labor-intensive. Nevertheless, user testing is a very valuable tool for usability engineering because actual users give an impression of how the Web site will be used in practice. Moreover, actual users might have problems with features that experts do not realize are problematic. The focus on the actual users and the vivid and expressive statements they give justifies the much higher expense in certain cases. From our experience, the combination of both heuristic evaluation with the *Heuristics for Web Communication* and user testing with thinking aloud is a very useful method of usability engineering.

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Design for (re-) Use

A Re-usable Software Framework for Authoring and Managing Web Exhibitions

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Abstract

In the course of a Web development project for the *Museum für Völkerkunde* in Vienna, ViEx, a reuse framework supporting authoring and managing hypermedia exhibitions, has been developed. The framework consists of three major components: a relational content database, a corresponding browser based editing interface, and a Web page generator which creates the final Web exhibition. Strict separation of content, structure and layout information promises ease of maintenance, especially in the context of multiple versions of the same exhibition to cope with different presentation languages and client platform dependencies.

Introduction

Authoring and managing a hypermedia exhibition is a tedious and time-consuming task requiring a set of skills not readily available in a museum context. In order to liberate curators and exhibition designers from the computer-centric tasks as much as possible and to reduce the resources spent for every new virtual exhibition, we developed ViEx ("virtual exhibition"), a software framework intended to introduce systematic reuse into the domain of Web based exhibitions.

The framework is based on building blocks that cover all structural parts of a Web document, e.g. title, various paragraph types, special character types, as for example, proper names and foreign words and media types like videos, panoramas or images. Some of these types are complex objects themselves, since they consist of a set of more atomic entities. Layout information is available in form of templates that may be nested to define a more complex page.

All building blocks and their instances are stored in a relational database, and pages may be rendered dynamically according to their content and layout definition. In addition, the framework comprises modules allowing for the evaluation of user satisfaction and behaviour, like, for example, guest book and a comprehensive statistics module and a special navigation module allowing for the pictorial representation and arrangement of users' favorite pages.

ViEx has been developed and tested within the project of a virtual exhibition on Bhutan (http://www.bhutan.at). In principle it has been designed to be platform independent. The current server is running under Solaris and utilizes PHP and Oracle8i. The reusability of the framework is currently being tested in the context of a site for Archaeology@Austria.

The remainder of this paper is organized as follows: In the following section, goals and motivation for the development of the framework are discussed. In Section 3, the framework itself is presented. Section 4 puts the framework development into the perspective of the project history and discusses some advantages and drawbacks of the approach taken. Finally, in Section 5, our current work related to ViEx is briefly described.

Goals and Motivation

Creating an exhibition web site for a museum is a major software development undertaking which may easily go beyond the resources and capabilities of a small or medium-sized museum. For example, the virtual exhibition project, Bhutan – Fortress of the Gods, (http://www.bhutan.at, Breiteneder et al., 2001) which gave rise to the development framework presented in this paper involved a set of project specific roles. From the category of staff and the number of physical people assigned to each role (stretched to varying degrees), we can easily con-

Role in Project	Category	#
Project management	Development team	1
Text authoring	Museum	2
Content advisor	Museum	1
Quality assurance	Museum	1
Translation	Translators	4
Screen design	Designer	1
Page editing	Museum	1
Picture editing	Designer + Museum	2
Video editing	Development team	1
3D modeling	Development team	1
Panorama modeling	Development team	1
Software design	Development team	3
Software implementation	Development team	5
Test (functionality, usability)	Development team	5
System administration (development site)	Development team	1

Table 1: Staffing overview for http://www.bhutan.at

clude that - at least as of today - such a project falls outside the main competence and self-image of a museum.

Outsourcing as the obvious solution to the problem of lack of human resources complicates communication during the development phase and impedes ongoing content maintenance after the development phase, as most maintenance requests will have to be directed to the development team which - as a (not unlikely) worst case scenario - may not even exist as such anymore.

In this situation, employing a reuse framework such as ViEx (presented in the next section) may result in the following advantages:

- It enables the museum-based project team together with the art designer to elaborate a complete specification of the exhibition site within the framework provided. This avoids the need for continuous feedback from the development team, thus eliminating significant portions of the communication overhead and focusing the development team on its main task, namely implementing the site according to the specifications provided.

- It shifts development work to a higher level of abstraction: instead of "coding" Web pages in HTML, the main tasks consist of editing and structuring content liberated from layout questions.

- It supports content maintenance in the post-development phase, i.e., it enables museum staff to consistently modify the exhibition without the need to resort to the development team.

- It simplifies the software development portion of the project due to "pre-fabricated" built-in features which can be used as-is and need not be implemented from scratch (concept reuse). For instance, the interplay between images, pop-up legends, and zoom-windows for higher resolution versions of an image is generated by the framework.

- It allows systematic reuse of content building blocks in different contexts within the same virtual exhibition (data reuse). Moreover, export interfaces can easily be established in order to reuse content material outside the project (e.g., consider XML exports).

- By all the above, it saves development time and costs.

The main benefit, however, will be the fact that a framework enforces well-structured and consistent building blocks for the Web presentation. Considering again size and complexity of the project team as sketched in Table 1, any site composed of individual, more or less "hand made Web pages is nearly guaranteed to end up in complete chaos with the typical symptoms of inconsistent hyperlinks, aberrations of page layout etc. The corresponding maintenance overhead - in this case arising already during the development phase - will consume essential project resources. From the authors' experience, such effects are likely to affect even mid-sized projects of about 20 to 50 Web pages.

The advantages discussed above will be especially beneficial in the case of *temporary* virtual exhibitions where high start-up costs may challenge the feasibility of the entire project.

In the specific case of a database-supported framework like ViEx, the existence of an object database containing descriptions and media files for all exhibits needed in the exhibition under construction would constitute an important additional asset, as a significant portion of editorial work could be settled by a straightforward export-import script pre-loading the framework's project database.

ViEx – A Framework for Virtual Exhibitions

The ViEx framework consists of three major components: a content management system, its underlying content database, and a set of layout templates. In addition, a parser was also implemented to support the transition between the older file system based framework ViEx^{FS} (cf. Section 4) to the current framework operating on a relational database, by transforming Web page files into sets of corresponding database entries. This auxiliary component may also be considered a "feature" of ViEx because it can be seen as an alternative input channel into the content database.

This section describes the ViEx framework in some detail. We begin with a brief summary of the features of a ViEx-based exhibition and present the main components of ViEx in subsequent subsections.

Supported Features

Any software framework designed for reusability will be more effective, the better its application domain is understood and the more specific the framework fits its application domain (cf. standard literature on software reuse, e.g. Biggerstaff & Perlis, 1989). Thus, when employing such a framework, the trade-off between generic applicability and reuse potential must be carefully considered. To this end, it is important to briefly summarize the features of a virtual exhibition realized on the basis of ViEx. For a more in-depth treatment see Bhutan - A Virtual Exhibition http://www.bhutan.at. (Breiteneder et al. (2001).

The content of a ViEx exhibition is organized in a layout-independent manner. Building blocks may be *pages* (content aggregates consisting of other building blocks), *pictures* with descriptive information, *video*, *audio*, *text* (individual text and standard text building blocks), *glossary entries* (currently two categories: foreign words and proper names), *script building blocks* (e.g., fader texts), and *panoramas* (possibly linked to descriptive information). Table 2 summarizes major attributes assigned to these building blocks. For all text-based information, the respective language is another attribute stored in the database (not shown in Table 2).

Content Building Block	Attributes
Page	type of page (chapter, subchapter…), template, window title, document title, color code, …
Picture	Image URL, zoom image URL, title, legend, display size
Video, Audio, Panorama	URL, title, legend, plug-in, size, quality…
Text	type (i.e., style class like header, paragraph…), content
Glossary entry	text, category, short description (»tool tip«), long description (glossary page)
Script building block	text

Table 2: Content Building Blocks

As navigation mechanisms, ViEx supports manually defined *ad hoc hyperlinks*, systematic *hierarchic links* (path to the current page, children emanating from the current page etc.) for navigating through the exhibition according to the underlying book metaphor, *local links* to navigate within a page, a *site map* containing thumbnails of the upper levels of the hierarchy, a *hierarchy browser* (available in three flavors: pull-down-menus, table of contents, tree controls), a *search facility*, an *exhibit index*, *pop-up windows* displaying descriptive information linked to pictures, and *zoom windows* displaying pictures at a higher resolution. In addition, there are two different tour concepts available: a *slide show* consisting of a predefined sequence of pictures with legends which are continuously presented (fading over each other), and a *guided tour* taking a sequential path through the exhibition, briefly explaining its different parts. Last but not least, registered users get access to a feature called *lookmarks* enabling them to create their own *catalog* of the exhibition by distributing thumbnails of pages of interest in a three dimensional space and grouping them according to subjective organizing principles. (The three dimensional arrangement and the visual cues based on thumbnails are deemed to provide a much better recognition / retrieval rate compared to ordinary bookmarking.)

The book metaphor mentioned above serves as the major structuring mechanism in ViEx. Its strict hierarchic structure is deemed to reduce the likelihood

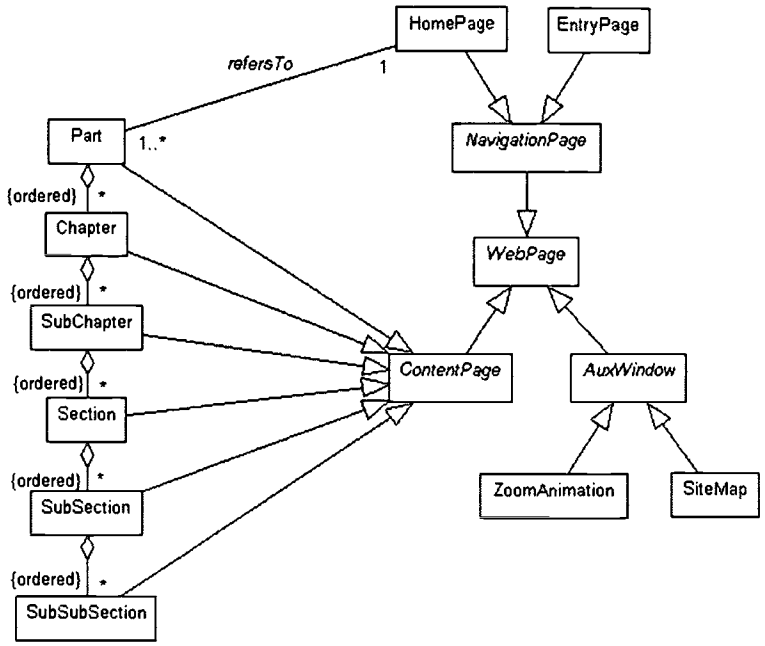

Fig. 1: Relationships between ViEx web pages (in UML)

for a visitor to the virtual exhibition to get "lost in hyperspace", especially since visitors are assumed to be able to relatively quickly construct a mental model of the Web presentation due to their acquaintance with exhibition catalogues and the like.

The six (at most – note the cardinalities indicated by * in the UML diagram in Fig. 1) hierarchy levels represent the main information-bearing content pages. Besides them, a few other, secondary variants of the abstract concept »web page« exist for rather technical purposes.

ViEx supports multiple coexisting versions of the same exhibition. Specifically, three versioning dimensions can be distinguished:

- Static vs. dynamic pages: During the presentation design phase, pages generated on demand are usually preferred to static pages, because changes in the »look & feel« of the site are immediately made visible on all available pages for persons working on the design prototype. When the design has stabilized, one may want to switch to static pages either for performance reasons or in order to prepare an off-line version of the exhibition on CD-ROM. Dynamic ViEx pages are coded in PHP.
- Different technological levels: Taking into account the diversity of client platforms now in use and their mutual incompatibilities, it is necessary to customize a Web presentation to several levels of browser technology. As a minimum requirement, a "high tech" version with contemporary ("cool") features and a 'low tech" version suited to old or low-end browsers should be provided.
- Language of presentation.

Content Database

The content database is implemented using a relational database management system and contains both the *content* and *structure* of the virtual exhibition, but excludes low-level layout information. This separation represents a standard design goal for complex Web sites, because it guarantees consistent presentation of the content throughout the whole Web site. The database oriented approach of ViEx pushes this design goal to an extreme: As no low-level formatting information can be entered into the content database, the separation of content and layout follows as a consequence.

The data model underlying the content database is given as a UML diagram in Fig. 2. As can be seen from Fig. 2; the core concept of the content database is the abstract entity *building block* which represents a unit of information to be presented and manipulated as a whole. The specialization hierarchy emanating from class*BuildingBlock* distinguishes between atomic entities and complex entities represented by containers consisting of other building blocks. Atomic entities may be:

- homogeneous portions of text (with no intermingled markup) in various paragraph types and optional special character distinction (e.g. for proper names and foreign words),
- pictures consisting of a small image, a caption, a more detailed description and a reference to a larger copy
- other media like videos and panoramas treated in a similar way (not shown in the figure), and
- various kinds of hyperlinks.

A content page is associated with an externally stored layout template divided into so-called »slots« (class *Content* in Fig. 2) which are to be filled by building blocks. Slots may in turn be subdivided into »subslots«, where the layout of each subslot is again defined by a layout template. The hierarchy specified in Fig. 1 is resolved as a recursive parent-child relationship between *content page* entities. For each content page, some layout information in the form of attribute-value pairs (such as color schemes or main titles) can be specified and is propagated down the page hierarchy by the page generator (hence the class name *InheritanceData*). Thus, every page in the hierarchy takes this information from higher level

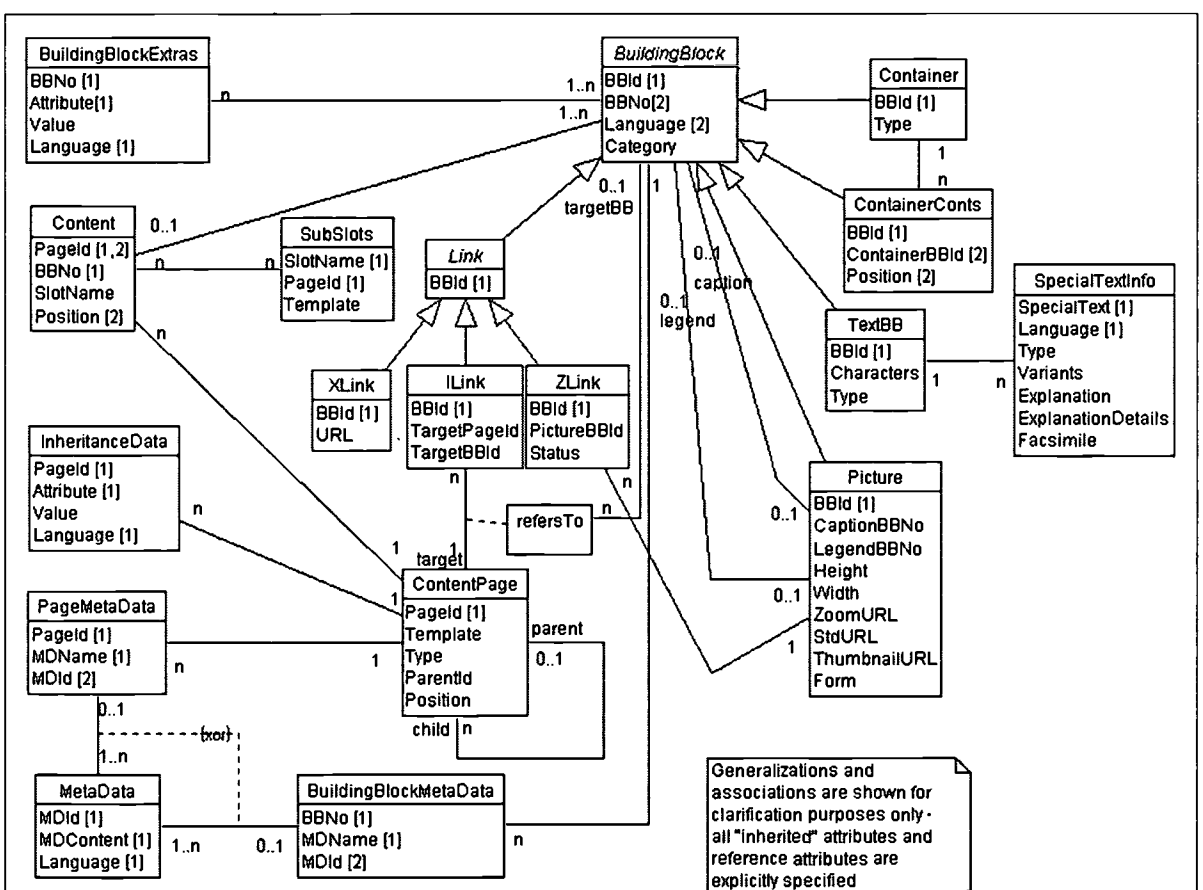

Fig. 2: Data model of the content database (in UML with database key designators in brackets)

pages, but it can also be assigned corresponding data of its own which overrides the »inherited« default.

When the exhibition is generated from the content database, the resulting page format is determined by

- the position within the page hierarchy at which the page resides which affects the inheritance mechanism explained before and the generation of structural navigation links,
- the layout template assigned to the page,
- templates possibly assigned to the slots of the template,
- a cascading style sheet (which is dynamically selected depending on the client's platform),
- the formatting strategy encoded into the generator for each type of building block,
- as well as additional layout information assigned to selected building blocks (class *BuildingBlockExtras*).

Front end (input and editing interface) and back end (pagegenerator) of the content database together form the content management system described at the end of this section.

Layout Templates

Layout templates reside in the file system (outside the content database) and define the principal layout of each type of page. Changing a layout template modifies the look & feel of the exhibition without modifying its content and logical structure.

Templates are »stub pages« with fixed HTML, includes etc. combined with special markups designating slots to be filled from the content database. The syntax of these markups is

```
<!— #BeginEditable "SlotId" —>
```

and is taken from MacroMedia Dreamweaver in order to allow employing Dreamweaver as a comfortable template editor. The generator replaces this markup with the building blocks selected from the database via slot identification *SlotId* and the identification of the page under construction.

Besides the content oriented slots mentioned, there are also so-called "technical slots" with predefined semantics which are used to designate the position of standard page elements like headings and navigation blocks within the page.

For instance, a typical template taken from http://www.bhutan.at contains the following slots:

a) Technical slots

- *Page title*: The browser's window title. Content explicitly given in the content database.
- *Page meta-information*: HTML meta information (invisible). Content explicitly given.
- *Script*: Includes client side scripting files (e.g., JavaScript) with functions taking care of CSS selection according to the client platform, window management, and pop-up handling. Content generated.
- *Document title*: Text or image. Content explicitly given.
- *Color scheme*: Color code or image. Content explicitly given or inherited from ancestor pages.
- *Path*: Navigation element consisting of titles of all ancestor pages. Content implicitly given (taken from ancestor pages).
- *Navigation* (»nav«, cf. the table below): One of two possible types of hierarchical navigation menu depending on the type of page. Content implicitly given.
- *Pop ups*: Place holder for pop-ups used as image legends. Must be last element in the template. Content generated.

b) True content slots

The standard layout for »Bhutan – Fortress of the Gods« is based on the following HTML table (with slot names):

row1-left	row1-center	row1-right
row1		
row2-left	row2-center	row2-right
row2		
row3-left	row3-center	row3-right
row3		
row4-left	row4-center	row4-right
		nav

Table 3: Content slots

All these slots may be assigned simple text building blocks, containers holding nested building blocks, or subslots with corresponding subtemplates. This latter feature enhances the range of application of a template: Instead of designing completely new templates, many variations can be incorporated into one and the same template by means of the subtemplate concept.

For technical reasons, ViEx only supports one level of subtemplates; i.e., subtemplates nested within subtemplates are not possible. However, for the virtual exhibition »Bhutan –Fortress of the Gods« this restriction did not impose any undue design limitations.

It should be noted that all content which depends on the page type only, i.e., which is identical for all pages using the same template, might also be kept in the template itself (and not in the content database). However, such an approach may jeopardize important features of the framework such as creating a presentation in a different language etc.

Content Management System

The content management system (CMS) consists of the content database input and editing interfaces and the page generator. It allows creation, maintenance and deletion of pages. In its current version, it supports ODBC, Oracle's OCI and MySQL databases, thus covering all major production platforms.

The *database input and editing interface* is browser based and provides features to manipulate content, structure and layout of the web presentation under construction by modifying respective database contents. Fig. 3 shows a screenshot of the hierarchy editor based on tree controls and an editing menu. This component is used to navigate and/or modify the hierarchic structure of the exhibition. From here, the main content edit window may be reached. In Fig. 4, building blocks 1, 2, and 3 of Container 11 (itself an aggregate building block of type »baui«) of page »Infrastruktur – Baudenkmäler« of a German web page are being edited. The structure of the edit window changes dynamically depending on the type of content edited.

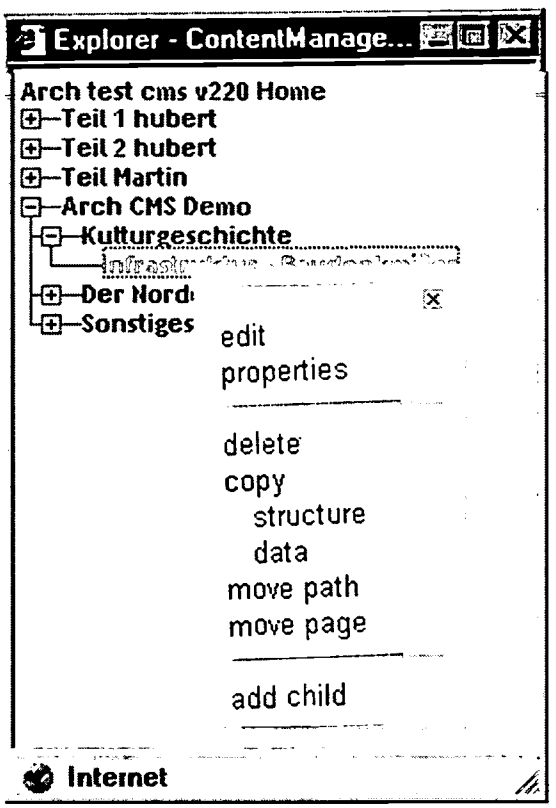

Fig. 3: CMS: Hierarchy editor

Fig. 4 illustrates not only the look & feel of the user interface for content entry but also the main disadvantage of the required pseudo-atomicity of the content database: As there is no formatting allowed *within* text building blocks, the granularity of text building blocks is somewhat smaller than mere reuse considerations would require. For instance, as text portion "*Bauperiode 2*" is used as a hyperlink to page titled "*Das Bad des Auxiliarkastells von Carnuntum*", it must be entered as a separate build-

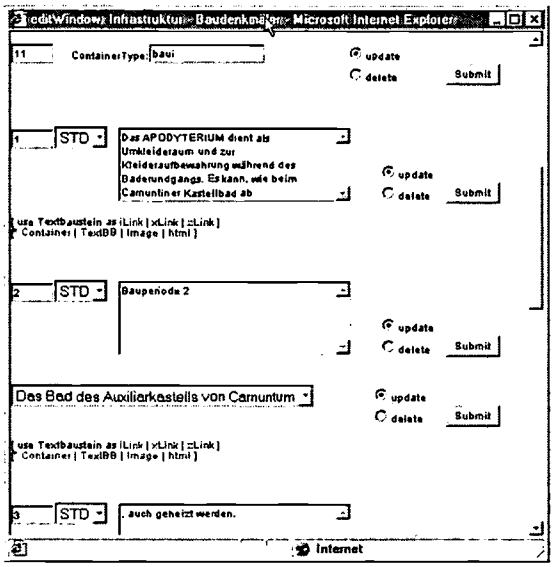

Fig. 4: Editing a page of Archeology@Austria

ing block (no. 2), although from a semantic perspective, building blocks 1, 2, and 3 together form a logical unit (i.e., a paragraph).

As mentioned before, it is possible to associate some layout information will different types of building blocks which will be taken into consideration by the page generator. The corresponding CMS module (style editor) is shown in Fig. 5.

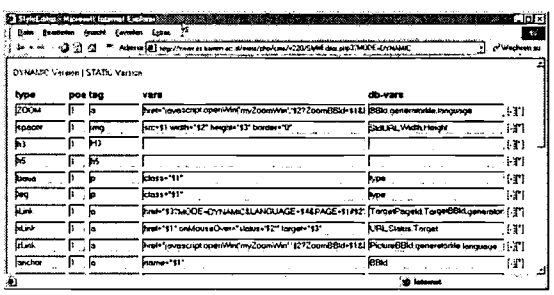

Fig. 5: Editing styles associated with building block types

Columns "tag" and "vars" define the HTML element to be generated for building blocks of type "type". "vars" contains variable references ("$1", "$2", etc.) which are to be substituted by corresponding database attributes listed in column "db-vars". These attributes are found elsewhere in the database. (Column »pos« is relevant for nested blocks only.)

Last but not least, a preview window allows the user to immediately see the outcome of the page generator run (Fig. 6). In such a window, special icons offer links back to specific edit windows (edit picture, edit container, edit text building block, edit styles, edit template slot. Cf. the bracketed icons in Fig. 6 – clicking on the one with the tool tip displayed would open the picture editing window to modify the presentation parameters of the image of Guru Rinpoche).

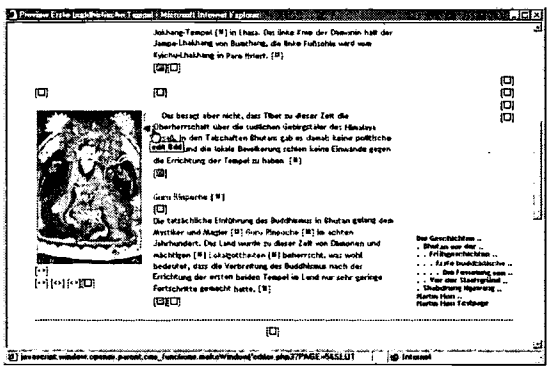

Fig. 6: Preview of generator run

The *page generator* represents the back end of the content management system, producing dynamic Web pages (a static version can be generated on demand in a post-processing step) according to the formatting rules given earlier. It is responsible for a homogeneous treatment of the different kinds of building blocks (e.g., generating the code necessary for the interplay between images, captions, corresponding pop-up legends and zoomwindows), and consistent navigation scheme, both within a page and within the web site (for deep hierarchies, managing the complex navigation menus is in itself a nontrivial task which is hard to accomplish manually, especially when the structure of the hierarchy is changed).

The generator is also capable of creating different versions of an exhibition as discussed in Section 3. For example, "Bhutan – Fortress of the Gods" (http://www.bhutan.at) exists in German and English, both in a "high tech" and "low tech" variant.

Project History and Reflection

The project which gave rise to the development of the framework presented in this paper begun as a research project to explore different approaches to virtual exhibitions, funded by the Austrian Federal Ministryof Education, Science and Culture (Breiteneder et al., 2000). However, as a by product, a production release of a virtual variant of a well-known and internationally successful exhibition of the Austrian *Museum für Völkerkunde* on Bhutan had to be developed. In this situation, the project partners opted for a dual approach: A conventional development track based on manually created dynamic Web pages was chosen in parallel to the development of the more advanced database based infrastructure presented in this paper (ViEx^{DB} or ViEx, for short). The first track was needed to guarantee a working product, while the second track was aimed towards a reuse environment for future virtual exhibitions.

During the development of the Web site along the conventional track, strong emphasis was laid on a well structured project and software design suited for a mid-sized project. Thus, after a short exploration phase, a set of tools (PHP3 as scripting language, homesite and BBedit as web editors, m4 as macro processor to introduce parametric text substitution etc.) to be employed alongside with corresponding strict coding and naming conventions were established, and the file system based version ViEx^{FS} of the framework was born. When its design had matured so far that a successful completion of the development project could be foreseen, all structural decisions made were frozen and the database oriented approach was started in parallel. From the modeling decision made thus far, the database scheme was deduced and the page generator was developed. Meanwhile, conventional development of the web site was progressing within the ViEx^{FS} framework, so that a content transfer tool was needed to initialize the database content from the web pages in ViEx^{FS}. The development and employment of a respective page analysis tool helped to verify and optimize the database model and also pointed out some inconsistencies within ViEx^{FS} which were corrected on the fly. Then, the editing front end was implemented as a working prototype, and finally the whole Web site was loaded into the database version ofViEx and manually polished. From this dual development experience, we are now able to contrast the two approaches taken.

In the file-system based version of the development framework, each building block was realized as a file in directory tree with strict localizing and naming conventions. The unit of work was defined as editing such a source file which usually took place on a client followed by some kind of data transfer (e.g., ftp) to the web server. With a Web-based editing interface, some edits could also be done directly on the Web server. Thus, a maximum of content creation flexibility was achieved, and all file system tools available on the server (under Unix) could be used (e.g., access right configuration, global search and replace etc.). In particular, pages systematically generated via PHP3 and m4 could easily be combined with some hand crafted individual pages where necessary. Also, authoring and configuration management activities could evolve with the complexity of the web site under construction.

The disadvantage was that many interfaces had to be mastered by the editing staff and that there was no real control whether all conventions established by the project team were observed (as the main portion of the content editing work was done by a single person with sufficient self-discipline, this aspect did not create a lot of problems in our project). Moreover, data transfer from the client workstation to the web server was not secured.

In the database version of the framework, content was moved from individual files into tables of a relational database system. The corresponding conceptual model guaranteed clear separation of content, structure and layout. There is only one editing interface (cf. the previous section). Modest use of relational features allows the employment of a wide range of DBMS from mySQL to Oracle 8. As the editing interface is somewhat more formal than for ViEx^{FS}, there were fewer accidental changes of content. On the minus side, there is the higher complexity of the editing task (due to the atomic nature of data), even though content editing performance seems to constitute a critical success factor for such a project. We also had to realize that late modifications of the underlying conceptual model cost a relatively great deal of work (an experience which seems counter-intuitive to classical arguments in favor of database technology). Thus, the database-

oriented approach seems to be especially promising if:

- the structure of the planned exhibition is compatible to the framework, i.e., it can be mapped onto the conceptual model of the framework,
- the exhibition project exceeds a certain complexity which allows amortization of setup costs (installing and getting acquainted with the tools, etc.),
- all tools are already well-defined and ready for duty at the beginning of the project,
- an exhibit database exists which may be linked to the content database presented here.

Conclusions and Ongoing Work

The primary project goal to develop http://www.bhutan.at to a fully functioning Web site meeting all requirements of a production system has put restrictions on the development of the prototype of a reuse framework discussed in this paper. We will definitely need at least resources equal to those spent so far on its completion to be able to use it in full practice and in a wide variety of contexts. Since reuse of software can only be proven by reuse, we have meanwhile tested the framework in a feasibility study in the field of archaeology. Because the participating archaeologists had different requirements from the ones to be met for http://www.bhutan.at, minor adjustments were necessary to increase the functionality available.

Currently, we are extending ViEx to be prepared for a much larger project covering all Austrian archaeological museums and sites in one Web portal. Since the total number of Web pages of this site will be a magnitude higher than for Bhutan, we first have to evaluate and improve the performance of ViEx for sites with more that 1000 pages. The most important additional extensions of ViEx will cover:

- support for XML
- support for metadata (RDF and Topic Maps) in order to move an important step towards the *semantic web*
- support for multiple concurrent users and
- the enhancement of editing features, as for example the splitting of building blocks.

Moreover, we want to compare available content management systems and to include some of the convincing additional features in our system.

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Design and Analysis of Virtual Museums

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Abstract

Using the same data, which could come from local databases or external sources such as the Web, virtual museum designers can build different hyperspaces. It is possible that visitors would find some of them more useful than others. Therefore, virtual museums designers should be equipped with a tool by which various hyperspaces for virtual museums can be easily designed and examined.

In this paper, we view a virtual museum as a hypertext that consists of nodes and links and show that a database publishing tool called Lazy, which generates a hypertext view (i.e., derived hypertext) of a given database, can be used for designing virtual museums. The Lazy system consists of a declarative hypertext view specification language, a node schema compiler, and a node server that processes node requests. Since the language is purely declarative, it is fairly easy to construct and revise hyperspaces for a virtual museum. With this tool it becomes possible to adopt an iterative design methodology.

Given a database for a virtual museum, we first construct a hypertext using the procedure (Falquet & al., 1999) called an initial structure. We then proceed to analyze the initial structure and examine possible refinement operations that can enhance the usability of the created hypertext. For that purpose, we use a simple graph-based analysis and we show kinds of analysis that can be done using the graph-based approach. Once the structure is refined using the refinement operations, we apply grammar-based formalism (Park, 1998) to the refined structure to see whether we can obtain a simpler grammar that can generate the same hyperspace. Our goal is to explore various analysis techniques on the hypertext and give insights into designing a good hyperspace using the analysis results.

Introduction

In this paper, we consider the issues that arise in the design and implementation of virtual museums. A virtual museum is defined as "a logically related collection of elements composed in a variety of media, and, because of its capacity to provide connectedness and the various points of access available, [it] lends itself to transcending traditional methods of communicating with the user; it has no real place or space, and dissemination of its contents are theoretically unbounded" (Andrews, 1996). According to this definition, it is reasonable to view the structure of a virtual museum as a hypertext since each element in a hypertext can be connected to others. However, it is well know that large hypertexts, in particular large Web sites, are very difficult to manage. Thus it has become common practice to store data in a database and to use some mechanism to automatically produce the hypertext.

In this paper, we will study the construction of virtual museums on top of databases. The content of a database can represent either real-world entities (e.g. existing works of art, or existing museums) or virtual entities (e.g. virtual exhibitions that exist only on the Web). When constructing a virtual museum, it is important to provide visitors to the virtual museum with a well-designed hyperspace so that they do not get lost while navigating inside the space. Although "lost in hyperspace" is a well-known symptom (Conklin, 1987), in our case, we have an underlying database that is structured by a database schema and we can avoid the symptom to some extent.

Given database contents, different hypertext structures can be created for the virtual museum, and visitors will find some structures more accessible than others. Therefore, the structure should be carefully designed, and it is important for virtual museum designers to easily define nodes and links that form hyperspaces and see what the results look like (examine different hyperspaces freely). In order to help designers who build virtual museums, we present a database publishing tool called Lazy (Falquet & al., 1998), by which different hyperspaces can be easily constructed. Using the Lazy system, designers can construct the web site for a virtual museum, and once the web site is created, they can analyze the structure of the virtual museum.

Some of the related works are as follows: a visual grammar-based formalism was introduced in order to analyze hypertext structures in (Costagliola & al., 2000), and an implementation in Prolog for analyzing hypertext that contains conditional linkage was sketched in [HT99 paper]. Recently, database publishing has attracted interest and some of the techniques are described in (Entin & al., 1998; Toyama & al., 1998). There are several approaches to create hypertexts from databases. In the procedural approach, the hyperspace designer must write programs (CGI programs in C or Perl, Java servlets, PHP scripts, etc.). These programs are generally large since the code must contain both tags and programming constructs. They are therefore difficult to read, and the hyperspace structure is hidden by the programming constructs. For these reasons, such a code is tough to maintain and update. The dynamic document approach consists in extending some document mark-up language (such as HTML) with specific tags for database querying, result processing and formatting, etc. See, for instance, Cold Fusion (www.allaire.com). These tags introduce procedural parts into the document description. The declarative approach (Fernandez & al., 1998), (Atzeni & al., 1998), (Falquet & al., 1998) consists in specifying a hypertext structure and specifying how to build the hypertext elements from the database content. It is conceptually simple and tends to be closer to the information designer's conceptual level. Our work is also related to hypertext design methodologies such as RMM (Isakowitz, 1995) and HDM (Garzotto, 1993). It also takes into account adaptive features such as content adaptation, a well-known adaptation technique in the field of adaptive hypermedia (De Bra, 1998).

The paper is organized as follows: in the next section, we will introduce the concept of hypertext view with examples constructed with Lazy. Then, we propose a design process for hypertext views and show its application in the design of a virtual museum. We proceed to explain possible analysis on the hypertext. Finally, we conclude the paper with discussions about our approach for the design and analysis of a virtual museum.

Constructing Hypertext Views with Lazy

This section presents the Lazy hypertext view specification language. The presentation is rather informal and based on examples from the sphere of virtual museums.

A hypertext view is a set of nodes and links that represent (a part of) the contents of a database. In the declarative approach, the hypertext components (nodes and links) are derived from the database content (relation tuples) according to a hypertext view specification, as shown in Figure 1.

A hypertext view specification consists of a set of node schemas that specify the collection from which

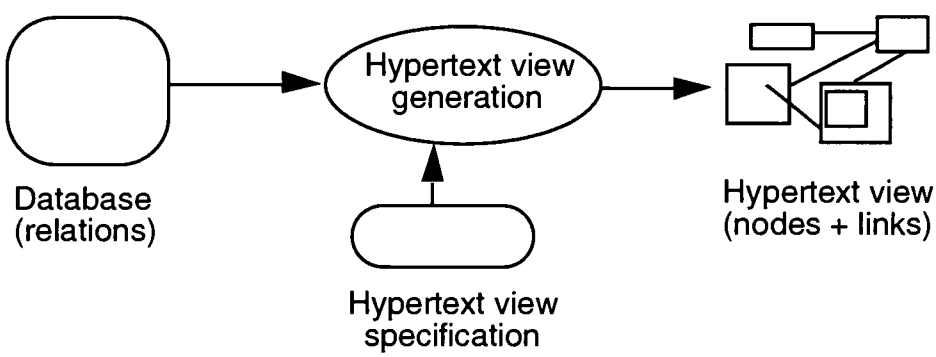

Fig. 1: Generating hypertext views from a database and a hypertext view specification.

the node's content is to be drawn; the selection and ordering criteria; the elements that form the node content; and links to other nodes. A node definition takes the following form:

```
node <node-name> [ <parameters> ]
   pre <element-list>
   items <element-list>
   post <element-list>
from <collection>, ...
selected by <expression>
ordered by <expression>
```

An element of an element-list is an expression of the form, '<' type '>' '(' <element-list> ')' or a <simple-expression>. In the items part, a simple expression may involve literal constants (string, integer, etc.), attribute names, parameter names, operators and functions. An atomic element, specified by a simple expression, represents basic document data (CDATA in XML terms). In the pre and post part, attribute name may only appear within aggregate functions like min(), max(), sum(), etc.

Although the node specification language is generic enough to support relational as well as object-oriented databases, in this paper we will only consider the relational case since most existing databases are relational. In this case, the <collection> of a node is a relation (or the cartesian product of several relations) and each node item will represent a selected tuple of that relation.

Example

Throughout this paper we will use the same database schema, shown in Figure 2, that represents a part of a virtual museum database. Note that this structure is close to a (simplified) real museum database schema. In fact, some of the relations (e.g. works) could be existing relations of a museum information systems, while others (e.g. exhibitions) could represent real as well as virtual objects.

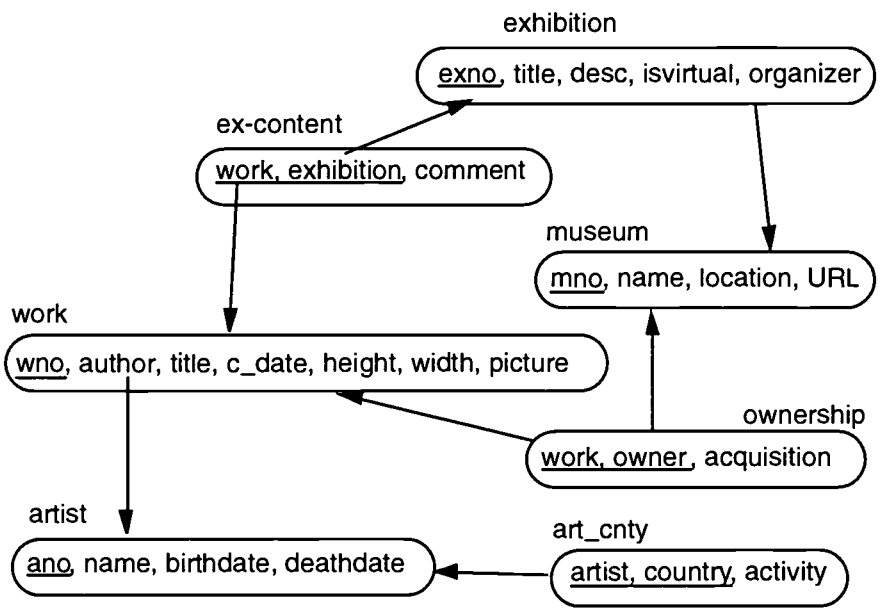

Fig. 2: Museum database schema

Consider the following node definition:

```
node Artists_after[date]
  items
   <p>(name, "(born ", birthdate, ") ",
       href Works_by[ano] ("works")
       )
from artists
selected by birthdate >= date
order by name
```

This is intended to present lists of artists born after a given date. The content of an instance *Artist_after[d]* of this node is computed as follows:

- all the tuples t of table artist that satisfy t.birthdate >= d are selected .
- an item is generated for each selected tuple, it contains an element of type <p> that is made of the artist's name, the text "(born ", the artist's birthdate, and the text ")".

This element also contains a reference link (works) to a node *works_by[ano]* which is intended to display the list of works of this artist. This node is defined as follows:

```
node Works_by[artist]
  items
     <p>(<img src=picture>()),
     <p>(<b>(title), " ", c_date,
<br>(),
          support," ", height," x
",width
        )
  from work
  selected by author = artist
```

Each selected work will be displayed as two paragrahs (<p>), the first one showing an image of the work and the second one giving textual information (title, creation date, etc.). Figure 3 shows the content of an instance *Artist_after[1900]* and an instance *Works_by[...]* that can be reached by following an href link.

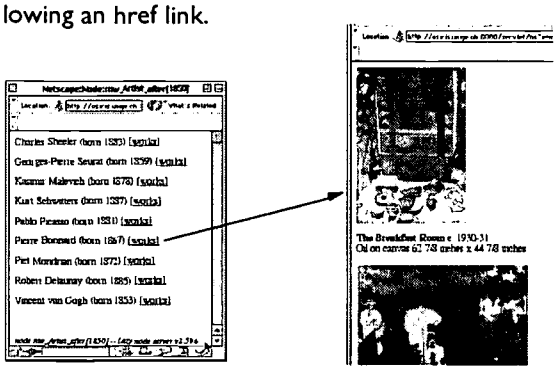

Fig. 3: Two node instance generated with the Lazy system.

The node definition language supports three kinds of links, which are "reference", "expand in place", and "include". A reference link creates an active element whose action (when activated by a mouse click) consists in jumping to (opening) the referred link. A link specification refers to a node through its identity (schema name together with parameter values). An inclusion link creates a compound-component relationship between two nodes. The content of the included node is a part of the content of the parent node. With inclusion links one can construct arbitrarily complex nodes, for instance to represent complex structured documents. Figure 4 shows an instance of the following node schema that includes three other node instances (Countries, Work_list, and Contemporary (defined in section 3.2)):

```
node Artist_ext[id]
   items
        <h2>( name, " (", birthdate, "-
", deathdate, ") "),
        include Countries[id],
        <h4>("Some works"),
        <blockquote>(include
Work_list[id]),
        <h4>("Contemporary with: "),
        <blockquote>(include
Contemporary[birthdate, deathdate])
   from artist
   selected by ano=id
```

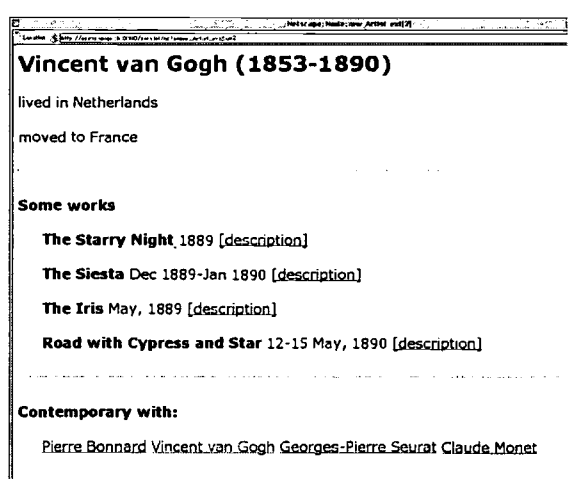

Fig. 4: An node instance which includes other node instances

Finally, an expand-in-place link is an inclusion link that defers the inclusion until the user activates the link. The content of a node with expand-in-place links will thus depend on user actions taken so far.

The hypertext view generation system is composed of :

- a node compiler that checks the syntax of node definitions and stores the node definitions (in a coded form) in the data dictionary
- a node server (a Java servlet) that receives node requests from clients' (browsers); loads the appropriate node definitions; executes database queries to build the node contents; and sends the resulting Web pages to the clients.

The Web site development cycle consists in writing or editing source files that contain node schemas; compiling the definitions; and viewing (testing) the newly defined nodes in a Web browser. Since the system is dynamic, once a node definition has been modified and recompiled, the new version is immediately available to the clients (there is no site generation phase).

Every page that is viewed by a client is an instance of a node schema; thus any design problem can be readily located (as opposed to procedural approaches in which the same procedure may be used to manage several different Web pages).

Design

In this section, we explain how one can construct an initial hypertext structure that reflects the structure of a given database and how that initial structure can be modified through refinement operations. We also present techniques that hypertext designers can use in order to implement an adaptive feature with the Lazy system.

Designing efficient and effective hyperspaces is a difficult task, probably because there are an extremely large number of paths that user can follow. It is thus difficult to ensure that the users will be able to reach any information node, that they will not get lost or disoriented in the hyperspace, that any information can be reached within a reasonable amount of time/ number of clicks, etc. Since we are starting from an existing database, we already have a conceptual schema, declared by the relation schemes and the integrity constraints such as foreign key constraints. This schema shows the type of entities that are being considered and some semantic relationships (materialized by foreign key constraints) between these entities. However, a database schema is not sufficient to create good hyperspaces. Database design and hypertext design do not have the same objectives. If we rely on the database schema at the semantic level, it will be possible to create a hypertext structure that is efficient for reading and navigating. Our design method for hypertext views proceeds in two phases: 1) define a first hypertext structure based on the database schema; 2) refine this structure by applying various operations to the specifications of nodes and links.

Initial structure

For the construction of an initial structure, we assume that the database schema is given and fixed. One obtains the initial structure by defining a node schema for each relation of the data base. An instance of such a schema is intended to represent a single tuple of the relation. The node schema has a single parameter that represents an object of the class (in the relational case it is a set of parameters that forms a key value). The contents of the node items are formed of all the collection's attributes.

Links are formed by attributes or groups of attributes that refer to other relations (foreign keys). For instance, the initial node schema corresponding to the relation

```
relation work(wno, title, date,
author, …)
```

is

```
node Work[w]
  items a wno, title, date, author, …,
    href Artist[author]
  from work selected by wno = w
```

This structure accurately represents the contents of the database, i.e. the graph of all node instances and possible links is isomorphic to the graph of the database objects connected through the reference attributes. However, this structure is not completely navigable, i.e., due to the unidirectionality of links, it is not always possible to reach any node from any other node. Thus reverse links must be added.

For example, if a node N has a reference (href M[r]) to a node M, we add a link from M to N

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which corresponds to the traversal in the opposite direction. To carry out this operation, an intermediate node schema is defined, and this intermediate node plays the same role as selection menus in systems that support links with multiple ends.

Note that the initial structure together with reverse links yields a fully navigable view of the database. This means that if two objects o1 and o2 are connected (directly or indirectly) in the database, there exists some path in the hypertext to go from the representation of o1 to the representation of o2 (and vice versa).

Refinement operations

Refinement operations are intended to improve the navigability (or the legibility) of a given hypertext view. We list below some of these operations.

Link composition (short cuts)

One way to reduce the number of navigation steps in the hypertext view is to create "shortcut" links. This consists in combining two (or more) links into a new one. This is particularly useful to increase the navigability of the initial structure that typically contains nodes of the form:

```
node A [...]
   ... href B[key_attribute]
from T ...

node B [k]
   ... href C[x]
from T selected by key_attribute = k
```

where key_attribute is a key of T, In this case, any element of B (e.g. the link to C) can be incorporated into A to suppress a navigation step through B.

Inclusions

This operation consists in changing a reference link into an inclusion link. It allows us, for example, to represent complex entities in the form of only one node (including sub-nodes). This operation is particularly interesting when the link has semantics of the type "part-of "or "compound-of". It is also a way of reducing the number of reference links in the hypertext and thus shortening navigation paths.

Summarization

When a node represents a large object having many attributes, it may be desirable to derive a "summarized" node by removing certain attributes of the initial definition. This summarized node will have a link to the complete node. It also should be decided for each link that leads to the initial node if it is necessary to "redirect" it towards the summarized node.

Adding computed links

The database schema usually represents relationships between entities through foreign key constraints (or referential constraints). However, some interesting relationships are not represented directly in the database schema. For instance, the relation "contemporary" between artists is not represented, but it can be computed since we know the birth and death dates of the artists. Links corresponding to such derived relationships can be created in the hypertext schema using diverse schemes. For instance, a relationship "contemporary" between artists can be implemented by creating a node

```
node Contemporary[abirth, adeath]
  item name, href Artist[ano]
from artist
selectedy by deathdate > abirth+15 or
bdeath > birthdate+15
```

and adding a new link in Artist

```
node Artist[id]
  items ...
    href Contemporary[birthdate,
deathdate] ("contemporary artists")
  ...
```

Widening

The widening of a node consists of weakening its selection condition. As a consequence, other objects will be shown in the node. This is a way to contextualize information by presenting it together with related information. For example, a painting could be presented together with other paintings of the same period or of the same region.

Previewing

Previewing makes it possible to see part of the contents of a referred node without having to traverse

the link. The objective is to avoid navigation to a node whose contents do not correspond to the information we are seeking. This operation consists of creating a summarized node (in general with only a few attributes), as in the derivation operation, and adding to the initial reference link by including the summarized node.

Building indices and entry points

An index structure is a set of nodes that allows us, by successive selections starting from a root node, to reach a particular node. A simple, concrete, case is the creation of an index on an attribute A. This requires the creation of a two node schemas: 1) a root node presenting all the possible values of A; 2) a node presenting a list of all the objects having the same value for attribute A. One can generalize this structure to create indices on several levels where each level corresponds to a different attribute. The traversal from the root downwards amounts to fixing an attribute value at each stage.

Creation of linear paths

This operation creates links that make it possible to traverse all the node instances of a schema in a prescribed order (guided tour).

Designing Adaptive Nodes and Links

Adapativeness in hypermedia systems consists mainly in taking into account the user's profile when deciding on what information to display, how to display it, and how to react to user actions. In the context of hypertext views, this means that the content of a node, and its links, should be generated according to a user profile. It can be implemented in a straightforward way, provided

- some "profile" relation contains suitable information about the user profiles,
- a global variable USER exists that stores the user name (in the current implementation it is represented by a supplementary parameter in each node schema).

For instance, the following node schema displays information about a particular work of art. It includes a Details node that will present more detailed information, but only if the user profile has detail_level > 2.

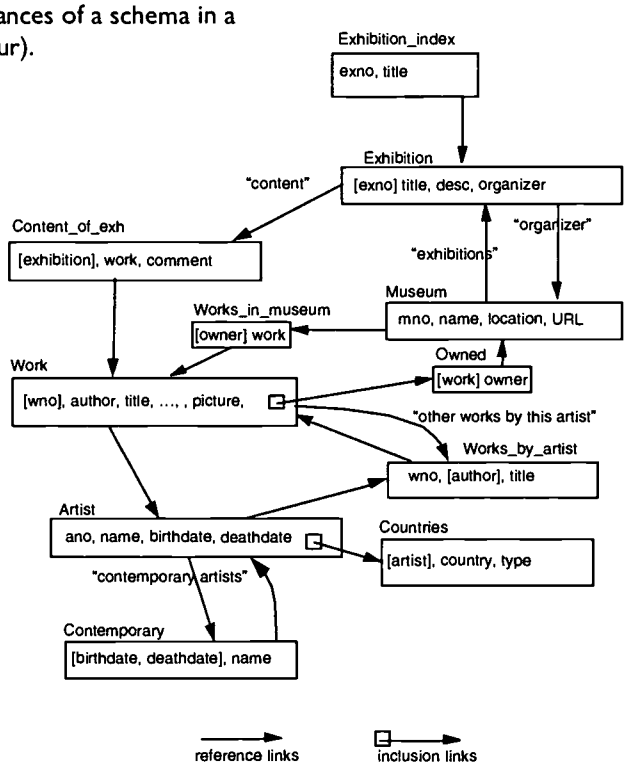

Fig.5: A hypertext view structure after several refinement steps.

```
node Work[n]
  items title, c_date, include
Details[n], ...
from work selected by wno = n

node Details[n]
  items width, height, acquired, ...
from work, profile
selected by wno = n and
   profile.user = USER and
profile.detail_level > 2
```

If the user has detail_level + 2 the selection condition will be false for every tuple and thus the node will remain empty. With the inclusion mechanism, it is thus possible to create contents and links that depend on user profiles or on other contextual information such as time, date, etc. (for instance, forthcoming exhibits could be announced in some nodes during the weeks before their opening).

Path-awareness is another form of adaptiveness, and consists of having node contents that depend on the user navigation path. Current Web browsers offer a limited path awareness feature that consists of displaying anchors of previously visited nodes in a particular color. Although very simple, this mechanism proves efficient when exploring a new site. In fact, we can think of many situations in which we would like to have the content of nodes depend on previously visited nodes. For instance, we could have an anchor "latest news" in the heading of every node, as long as the "News" node has not been visited. Once is has, this anchor should disappear from all the nodes.

In order to implement this type of behaviour, we need some way to refer to the navigation history. The navigation history can be stored in a HISTORY parameter added to every node definition. Each node can then add its own identity to HISTORY and pass it forward to the nodes it refers to. The general schema is thus

```
node N[…parameters…, HISTORY]
   …
   href AnotherNode[ … parameters …,
HISTORY + "(N)"]

selected by … conditions on attributes
…
AND condition on HISTORY
```

Analysis

Graph-based Approach

To analyze hypertext structures and see the effect of refinement operations, it is convenient to have a compact graphical representation. Our analysis is done on the node schema instead of node instances, and graphical representation is smaller than the generated hypertext (i.e., the set of node instances and links among them). Based on the analysis of the initial structure for the virtual museum, we can apply appropriate refinement operations.

Once we have a graphical representation of the node schemas, these are possible analyses that we can do on the initial structure.

1) Identify links that do not exist in the initial structure, but might be helpful if we created them. Notice that those links that exist in the initial structure are directly come from the associations of data in the database (e.g., foreign key). After such links are identified, we can apply appropriate refinement operations to the initial structure.

2) Check the number of navigation steps between the nodes and determine the semantic proximity (or semantic distance). If they are semantically close, the number of navigation steps should be reasonably small.

3) Explore different types of links between the nodes and select a better type than others; for example, it might be necessary to change "jump" to "include" or "expand in place".

4) Check whether a node is reachable from a given node (i.e., accessibility analysis). Notice that the schema connectivity does not ensure that the hypertext itself (the node and link instances) is fully navigable. This depends on how objects are interrelated in the database. However, knowing properties of the links (like cardinalities), it is possible to prove the full connectivity of the hypertext view.

5) Compute the maximum number of steps that a user can follow from one node to another. Since the user does not see the entire hypertext, it is not obvious to the user whether a path is the

shortest distance from one node to another. Information about the longest path that one can take to reach a destination node can inform us about how a user might get lost in the hyperspace.

Grammar-based Approach

After we determine the refined structure for a virtual museum, we can proceed to represent the node schemas in terms of grammar rules for a further analysis. We use grammars in two ways - one for the inner structure (i.e., the structure of a node) and the other for the outer structure (i.e., the structure of a set of nodes and links). Once node schemas are represented by a grammar, the following analyses can be done:

1) Find a different grammar that is simpler than the original grammar, but generates the same hyperspace. The set of all virtual documents can be found first, and we can find another grammar that generates the same set.

2) Investigate a property of the grammar, such as "inherently ambiguous", and determine the connection between that property and the navigational structure of the hypertext

a) Inner structure

The purpose of representing node contents with grammar rule is to obtain a compact representation of the node contents in terms of document structure and semantic content. For a node,

```
node N[p]
 items item1, ..., itemk
```

the corresponding grammar rule (in BNF) is N ::= { $s_1 \ldots s_k$ }, where s_i is (1) empty if $item_i$ is a constant (2) the attribute list $a_1, \ldots, a_n$ if $item_i$ is an expression involving these attributes (3) the non terminal symbol M is $item_i$ is an inclusion of the form include M[...].

If we can prove that a node instance will always contain at most one item (this depends on the selection predicate), then the iteration indicators { } can be removed from the grammar rule. For example, the grammar rule corresponding to the node schema

```
node Artists_after[date]
  items
    <p>(name, "(born ", birthdate, ")
",
       expand href Works_by[ano]
("works"),
       include Biography[ano]
       href ...
       )
from artists
selected by birthdate >= date
ordered by ...
is Artists_after ::= { name birthdate
[Works_by] Biography }.
```

The grammar of a node is the set of rules corresponding to this node and all the included and expanded nodes. For the above node this could yield (if nodes Works_by and Biography were so defined)

```
Artists_after ::= { name birthdate
[Works_by] Biography }
Works_by ::=  { title date support }
Biography ::= { country date activity }
```

Since no rule in this grammar is recursive, this can be rewritten as a single rule:

```
Artists_after ::= { name birthdate [{
title date support }] { country date
activity } }
```

In fact, this grammar shows the structure and semantics of a node. It is similar to a basic document type definition (DTD) for this node.

b) Outer structure

We explain the construction of grammar productions that describe the outer structure of a given hypertext using a simple example.

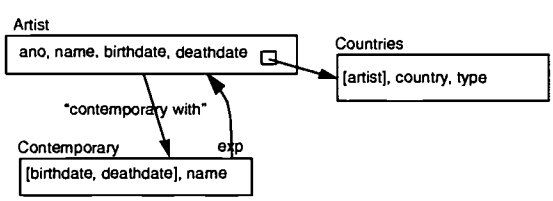

Fig.6: Example

In this figure, we see that there is one href link, one inclusion link and one expand-in-place link. In order to describe the outer structure of this hypertext, we find possible paths from each node to others. We see that the Artist node has two different types of links, one for inclusion (to Countries) and the other for href (to Contemporary). From Contemporary, there is one expand-in-place link to Artist. The node Countries does not have any link to other nodes.

Let the node Artist be described as two characters, a1d1, the node Contemporary as a2d2, and the node Countries as a2d3. (Each ai and di can be considered as "brackets" for each node.) If we attach prime symbols to each of those, that represents a node instance of the node schema. For example, a1'd1' is a node instance for the node a1d1. Then, each of the following products represents each link in the hypertext.

```
a1d1 -> a1'd1' | a2d2 | a1a3d3d1
a2d2 -> a2'd2' | a2a1d1d2
a3d3 -> a3'd3'
```

If we change a1d1, a2d2, and a3d3 as x, y, and z, respectively, and introduce a starting symbol S, we get the following products:

```
S -> x | y | z
x -> x' | y | a1z'd1
y -> y' | a2xd2
a1z'd1 -> x
a2x'd2 -> y
```

Notice that x', y', and z' is a1'd1', a2'd2', and a3'd3', respectively.

Once this first grammar is found, we can analyze the structure by examining the property of the grammar. We can also find a simpler grammar that represents the same hyperspace. One usage of this grammar formalism would be that one can use it as a site map for a given wWeb site so that users can get an idea of how the hyperspace is structured.

Conclusions and Future Directions

In this paper we presented a language to specify virtual museums in the form of hypertext views of databases. Since the language is non-procedural and explicitly shows the structure of the generated hyperspace, it is well suited for an iterative design process. The existence of a hypertext schema makes it possible to check properties of the hypertext, such as path lengths or accessibility, without accessing the hypertext nodes themselves. The development process we propose consists in starting from an initial design and then entering an analysis-refinement cycle. The structural analysis of the hyperspace uses graph and grammar formalisms while the refinement is based on several basic operations.

This development process is supported by software tools to compile the specifications and to dynamically generate Web pages (node instances) according to the specifications.

In the near future we plan to increase the adaptiveness capabilities of the generated hyperspaces, in particular the path-awareness. We are also starting experiments with a new version of the Lazy system to make the hypertext views active. This means that users will not only navigate in a virtual museum but will also act on this museum by updating the information nodes they see. For instance, users could create their own virtual exhibitions within the virtual museum, add annotations to objects, etc.

Acknowledgement

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Re-Purposing of Content and Digital Delivery Convergence: Implications for Interface Design

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Abstract

With the introduction of the digital medium, an abundance of content previously obtainable through other media became available in digital form. Digital delivery implied the necessity for some kind of content modification dictated by the specific characteristics of the digital medium.

The situation is further complicated by the convergence of different media used for the delivery of digital/digitized information. The same content has to meet the constraints of different display devices and bandwidth limitations. Furthermore, digital delivery makes possible adaptations of content not only in regard to characteristics of hardware used to display it, but also in regard to individual user's goals and needs.

In this paper I will present the implications for content re-purposing with the migration from the traditional to the digital medium as well as the problems that arise from convergence of different types of digital delivery mechanism.

Introduction

The effects of the 'discovery' of the digital medium are global and profound. I have described some aspects of these changes elsewhere (Milekic, 1999). In this paper I will analyze two currently observable trends connected to the introduction of the digital medium. These trends are:

a) re-purposing of content previously available through other media for delivery through the digital medium;

b) convergence of means (physical devices) used for the delivery, display and manipulation of digital content.

Each of these trends creates complex constraints but also opens up new possibilities for content delivery/exchange. These possibilities can be explored only by modifying the traditional interface design practices of applications created for digital content delivery. However, before proceeding to the analysis of general effects of these trends, it is advisable to clarify the consequences and implications of each one separately.

Re-purposing

According to the on-line version of Merriam-Webster dictionary, a literal definition of re-purposing would be that it is a new way (from Latin re-, again) of achieving the same outcome (from Latin *proponere* /to propose/: something set up as an object or end to be attained: INTENTION). In most general terms re-purposing can be described as manipulations of *space*, *time* and *meaning* within the new medium. Most often re-purposing involves some kind of *compression*. Compression of data space (ultimately corresponding to the physical storage space necessary for storing it) in a medium currently constrained by bandwidth limitations is frequently proportional to time compression. However, with bandwidth limitations resolved, the space compression will be relevant only in regard to the characteristics of a user's display device. This does not mean that the need for time compression will disappear. In future, time compression will not be tied to how long it takes an image to be downloaded to one's hard drive, but to how quickly one is able to use (understand) the content. In other words, time compression will be related to the *compression of meaning*.

In regard to the digital medium, one can distinguish two different kinds of re-purposing: a) one that refers to re-purposing of content from another medium (that of print, audio or video, etc.) for delivery in the digital medium, and b) re-purposing that occurs within the digital medium. These two forms of re-purposing can be labeled as *inter*-media and *intra*-medium re-purposing.

Inter-media re-purposing

Inter-media re-purposing is historically not a new occurrence. A clear example is a shift from oral tradition to written transmission of myths and folk tales. In order for oral content to be successfully transferred into the new medium, it had to be adapted to the constraints imposed by the new medium. In this process some of the characteristics of the content and possible interactions with it were lost or changed, while new ones were gained. For example, oral traditions rely on a very undependable storage medium – human memory. Historically it has often been the case that certain folk tales and myths were confined to the brain of a single individual, upon whose death they would be irretrievably lost. Committing these to print preserved the content and made it available for transition to any number of (literate) individuals in the future. The other side of this transition is that some possibilities were lost. Human memory may be unreliable as storage medium, but it is inherently flexible and creative. Storytellers freely added and embellished the story so that it suited particular circumstances. This led to the enrichment and the creation of different versions of popular myths. Transferring such material to print meant that it had to be 'edited'; that is, redundancies had to be removed, inconsistencies corrected, and one had to settle for a single 'true' version of the content (it is only much later that the value of the diversity of oral interpretations was recognized and is now extensively documented). It is important to note that these changes were mandated by the characteristics of the medium itself.

Transferring (re-purposing) content from any other to the digital medium will be affected in a similar way by properties of the digital medium. In order to anticipate the effects this transfer will have on content accessibility and usability (and user interface design), it is important to identify in advance the specific characteristics of the new medium. Properties unique to the digital medium are consequences of binary encoding of information and, as I argued elsewhere (Milekic, 1999), at the most general level they can be labeled as:

- reproducibility
- transferability
- pervasiveness
- manipulability

Reproducibility refers to the fact that any content transferred into the digital form becomes instantaneously reproducible. As a matter of fact, the very act of making it available to our senses (by displaying it on the monitor screen) involves reproduction. Reproduction in a digital medium is perfect; that is, reproduced code (even if it was reproduced millions of times) is indistinguishable from the 'original' one. Thus, the notion of the original in the digital medium is going to be very different from the one used for works in traditional media. Most likely, it will be defined temporally as the time of the first occurrence of a certain binary pattern, before digital 'originals' started multiplying.

As instantaneous as reproduction, *transferability* refers to re-creation of a binary code at another location, with the loss of the 'original' code. The ease with which any portion of binary code can be reproduced, transferred and modified led to the *pervasiveness* of the medium. We are already at the level where any bit of information stored in this medium is *simultaneously* accessible to anyone with access to a digital portal.

It is the level of control over manipulations in this medium that is unlike any other traditional medium. Not only can one manipulate information at the level of a single bit, but one can also selectively interact with the data specified at a level of a particular *pattern*. For example, it is possible (and trivially easy with modern rendering software) to change only those data bits corresponding to a certain shade of red in a digital photograph. Hyper-linking of data (which may be in different modalities) represents yet another level of *manipulability*, the one at the level of meta-structure. Thus, the information in the digital medium is infinitely personalizable, malleable, modifiable and adaptable. Because of its creative potential the manipulability of digitally encoded information has been the driving force behind the globalization of digitization.

However, blind use of recognized properties of the medium can also lead to less-than-perfect results. Good examples are early attempts to re-purpose text documents for use on the World Wide Web. Re-purposing was done with a knowledge that the medium allows for hyper-linking of any two points in the information space. Although the abundance of hyper-links made the text seem more usable, their

net effect was not any greater than what would be achieved with an automatic page-turner.

Intra-medium re-purposing

Re-purposing within the digital medium is achieved by *modification* of certain aspects of the content or its delivery mechanisms. Depending on the motivation for re-purposing of the content, one can distinguish two broad categories which I will label

a) device-centered content adaptation
b) user-centered content adaptation

Very often the line between the two is blurred because the distinction is not made between the users who access certain content and the devices that they use for this purpose. Needless to say, equation of a user's goals with the characteristics of the device being used to reach it leads to serious flaws in interface design. For this reason, I will describe these two different categories separately.

a) Device-centered content adaptation

In the field of HCI, re-purposing of the content focused mostly on technological constraints of different devices used to access the content and not on user interests, goals. etc. Examples of device-centered content adaptation are provided in an excellent paper by Ma, Bedner, Chang, Kuchinsky and Zhang (Ma, Bedner, Chang, Kuchinsky and Zhang, 2000). They provide five general categories of content adaptation applicable to different data modalities within the digital medium: video, image, audio and text.

They label these categories as:

- data prioritization
- data transcoding
- modality transformation
- information abstraction
- purpose classification

Data prioritization is achieved by assigning different levels of delivery priority to different content aspects. These could be related to content modality, for example, by assigning priority to delivery of text prior to the delivery of images or audio and video information. Or it can be achieved by prioritized progressive delivery within the same media type, for example, by delivering images first in low-resolution version, and then filling-in more detail if time and/or user display device allow.

Data transcoding is the process of converting data format. In their paper the authors (Ma et al., 2000) refer to data transcoding only in the context of client display device characteristics. This would include transcoding of original images to display-appropriate format; for example, GIF-to-JPEG or color-to-grayscale. However, it is important to note that some forms of data transcoding may also provide other forms of content adaptation, like information abstraction. This is demonstrated in Figure 1 which depicts the same information (photograph of a young woman) transcoded to formats compatible with different display and bandwidth characteristics.

Notice, however, that image 4, although claiming the least amount of data space (and thus the least amount of download time) provides the viewer with much more information due to the addition of a "thought bubble" which provides relevant contextual information for the interpretation of the image.

Figure 1. Sequence of images with different levels of data (and hence time) compression, ranging from 232 kilobytes for uncompressed image in TIF format to less than 10 kilobytes for duo-tone image.

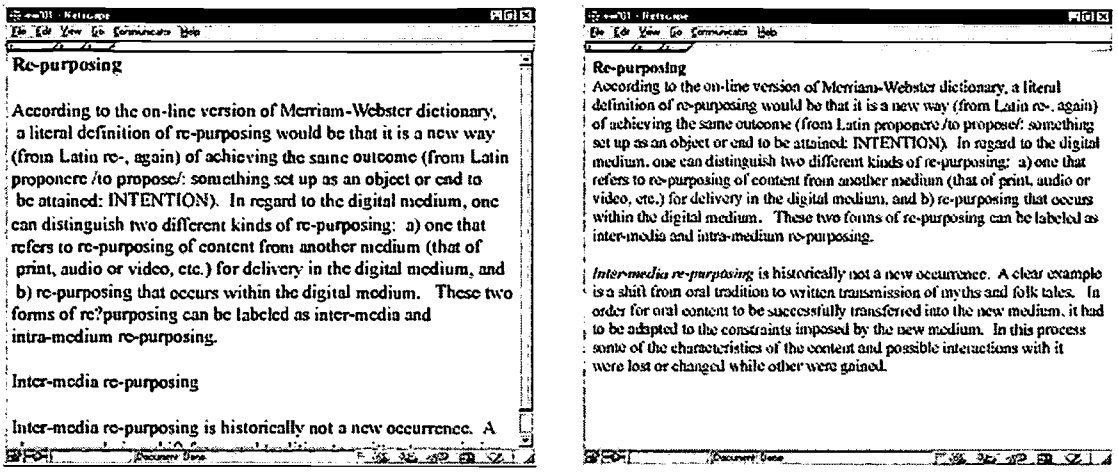


Figure 2-3. Information abstraction by reduction of font size and reduction of white space allows the text to fit into the browser window without scrolling and without any change to the text itself.

Modality transformation is the translation of the information delivered in one modality into another modality. Examples include transforming digital video stream to a series of still images, delivering only the audio component of the video, or closed caption text. True modality transformation would not be characterized by loss of information, and therefore one should distinguish it from modality transformation-based reduction.

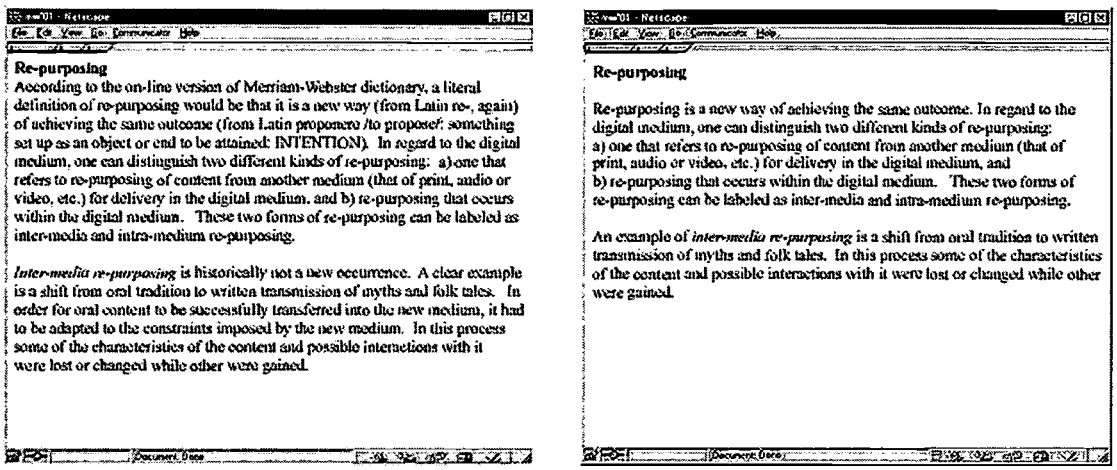
Information abstraction refers to the procedures that reduce bandwidth requirements by delivering extracted information to the user. Ma and his colleagues (Ma et al., 2000) provide examples such as video highlights, video frame and/or rate reduction, image dimension reduction, image data size reduction (by increasing compression rate), stereo-to-mono conversion, text summarization, font size reduction etc. However, these examples mix both semantic and non-semantic information abstraction – reducing image data by using a better compression algorithm does not have to lead to perceptible loss of information and have an effect on meaning, while text summarization may.

Another difference is that some of the given examples use automatic algorithmic procedures (like image compression, thumbnail generation, audio subsampling) while the other ones depend on human editing (text summarization, video description and such) to achieve data compression. Thus, it may be useful to divide this category into two separate ones: *data compression* achieved through different automatic procedures, and true *information abstraction* achieved (at least for the time being) through human intervention.

Purpose classification is the least clear category suggested in the above-mentioned article (Ma et al., 2000). While it is definitely true that "a typical Web page contains a lot of information and media objects that are redundant or may not be of interest to a user" by which they refer to advertisements, banners and promotional material, it is often the case that the very existence of a particular page depends on displaying this (redundant) information. Although the authors invoked this category with the goal of meeting low bandwidth characteristics of different user devices, they are coming very close to user-centered content adaptation, by discussing the purpose and usefulness of ads for a user.

b) User-centered content adaptation

Adapting the content so that it can efficiently accommodate users with different needs, skills, backgrounds, knowledge level, etc., is another challenge in the research agenda for universal usability (Shneiderman, 1999). It is worth noting that tools for user-centered content adaptation focus on dif-



Re-purposing

According to the on-line version of Merriam-Webster dictionary, a literal definition of re-purposing would be that it is a new way (from Latin re-, again) of achieving the same outcome (from Latin proponere /to propose/: something set up as an object or end to be attained: INTENTION). In regard to the digital medium, one can distinguish two different kinds of re-purposing: a) one that refers to re-purposing of content from another medium (that of print, audio or video, etc.) for delivery in the digital medium, and b) re-purposing that occurs within the digital medium. These two forms of re-purposing can be labeled as inter-media and intra-medium re-purposing.

Inter-media re-purposing is historically not a new occurrence. A clear example is a shift from oral tradition to written transmission of myths and folk tales. In order for oral content to be successfully transferred into the new medium, it had to be adapted to the constraints imposed by the new medium. In this process some of the characteristics of the content and possible interactions with it were lost or changed while other were gained.

Re-purposing

Re-purposing is a new way of achieving the same outcome. In regard to the digital medium, one can distinguish two different kinds of re-purposing:
a) one that refers to re-purposing of content from another medium (that of print, audio or video, etc.) for delivery in the digital medium, and
b) re-purposing that occurs within the digital medium. These two forms of re-purposing can be labeled as inter-media and intra-medium re-purposing.

An example of *inter-media re-purposing* is a shift from oral tradition to written transmission of myths and folk tales. In this process some of the characteristics of the content and possible interactions with it were lost or changed while other were gained.

Figure 3-4. Further compression is achieved by condensing the text and presenting it in a list form.

ferent kinds of problems compared to the device-centered content adaptation. In this case the problem is often not the network bandwidth but rather the *cognitive bandwidth*. The unique properties of the digital medium also play a much larger role in user-centered content adaptation by providing the opportunity for the development of new cognitive tools for knowledge sharing and discovery. For example, the potential of the digital medium to log all of the interactions that take place in it can be used for a qualitatively different level of the *preservation of the past*. In the following section I will briefly outline different user populations and possible strategies for re-purposing the content to suit their needs.

Adapting content for use by different age groups (from preliterate children to adults) has traditionally been resolved by creating a new genre; for example, children's books, movies etc. This approach has been implemented successfully on the Web on the NASA space mission sites that have sections designed for K-12 children. Ideally, the content should be made adaptable for different age groups (children, adults) by creating an interface mechanism that would enable the user to fine-tune the level of complexity of the displayed content.

The content should also be made available to fit a user's interest and immediate goals. Relative failure of algorithm-based search engines to satisfy user needs indicates that this challenge has not been satisfactorily resolved. More successful Web portals, like Yahoo, owe their success to the fact that segmenting of the content to fit different users' interests has been done by humans. However, recent advances of "data mining" techniques (also known as "knowledge discovery in databases" - KDD) hold promise that in very near future one will be able to "build knowledge" by searching vast amounts of text available on the World Wide Web or be able to search through video materials in the same way one searches text today. Other examples of making the content of other media (TV) more adaptive by transferring it into the digital form include ReplayTV and TIVo, devices which allow users automated recording and replay of preferred shows (and even learn from viewing behavior), slow motion replay, pause and resume of live TV broadcast.

On the side of content providers, re-purposing is necessary for achieving different goals. The same content has to be presented and interacted with in a different way depending whether it is going to be used for teaching/learning, information, or as a data base. This idea is still in its infancy, although some large content providers (NASA, NY Times, as well as some museum sites) are making an effort to present part of their content in form suitable for use in education.

Re-purposing of content should also address the issues involving different cultural expectations. Currently, English language and Western cultural models dominate the World Wide Web. Issues of culture-specific content delivery have potential broad economic implications, and there are already some services that provide automatic translations of Web pages into different languages (AltaVista). However, the quality of automatic translation is severely limited, and commercial Web sites catering to users belonging to different cultures resorted to the creation of multiple, human translated and acculturated mirror sites.

Adaptation of content for users with special needs is a large and looming issue that has not been satisfactorily resolved. It is worth noting that answering the needs of these populations has historically been the path to improvement in general usability or led to the introduction of appliances with global impact (like the telephone, tape recorder, etc.). Technologies like continuous speech recognition, screen readers and haptic-enabled interaction devices (like the iFeelä mouse) will play a major role in this area.

Convergence

The term convergence has several meanings (Merriam-Webster), of which two are especially applicable to the topic of this paper:

1. the act of converging and especially moving toward union or uniformity;

2. independent development of similar characters (as of bodily structure or cultural traits) often associated with similarity of habits or environment

The two above definitions illustrate both the problems and the state of affairs in the arena of digital convergence. Wireless telephones, PCs, television and various other Internet appliances are competing with each other in taking each other's function. One can get the weather report on the display of mobile phone, watch TV on a computer screen, and interactively shop over TV. This, in itself, can only benefit the end user if there is true uniformity between the platforms. However, this is not the case. The number of competing standards and architectures is staggering.

There are three major aspects of digital convergence (Forman and Saint John, 2000):

- convergence of content (audio, video and data);
- convergence of platforms (PC, TV, Internet appliances, game machines);
- convergence of distribution (how the content gets to a user)

What is evident today is the user-demand-driven convergence of content — the use of re-writable CD ROMs is increasing because of the possibility of storing large amounts of digital data that are common household items - like digital photographs, music files in MP3 format, multimedia presentations, etc. That the trend is going in this direction is also evident from the fact that DVD players/recorders (which can store even larger amounts of data) are the most successful electronic product in recent years.

Convergence of delivery platforms is a much thornier issue that has not even been resolved for the shift from analog to digital television. We are witnessing a kind of parallel evolution similar to the second definition of convergence quoted above: different platforms are developing similar characteristics, and the 'selection forces' are user preferences and the characteristics of the medium itself.

The questions of delivery of digital content are also far from being resolved. Whether the content will reach us via fiber-optic cable, broadcast or satellite is not clear. Although it may seem that the questions of the delivery method are irrelevant, for the end user they have enormous implications for the future of power and control over the media.

Design Implications

While it may seem pointless to speak about interface design in light of chaos and unresolved issues in the domain of digital convergence (further complicated by lack of clarity regarding the characteristics of the digital medium), there are some general design guidelines that seem evident. In simple terms, the design has to be device-aware and user-aware. This means that the content has to be *scalable* (useable with devices with different display characteristics, storage space, processor power) and adaptive (useable by users of different abilities, goals,

backgrounds and cultures). Use of intelligent algorithms and adoption of common hardware standards can resolve scalability of the content. Creation of truly adaptive content is still a huge challenge and currently can be resolved only by human effort in creating adequate redundant content representations that suit different needs. On the other hand, adaptive delivery of content (and 'awareness' of user actions) is part of the digital medium potential, and will eventually determine the ways in which the medium is used.

Ultimately, delivery in the digital medium (and use of the term digital medium) will include any end-user delivery method where the content, at some point, was encoded in binary form in order to use some of the advantages of the digital medium (for example, reproducibility). This would include a printed page (from a printer), or an email message retrieved with a mobile phone via text-to-speech software.

Theoretically, the need for re-purposing should disappear if the medium is used to its potential: that is, the delivery of practically limitless accumulated content becomes infinitely adaptive (and user adaptable) to meet any individual's need, knowledge level or cultural background. Of course, we are far from this ideal, and in the meantime, we still have to develop efficient ways of inter- and intra-medium repurposing of content.

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New Content New Uses

A New Way of Making Cultural Information Resources Visible on the Web: Museums and the Open Archives Initiative

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Abstract

Museums hold enormous amounts of information in collections management systems and publish academic and scholarly research in print journals, exhibition catalogues, virtual museum presentations, and community publications. Much of this rich content is unavailable to web search engines or otherwise gets lost in the vastness of the World Wide Web. The Open Archives Initiative (OAI) has developed an easily implemented protocol to enable data providers to expose their information and service providers to access and use it. The CIMI Consortium is working with the OAI to make it possible for museums to enhance the availability of their research resources, allowing them to be discovered in Web-space by the specialist audiences for which they are intended or by service providers who collect, distribute or in other ways provide access. By building on the OAI protocol, Dublin Core, and museum community XML developments, significant advancements can be made in exposing museum information resources. This paper introduces the OAI and its protocol, explores its potential relevance to museums, presents CIMI's work as an alpha tester of OAI, and looks ahead to future developments.

Introduction

The ubiquity of the Web and success of popular search engines have fueled an expectation for quick, easy, and successful results in the quest for information and knowledge. Increasingly, scholars, students and other explorers are turning to the Web for their research needs and relying less often on traditional research sources. Museums have immensely rich information resources in publications, research papers, exhibition catalogues, virtual museums, databases, and intranets, but access to much information of value about the kinds of materials museums hold is rarely available through web search engines. Internet search engines only reach static HTML web pages, but much of what museums have is opaque to the indexers because it is in databases, dynamically generated, or in some other non-HTML form. These resources constitute what is becoming known as the hidden Web, estimated to contain 400-550 times more content than the commonly defined Web. (BrightPlanet 2001)

If this problem alone were solved and all the hidden web resources were suddenly available for indexing, the difficulty of finding reliable, useful, precise information would be seriously compounded, not alleviated. One way to address this is through collecting and indexing metadata records, rather than indexing the entire contents of HTML pages, thereby providing greater possibilities for precision. This is essentially the traditional library approach of creating descriptive metadata and building union catalogues. However, library catalogues are expensive to maintain and in the Web world, both difficult to find and hard to search across.

As separate approaches, it seems neither the old library methods nor the new Internet approach is serving researchers and scholars particularly well. (CLIR 2001)

A particularly promising solution is to explore the utility of combining the best of traditional library and museum techniques, such as creating descriptive metadata records in catalogues, with the best of new Internet techniques like large scale, machine harvesting of information. It is possible to consider this because of new developments in Web workable technical protocols, the uptake of XML as a way to package and transfer information, and the development of international standards for describing museum metadata content.

The Open Archives Initiative

The Open Archives Initiative, OAI, (http://www.openarchives.org) develops and promotes technical protocols and standards, collectively called the OAI technical framework, to facilitate access to

scholarly research information on the Web. It is based on the premise that a simple, easily implemented technical framework can allow holders of information to create repositories of metadata describing their resources that in turn can be harvested and made available for further processing or use. (OAI Protocol 2001)

The OAI technical framework describes how *repositories* of metadata about information resources are constructed. Repositories are essentially network accessible servers offered by data providers. A repository makes available via a simple protocol *records* that contain metadata about its items (content). A repository may, optionally, organize its items into sets corresponding to its collections or other groups, thus allowing clients to harvest metadata records selectively.

A *record* is an XML encoded byte-stream that serves as a packaging mechanism for harvested metadata. The OAI protocol mandates the use of unqualified Dublin Core as the common record for discovery. (Dublin Core 2001) It also allows community-specific metadata sets described by XML SCHEMAS for more detailed description based on the assertion that both simple metadata for interoperability and cross-domain discovery as well as a method for conveying richer community-specific descriptions are needed.

All OAI repositories must recognize a set of requests or *verbs* carried in http POST or Get methods that allow access to the metadata records. It is through these commands that metadata is harvested and transferred.

One design criteria of the OAI technical framework of particular relevance to individual communities such as the museum community is the notion of *extension packages*. Not only does the protocol allow a community to expose its own metadata schema, but it also allows other extensions such as unique collection level metadata or, if deemed necessary, rights metadata. The OAI protocol doesn't place limits on the number of allowable metadata sets, but does specify that their data formats be describable by an XML Schema.

In order to federate distributed repositories, the OAI has established a registry service available through the OAI web page to provide a list of publicly available repositories and to provide a mechanism for conformance testing. (OAI Registry 2001)

The potential of OAI technical framework is in providing the enabling technology for the federating of distributed information resources and their discovery and use. The power of the OAI technical framework is in its simplicity and ease of implementation.

Describing Information Resources for Discovery: Dublin Core and XML

While the OAI protocol defines new technical standards for repositories and the machine-to-machine dialogue between data providers and harvesters, it draws on the established international standard Dublin Core for the mandatory metadata record format. (Dublin Core 2001) The Dublin Core metadata set was developed specifically to allow a simple and easy-to-use description of information resources for their discovery. The utility of Dublin Core was corroborated by CIMI in its Dublin Core Metadata Testbed that explored the use of unqualified Dublin Core for discovery of museum resources, both at a coarse grain level and at a more detailed, complex level. At the higher, coarse grain level, the Dublin Core is effective both for discovery of resources and as a means for museums to interoperate with other communities in a networked environment such as the World Wide Web. (CIMI 1999a)

To go beyond simple discovery and interoperation, the OAI anticipated, through inclusion of the *extension packages* concept, that in addition to a core metadata format, individual communities of implementers would require additional descriptive formats. Again, this need was borne out in the CIMI Dublin Core testbed findings where it was concluded that extending the Dublin Core to handle community-specific needs was problematic. (CIMI 1999a)

Alternatives need to be found to extending or qualifying Dublin Core to facilitate the more complete descriptions needed by the museum community. The OAI addresses this by allowing support for parallel metadata sets. For museums, this could conceivably include record structures such as SPECTRUM (rich

museum object information), CIMI (public access), AMICO (art museum images), MIDIS (monuments and built environment), OBJECT ID (loss and theft), and RLG Inc.'s CMI (Cultural materials).

The challenge is that each community of OAI implementers must agree on what metadata formats are needed beyond the core, and must provide XML SCHEMAS for each of them. Once this is accomplished, the metadata foundations will be in place for use of the OAI protocol.

Early in the development of the OAI, CIMI recognized it had a number of features that could help significantly advance access to museum information. First and perhaps most importantly, the OAI protocol was simple and appeared to be easy to implement using tools and skills (Webservers, http, JAVA, PERL, CGI etc.) within the easy reach of museums. Secondly, it relied on the Dublin Core as a metadata format for the simple discovery of information resources within and between communities. This format was proven workable for museums, and there exists a guide to best practice for its use. (CIMI 1999b) Finally, the OAI mandated XML for packaging richer metadata sets and transferring records. XML is a standard that is gaining wide acceptance in museums, and XML SCHEMAS exist or are in the process of being created for many of the community standards mentioned above.

CIMI's test of OAI V.1.0

Because of the perceived potential of OAI for museums, CIMI participated as a pre-release tester of the OAI protocol. (OAI Alpha Test 2001) As part of the test, we built a generic OAI-compliant repository. (CIMI OAI Repository 2001). The repository architecture shown in Figure 1 uses a layered approach, standardized APIs, a generic http interface, and interchangeable components. This allows implementers the use of different back-end databases, webservers, or XML generators and minimizes hard-wired coding.

The repository took a skilled JAVA programmer two weeks elapsed time to build. This period included both an orientation to CIMI and the OAI as well as reading and understanding the protocol, and then building the application. The development process started with designing a JAVA API for the repository and a JAVA servlet to interface between http/OAI protocol layers and the repository. The reference repository was written using MySQL and JDBC.

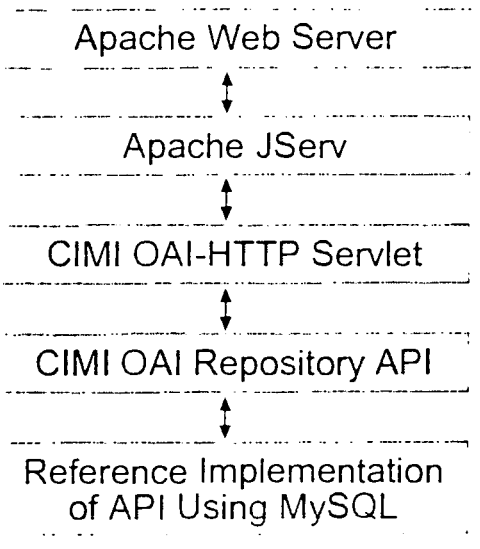

Figure 1: CIMI OAI Repository Layered Architecture

The CIMI reference application serves Dublin Core records from an Apache Webserver generated by the earlier CIMI testbed from the MySQL database. Because of the modularity inherent in the architecture, the Repository could be layered on top of any ODBC-compliant database, be served from other servers, and make use of different XML generators.

Looking Ahead

The initial evaluation demonstrated that the OAI protocol is indeed simple to build. CIMI has limited technical resources and skills but was nonetheless able to successfully build an OAI repository that appears to be useful. Based on the positive experience as an alpha implementer, CIMI plans to continue explorations of the OAI protocol and research its use by museums.

One way is by making the code for the CIMI repository and its associated explanatory materials available for downloading from the CIMI Website. (CIMI Publications 2001) We hope museums will take advantage of its availability to install, experi-

ment with and use the protocol. We hope to compile and report the experiences of these *ad hoc* tests.

CIMI is also interested in conducting a more formal, large-scale test of the OAI for museums as a CIMI testbed. As part of this work, we propose using OAI V.1.x in combination with scoped extensions and other applications necessary for aggregation processes (e.g. editorial control, content management and enhancement, registry) to harvest and collect museum metadata from cultural memory organizations. It will focus on materials that document culture and civilizations, including museum objects, art, images, and related materials. We will structure this as a CIMI testbed, inviting participation from a group of interested members. We expect respondents to include national museum organizations, individual museums, commercial enterprises, and museum system vendors. Once underway, the project will run 12-18 months in concert with projects in other communities and the OAI test period.

The purpose of the research is to explore how a specific community of users can use the OAI protocol. Part of this is to investigate what agreements users need to make within the protocol framework itself (e.g. additional metadata sets), and part is to identify any extensions or modification required to make the framework additionally useful. Our testbed will give museums a place to expose their metadata and promote their institutions, test the OAI protocol for utility in describing non-bibliographic resources, and could provide a rich resource of cultural metadata leading eventually to the materials themselves and the institutions offering them.

It is one thing to test the technical viability of the OAI protocol by implementing the protocol at a technical level, but another to imagine and determine useful services that might be built on it. We have imagined a number of scenarios that could be tested.

We imagine, for example, that services like AMOL (Australian Museums Online), AMICO, the Canadian Digital Museum, or RLG Inc.'s Cultural Materials Initiative might want to add a feature to "search for more like this" in collections or repositories not under their direct control. We imagine that individual museums or groups of museums all using the same collections management system might make use of the repository for internal operational needs, for scholarly access, as well as for supplementing information services they provide publicly. We imagine that commercial services such as AskArt (http://www.askart.com) - a directory of American Artists - or Virtualology (http://www.virtualology.com) - a virtual education project - would find the resource attractive and useful. We imagine that an easy-to-use protocol might be attractive to sales and auction houses, encouraging them to make useful research information resources available (such as those now manually compiled). We expect national service providers like the UK JISC higher education information services to have an interest in using museum repositories. We know that the operators of the new Internet top-level-domain for museums (MusDoma) are extremely interested in providing directory-like services that would include search access to our harvested cultural materials metadata. We also imagine that harvesting exhibition catalogues and museum publications from library catalogues, artist biographies, museological literature from A&I services, and sales records from auction houses is of interest to museum researchers. These all are the kinds of services that might emerge once the OAI is widely deployed in the museum community.

Regardless of the services developed, there will be a number of issues relating to widespread adoption of the OAI protocol in the museum community. We foresee a need for our community to test hypotheses, assertions, and issues such as:

- the utility of the Dublin Core for meeting information requirements of service providers and consumers;
- the functionality of the OAI protocol as a basis for a harvesting service, including issues of hierarchical descriptions, scalability, required extensions, presentation and partitioning;
- community extensions required for the OAI and DC in order to provide useful metadata within and between communities;
- requirements and practices for content management, metadata enhancement, and editorial control

- aggregation, integration, access and presentation of bibliographic, textual, multiple media, and object metadata
- the need, scope and services of a registry
- access control and rights
- mechanisms, processes for paths to underlying content
- business model for sustainability

Conclusion

Both CIMI and many of our members have significant experience in the metadata harvesting business. It is this experience that motivates us to explore the OAI protocol as an enabling technology to facilitate access to resources by making it easier for museums to expose and collect metadata. The OAI protocol in concert with a museum testbed seems a logical and sensible research initiative that will bring us closer to making the rich information resources museums hold more widely available to researchers and other users.

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Using Interactive Broadband Multicasting in a Museum Lifelong Learning Program

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Abstract

The Cleveland Museum of Art has embarked on an innovative approach for delivering high quality video-on-demand and live interactive cultural programming, along with Web-based complementary material, to seniors in assisted living residence facilities, community-based centers, and disabled persons in their homes. The project is made possible in part by a grant from the Technology Opportunity Program [TOP], National Telecommunications and Information Administration, U.S. Department of Commerce totaling more than $500,000. The purpose of the grant is to demonstrate how emerging broadband telecommunications technology can deliver "lifelong learning and the arts" to populations for whom direct involvement with cultural institutions would otherwise not be possible.

The approach uses Cisco IP/TV interactive video archive/broadcast servers and broadband multicast technology in a controlled public infrastructure environment, rather than the closed corporate or campus network environment for which it was designed. In addition to describing the program design and operation, this paper analyzes how this Museum, whose core competency is not, nor should be, advanced technology development and management, mustered the expertise to achieve technological innovation in pursuit of programmatic goals. It also focuses on the process of convening outside individuals, organizations, and expertise to complement each other to achieve a common goal.

Introduction

Be forewarned! You are about to read a tale of great technological, social, and educational aspiration. Of community groups, corporate interests and federal funding. Of populations isolated and impaired. Of external evaluation and intradepartmental coordination. It is a work in progress about which the known facts are provided and our hopes for the future are unveiled.

This paper presents an innovative approach for using broadband multicast technology to deliver high quality video-on-demand and live interactive cultural programming, complemented by Web-based resources, to seniors in assisted-living residence facilities, community-based centers, and disabled persons in their homes. But that is a rather cold description. We want to change people's lives through continuing lifelong learning and the arts and interaction with each other. We strive for no less than arousal of the spirit, though we will define our goals a bit less spiritedly later on. The technology we have chosen comprises the best tools we could find at this time, ones we believe harbinger the future. The combination of technology, program and process form an experiment which has been funded. No doubt the details of technology will change dramatically over time, but we hope that the process and program model we are presenting will survive, evolve and prove useful to others.

Background

To understand the genesis of the program, it is important to understand its host's core values and experience. The Cleveland Museum of Art, established in 1916, is one of the finest encyclopedic art museums in the United States and is an integral part of Cleveland's cultural and civic identity. As an institution established "for the benefit of all the people forever," the Museum welcomes close to 600,000 visitors each year. The Museum also has a long history of extensive public programming in film, music, and dance as well as art-related classes, lectures and family programs. In addition, the Museum has strong relationships with the community and community groups through a range of outreach programs and community festivals as well as its teachers school services, and adult continuing education programs. Most recently, in 1998, the Museum became a content provider and remote site for the Ohio SchoolNet Program. Ohio SchoolNet provides live interactive distance learning programs for students in grades K-12 throughout the state (http://www.osn.state.oh.us). This is all no quirk of fate. The Board of Trustees had long established the Museum's strategic goal of creating "rich and diverse educational and public programs that serve and engage many different audiences and communities in an innovative and dynamic fashion."

In addition to its education context, the emerging role of technology within all areas of the Museum was recognized by the Board. This resulted in another important strategic goal: "to become a national leader in the use of new and emerging technologies to enhance the value to society of the museum's collections, intellectual initiatives, and other activities." To accelerate progress in this area, in 1999 the Museum established a new Information Technology Division (I.T.), headed by a Chief Information Officer (CIO) on peer level with other senior management and reporting to the Museum director. The new CIO (the author) immediately established a guiding doctrine for technological leadership and adventurism: "The core competency of a museum is not the mastery of diverse, complex technologies... it is the creative use of them." There is no contradiction here. It is quite possible for a Museum to achieve its techno-dreams without insisting that it find the capital and human resources necessary to become the be-all end-all of complex technology knowledge and management. This principle will be echoed throughout this project plan.

This backdrop is important. Without a history of community involvement, strong educational programs, and a dedication to the use of new and evolving technologies, it is unlikely that the Museum would ever have conceived of this project nor received the funding and other support needed to make it happen.

(Technology) Opportunity (Program) Knocks

In the fall of 1999, the Museum became aware of the availability of funds for 2000 from the Technology Opportunities Program (TOP) of the National Telecommunications and Information Administration of the U.S. Department of Commerce. Since 1994, this has been a highly competitive, merit-based federal grant program that brings the benefits of an advanced national information infrastructure to communities throughout the United States (http://www.ntia.doc.gov/otiahome/top). The focus of its funding may vary from year to year, but for FY2000 the intent could not have been more congruent with the Museum's interests. TOP was "especially interested in projects...using advanced network technologies...for example, broadband networks... to deliver immense amounts of data quickly to the desktop." In addition, the notice identified "Lifelong Learning and the Arts" as an area of interest, particularly "training and instruction to lifelong learners in non-traditional settings such as homes (and) community centers." With this scope defined, we proceeded to explore whether there was a program the Museum would want to develop which would further its goals. However, it is not our nature to contort our goals in order to "follow the money."

Lurching Toward the Bait

As would be expected, there was significant brainstorming within the Museum, including staff and leaders from Information Technology, Development, Education, Curatorial, and Community Outreach. We had many answers and ideas, but finally realized that the truth lay not in ourselves but in our stars... our friends and colleagues in the community. We held a technology/program brainstorming party. Colleagues from SchoolNet, from schools, and from nearby cultural organizations converged. Representatives of Community groups aggregated. Technology companies whose help might be needed in specification and installation were there to keep our feet nailed to the ground. (Luckily, we still could reach for the sky.) Curious curators convened. The public TV station was tuned in and got turned on. You could not have too many cooks in this kitchen. After two hours of guided discussion a general consensus seemed to evolve. We would focus on isolated older persons in residential facilities or those who frequented community centers, and, if possible, disabled persons who primarily spend their time at home. We would provide both programming on demand and live interactive programs where they live or congregate. It felt right and meshed with Museum goals. However, more precise goals and next steps would have to be defined.

Before addressing those issues, it is noteworthy that this meeting, born of prior excellent relationships within the community, generated more than a concept. Our guests informed our thought process, and we made it clear that we were in this together. This setting of stage would prove invaluable as the project moved forward.

At this point, the project development process still had to answer several critical questions:

- What did we hope to achieve?
- Was there available technology which would let us demonstrate the conceived program at feasible cost and effort?
- Would residential facilities and community-based organizations commit to participating in this program?
- Where would we get the content, both live and archived, for this project?
- How could the Museum inaugurate this level of technology without diverting resources, or violating the precept of creatively using technologies without investing an inappropriate amount of time and effort in them?

Proof of Concept/Definition of Goal

Intuitively, it seemed reasonable to expect that older and impaired persons might benefit from interaction with cultural activities, but we needed to confirm our hunch. With the assistance of Malvin Schechter, a noted journalist, gerontologist, and consultant on issues of population and aging, important research findings were brought to our attention. Gerontological research seemed to assert that programs in the arts stimulate cognitive functions, enhance daily life experience, and trigger memories and creativity in older Americans. Research confirmed that being part of a social network and diminishing isolation and loneliness have significant impacts on health and longevity (Rowe & Kahn, 1997; Fees & Martin, 1999) . One study concluded that "interactive computing technology opens up access to levels of communication and personal control that impact directly on the quality of life for 'confined' individuals. Indeed, the term 'confined' loses much of its meaning when the world is at one's fingertips" (McConatha, McConatha & Dermigny, 1994).

The Museum also had its own experience in this area. For example, the museum has worked with the Cuyahoga County Board of Mental Retardation and its constituents for about three years in a studio art program..Work with this population has already resulted in dramatic changes in participants' lives. The simple artistic freedoms like choice of colors or how to position the paper have increased confidence in participants who have since attempted other personal achievements. Participants in this program are now showing their artworks in community exhibitions. One individual learned to climb stairs for the first time at the museum, while another spoke his name for the first time in his life.

We knew enough to know we were on the right track. Our program goal was then articulated as follows:

> To enrich the lives of seniors and disabled adults through excellent arts programming delivered to them where they live and congregate via broadband technology. Arts-related programs will be delivered to participants at three types of sites: assisted living residence facilities, community-based centers, and private homes. Older as well as physically and emotionally disabled adults will benefit from relevant and rewarding exchanges with cultural institutions through the new technologies proposed herein by making it possible for them, for the first time, to participate in a broad range of excellent programs from which they have been historically isolated.

Specifically, we would:

- Develop an art program that provides a mechanism for intellectually stimulating older adult learners;
- Develop an interactive, art-based program that facilitates social engagement among older adult learners;
- Develop a delivery medium which can reduce the social isolation often associated with living in senior care facilities; and
- Develop a replicable model that can be used by other cultural organization seeking to deliver comparable content to similar populations via broadband technologies.

Most important, our program would explore and demonstrate how learning makes more meaningful the lives of older persons or disabled persons for whom a visit to the conventional museum and cultural institutions and activities would be difficult, inconvenient or impossible. We would hope to learn how these extramural programs might stimulate such audiences to inquire and learn in satisfying ways. Additionally, we would develop a model and experience base that, by the nature of content and technology, is replicable throughout the country, especially as this technology becomes increasingly available.

The Future is Now: Selecting the Technology

The technological vision for the project now had to emerge alongside the more programmatic and content-oriented goals. The vision was to establish a multi-point "distance learning-like" environment with some level of interactivity, one which would include archived material, additional Web-like content and Web access. The technology should be more open, less complex and less expensive than traditional video teleconferencing. After all, this is the way Internet is going: more, richer content and greater interactivity through affordable access to a high-speed public infrastructure. Even if it is not there yet, our charge was to be innovative in our use of broadband technology and demonstrate what the future may be.

This presented three technical issues: how to capture, digitize, and compress video; how to develop and manage a video archive which can provide video on demand on line; and, how to achieve an infrastructure for getting the content from the source to the client.

A special work group was established to discover what existing technology might be right for us. This small group initially included Museum I.T. staff and a consultant from Keane, Inc., a major national I.T. consulting firm which was engaged in another Museum project. He agreed to contribute the assistance.

Some prospects were easy to rule out. Although we considered cobbling a variety of products and technologies together to accomplish our goal, we knew this would conflict with our "core competency doctrine" and hobble our chance for success. The best opportunity for Museum support and a successful implementation would be as close to a turnkey solution as possible. Environments such as those available from Real Networks or Microsoft NetMeeting and others were immediately ruled out. The nature of both content and clients would demand close to full screen video of near television quality. We wanted our clients to have warm, seemingly familiar experiences with both our technology and our content. After all, the program was not targeted toward highly self-motivated Internet users who would put up with quarter-screen jitters. Our content should be the reason for participating, and our technology should not get in the way.

We knew that we would require high-speed connections to our clients. We also realized that we were looking for an IP multicast solution, particularly for our live broadcasts. We decided that the increasing availability of ADSL (henceforth, DSL), with its emphasis on downstream speed, would be a feasible enabler (Craioveanu, 2000). We did not consider Internet access services through cable-TV providers, since this was not available in our area.

IP multicasting is defined as an "efficient means of transmitting of a single large stream of data to a group of selected users at the same time on a TCP/IP network such as the Internet" (http://www.techweb.com/encyclopedia). It is also fundamental to the evolution of the Internet as demand increases for better quality transmission of video and audio, and as transmissions become targeted toward groups rather than broadcast to all. IP multicast protocols have been under development since the early 1990's. Thus far they have been used primarily in corporate and academic environments where network traffic can be carefully engineered and monitored. We were aware of some public initiatives in this area, such as Mbone, since 1996 a cooperative and voluntary experimental virtual network within the Internet. This has been succeeded by other "bones," including 6bone and Qbone, and protocols, like the Internet itself, continue to evolve. But there is no current standard (Wirbel, 2000).

In addition to the protocol issues, IP multicast also requires a telecommunications infrastructure which is "multicast enabled." That is, it is comprised of rout-

ers and cabling which can handle the traffic demanded by rich media and which can also filter signals to allow clients to selectively receive transmission with a quality of service that would make the product palatable. (This is somewhat simplified, but sufficient for this purpose.) The current acceleration of commercial interest in IP Multicast is clearly evidenced by the IP Multicast Initiative, "a worldwide, multi-vendor forum accelerating the adoption of IP Multicast stimulating demand of IP Multicast products and related services" and significant source for articles, white papers, and conference information (http://www.ipmulticast.com). More than fifty companies now participate in this forum, including Cisco Systems, Real Networks, Yahoo Broadcast, and Lucent Technologies. There are even a number of national conferences each year focusing on this area. Although there may be some complex and costly workarounds, the public infrastructure was not ready yet for broadband IP multicast, even though we were.

Welcome to the Turnkey Multicasting System

Our product review brought us to Cisco Systems, Inc.'s IP/TV system. Cisco's IP/TV was chosen over other prospective solutions because it provides a more comprehensive set of features, in an end-to-end turnkey solution, than any other solution we could find (http://www.cisco.com). It comprises video capture with a choice of compression techniques, real-time broadcasting capability, video archiving, an Internet-based interface, and full router support at all points. As a tool designed for education and training applications within an academic or corporate environment, other features, including an interactive question manager and usage monitoring tools, would also add value. A true broadband multicast solution (when used within a network infrastucture supporting these features), IP/TV can provide very high quality full- or near full-screen video, something we had identified as a requirement. We also decided that the implementation of a turnkey solution by a single well-known vendor had the added advantage of one-stop training and support. If our program model of content delivery proved successful, new and more feature-rich products could simply replace the elements we had chosen. Finally, because we would use Cisco routers, Cisco could be held responsible for the system's performance truly end-to-end. This initial assessment was followed by a product demonstration and tutorial for our technology team at Cisco's Cleveland office, and additional telephone conferences with Cisco's IP/TV specialists. The agreement that our local Cisco sales and technical reps would join our technology team as needed, and that the regional office would provide training and technical assistance to help assure project success, clinched the decision.

The decision was later bolstered by an informative case description of an IP/TV project at the Virginia Community College System (http://www.so.cc.va.us/vccsit/IPTVproj.htm).

The planned configuration of the Cisco IP/TV system comprises the following components:

- *IP/TV 3411 Control Server* which centrally manages the entire IP/TV system. The Control Server communicates instructions, such as scheduling information, available video types, and bandwidth considerations to IP/TV Broadcast and Archive Servers, along with program information, to the IP/TV Viewer client software at the workstation. Its interface allows system administrators to manage content, servers, and bandwidth, and schedule broadcasts. It also balances network video loads and optimizes network performance automatically. This server can be fully controlled remotely from any, even low speed, IP-connected terminal.

- *IP/TV 3422/3423 Broadcast Servers* capture and digitize, store, and transmit programs according to directions received from the Cisco 3411 Control Server. They are primarily used for multicasting live or prerecorded programs from devices such as video cameras, VCRs, DVDs, satellite, or cable feeds, or from prerecorded Windows Media, AVI, MP3, and MPEG files. The Server must be located physically near the source devices, such as cameras, mixers, etc., to which they directly connect. The model differences pertain to the servers' digitization format capabilities.

- *IP/TV 3431 Archive Server* provides large-volume storage capacity for Video on Demand (VoD). It enables the appropriate stored video programs to be delivered at the right time, to the right audience, whether streaming prerecorded video on a

scheduled basis or responding to a singular request. This server can be fully controlled remotely from any, even low speed, IP-connected terminal.

- *IP/TV Viewer* is the IP/TV system client-side software, which communicates with the IP/TV 3411 Control Server to get information about all available programs and display a program listing. It allows participants to select and display programs, ask to receive a scheduled program, or choose to display a program on demand. (It informs the Control Server of what content is desired, and the control server then directs the content delivery from the Broadcast or Archive servers.) The Viewer can list both available IP/TV format and Windows Media programs and offers VCR-like controls, key word searches and program pre-scheduling. [Although IP/TV content could also be accessed via an html web page and Windows Media Player, this client is required in order to receive archived content stored in Cisco's proprietary RTP format (sort of an encapsulated MPEG-4). We will require the Viewer on all client stations in order to benefit from RTP's high quality video compared with the bandwidth needed to receive it].

The configuration of the equipment is described later and portrayed in Figure 1.

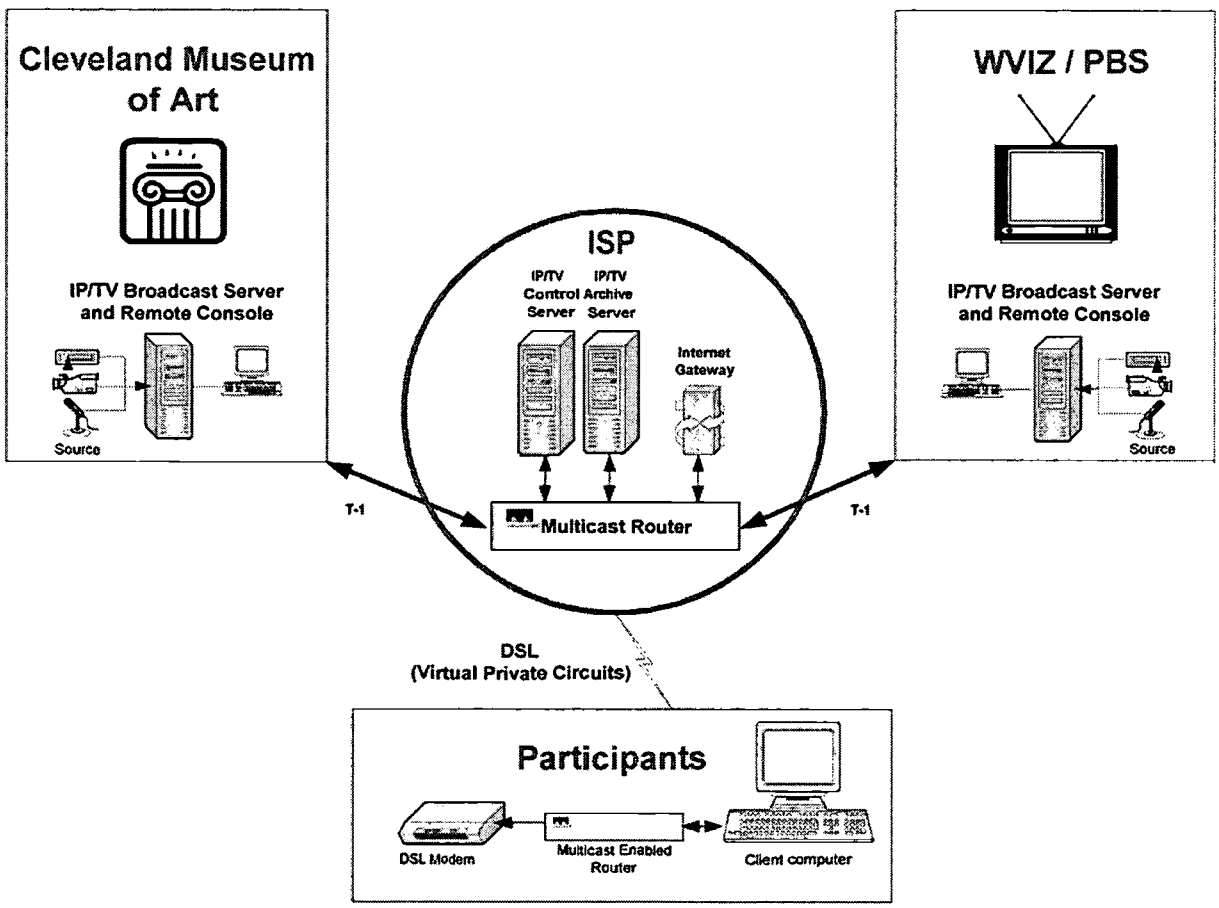

Figure 1: IP/TV Broadband Multicast Distribution Network

Supplemental Cisco software which should prove effective for providing, managing, and monitoring content development and delivery include:

- Web Presenter, which allows the opening of a video window and Web-based slides concurrently.

- Web Plug-in, which allows a participant to watch an IP/TV program embedded directly in a Web page.

- Question Manager, which provides a participants interactivity by letting participants type in questions on line. A moderator or instructor either answers the questions in real time or archives them for follow-up.

- Web Info, which allows participants, while watching a program, to click a button and travel to a predefined URL location, typically a Web page, containing additional program information.

- SlideCast, which permits participants to simultaneously see the presenter's PC-generated presentation materials in one window and the presenter in the other, as if they were in the same room.

- StreamWatch, which gathers participant demographics such as number of participating stations, identities, and viewing times for pre scheduled programs, and for on-demand programs logs information about which programs participants are watching and when.

Ticket to Ride

Having tentatively selected the product suite that should meet the video capture, storage, management and distribution requirements of the project, the network infrastructure on which this would ride had to be identified. As noted earlier, the public Internet is anything but ready for broadband multicast prime time. We enlisted the assistance of a local major ISP who recognized the benefits of early involvement with broadcast multiband. Their assistance was also encouraged by their ongoing relationship with the local Cisco office, not to mention the prestige and good will associated with assisting the Museum. This A-Team team, now comprised of representatives of Keane, Inc. (consulting), APKnet (ISP), Cisco Systems, Inc., and Museum technical staff, along with any additional ad hoc experts we could think of to call or e-mail, set to task. I love it when a plan comes together (Smith, 1983)... and it did!

The network infrastructure would work as follows:

- As a DSL reseller through local telephone providers with direct lines to their central offices, the ISP would create private virtual circuits between themselves and our clients (ISP-to-TelcoPoP-to-client])

- The DSL client lines at the ISP could be then be connected to a single high speed, broadband, multiprotocol, multimedia router (Cisco 7206VXR) with a highly secure, specially configured gateway connecting it to the public Internet.

- The IP/TV Control and Archive servers would be co-located at the ISP and connected directly to the high speed router to assure the fastest and most direct service delivery. Demanded video would travel directly from the ISP to the client via the virtual private circuit. The servers could be operated remotely from any site with an authorized IP connection, yet benefit from the power management and physical security inherent in a ISP facility.

- Live broadcasts would be compressed and fed by Broadcast servers "on location" to the Control servers at the ISP via dedicated T-1's terminated at the same high speed router; similarly, video-on-demand archival material could be loaded onto the archive/media servers at the ISP using the same Broadcast servers via the same T-1's.

- Client locations would require multicast enabled routers (Cisco 1720) in addition to the DSL modems specified by the provider of the DSL loop.

This configuration establishes a fundamentally closed system. The ISP, which acts as the hub, maintains end-to-end control of all emanating lines. The project relies on a private IP routing scheme for our client stations and media servers. Remote management access is also protected through access control lists that permit access only to devices with authorized IP addresses, in addition to correct passwords. The gateway to the Internet, also located at the ISP, pro-

vides network address translation, thereby masking the identity of the originating workstations and servers. In turn, the gateway is configured to provide anti-spoofing protection and a multi-layered and firewalled environment to assure a high level of overall security for components of our system. Similarly, filtering at the gateway prevents our high bandwidth content from spilling into and degrading service on the ISP's Internet backbone. Overall, thanks to an ISP with end-to-end connection control and willing to provide multicast broadband support for a small population, we expect to successfully emulate the Internet of the future.

Content Capture, Transmission and Display

While the fundamental infrastructure and core components of this project have been described, there are key ancillary devices and technologies worth noting, although elaboration exceeds the scope of this paper. For live transmission we will use MPEG-4 (http://www.cselt.it/mpeg/) with its high ratio of full-motion video quality to bandwidth and other features. For archival storage and video-on-demand we will use Cisco's RTP format, which is essentially encapsulated MPEG-4 requiring IP/TVViewer client software at the workstation. Content will be digitized locally using Broadcast Servers and downloaded/transmitted via T-1 to the Archive Server at the ISP hub.

Ancillary equipment associated with content production, distribution, and storage include video cameras, microphones, mixers, video editing system with special effects, video recorders, document cameras, slide-to-video projectors and others. Some of these were already available through our existing distance learning programs while others were acquired for this purpose.

Work stations at participant sites will be standard PC's with at least the equivalent of a PIII/600Mhz processor; the IP/TV Viewer uses the processor to decode MPEG-4 and RTP media. Also, 128 MB RAM will be provided. At this time we have not identified any specific video or audio requirements beyond the minimum generally provided with current model workstations. Where a personal residence is the location of participation, standard small speakers and a 17" monitor will be provided. For group facilities, a 36" RGB monitor, appropriate speakers, and wireless keyboard and mouse (if desired) will be provided, along with any special cart or cabinet requested.

Program Operation and Management: Partners, Partners, Partners

The technology plan described, although at the core of the project, is merely a facilitator of the program. The program needs content to distribute and participants to participate. If one concedes that the Museum has designed a program that qualifies as "creative use" of technology on behalf of the Museum's strategic goals, then there still remains the question of where the mastery of complex technology should reside. The answer is, with those whose core competency is technology. Similarly, although the Museum has extensive experience in educational programming within the scope of its expertise, there is more to Lifelong Learning and the Arts than a single institution can provide. Finally, we needed to identify and enlist community facilities and residents who would be willing to join our experiment and work toward its success.

To achieve this level of distributed responsibility, participation and interest, three spheres of "Partners" have been convened, many of whom had been at our initial brainstorming meeting: Content Partners, Community Partners, and Technology Partners.

Content Partners is a consortium comprised of the Museum and additional arts and cultural institutions, including the Cleveland Orchestra, one of the finest in the world; the Crawford Auto-Aviation Museum of the Western Reserve Historical Society, a repository for artifacts and archives related to the history of Ohio; and, WVIZ/PBS, the area's public broadcasting station and active producer of educational television programs. The number of content partners may grow as the program matures. The combined resources of these organizations will provide a broad and varied menu of programs in the areas of local history, visual arts, jazz and classical music, theater and the applied arts, as well as a range of thematic programs about general artistic, cultural and literary issues. We are projecting a minimum archive of 300 programs by the end of year two, in addition to a minimum of 12 live broadcasts offered monthly. These organizations receive no payment

for their contribution. It is noteworthy that TOP grant conditions unequivocally stipulate that funds may not be used to "produce information content," although it will support some "creation or conversion of content (in order) to utilize information infrastructure technologies to address real-world problems" (TOP Application Kit, 1999). For example, the program is funded to videotape an already planned lecture series, but cannot pay to create one. Content partner contributions of time and any direct expenses incurred on the project's behalf are recorded and considered in-kind match to the federal cash grant. The Museum's Education and Public Programs Division manages the Content Partners.

Community Partner organizations bring a diverse population to the program, including minorities and seniors, and those with varying levels of physical and mental abilities. Organizations include several assisted living community residential facilities; the Cuyahoga County Board of Mental Retardation's training center; and a college-based special educational program for persons age 50 and over. As the program matures, participation may change. The personal commitment of community partner staff is crucial to the success of the program. Community partners have committed the time and talents of their on-site staff to facilitate the use of the technology, to integrate the project into their ongoing program activities, and to create follow-up activities so that their clients can achieve the maximum benefit of this experiment. They have also agreed to encourage use of the system for video-on-demand and access to complementary Web resources. This includes making the equipment accessible to clients for independent as well as group use. The partners also agreed to take part in the evaluations, complete surveys and interviews, and send a representative to meet at least quarterly to discuss the program progress and recommend improvements. These organizations receive no payment for their contribution. Their contribution of staff time spent in activities, meetings or paperwork uniquely related to the project and any direct expenses incurred on the project's behalf are considered in-kind match to the federal cash grant. The Museum's Education and Public Programs Division manages the Community Partners.

Technology Partners comprises technology organizations whose core competencies are congruent with their projected roles. For example, APKnet, Inc., the major regional ISP referred to above, will provide end-to-end network management and connectivity services and support to our clients and content origination/management points; that is, the Museum and WVIZ/PBS. They will also co-locate the Archive and Control servers on their premises. WVIZ/PBS, the area's public television station, will remotely manage the Archive and Control servers, including video-on-demand sources and broadcast scheduling. With an IP/TV Broadcast server on their premises, they will also provide their studio as a live broadcast venue as well as download content to the archive. Cisco Systems, Inc.'s Cleveland office has committed to a special technical support effort and has contributed training to assure that the project works. Keane, Inc. will help monitor and evaluate the implementation. Museum Information Technology staff manage the implementation process, and will perform all remote site equipment set-up (except network connectivity devices), provide help desk support for the project, and develop a friendlier end-user interface than is provided with the IP/TV package. The vendor partners are participating on the basis of fee-for-service and/or contribution/discount of services. Contributed time and services from technology partners are accorded a value, which is considered in-kind match to the federal cash grant. The Information Technology Division manages the Technology Partners.

Project Evaluation

Intrinsic to any federally funded project, and vital regardless of auspice, is the ongoing and final formal evaluation of project process and outcome. We have divided the evaluation into two distinct components: technology implementation and program effectiveness.

In order to assess our technology implementation, Keane, Inc. will identify and document all technical implementation, training and support issues, problems and resolutions. This record should serve as an important source document for any organizations that would like to replicate in whole or part the technical program we are modeling. Our Keane representative has been involved with the project from our initial investigations and has an exceptional understanding of what we are trying to achieve. However, since identifying the core technologies,

Keane has not been involved in specification or implementation, thereby enabling an unbiased view of our process

In order to assess program effectiveness, we were fortunate to have enlisted the Institute for Innovative Learning, Inc., led by noted researcher John H. Falk. This non-profit research and evaluation organization specializes in "free choice" learning and arts-related programs and has extensive experience in evaluating Museum-based educational programs.. Formative and summative evaluations, based on integrated evaluation planning with all program partners, will encompass direct observations by evaluators, focussed and open-ended interviews, questionnaires for caregivers, and case studies as appropriate. Interim and final reports will assess the efficacy of our approach and promote the sharing of our experience. Ongoing informal feedback will help us navigate the program. This Institute's involvement began at the very onset of the program, even before our first formal *Partners* meetings were convened, and we believe that early involvement of evaluators is essential to the evaluation process

Budget and Staffing

The formal budget for this program is $1.2 million over a two-year period. Of this, $545,000 represents the Technology Opportunity Grant financial assistance award. The remainder is matched through the in-kind support of our Content, Technology, and Community Partners, and the Museum's dedication of time of existing management and staff, and direct expenses for some equipment and supplies. The federal contribution is primarily used for hardware, software, initial network configuration, and monthly telecommunications charges. Approximately 10% is applied to evaluation. Federal dollars also directly fund 1.5 full-time equivalent positions at the Museum: a full-time Project Coordinator acts as a liaison between Program and Content providers and the Museum's project managers, evaluators and others, performing a variety of functions to assure that the program runs smoothly and effectively. A half-time Education Assistant works with all content and community partners, including Museum staff, to modify or enhance prospective content to better meet the needs of older or impaired participants. A variety of staff from both the Information Technology and Education and Public Program Divisions are involved with this project as needed. The Museum's Informaton. Technology Division's Help Desk also serves as the project's help desk. The Director of Education and Public Programs is responsible for program content and working relationships with our community partners. The Chief Information Officer, who heads the Information Technology Division and is Project Director, is responsible for all aspects of technical implementation, , all budget management, reporting requirements, and program evaluation.

Current Project Status

The grant award was announced on October 1, 2000. As this paper is prepared in mid-February, 2001, following many planning meetings, much of the IP/TV equipment has arrived. Technical staffs at WVIZ/PBS and APKnet have been experimenting with demonstration units for several weeks. Museum technical staff received a briefing and started demonstrating IP/TV features to our Community and Content partners. This proved a significant energizer for the group, who could finally see what they were getting and know that it was for real.

The only big surprise is that there haven't been any big surprises. Telecommunications lines have also been ordered and are at the brink of hook-up but here, too, no surprise.... local DSL providers do not really know if DSL is available at a location until the time of installation. Although we "pre-qualified" community partner sites last year, as to whether they could be connected, that turned out to be meaningless. Possibly two of our participants may get T-1 connections until DSL is really available. Site visits have been made to all community facilities, in order to perform facility surveys for equipment selection and set-up, and to start getting to know residents and staff (the "joy" part).

Our community partners have already participated in the baseline stage of the program evaluation, which entailed the on-site collection of baseline data about how staff feel about the forthcoming program, and about the current state of social isolation, activity and relationship with the arts of prospective participants. Here the feedback from our evaluator has already proven invaluable.

First, our informal feedback was that our Community Partners' staffs were extremely enthusiastic about the project and were already identifying additional ways of using the technology before our first program even "airs." For example, it was suggested that we share special programs currently at one facility with another, or allow residents' talents to be displayed live from our studios. One facility which has a regularly scheduled discussion of social and political issues suggested that we open it up for multi-facility participation or view. We are now challenged to harness this energy and level of ownership which we never presumed to rely on, nor expected to achieve at start-up.

Second, we have discovered that facility staff are planning to target our programming toward persons who still maintain very active lives, and have strong longstanding interests in the arts and our cultural institutions. This may suggest that there is not much room for great improvements for these folk in life satisfaction from our "diminishment of social isolation" or "increased socialization" in this group (or maybe there is?). On the one hand, this population might actively help us evaluate the quality and effectiveness of our programming; on the other hand, this might preclude us from impacting on a more needy population, giving us no more than a short-term Pyrrhic victory. On the third hand, we do not want to dampen staff enthusiasm or set ourselves up for self-fulfilling failure either by second guessing their judgement or foisting our programs on participants before we have ironed out the kinks. For now, we believe we have elegantly solved this trilemma. We will enthusiastically beam our programming toward the audience of the facilities' choice, respond to their feedback and analyze our impact. As we become more experienced at content selection and delivery, and facility staff become more confident in their use of the technology and the success with their audience, we may urge that the audience be expanded to those thus far deprived of participation. We may even find that this occurs naturally over time without our intervention.

The relevance of this scenario is not so much the problems and issues it describes. More importantly, this story illuminates the critical importance of early independent evaluation of program progress, and thoughtfully deliberate intervention (or in this case lack thereof). Without the early warning, this may have become an urgent issue bordering on adversarial. Instead, we share an abundance of lemonade.

Content partners have also been meeting to develop our program schedule, and the wealth of ideas is breathtaking: a special live marimba and organ concert; our Art of the World appreciation course for adults, videotaped and parsed into small morsels and archived for demand, complemented by live follow-up conversation from the museum; an historian showing neighborhoods of yesterday and today to stir memories, emotions, and intellect; a Panorama of African American Theater from WVIZ/PBS. These are ideas and plans, and fodder for another paper. One challenge will be to develop the synergy of this program with the existing programs of the Content Partner institutions. Recalling that grant conditions unequivocally stipulate that funds may not be used for content development, it becomes all the more important to sense what existing programs may be most amenable to re-purposing for this program audience and technology. Another challenge will be to choose programs selectively and carefully, learning from those that have proven most and least effective and popular. Additionally, we may need to consciously differentiate or vary programming to best match differently skilled members of our target population. Learning from our success in art classes with impaired populations, we will probably include live and archived activity lessons, with guides for staff. Only one cloud hangs overhead; that is concern raised by some content partners that in their enthusiasm for our program goals, they may have underestimated the need for their institutions' unreimbursed commitment of time and resources. This may result in a need to attract more content partners, or our partners may find that their contributions are not so onerous after all.

As we continued to walk through and talk through this program, we recognized one more question to confront: Why should staff at our Community Partner facilities actually believe this could be significantly beneficial to their residents - more beneficial than TV or any other leisure activity? Staff attitude in fact might prove key to project success. To help establish insurance in this area, the Museum produced a day-long seminar, demonstration, and pizza lunch for all of our Partners (Technology, Commu-

nity, Content). We featured a special film and lecture presentation by gerontologist Mal Schechter, who had helped with our original research. Staff from the Cuyahoga Community Board of Mental Retardation and Developmental Disabilities demonstrated how technology benefits the lives of the people they serve. All of us focused on why we believe that this program is not just entertainment; it's life enhancing. A pre-kickoff rally. And it got rave reviews.

Conclusion

This paper has tried to present the evolution of a notion as it becomes an innovation. It has tried to relate the importance of matching an institution's persona to an almost far-fetched goal. It tries to make a case for developing sound inter-organizational relationships as a means of achieving projects that would otherwise be out of reach. And of course we are trying to demonstrate how advanced telecommunications may bring cultural organizations closer, and with more profound impact, into many more lives, in the not too distant future. If the process described seemed too well thought out, too much on an even keel, a piece of cake, then I may have abused my literary license. Guilty as charged on bypassing some of the bumps in the road; we are just too busy trying to catch sight of the potholes in the darkness ahead. But really, don't you just love it when a plan comes together!

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Streaming Audio and Video: New Challenges and Opportunities for Museums

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Abstract

Streaming audio and video present new challenges and opportunities for museums. Streaming media is easier to author and deliver to Internet audiences than ever before; digital video editing is commonplace now that the tools — computers. digital video cameras, and hard drives — are so affordable; the cost of serving video files across the Internet has also significantly decreased. The initial growth of the World Wide Web was driven by the ease of authoring Web pages. the affordability of the medium. and the potential to reach large audiences. The same conditions are now in place for streaming audio and video, and we're just beginning to see the widespread use of the technology.

The challenges and opportunities presented to museums today are similar to those that existed when the World Wide Web first became popular. Many questions raised are the same: Can this technology be used to expand the museum experience? Are there ways to take advantage of the "two-way" nature of the Internet? A few museums have already experimented with streaming media and some lessons have been learned. However, presentation methods and the technology itself continue to evolve. This paper shares experiences with streaming media (focusing on streaming video), and discusses some possible new directions for effective use of the medium within online museum environments.

Introduction

Ten years ago Apple Computers Inc. released QuickTime, a digital video and animation system. At about the same time the World Wide Web was developed at CERN in Switzerland. These technologies converged in 1995 when the first QuickTime movies appeared on the Web and when the first streaming media format (Real Network's RealAudio) was released. No longer an oddity on the Web, digital video has now become commonplace. Most digital video and audio now developed for the Web is in a "streaming" format, meaning that the entire file or large portions of the file don't need to be downloaded in order for the users to view or listen to its contents.

Streaming Media Drives the Internet

The growth and reach of streaming media continues to hit all-time highs. According to statistics (http://www.Nielsen-NetRatings.com), 35 million Web users accessed streaming content in November of 2000 from their homes. This represents a 65 % increase from November 1999. The same study found that streaming media increased to 36% among all Internet users. This figure compared to a reach of 28% of all Internet users the year before. A November 2000 study by MeasureCast (http://www.measurecast.com) and Harris Interactive (http://www.harrisinteractive.com) found these figures to be even higher, with 57% of online users found to be using streaming media weekly.

Citing ease of use, availability of content, and growth of bandwidth, a study by U.S. Bancorp Piper Jaffray (http://www.piperjaffray.com) suggests that streaming media will be the next "macro-growth driver" on the Internet. The growth of broadband has been well documented. According to Gartner Group's Dataquest Inc. (http://www.dataquest.com), six million US customers signed up for high-speed Internet access in 2000, bringing the total number of broadband users to 11 million. This represents about 9% of all US users. While this is a small percentage overall, it represents significant growth. Last year, according to the Computer Industry Almanac (http://www.c-i-a.com), the figure was a mere 3% of home users.

High-speed Internet access is not essential for streaming media but it does enhance the user's experience. As detailed in "Creating Online Experiences in Broadband Environments" (http://www.archimuse.com/mw2000/papers/spadaccini/spadaccini.html), users get more data throughput, which means better quality video, more frames-per-second, a larger image, better quality audio, and less "lossy" compression. Also, users with a broadband connection (56kbps or faster) are 50% more likely to access streaming media than users with slower

(56kbps or slower) connections, this according to Nielsen-NetRatings (http://www.Nielsen-NetRatings.com).

Easier and Cheaper All the Time

The tools for creating streaming media continue to get easier to use and cheaper to purchase. DV video gear, computers, and software are more affordable and easier to use. Many home users and students have begun making their own digital videos. The tools for shooting professional-looking digital video have never been cheaper. A $3,000 camera now has the same resolution that a $30,000 camera had just five years ago. Desktop video systems are commonplace. The success of the iMac and their free iMovie software is a good indication of this trend.

The tools for streaming video, server software in particular, continues to decline in price. This is due in part to competition between three companies: RealNetwork's RealMedia was the standard until in the last two or three years, Microsoft's Windows Media and Apple's streaming QuickTime entered the market. Microsoft's server software is now built into Windows 2000 and Apple's QuickTime Streaming Server is included in the Mac OS X Server. Both of these products cost less than $1,000.

In addition, the number of ISPs (Internet Service Providers) who offer streaming media services continues to expand. Bandwidth costs have declined and competition has eroded the cost of delivering streams to Web visitors. All of these trends take streaming media out of the experimental realm. Even with its limitations (small window size, poor video quality), streaming media is quickly becoming a viable way to reach Internet audiences.

Museum Visitors

Specific information about museum Web visitors is difficult to find since the medium is still so new. The only study examining connection speed and streaming media is "Who's Out There? A Pilot User Study of Educational Web Resources by the Science Learning Network (SLN)" (http://www.archimuse.com/mw2000/papers/semper/semper.html) found that "a significant percentage of visitors (14 to 22%) now have access at speeds faster than 56k." While this study used a small sampling—about 50,000 visitors over a one-month period—it did study three different Web sites: The Exploratorium, The Franklin Institute, and Science Museum (NMSI) in London.

About 22% of visitors accessed these museum resources from school and about 10% visited the sites from work environments. It's likely that a larger percentage of these visitors were accessing with high-speed connections. This might help explain the discrepancy between the broadband figures from the Gartner Group's Dataquest Inc. study, that found 9% of users connecting at 56kbps or greater, and the figures from the SLN Pilot User Study.

The SLN Pilot User Study also asked visitors whether they viewed one or more multimedia clips: 23% stated they did. While it's difficult to draw too many conclusions from this one figure taken from only three resources (and considering that only two of the three resources contained streaming media), it's at least an indication that a significant percentage of museum Web visitors were actively interacting with streaming media in 1999. So that from this somewhat limited data, one could infer that the number of Web visitors to museums who can access streaming media continues to grow (as it certainly has in the general Internet population).

Expanding the Museum Experience

The complex question of how to present streaming video remains. Obviously, the answers are subjective. Streaming media can be presented either live, or more commonly, on demand. Each type of streaming media requires different presentation methods to effectively reach Web audiences. On-demand video has offered much more variety, while most museum Webcasts have been presented in very straightforward ways, with the developers concentrating on the more complex technical and programmatic aspects of producing and delivering the live video stream.

On Demand

In early 1997, while working at the Exploratorium, the author developed a resource called "The Science of Hockey" (http://www.exploratorium.edu/hockey), the first in a series of sport science Websites developed over the next two years. Permission was granted to interview local professional hockey team, the San Jose Sharks. It was perfect timing as the

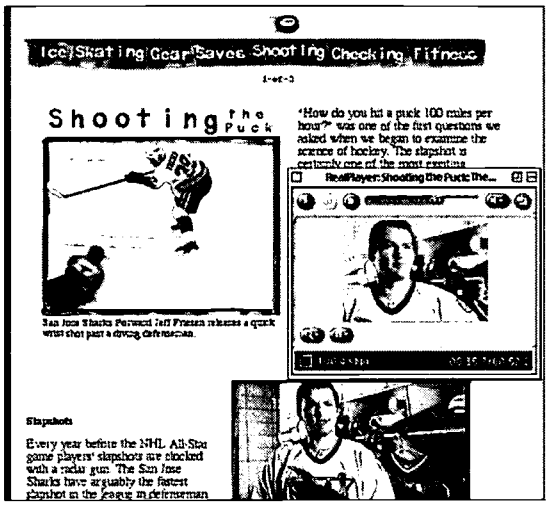

Figure 1. The Science of Hockey

first streaming video format, RealVideo, had just been released.

There was no question that the video had to be presented within the context of a text- and image-based site. This had little to do (in the thinking at the time) with creating a context for the video, but rather the reality that most users would not have the technical equipment to view the video. The clips that appear in the site were thought of as "bonus" materials, available to those who at the time were on the cutting edge of Internet technology.

The clips were short—from 45 seconds to about four minutes. From a technical standpoint, entire video interviews could have been presented; instead clips that matched the topics in each part of the site were created. The length of the video clips provided flexibility, allowing users to choose which clips they wanted to view and in what sequence.

In looking back, this formula worked fairly well. The reality was, and still is, that the Internet is primarily a text- and image-based medium and that Web sites can be explored in a non-linear fashion. This same formula was used for many resources on a variety of topics: "The Science of Baseball" (http://www.exploratorium.edu/baseball), "The Science of Cycling" (http://www.exploratorium.edu/cycling), "Sunspots" (http://www.exploratorium.edu/sunspots), "Frogs" (http://www.exploratorium.edu/frogs), and "The Faultline" (http://www.exploratorium.edu/faultline). These sites used text and graphics to tell the story, and video and other media to enhance it. This format provides end users with options: they can read the story, print it out, skim the text, look at the images, or just view the video clips. Most news organizations and variety of other content sites take similar approaches.

Recently Ideum helped create a site called "Robotics: Sensing, Thinking, Acting" (http://www.thethech.org/robotics) for the Tech Museum of Innovation. Four features were created for this site. Three of the four used streaming media, presented differently in each feature. In one section, video was used in much same way it was done in the Science of Hockey: an article with images, video, and other media used together to tell the story. For another section audio clips create a context for an interactive discussion area focusing on robotics and ethics. The "Robot Art" feature relies heavily on streaming video, to enable the artists themselves, and their work, to be the primary focus. The section contains streaming video interviews with the artists, images of their work, and QuickTime VR (360-degree panoramas) of the artists in their studios. The video clips are short, one to three minutes each, and the corresponding text briefly describes the subject of the clip. These clips, along with additional media resources, provide a variety of choices for the Web visitor.

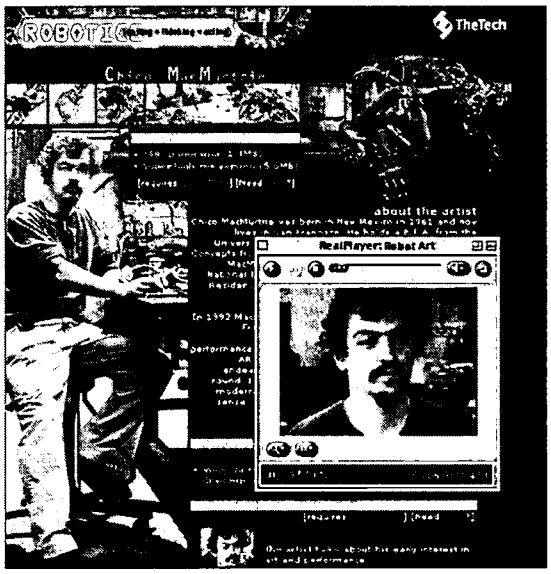

Figure 2. Robot Art

An excellent site that makes use of on-demand video is the "The Living Room Candidate" (www.ammi.org/livingroomcandidate). The site focuses primarily on political advertisements that ran during presidential campaigns from 1952 to 1996. The ads are presented as separate streaming video clips. Additional materials consist of a short introductory text, a larger program, an educational guide, and thumbnail images from the videos. The additional materials help explain and enhance the video, provide historical context, point out themes, and create a richer experience.

These examples use additional media elements to complement streaming video. In the case of "The Science of Hockey," for example, on-demand video is used within a text- and graphics-based story. The video is not required to tell the story. Whereas both "Robot Art" and "The Living Room Candidate" rely much more heavily on the user's ability to view streaming video. All the examples use short video clips that provide flexibility in what the user views, and in what sequence. Live Webcasts have not provided the end-user with this sort of flexibility until now. Nor has the addition of other media elements to Webcasting been focused on.

Live Webcasts

In most cases, video-on-demand is just one of a variety of media types used to tell a story. A Webcast, on the other hand, has been viewed as an end in itself. Many times little thought is given to how other media elements could enhance the Web user's experience. Considering the technical, organizational, and programmatic complexity involved in presenting live Webcasts it's not surprising. But despite the limitations of medium (poor video quality and the small window size), exploring other ways of improving the end-user's experience would seem to be the next logical step.

Live Webcasts can bring the museum floor to remote visitors or remote locations to the museum and Web visitors. At the Exploratorium, the author was involved, to one degree or another, in about two dozen Webcasts. To date, the Exploratorium has presented over fifty Webcasts.

The 1999 Eclipse Webcast (http://www.exploratorium.edu/eclipse) was easily the most popular Webcast (to both Web and museum audiences) the Exploratorium ever presented. The ingredients for success largely had to do with the structure of the program. First, it presented a unique phenomenon, a total solar eclipse. Second, it presented a live video signal from an exotic remote location, in this case, Turkey. Promotion efforts and media hype about the eclipse helped drive traffic to the site. The event itself was an excellent vehicle for exploring the science and history surrounding eclipses. On the museum floor, the "Webcast" studio and surrounding

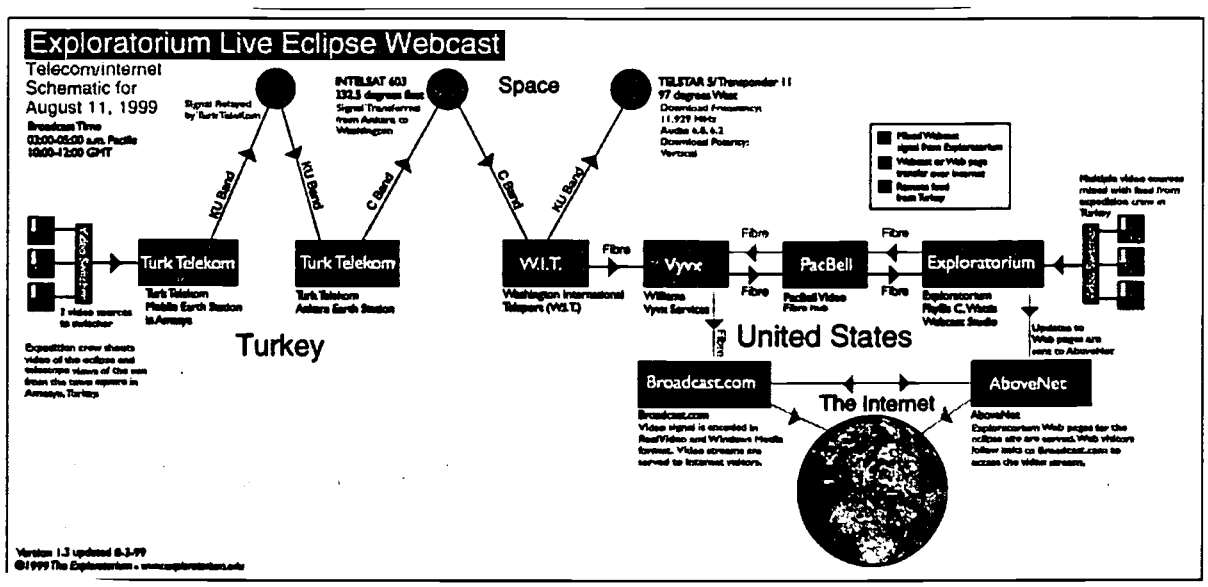

Figure 3. Exploratorium Eclipse Telecom/Internet Schematic. This schematic demonstrates the technical challenges involved in the most complex Webcasts.

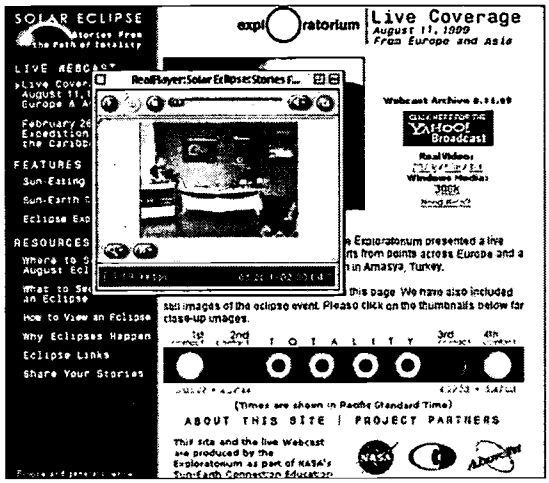

Figure 4. Solar Eclipse Page. The Exploratorium's Solar Eclipse Webcast page hosted by Yahoo! Broadcast.

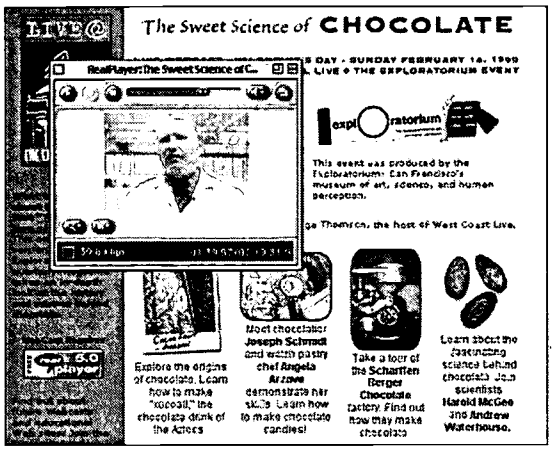

Figure 5. The Exploratorium's Sweet Science of Chocolate Webcast Page.

areas were packed with visitors who by all accounts greatly enjoyed the Webcast. On the Web, our visitors enjoyed the event, too, but the museum visitors a more universally favorable impression.

In 1999, the Exploratorium produced a Webcast on the *Science of Chocolate* (http://www.exploratorium.edu/chocolate) for Valentine's Day. The event was hugely popular on the museum floor. Well over 500 people visited and the museum sold a record number of museum memberships; but on the Web, the event was not as popular as anticipated. For obvious reasons, meeting scientists, pastry chefs, and chocolatiers, and getting to sample chocolate was much more appealing to museum visitors than to Web visitors. In addition, museum visitors seemed to enjoy the two-hour format, but Web visitors didn't stick around to watch the entire show. Similar criticism was offered from some Web visitors about the length of the Eclipse Webcast, which was also two hours in length.

Just how long a Webcast should be is a difficult question to answer. The average duration of a Web visit to the educational resources examined in "Who's Out There? A Pilot User Study of Educational Web Resources" was about eight minutes. Webcasting can hold visitors' attention for longer periods of time, but at the Exploratorium, the number of viewers frequently dropped off during the course of a broadcast.

Another factor is how people use their computers. Few people regularly use their computers to view lengthy movies or TV shows (even when they can fill the entire screen, which DVD players can do). Generally, computers are used in active ways, working, surfing, clicking around—it's a lot to ask of a viewer, to sit at a computer for two hours and just watch the screen, particularly when the size of the video window is so small.

Most Webcasts have worked very well as a museum event. Visitors to the museum floor can communicate with each other and with scientists or other guests; they can watch videos or demonstrations, and interact in other ways. If the presentation on the Web could somehow be more dynamic, perhaps by injecting other types of media, or by somehow involving users more actively in the Webcast, they might stick around longer and the experience might be richer. In other words, perhaps there is a way to replicate the qualities of the museum experience for remote Webcast viewers.

In retrospect, the "Webcast pages" for the Eclipse and Chocolate events could have been much more dynamic. Both pages work in the same way (and in fact, are similar to most other Exploratorium Webcast pages). The user clicks on a link launching an external player that shows the video. These pages took a great deal of time to develop, making sure that links to "help pages" were easy to find, linking

to other resources, and creating a "look and feel" that enhanced the presentation of the topic. The problem with the design is one of function rather than one of form.

Both sites contain images and text-based information that provide background information and create a context for the Webcast. Additional resources greatly add to the visitor's experience. They could generate anticipation for events yet to come, and provide some longevity to the sites, bringing visitors back well after the excitement of live events has dissipated. This approach was developed while experimenting with on-demand video.

Unfortunately, there was never the time to develop a method to allow visitors to browse these resources (or to "push" additional media types) during a live event. Here's what would happen: When a Webcast viewer wanted to explore these additional resources, their video window would disappear behind the browser window. These resources could be used before or after the event—but not during. Unlike sites that use on-demand video, you'll miss some of the live Webcast program if you try to view these additional materials.

Both the Eclipse event and the Sweet Science of Chocolate did allow users to email questions, which provided a limited feedback mechanism. A better method was chat areas, but again these were separate links that if clicked on sent the user's video window behind the browser window. For many visitors the Webcast experience was a solitary one, with no interaction with other visitors or with the producers or guests of the event.

The Webcast Viewer: A Possible Method For of Presenting Live Video

Most Webcasting examples work in similar ways to the Exploratorium Webcast pages. The focus has been primarily on the video stream itself. Rarely have museums experimented with two-way communication such as chat or messaging during Webcasts. Keeping in mind how most Web visitors seem to use their computers, I've given some thought to an alternative way of presenting museum Webcasts, one that would make additional materials available and that could incorporate user participation and interaction, all of this while not interrupting a continuous program stream.

Some streaming media service providers and Application Service Providers (ASPs) have or are in the process of developing custom interfaces for business presentations. For example, Presenter.com (http://www.presenter.com) uses a pop-up window that allows the user to view a video stream and slide presentation. Obviously, for business presen-

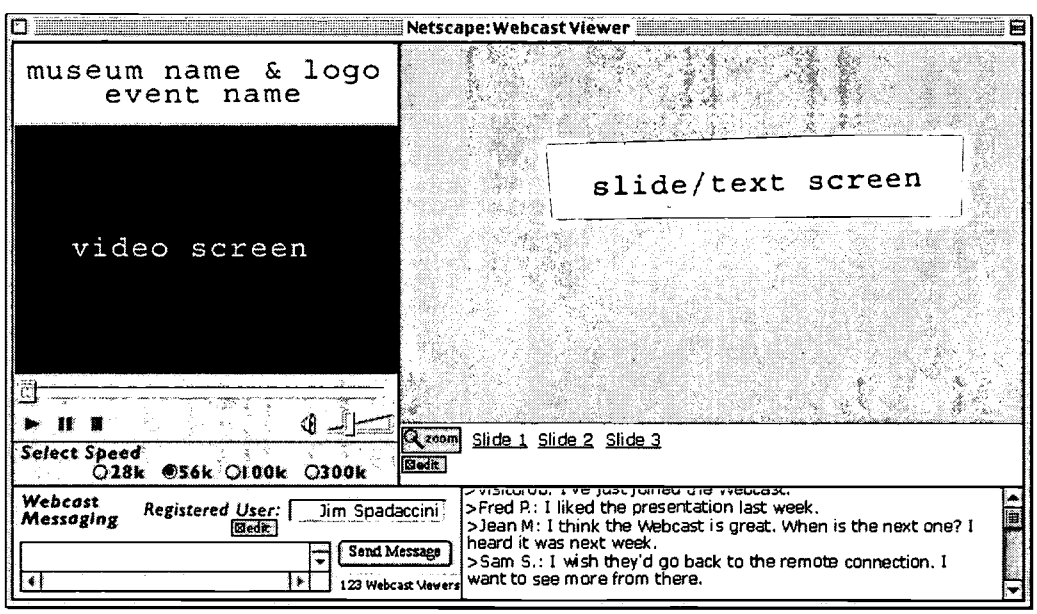

Figure 6. The "Webcast Viewer"

tations, this is a must. Certainly the addition of a similar feature could help enhance museum Webcasts for Internet audiences.

An interesting real-time messaging system called SPARC (Space Physics & Aeronomy Research Collaboratory (http://sparc-1.si.umich.edu/sparc/central/page/SPARC) deserves mention, too. It enables Web visitors to chat on a page in real-time. On the site, others who are visiting the page are visible, either as guests (with no chat abilities) or as registered users (with the ability to chat). This is similar to popular sites that use Java IRC.

Inspired by these interesting examples, the author has developed a mock-up of a proposed "Webcast Viewer." It incorporates the slide area and a messaging feature, along with an embedded video window into a pop-up browser window. Frames are used to present the different features within the window.

The embedded video screen can support a variety of connection speeds. The mock-up incorporates a Windows Media player, but RealMedia or QuickTime could be used instead.

There is an area for slides or text, a window that could support any HTML document. A scrolling feature could also be added. A "zoom" feature could be used to allow visitors to examine details of the materials presented. An "edit" feature would allow users to set preferences such as image types or sizes. Additional links (which appear as "Slide 1" etc.) could permit users to browse slides, or the slides could be "pushed" automatically as the Webcast proceeded. This could be done with a CGI (Common Gateway Interface) script, Javascript, or Java applet. Thumbnails of the images could also be used within the window.

The slide area could provide space for animations, or even applications. Obviously, this would require additional resources for development. Flash, Shockwave, or Java technology could be used. This route would require that the end-user have the proper browser or plug-ins to view or interact with the file, but it could certainly add a new dimension to a live Webcast. The real benefit of a slide area for museum presentations is that artwork or scientific charts could be shown at an adequate size for visitors to properly see the details.

The bottom of the figure contains a Webcast messaging frame that allows users to chat with other visitors and/or museum personnel. Registered users would have chat privileges while unregistered user could "lurk," that is, observe the chat without participating. The "edit" feature would allow users to change their names and/or other information. The chat area could be moderated, although registration would provide a degree of protection from unwanted graffiti.

The window would serve the important purpose of displaying the number of individuals who are tuned in to the Webcast. Currently, viewing is a solitary experience with no indication that others are watching or viewing the event with you. During small events visitors could chat and carry on conversations about the topics presented by Webcast. With large-scale events it would very difficult to carry a conversation, but viewers might be able to influence the direction of the Webcast with their comments, which also might be of interest to other online visitors.

Technical Issues

The technology exists to create a working version the Webcast Viewer presented. (It should be mentioned that this was not always the case. The "embedded" video screen was not well supported on some platforms and with some older versions of browsers.) The Webcast viewer simply combines a number of existing technologies in one pop-up browser window using frames.

The question of bandwidth is a tougher one to answer. Sending additional text and/or images may interrupt streams for some users connected at slower speeds. Webcast streams bit rates may need to be reduced to allow for more "overhead," insuring that the viewer could receive additional media without interrupting the continuous stream. In addition, the "edit" options for both the slide and message features could contain preferences to limit the size or the number of times the screens "refresh." Another approach might preload slides or images allowing users to store them locally before the Webcast begins.

The Archive

Most Webcasts are archived, leaving an on-demand clip usually of the entire presentation. With the Webcast Viewer, archives could be shown in much the same way the live broadcasts were. School groups or other organizations could visit the archive at the same time using the built-in messaging system to communicate during their visit.

Conclusion

Resources that are flexible and that give visitors choices in how they interact with streaming media seems to work best. Multiple media types provide the user with options on how to use the resource and work around the technical limitations that many users have in viewing streaming media. Webcasting is much more technically and programmatically complex than producing on-demand clips. While Webcast events have been very successful on the museum floor, informal feedback suggests that the experience on the Internet has been mixed.

On the floor, visitors can interact with each other and can watch a variety of demonstrations that are occasionally presented simultaneously. As a possible solution, the Webcast Viewer attempts to incorporate some of the features that make "in person" museum Webcast events so appealing, by creating a multimedia experience and providing the potential for user interaction. Some of these qualities are the same ones that seem to work in presenting on-demand video. The Webcast Viewer could present users with choices, making Webcasts more interactive and more compelling.

The reality is that, from a technical standpoint, streaming media is not going be "TV quality" any time soon. While the promise of broadband will eventually change the situation, it will be years before Webcasting can compete with television and even then it will not be universally implemented. Recognition of this went into thinking about how the Webcast Viewer might be designed. Incorporating additional media elements and some sort of a "two-way" mechanism will surely enrich the visitor experience. Otherwise the Internet is just a broadcast medium and not a very robust one at that.

The Webcast Viewer is that it could be used as a "turn-key" solution—used over and over again to support a variety of Webcasts and topics. ASPs like Presenter.com are trying to do just that, mostly for business applications. The design and technical specifications of the Webcast Viewer could be modified and improved after each broadcast.

Perhaps as more museums begin to experiment with Webcasting, new approaches will be developed. In the last two years, several museums have conducted Webcasts, among them the Canadian Museum of Civilization (www.civilization.ca/membrs/theatre/iqqaiple.html), the Franklin Institute (http://webevents.broadcast.com/unisys/fi042700/register.asp), the Denver Museum of Natural History (http://event.webcasts.com/dmnh2000/event.html), and the Cleveland Museum of Art (www.clevelandart.org/byzantine/webcast.htm). It will be exciting to see what the next few years will bring, as more museums venture into this arena.

The Webcast Viewer is just one way of visualizing what could be done to make Webcasting more appealing to museum Web visitors. Any method for delivering other types of media along with a video stream would help make the experience for online visitors more informative and more exciting. Taking advantage of the unique two-way nature of the Internet would help make Webcasts a more engaging, less solitary experience for remote museum visitors. The technical elements to make this possible are already out there. Perhaps it's time to begin the experiment.

Personalizing Web Experiences

Co-operation Metaphors for Virtual Museums

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Abstract

Cooperation Metaphors are sets of rules to support interaction and collaboration between users who want to explore complex content and information together. The rules determine how the collaborative community can be created and managed, how members of the community can operate on their own or can cooperate with other members. Different types of situations, tasks and user roles determine different behaviours and therefore need different metaphors. The paper will present the general issue, describing in general what cooperation metaphors are and how they can be defined. A number of examples, related to typical activities for virtual museums (i.e. museums on the Web) will be used in order to give a practical understanding of what cooperation is, or can be. The paper will also argue that virtual metaphors lack some of the features of real-life cooperation, but, on the other hand, can also offer unexpected, powerful and effective possibilities not available in (traditional) real-life. Finally, the paper will describe how collaborative activities for virtual museums can be implemented using today's tools and applications for collaboration on the Web; such as Net2gether, Microsoft Research's Virtual Worlds, and the WebTalk series.

Introduction and Motivations

In most cases, users today access the shared space represented by a web site in isolation, with little awareness, or no awareness at all, of what other users are doing "at the same time". In a truly cooperative environment, by contrast, different users try to accomplish something together, accessing the shared space simultaneously and trying to collaborate to reach their goal. Several different goals may be the subject of cooperation: teaching/learning, shopping, design, supervising and monitoring, consulting, etc. Several different behaviours are associated with the notion of cooperation, but we should distinguish between two extremes:

- the cooperating users are peers, with similar knowledge and similar powers.

- one or more of the users control the situation, with knowledge or powers superior to those of the others, as for example tutors with pupils, shop-clerks and shoppers, tourist guides and tourists, etc.

One basic observation informing our work is that in the real world most activities are performed, if possible, in cooperation. Cooperating while trying to accomplish something very often appears more interesting, more engaging, more amusing or simply more efficient,

This initial observation is coupled with the fact that virtual shared environments have existed for a number of years. Initially they were text-based (IRC-II, MUDs, MOOs), allowing users to exchange typed messages, but they have evolved (Blaxxun Community, Virtual Worlds) introducing 3D graphics, audio, and other advanced features. In these "virtual worlds", as they are usually called, users are represented by virtual objects, called "avatars"; users can "move around", cooperatively interact with the virtual world and its objects, "talk" each other, etc.

These worlds allow a great deal of interaction among users, but they lack some of the features that we feel are crucial for an effective collaborative visit to a Virtual Museum:

User interaction seems to be the goal, rather than the means to accomplish something. Users amuse themselves by interacting, but they are not trying to get any specific result out of their experience. Visitors to a Virtual Museum, on the other hand, share the goal of better understanding the content and the background of the museum.

The amount of information being exchanged among users, or being made available by the world, is relatively small and loosely organized. Sophisticated museum sites by contrast convey a large body of sometimes very difficult knowledge.

The cooperation is loose, in the sense that users are free to behave as they want, with few constraints or enforced patterns. Our experience, however,

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shows that cooperation must be organized and follow precise guidelines in order to be effective.

Based on this we have been working on the following ideas since 1998:

- Access to a complex museum Website can be made more interesting, engaging and efficient by allowing a certain degree of cooperation among the users accessing the site at the same time.

- The cooperation must follow well organized guidelines, in order to be effective at reaching a specific goal (it could be learning, or shopping, etc.).

- A 3D virtual world, with avatars representing users "being there", can be an interesting space for an efficient and engaging cooperation.

- The information directly represented in the cooperation space (the 3D world) can't reproduce all the information of the Web site - the object of cooperation. Too much information, in fact, will clutter the cooperation space, making it less useful and effective.

- The cooperation space must offer enough information to allow the user to locate and find the objects on the Web site; once the parts of interest are located, there must be gateways allowing the user to "pass" to the selected portion of the Web site.

With the above prerequisites, a development environment, WebTalk-I (WebTalk, Barbieri, 1999) was developed and a few applications were developed. The best known of these applications was developed for the Museum of Science and Technology of Milan. The application, named "Virtual Leonardo" (Paolini, 1999), allowed users to co-operate while accessing a site with a number of pages describing different machines invented (designed but never built) by Leonardo da Vinci. Virtual Leonardo was presented in previous editions of Museums and the Web.

Virtual Leonardo allows users to visit the museum together, exchange opinions, and interact with the world and with each other in a number of ways: interactive gateways allow the users to visit the pages of the Website though standard Web technology.

Our experience with Virtual Leonardo, reinforced after collecting usage data and impressions from the users (Barbieri 2000), convinced us of the necessity to support the creation of such collaborative environments with a theory of design patterns. These are the subject of this paper.

Designing for Collaboration

Within a cooperative environment the goal, for a user, is to accomplish something specific (e.g. to get work done, to learn something, to buy something, etc.) through cooperating with other users. The other users can be at the same level of knowledge and power, or can be more expert and/or have greater control over the application. A number of visitors in a museum, for example, can be at a comparable level, while a museum guide is a user with more expertise and with the power to "take" the group of visitors around.

When the users interact with each other, they follow patterns of interaction that we call "cooperation metaphors". The goal of this section is to analyze the general features that cooperation metaphors must satisfy, in order to be effective, and at the same time engaging and compelling. The discussion that follows is based upon literature and our experience gained with WebTalk-I (Barbieri, 1999) and the deployment of applications.

First of all, in a cooperation environment, it is important that all actors share the notion of a common state, bound within time and space. The intensity with which this feeling is conveyed to all users determines the level of awareness (Gutwin, 1997) within the environment. The higher the awareness of the shared state, the better the cooperation between users: thus awareness is the primary effect we must create to allow users to work and discuss together. In a virtual space described in three dimensions, users can experience perceptual stimuli that are more similar to everyday life. By processing and understanding these stimuli, they can interact with the environment and the other actors, increasing their awareness, and creating in turn new stimuli for the others. In a collaborative system, this leads to the phenomenon of *prediction*; that is, participants can anticipate, within a short time, the actions of the others, because the number of informational details they have regarding the space and time they

share with others (in one word, their awareness of the system) can lead them to such conclusions. (In this respect, for example, the "slow motion" of avatars in a 3D space can be more effective than fast motion or jumps, since the other users can better predict where an avatar is going if it is moving around slowly). Other important consequences of awareness are the possibility of learning indirectly from other people's activity, or of gathering information from the state or behaviour of the artefact in the shared environments, or the possibility of using gesturing or indirect communication forms to support one's communication (e.g. "Follow me this way", "Take this..", etc.) when coordinating multiple actions for which more users are needed.

The problem in conveying the correct form of awareness is often application-related, meaning that not all kinds of collaborative information are always needed to perform a task within a determined environment. That is why before deploying a collaborative system it is important to design in advance the means by which information will be presented in three-dimensions (*Spatial Patterns*), and to determine precisely the rules by which users are able to cooperate with each other, and with the environment, and to enhance their awareness during their activity. We call this set of rules *cooperation metaphors*.

In our vision, a *cooperation metaphor* (Barbieri, 2000) is a set of *basic rules* that describe the different modalities of interaction between users and between users and their environment. These rules encompass various aspects, such as the way users can gather in groups to talk to each other or navigate virtual space, or how visualization of the state of the artefacts and of the avatars (the *figurines* which represent the current position of each user in space) is to be performed. By making decisions about all these aspects, it is possible to define a *global description* (a metaphor) of the possible forms of collaboration of users within a system. In the following section, we present an abridged list of these small rules, which can be freely selected to form any metaphor that is felt suitable to regulate collaboration within a certain application.

In addition, the design of the application also calls for deciding which *spatial patterns* are to be followed. Such decisions include whether the world will be represented in an abstract way or by mimicking reality in a simplified way (Bridges and Charitos, 1997, Benford and Snowdon, Hearst, and Karadi 97). Moreover, we must decide how to represent, in a consistent fashion, important visual elements that aid the navigation in space of the users, such as *places* (Cerulli, 1999), *thresholds* between one space and the other, *landmarks* to assist users in finding their own routes within the space (Charitos and Rutherford, 1997), *spatial hyperlinks* to jump from one point of the space to another (Campbell, 1996, Charitos, 96), and so forth. We will not investigate this complex issue in detail in the present paper.

Our (limited) experience in designing cooperative applications has shown that although the basic cooperation metaphors are the same, the way to actually implement them or to assemble them, changes from application to application. The role of the designer of a collaborative environment, therefore, is not solely limited to gathering contents and drawing 3D geometries, but includes conceiving a consistent pattern of cooperation metaphors suitable for the different application situations; the designers, in other words, must describe the rules for the collaboration between users.

A generic package for supporting cooperation over the Web, therefore, must not provide a fixed set of cooperation metaphors, but rather must present the designers with a vast range of possibilities that can be selected and tuned to the specific needs of the application. This functionality is lacking in all the Virtual Communities tools available today, and that is why we are designing WebTalk-II, a collaborative environment where powerful cooperation metaphors can be combined and tuned at will.

Cooperation Metaphors for Virtual Museums

With some oversimplification, we may state that collaboration can be represented with two visualization paradigms corresponding to 2D and 3D representations. While both representations are in fact two-dimensional, since the visualization field is a 'flat' computer screen, the main difference between the two is that the first visualization paradigm causes the users to think in term of flat geometric elements and flat structures (windows, icons in windows, buttons laid in a bidimensional grid...), while

the 3D paradigm utilizes perspectival projection to convey a sense of spatiality and immersion. Very often this paradigm takes advantage of a subjective view; that is, the users infer position in space by viewing a perspective representation of immediate surroundings, but without the ability to see themselves (exactly as in Real Reality). This is usually the approach taken in gaming and web-oriented virtual reality. In high-end virtual reality systems that make use of complicated devices such as gloves and head-mounted displays, there is an effort to convey much more immersion to the user, by tricking the human eye into seeing depth and space in a synthetic computer generated scene.

Most of the collaboration patterns can be implemented in either 2D or 3D. In 3D, however, it is possible to conceive a set of collaborative situations that are impossible to represent in 2D, and which can convey a very heightened mutual awareness. In the following we will list the most important collaborative elements, and we specify how they could be implemented in 2D or 3D. For some of these cooperation patterns, it is possible to describe situations that have no match in reality, but can be effectively used for the purposes of particular applications. We will point out some of these cases.

At the end of this survey, we will describe sample scenarios with which these collaborative sets can be composed into collaborative behavioural patterns to support a virtual museum application, by using commercial or research tools available today.

Distribution of the Shared State

A shared state is a collection of information about the status of each participant in the application. In 3D environments, it could be the avatar position and its movement or idle state, or the status of a shared resource, like the writing on a collaborative whiteboard. Each user can participate or be isolated from the shared state (and in this last case, it cannot be part of the collaboration mechanisms). The sharing of the state works on two levels:

- **Sharing Space:** All the modifications in space are shared (movements, changes in the bounding environment)

- **Sharing Time:** The unit with which time passes, and current time and speed of the animation, are common between the users. It is possible for users to cooperate in a common environment only if they share the same notion of space and time.

- **Integral Sharing:** All users within the system or the application share the same events. All of them thus have the same notion of the environment at a given moment.

- **Group Sharing:** The shared state can be partitioned in sub-groups; that is, several parallel different states can exist for the same environment. Each participant can belong only to one of the state partitions at a time.

Mutual Exclusions

If space and time sharing are not enabled simultaneously, it is not possible to support collaboration. If space and time sharing are enabled, an Integral or Group sharing mode has to be specified. If Integral sharing is used, it is not possible to enable Group sharing and vice-versa.

Enhancement of these collaborative patterns over reality

The possibility of creating applications in which time is counted differently between users, or in which for a same environment there exist several possible states at the same time, has no counterpart in real reality. The first option can be used to let users experiment with artefacts or situations with different speed and timings. The second option is interesting to create multi-path situations in which different choices give rise to different events. An application could model this line of thinking and supply the users with an original way to experiment with this, using Group Sharing.

Grouping Mechanism

Grouping mechanisms refer to rules set to the management of user groups. Groups are a means tocluster users by interest or activity; each group shares particular cooperation elements, and behaves following a common pattern. Each group has to be identified by a unique name, so for example a group created to discuss Modern Painting following a renowned critic may be entitled "ModernArtCritique", while a group designed for free browsing around

the museum resources can be called "StrollingAroundTheMuseum". Group management is handled by the following four subcategories.

- **Group Creation**: rules how groups can be formed within the system

  - **Dynamic:** it is permissible to create a new group, with no restrictions. The user that requests the creation of the new group is called the *owner* or *creator* of the group.

  - **Fixed:** the designer of the collaborative environment prepares in advance different groups with different names (as at pre-arranged thematic conferences, for example). The *owner* is the designer himself or any user that can be determined by a pre-arranged password (see *Leadership Management*).

- **Group Protection:** defines how a group can be entered by a user

  - **Free:** any user can join the group at leisure.

  - **Password:** the user can join only if he knows the related password.

  - **Fixed Quota:** the user can join only if the current number of users in the group does not exceed the maximum number requested by the designer of the application

  - **Banning:** it is possible to attach to the group a list of particular users who cannot join the group under any conditions (they are banned).

Kicking: other users are allowed to force a user out of the current group. Usually this operation is tied to some kind of privileged status.

- **Group Disbanding**: defines a criterion by which a group has to be disbanded.

  - **Persistent:** the group remains active and joinable even if no users are participating to this group.

  - **Dynamic:** the group and all its rules are destroyed when the last user leaves.

  - **Forced:** a particular user can force the disbanding of the group, scattering all its current participants. This can happen only if there is the availability of a free group to host all dispersed participants (usually called *global*).

- **Leadership Management**: in many collaborative situations the users do not cooperate on the same level, but one or more participants may have special abilities (they lead the way, or they show an object, or are the only participants enabled to talk). *Leadership* models a particular privilege within the collaboration, and the mechanism by which leadership is acquired and passed on has to be specified.

  - **Forbidden:** once leadership is acquired, it cannot be passed on.

  - **Password Protected:** leadership can be acquired by providing the proper password.

  - **Op-Passing:** a user who holds leadership can yield it to another user in the group.

  - **Inheritance**: users with leadership can grant leadership to one or more other users, without yielding their own leadership.

  - **Tokenized:** leadership is a token that can be acquired by the first user who requests it. There are as many leaders as leadership tokens available. For someone to acquire leadership, a token must be available. Users with leadership can yield leadership, thereby freeing a token.

  - **Creation Based:** in free group formation mode, leadership is automatically granted to the user who creates a new free group.

Mutual Exclusions

A group can be either dynamic or fixed. Similarly, it can be either free or password protected, but both types can have a fixed quota, banning and kicking.

Only one type of disbanding can be specified. Leadership management can be defined by using more elements at a time; that is, leadership can be Creation Based and Forbidden, or Creation Based and Tokenized. Some of the management elements cannot be used together, e.g. leadership cannot be Tokenized and Inherited.

Enhancement of these collaborative patterns over reality

Group collaboration in real reality is usually described by a Creation Based, Forbidden leadership pattern, with a fixed/fixed quota group creation and dynamic disbanding. There is no complex notion of leadership management in real groups. In virtual collaboration, leadership can be spread over the group and be used to control enhanced collaboration facilities. (See for example visualization and view-point shifting capabilities).

Information Flow

Information flow rules can be attached to any other cooperation element to specify which are the directions and modalities in which information can be transmitted during collaboration.

- **Pull**: information transmits from the information provider to the information consumer because the consumer explicitly asks the provider for a piece of information (*pulls* information from the provider).
- **Push**: information transmits from provider to consumer, because the provider explicitly publishes new information for the consumer.

Mutual Exclusions

Push and Pull modalities can be used simultaneously. For example, a textual message or information item can be pulled or pushed, even if usually the message text is pushed to the user when new messages are incoming (as phone calls are pushed to your cell phone). Push and pull are particularly effective in visualization, where it can be decided if one user wants to see from the point of view (through the eyes) of another user, or conversely if one user wants to force other users to see what he sees (pushing his view onto others). Moreover, it could be possible to push one's position to others, to force other users to determined positions in the virtual space, and so on.

Enhancement of these collaborative patterns over reality

Push and pull are in general common modalities for textual and vocal communication, but are uniquely an achievement of virtuality when it comes to visualization and physical position.

Visualization

- **Personal View:** the kind of visualization each user has of the environment in which he is immersed.
  - **Normal:** purely subjective, from his own eyes
  - **Proximity:** from a camera external to the avatar, but placed near to it
  - **External:** from an external camera that chases the avatar, but at a distance
  - **Bird's View:** from a fixed camera placed in an elevated place
  - **External Avatar:** from the eyes of another avatar (a *tour guide* or a *friend*)
  - **Scene View:** modifies how other avatars are represented in the environment
  - **Global:** all avatars belonging to all groups are visualized
  - **Group:** only avatars of the same group of the user are visualized
  - **Selective:** only some particular, selectable avatars are visualized

Mutual Exclusions

Personal views can all be used, or forbidden for particular application-related reasons. However, only one kind of view at a time is possible. Scene views are all mutual exclusive.

Enhancement of these collaborative patterns

Visualization elements strongly enhance the daily experience of collaboration in reality. In virtual realities it is possible to see oneself acting, or to incarnate other users by seeing from their eyes. This yields enormous gaming, demonstration and collaboration potential.

Movement

Specifies which kind of movements are allowed to users in the environment. Movements can be restricted for educational or navigational purposes within the particular application.

- **Normal walking**: allows users to wander freely in the environment by contiguous movement (walking)
- **Near Jump:** allows jumping in space next to another avatar of choice
- **Zone Jump:** allows jumping in space inside a predefined landing zone (also known as 'teleporting')

Mutual Exclusions:

All movement modalities can be allowed simultaneously.

Enhancement of these collaborative patterns

The usual pattern in reality is normal walking in contiguous ranges of time and space. In virtuality the possibility of hyperjumping, not present in reality, enables a more effective collaboration.

Self-Representation

Self representation describes the means by which the particular state of the user can be represented. These elements can be enabled or disabled according to their relevance to a particular application.

- **Emoticons**: *emoticons* are short sentences or adjectives, often coupled with symbols, drawings or animations, that represent the emotional state and feelings of the user. They are used to better convey a meaning, and thus enhance cooperation. Example are: *smiles, *shrugs, *whistles, *frowns, *yawns, *blows a kiss, *strikes a pose, etc. etc.
- **Degree of Presence:** *degree of presence indicators* indicate the involvement of a user within an environment. The representation can be textual or symbolic. Some examples are: busy, do not disturb, away, extended away, free for chat, etc. (The ICQ)

Text-based Communication

In most virtual environments, the most effective mean of communication is still text based: users type in what they want to say to other users, and read the answers. Some environments also offer vocal communication, and there is a pattern about governing vocal communication that we will not discuss here. Still, it is hard to operate in a 3D synthetic environment and talk. For a number of reasons, typing is still the favored method at the moment.

- **Free:** everybody can talk to all users in all groups, and receive messages from them
- **Group:** talking and listening is limited to within the group
- **Group Restricted:** like Group, but only users with leadership can talk; everybody else just listens (reads).
- **Whisper**: one user talks directly to another user, without being heard by the rest of the group
- **Private:** one user establishes a permanent talking session with another user, like a group composed of only two people
- **Multiple Whisper:** like whisper, but with multiple recipients

Mutual Exclusions

Free mode, Group and Group Restricted are in mutual exclusion. The rest of the elements can be used in combination with these first three.

Enhancement of these collaborative patterns

These elements model how talking can happen in real collaboration sessions; however, multiple whisper and group restricted elements may be harder to enforce in reality than they are in virtuality.

Using tools and metaphors for creating collaborative museums

We will now present a short survey of some software tools that enable us to create collaborative virtual environments for museums, commenting on how they can be used to enforce collaboration metaphors in the ways we presented them. Some of these are strictly 3D Virtual Environments (Zyda and Singhal 99), which strive to present a perspectival representation of the environment in which all participants are immersed. Others simply provide users with a way to collaborate over the Internet with usual 2D metaphors. Still, they can be usefully employed for museum applications, and they do use some of the cooperation elements we mentioned earlier.

WebTalk-I

WebTalk-I (see papers in previous M&W conferences,(Barbieri 2000. T. Barbieri 99)) allows you to draw a 3D environment that represents a virtual exhibition, and publish it on the web. Users that connect to the web page are presented with the 3D representation and can navigate in it together with others, seeing the other users and chatting with them.

There are two co-peration metaphors, fixed and imposed by the framework:

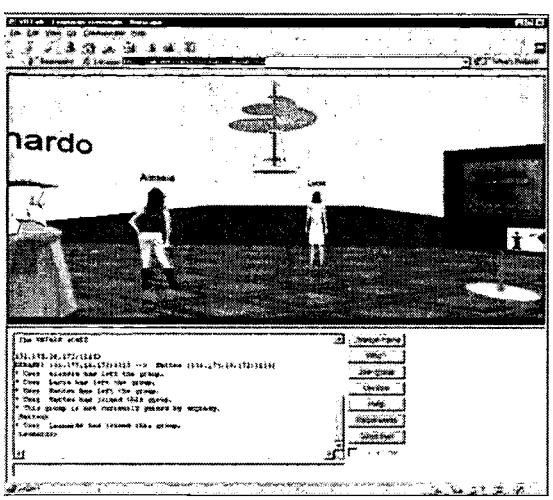

Fig. 1. In WebTalk-I, collaboration is supported via a fixed set of collaboration metaphors, like free-formed groups, and a guided tour in which leadership uses a tokenized mechanism.

- **Free Visit to the Museum**

  - Groups can be created and disbanded dynamically, and they allow free access. It is thus possible for users just to form their own groups, or join any group, and start visiting the museum freely, like in reality. Text communication is grouped, and there is a whisper mechanism. Movement can be by walking, flying, and zone jumping to important spots of the museum. Visualization allowed is Normal.

- **Guided Tour of the Museum**

  - Leadership in groups is tokenized, so any participant can acquire it and become a *Tour Guide*. In this metaphor, other participants can follow the one who acquired leadership, and *pull* inside their point of view what the guide is looking at (in simple words, seeing from the eyes of the guide), using the External Avatar visualization mode. This enables us to make very interesting virtual guided tours inside the virtual museum.

WebTalk-II

The goal of the WebTalk-II framework is to provide an environment in which it is possible to design and deploy 3D collaborative environments, acting as a way to improve the access to "traditional" Web sites. There is no assumption or constraint about the technology used to implement the Web sites, nor any implication about the design "philosophy". It is clear, however, that well structured and well behaving Web sites, like the ones that could be obtained using a proper design methodology (HDM and W2000, Rohel, 1997, Bochicchio and Paolini, 1998, Bochicchio and Paolini, 1999, Garzotto, 2001), are targets of specific interest. In addition, there is the further requirement that WebTalk-II must be able to interface to Websites where pages are not statically defined, but dynamically generated (it is in fact much easier to define gateways to a set of statically defined pages, than to a set of pages with number and content dynamically defined), according to user requests. The JWEB (Bochicchio et al 1999) environment is one, of the many available, that does exactly this.

Consider, for example, the need to coordinate access to a number of pages, for a museum application. The user accesses an "index page" that allows "navigation" to the item of interest. In a collaborative environment, the equivalent of the index page is a 3D sub-space, where the users move through visualizing "gateways" to the indexed pages.

In "Virtual Leonardo" for example, the index is represented by a virtual "cloister", while each page is represented by a virtual room. Each room, in turn, contains an exhibit that can be browsed in a collaborative fashion with other participants.

Unlike WebTalk-I where you can have only free groups and pulled visualization from a privileged group user (to form a "guided tour group" metaphor), WebTalk-II allows you to specify (for any virtual exhibition one may design and implement), any possible combination of the collaboration elements discussed earlier in the paper, choosing the best way for people to work with each other given the particular nature of the exhibition the virtual museum is proposing. In other words, you can conceive any cooperation metaphor you like, assign it a name, and specify its properties by enabling or disabling each of the collaboration elements designed above.

Net2Gether

Net2Gether (http://www.net2gether.com) is an interesting tool for 2D based collaboration over the Web. It provides a chat window under the usual browser window. Chat is organized in groups, and each group has a leader. The leader is able to push the Web page being visited into the browsers of the other participants. It is thus possible to 'share' the 2D navigation of the museum Web site. The tool also allows pre-recording of sequences of chat messages and of navigation events within the site, and plays it remotely to the users. In this way it is possible to create various exploration paths within the exhibition proposed in the museum Web site.

Since Net2Gether has no notion of what cooperation metaphors are, it is not possible to change the way users collaborate. N2G metaphors are thus fixed. They can be classified as:

- **Guided Tour**

  - Uses Dynamic group creation, with free protection, and the possibility of banning and kicking. Disbanding is dynamic as well. Leadership is creation based, and there is an oppossing mechanism that allows other people to push web contents to the group. It is interesting to note that leadership cannot be inherited, as only one user must be able to push web contents to other users. Movement and Visualization elements are not used, since the environment is 2D. Text based communication is grouped and there are mechanisms for whispering and private communication.

- **Pre-Recorded Guided Tour**

  - In contrast with the Guided Tour metaphor, this metaphor requires fixed groups, with a fixed number of participants. The

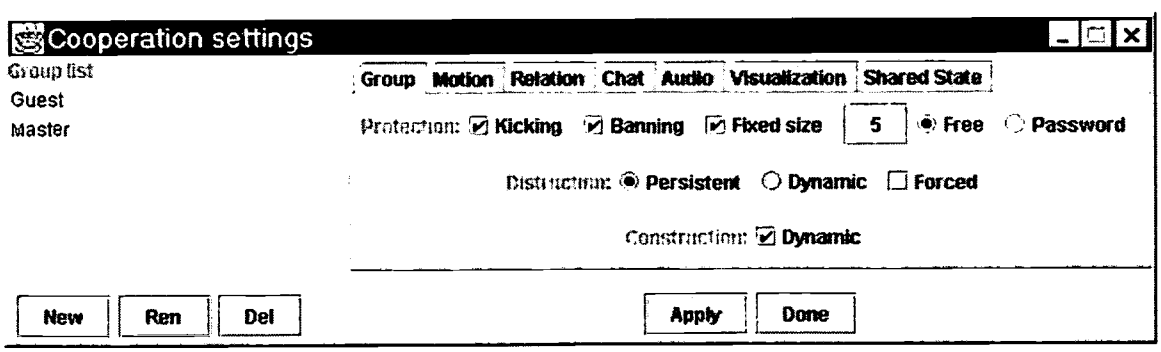

Fig. 2. The designer is able to define the general access structure, and specify which rules to enact for the collaborative exploration of the museum (creating cooperation metaphors).

group is also persistent. Leadership management is forbidden, since it is the system that does the pushing of the content. Communication can be either Grouped or Group Restricted.

Microsoft Virtual Worlds

Microsoft Virtual Worlds (Microsoft Virtual Worlds) is an authoring environment for creating 3D Collaborative Virtual Environments (http://www.vworlds.org). Even if there is not an explicit way to model general Cooperation Metaphors in the sense we described in this paper, Virtual Worlds provides the designer with a high degree of flexibility, allowing them to define, for each object, sets of attributes and properties describing them. Some of the most common cooperation metaphors in virtual museums deployed with Virtual Worlds might be:

- **Free Visit**

  - Virtual Worlds does not directly support the notion of groups, but divides users in *rooms*, with the idea that only users in the same virtual room can talk to each other, like in any real environment. So even if communications can be considered Group based, the Groups are all predefined and persistent. Movement can be done by free walk, zone jumping and near jumping to another avatar. Visualization is extremely flexible, and can be of Normal, Proximity, External, Bird's View type, at the designer's will. It is possible to push and pull visualization to any External Avatar. VW also has a well designed system of *Emoticons* which allow users to express their feelings by modifying the posture and expressions of their own avatar representation.

- **Piloted Guided Tour**

  - Extends the Free Visit metaphor, with the possibility of attaching a camera to a particular automated Avatar which can play the role of a semi-intelligent and automated virtual guide in the museum. The users can pull in the visualization of this particular camera and enjoy the ride.

- **Treasure Hunt**

  - Virtual Worlds augments collaboration by using the notion of ownership of objects (abridged from the brief sketch of collaborative elements presented in this paper). It is possible for users to take objects from the worlds, giving rise to the possibility of organizing collaborative games or activities

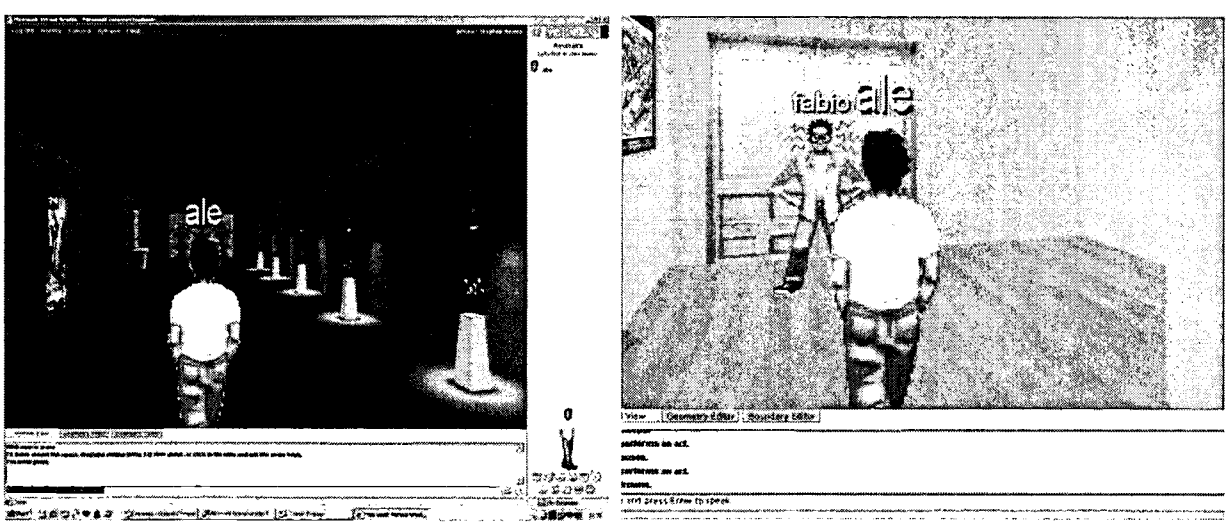

Fig. 3. An art gallery of a museum can be freely navigated with walking movements in Virtual Worlds (left). Virtual Worlds' Emoticons provide a better way to convey information (right).

like '*treasure hunts*', where the guide invites the participants to look for a particular object in the museum, mixing entertainment with education.

Conclusions and Future Work

The main point of this paper is that for a large range of applications, cooperation among users while visiting a web site is a very important improvement over current practices. Museum applications belong to this class for a number of reasons:

- They support a (potentially very) large body of knowledge
- The users have strong motivations to try to get the most out of their "virtual visit"
- Exchanging knowledge, comments and ideas with other people is an inherent part of an effective (and amusing) visit to a real museum. Why should it not be the same for virtual museums?

We have started analyzing the different components for making cooperation effective, recognizing that different situations require different organizations and different actions for cooperation. We have used the name "cooperation metaphors" to identify different cooperation solutions. Also, we have reviewed a number of tools, from the market or our own, in the light of the needs of implementing sophisticated cooperation metaphors.

In the future we will work in the following directions:

- Building new museum (and non-museum) collaborative applications, in order to gain further understanding of the key issues.
- Conducting theoretical and empirical research about the primitives making up effective cooperation metaphors, trying to obtain a more comprehensive list of elementary possibilities and a more complete set of ways of organizing them.
- Investigating the correlation between visual representations and cooperation metaphors.
- Completing the development of WebTalk-II, while, at the same time, keeping a close eye on industrial solutions offered by the market.

Among other application areas, (virtual) museums remain our favorite area of application for these general ideas.

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The HyperMuseum Theme Generator System: Ontology-based Internet Support for the Active Use of Digital Museum Data for Teaching and Presentation

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Abstract

Museums have always been, sometimes directly and often indirectly, a key resource of arts and cultural heritage information for the classroom educator. The Web now offers an ideal way of taking this resource beyond the traditional textbook or school visit. While museums around the globe are embracing the web and putting virtual exhibitions, cultural databases and archives on-line, the educator (or user in general) is still facing the daunting task of integrating this material into an active document, course, curriculum or presentation. This paper reports on the construction of a personalized theme creation engine as a possible catalyst to the active use in secondary education in Europe of digital media published on-line by selected museums.

The HyperMuseum Theme Generator System (TGS) is part of the HyperMuseum system, a European virtual museum portal (Fig. 1). Its function is to assist in the creation of so-called *personalized themes*. A personalized theme intends to allow the end user to bring together a unique collection of multimedia objects from the HyperMuseum Server, and to create a personalized rendering of the perceived and/or recorded relationships between these objects, realized as a new multimedia document (website, PowerPoint® presentation, hypertext or Word® document etc.). The TGS supports this creative expression both during the *discovery* phase, exploring the collection and discovering thematic relationships, as well as the *realization* phase, the construction of the resulting documents. The primary target audience is non-expert users mainly from the secondary education community.

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Fig. 1: The Home Page of the HyperMuseum site http://www.HyperMuseum.com

A discovery system is grounded in a liberally linked *ontology service*. Ontologies, roughly speaking, are computer resources describing application domains in terms of standardized vocabularies, linking and categorizing those terms, for example as taxonomies. In our case, multiple linkage forms, selectable by the user, express and enhance the published collection of HyperMuseum digital media as a semantically linked network according to principles developed in the DOGMA project (http://starlab.vub.ac.be/dogma.htm) (Meersman, 1999a). Relationships between different objects are suggested and derived from the *metadata* that accompanies each object (as put there by subscribing museums), as well as previously published themes and general "background" ontologies. In exploring this network the user discovers a (new) path through the semantic links covering a theme, i.e. a novel set of relations between the objects. At any time he can export the newly discovered objects into the TGS creator tool, where the realization of the theme is ongoing. This creation phase concentrates on expressing and constructing the new relationships between the objects. It maintains a level of abstraction separate from the details of implementation in a specific medium, e.g. as an on-line Web presentation.

Overall HyperMuseum Functionality

The overall architecture of the complete HyperMuseum system consists conceptually of three different parts: The Museum Data Centers, The HyperMuseum Service Center (HSC) and the HyperMuseum Client (Fig. 2).

The philosophy of the HyperMuseum is that requirements for participating museums should be minimal. It was felt that at this experimental stage the participating cultural institutions as well as most of the target market would not be inclined to dedicate the funds necessary for data conversion to a

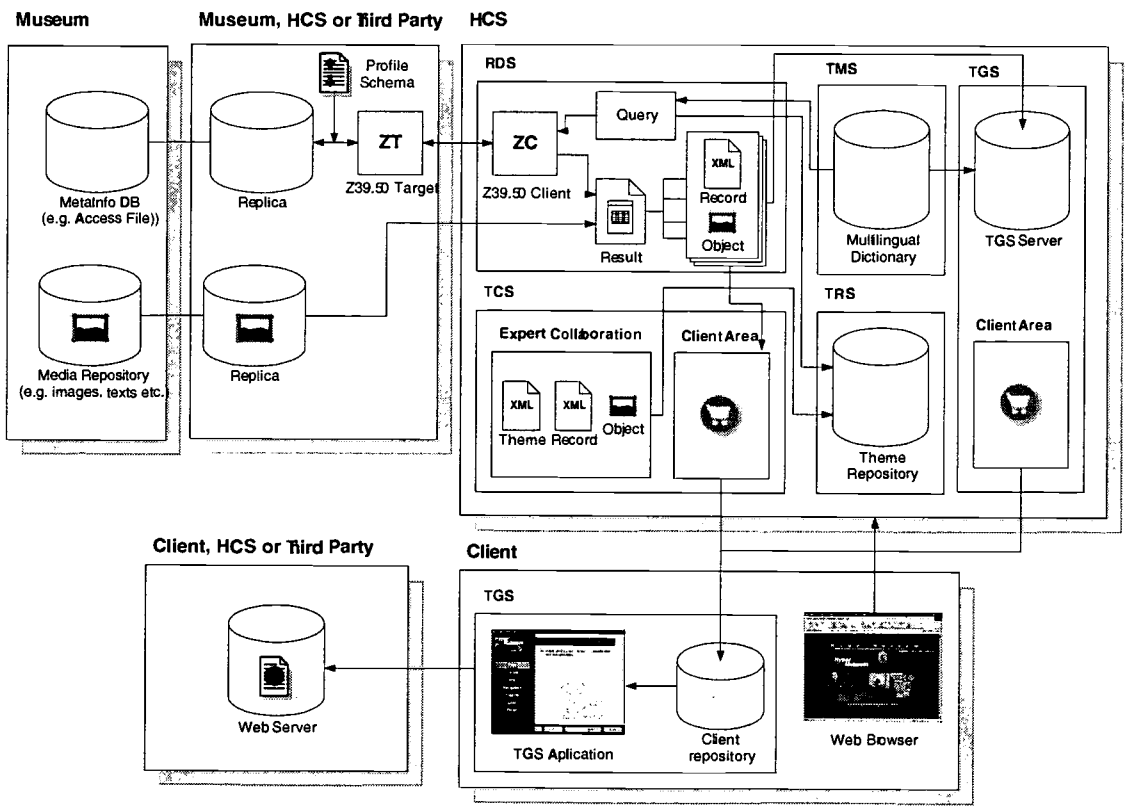

Fig. 2: Architectural overview of the Hypermuseum system.

specific application. Therefore, existing data systems should if possible be reused without a requirement for conversion or standardization. Museum data can be replicated to the HSC servers, or be hosted by the museum itself on an accessible site. Media objects are served through a normal HTTP Web server, while corresponding data records are consulted through a Z39.50 server, with the HSC acting as a Z39.50 client (ANSI/NISO 1995). For each museum database, a Z39.50 profile is developed to map the existing (meta-)data fields onto a common structure. At the HSC side the retrieved data is converted into an XML format, and packaged in a ZIP file together with its corresponding digital media files. The result of this operation is referred to as an HMRecord file and will become the basic operational unit inside the rest of the HyperMuseum system.

The first service offered by the HSC is a traditional media consultation service called the Resource Discovery System (RDS) adapted from Aquarelle (Michard 1998). The RDS offers a Web interface to the virtual HyperMuseum collection, allowing the user to query for and retrieve information on the media objects. Several query methods are available, from generic free text search to structured search in specific contexts. This service is supported by a Terms Management System (TMS), offering assisted access to controlled vocabularies and multilingual dictionaries to facilitate intra linguistic retrieval.

The second service, the Theme Collaboration Service (TCS) is targeted towards the professional community. This part of the HyperMuseum eventually wants to offer a common workspace for creating themes based on the records in the HyperMuseum collection. This resulting theme files are once again based on an XML formalism, which allows the accompanying Theme Repository System (TRS) to make a collection of themes available to the public in a maintainable fashion. Both the Resource Discovery System and the Theme Repository System are accessible with a Web browser at http://www.HyperMuseum.com (see also Fig. 1).

A third service, the Theme Generation Service, is the focus of this paper and will be explained in detail below

Rationale of the Theme Generation System

Experimenting with technology that can enhance the use of museum digital resources in secondary education is one of the main goals of the Hypermuseum project, and the central motivation underlying the creation of the TGS. We try to provide an alternative to the *passive* use of museum Web sites, which we might characterize as educational browsing, and support a more *active* type of usage, by letting the user explore and create with the objects of study.

Museum Web sites tend to fall into two categories. On the one hand there is the database approach to the holdings. The users are confronted with a search/query-like interface that allows them to get to the various assets in the digital collection. This approach has as an advantage in that it can easily offer access to the entire digital portfolio of the museum, and knowledgeable exploration can be made highly efficient because of the structured nature of the approach. Furthermore, the elements are more often presented without a contextual bias, allowing the users to appreciate the items from a personal background.

This approach is supported in the HyperMuseum through the RDS/TMS.

A second approach is that of the digital exhibition. Selected holdings are presented in a thematic context. This approach allows the *exhibitor* to convey a personal or institutional vision of a chosen set of media items. The educational and appreciative benefits of a professionally presented theme are evident and are supported in the HyperMuseum by the TCS/TRS.

With the Theme Generator System (TGS) we are experimenting with a third approach. From a previous project, Web For Schools (http://wfs.vub.ac.be) (Van Assche 1998) we had observed the need and enthusiasm from the secondary school educational community for uses of digital media in which there was a constructive component. This hands-on learning approach has become ingrained in the curricula of several European countries. Students not only observe, but also actively create and experiment

with the educational materials on offer. The main goal of the TGS is to allow the discovery and the realization of a student's personal theme, based on the materials offered through the HyperMuseum, that can be used for a transient presentation to his peers in the classroom, and that can optionally be further elaborated into a more permanent project for sharing with others.

To support this approach, there must be access to the HyperMuseum resources that allows for the *discovery* of a theme. This is clearly different both from the strict catalogue approach and from the pre-packaged thematic approach.

The implementation of the Theme Generator is also intended as an early example of a practical *ontology-based,* or rather, in this case, *ontology-assisted* software tool. Tools of this kind assist the user in the creative process by suggesting (or limiting) choices during the activities of query, search, design or composition of desired results by conceptually (semantically) linking linguistic elements of these activities (query text, figure captions, documentation, ...) with other documents and elements through "common" thesauri, lexicons, dictionaries, ... that cover the domain under consideration. Such linguistic resources may be quite general (i.e. domain-unspecific), as in the case of WordNet (Miller 1990), or alternatively quite specific to a particular domain. The latter kind of resource, now often referred to as a (*domain*) *ontology*, at present is much harder to come by. As an example of such an as yet hypothetical domain ontology, consider a (partial or comprehensive) listing of all the technical term linkages that may plausibly occur in the context of "restoration of medieval paintings". In fact, one of the primary goals of the DOGMA project (Meersman 1999b) at VUB STARLab (http://starlab.vub.ac.be) is to define a formalism, method and representation for such domain ontologies so they may be stored and integrated on an *ontology-server* and then retrieved, consulted and "plugged" into applications.

The main purpose - and advantage - of an ontology-based approach is to make the implementation of an application such as the TGS as independent of the data semantics (*meaning*) as is currently feasible, somewhat abstractly comparable in purpose to the way databases were invented to make applications maximally independent of data *structure*. While we certainly cannot claim that the TGS implementation presents a prototypical solution for this, we trust that it adequately illustrates the underlying principles - as well as offering an already useful tool that is extensible according to these principles, as discussed below in more detail.

Assisting systems with ontologies is not limited to the application under consideration. E.g. In the DOGMA research context also, library search systems as well as database (reverse-) engineering tools with ontological support are studied.

Supporting Personal Theme Discovery

While the database/catalogue approach to accessing museum record data is highly efficient in a *search* type of application, it is far from optimal in assisting in the discovery of the relations between the different elements. The thematic approach is strong in showing a possible linkage, but forces the user into considering a possibly very interesting set of relations in a pre-packaged format. For thematic discovery, we wanted an application, the Theme Hunter, which would support the user in fluidly discovering the patterns of possible, but as yet unrealized, themes.

We set out to construct a Web of relationships among the different objects in the HyperMuseum. In such a structure, the user could explore the space of relations by browsing this network from point to point, until a theme would emerge as an idea or pattern. At the same time, the user should be able to select the objects encountered for use in the realization of the theme.

For finding the possible relationships between the different objects in the HyperMuseum, we started from the textual metadata that is provided with each of the museum media objects (e.g. physical descriptions, materials, caption). We concentrated on the textual fields in the records. Normalization of the words by using a stemming algorithm (Porter 1980) gives us a set of relations to words for each media-object. Bringing all the objects with their respective word links together in a graph creates a browsable structure (Fig.3), where one can move from object to object through the shared word links.

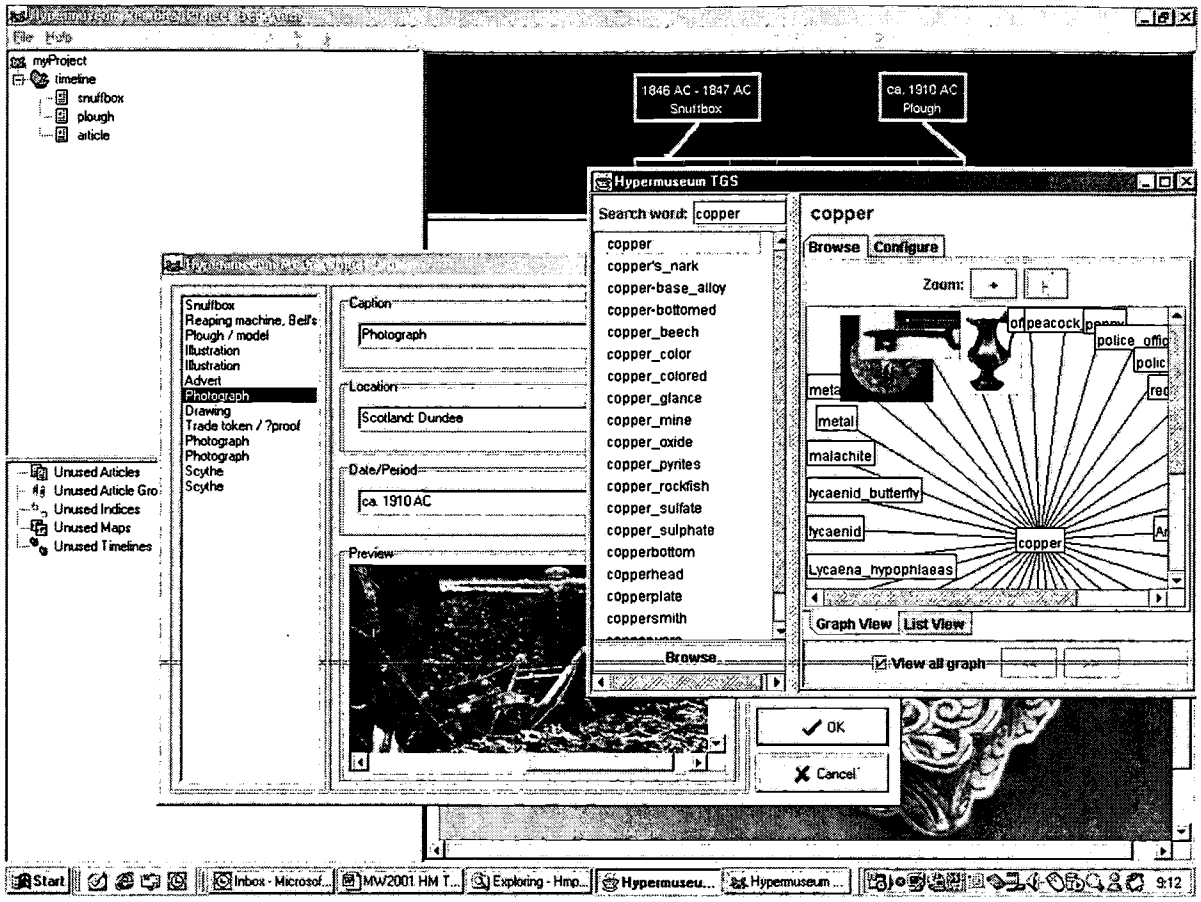

Fig. 3: Screenshot of the Theme Generator System User Interface showing the HMPPG (background) with the Theme Hunter (foreground)

While the browsing interface might be more adapted to the task of theme discovery, with only the word relations from the records we have done little but facilitate iterative searching of the record database. In order to get more depth in the possible theme exploration, we add in the system background ontological resources. These can provide for semantic links between the words that were linked to the records. Since this operation will provide the context for exploring thematic space, the choice of resources should be carefully matched with the intended audience and application. For our initial prototype we used an adaptation of the WordNet lexical database (Miller 1990).

The WordNet lexicon is centered around *synsets*, lists of synonyms that are intended to represent a meaning. Each synset is related to other synsets through semantic links. The types of links include among others *hyponym*, *hypernym*, *meronym*, *holonym* and *antonym* relations. Since a word can have more than one meaning, it can be part of more than one synset.

By extending our graph to include the word relations obtained from WordNet, we get a significantly richer linkage structure in our system. We no longer need to navigate through coinciding words, but can resolve synonyms and go into generalizations and specializations, opposites and hierarchies. This brings a qualitative change in the support of theme discovery. In the next section, we will delve deeper into the consequences of this type of facility.

A third source of relations between the objects and the graph can be mined from *realized themes*. Since the HyperMuseum Theme Repository stores themes as XML documents, with embedded links to the media records, it is relatively straightforward to get the context of the reference and construct links in our graph between the context words and the objects. This expands the number of meaningful links (within this context) that exist between an object and the rest of the graph.

Supporting Personal Theme Generation

In general, one performs theme discovery with the purpose of communicating it. While it is certainly feasible to use a modern content creation package to construct multimedia presentations, there are tasks specific in our context, for example generating timelines or maps, that would clearly benefit from specialized automated support. This need has also been identified and reported in similar projects such as (Buchanan 1999). The Theme Generation System contains a client side application, the HyperMuseum Personal Project Generator (HMPPG), whose primary goal will be the facilitation of this aspect.

Since the theme itself should be kept independent of the details of the medium in which is it rendered, we tried to keep a separation between the conceptual creation of the theme (and in particular the ontology it uses), and its instantiation in a particular environment (e.g. as a Web site or Word document). While the current prototype only contains generators for Web site creation (as sets of HTML files), the implementation is such that the generation of different output types such as e.g. 3D virtual exhibitions as described in (Alonzo 2000) can be achieved through the inclusion of a new set of generators. The user constructs a theme based on conceptual objects such as groupings or indices that in one medium may be generated as Web pages and navigational menus, in another as virtual rooms and floor plans, and in yet another as chapters and a table of contents.

Realizing a theme based on museum objects is typically the creation of a new (thematic) dimension on the set of these objects. This new dimension does not replace the existing time or geographical dimension, but adds to these more objective references. Often the theme woven from a string of objects described in the thematic light will benefit from being also placeable and navigable along a timeline, or on a geographical map. Indeed, these factual data are often present in the HyperMuseum records, but the inclusion of these perspectives with general tools might be a laborious task. The HMPPG prototype generator automates the generation of timelines as HTML clickable maps, and a tool that automates placement of objects on geographical maps. These geographical maps can be created through a separately developed tool, GeoMap Editor, which is included in the HyperMuseum TGS toolset. Both these systems are based by default on the extraction of metadata from the HyperMuseum records. However, all project data can also be entered and edited manually for each instance, should this be necessary.

All elements in the HMPPG have themselves time and location *meta-data*. This makes it possible to cascade these elements into each other in essentially limitless combinations. One can easily construct timelines of maps and vice versa. Changing the order in the navigational hierarchy is a simple matter of dragging and dropping items from one place to another. The system is constantly checking for constraints (e.g. in order for an element to be placed on a timeline, it needs to have a date or period associated), and will prompt for missing data as needed. This feature makes adding and changing different perspectives relatively straightforward.

At all times the user can observe what the element being constructed will look like with the currently selected generator. This provides immediate visual feedback. At any time more data can be fetched from the HyperMuseum through the Theme Hunter or the RDS, or new media files canbe added from the local file system. Most popular media types for images, audio and video are supported. The application can be used by itself to construct presentations. The output produced by the current prototype Web generator is standard HTML and can be further processed with other packages.

Architecture of the Theme Generation System

The Theme Generator System (Fig. 4) can be broken down into two major parts. One part is responsible for the theme realization and is referred to as the Hypermuseum Personal Project Generator. The second part is referred to as the Theme Hunter, and is responsible for theme discovery support. While both are very different in their implementation details, they integrate seamlessly from the user's point of view, with no noticeable transitions.

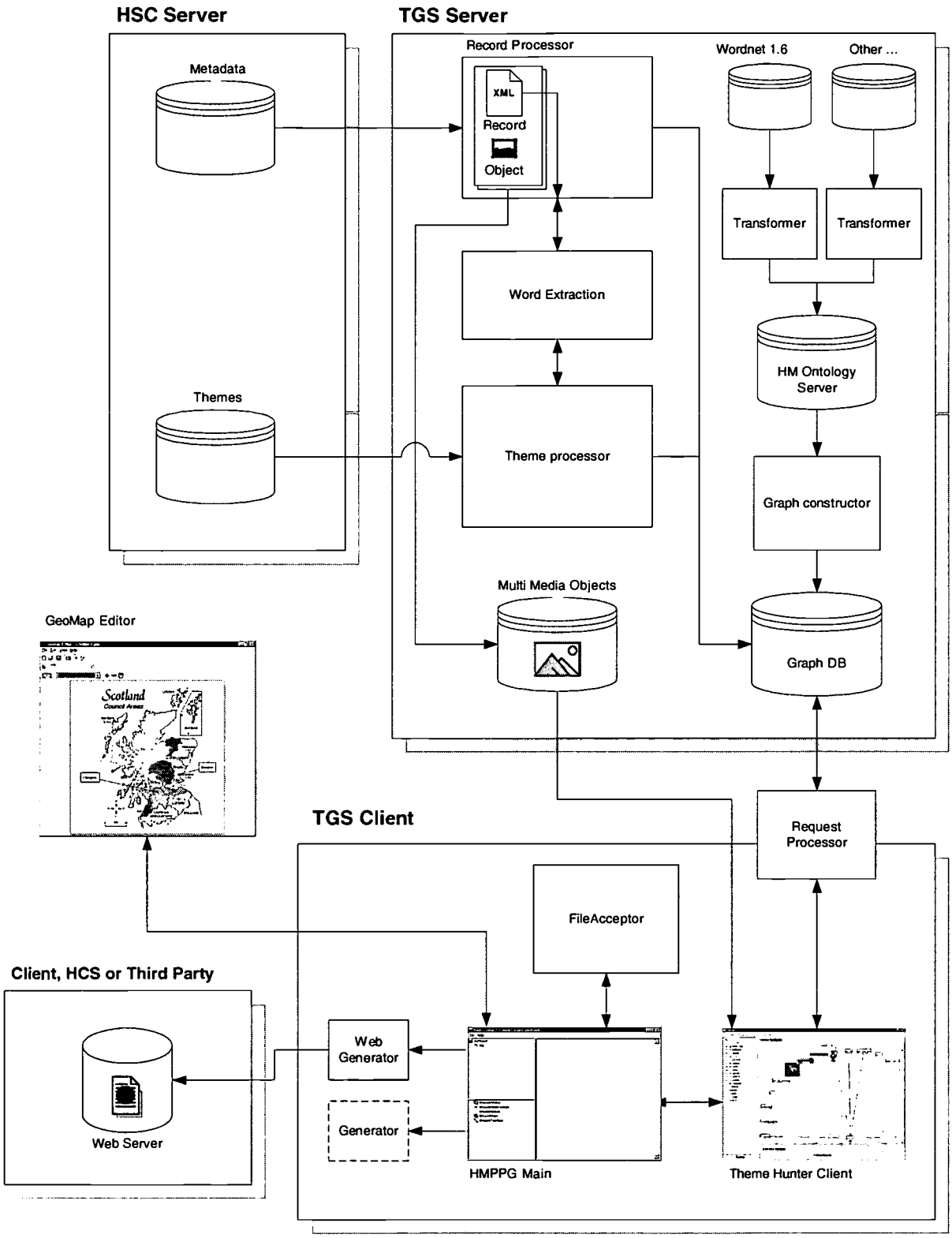

Fig. 4: Overview of the Theme Generator System Architecture

The Theme Hunter is a classical client-server application. The centerpiece of this system is a relational database system which houses the object-ontology graph described above. Client applications are either delivering new graph elements, or querying the graph. For practical purposes, the delivery of the actual multimedia files is handled through a standard Web server. Since the only point of interface is the graph in the database and the media files on the webserver, any application that can deliver graph extensions can be added to the system. This feature, together with the localization of format-dependent code in the HMPPG, will make it possible for the system to easily migrate to or be extended with new data formats.

As seen in the database diagram(Fig 5), the graph is represented as a simple set of binary relations between entities. The entities are typed to distinguish e.g. between words and object references, and associated with a source. This source is itself typed, and in our current system there are three types: the Hypermuseum Records, the Hypermuseum Themes and WordNet. Each source type has a set of relations that can be further classified into relation types for easy property attribution. From the Theme Hunter client, the advanced user can configure the system to work only on certain sets of sources, or take into account only certain relations.

On the server side there are three main data delivery modules, each responsible for extracting information from the different data sources: the Hypermuseum Records, the Hypermuseum Themes, and the WordNet 1.6 data files. For the WordNet intaker, we start from the DOGMA representation

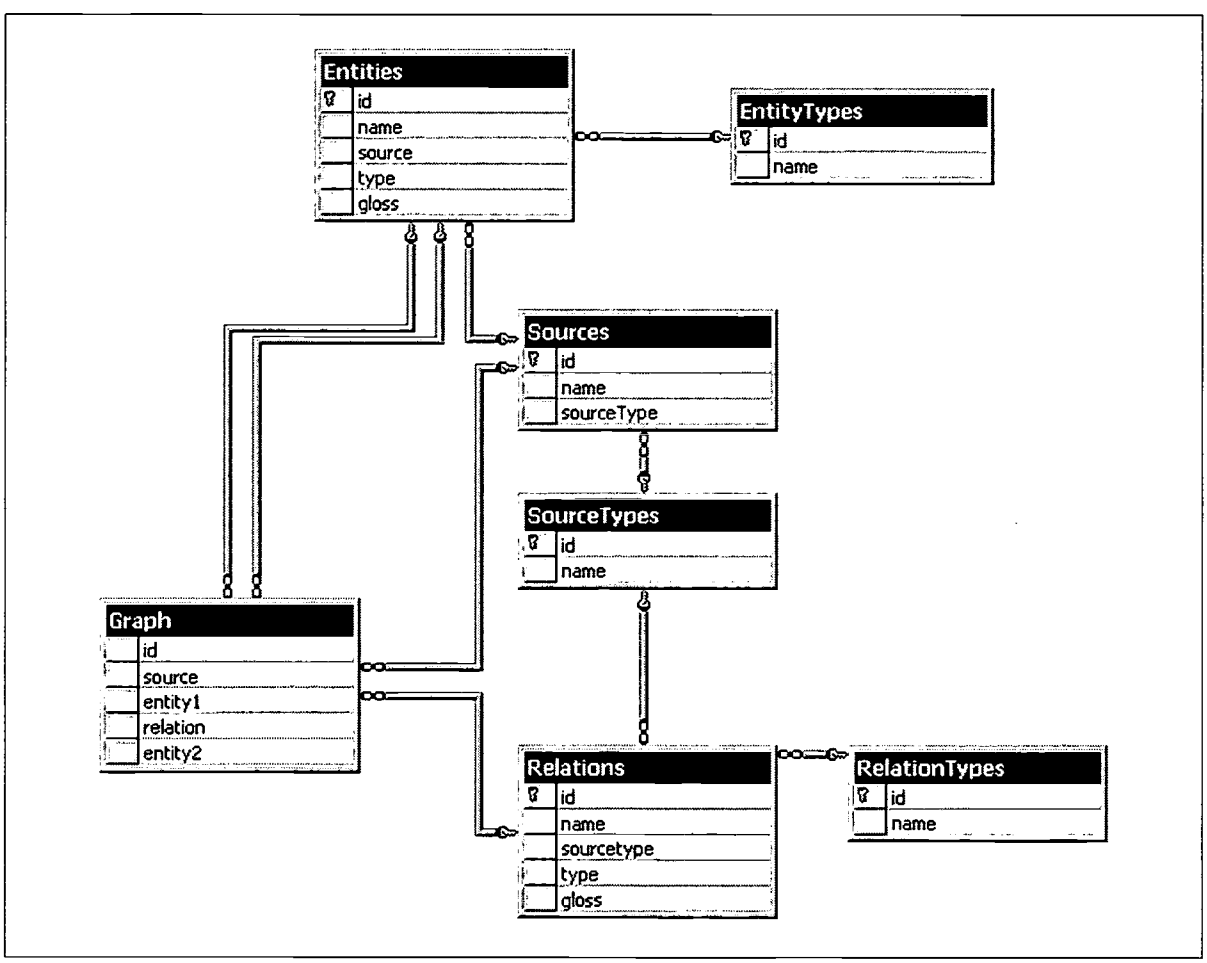

Fig 5.: Theme Generator System Graph Database Diagram

of WordNet 1.6, which is in content identical to the WordNet data files, but allows for easier manipulation. From this representation we can build the required graph representation through direct SQL manipulations. We build a semantic net graph centered around the words, as opposed to the synsets. We ambiguate the meaning structure by flattening the word-meaning relations into a single node, and transform the synset objects into explicit synonym relationships between the member words.

For the Themes and the Records, the first step is extracting the field data that is to be considered for word mining. This operation is made easier by the fact that both use an XML representation, making the parsing and validation of the files more convenient. From this step the relation between the object and the possible word set is determined. Text data is passed through the word extraction process, in the current prototype a chunking (cutting the sentence into pieces) and stemming operation. There are many opportunities here for the application of advanced Natural Language Processing techniques that could improve both the accuracy and the depth of the text mining operation. The last stage in our current mining pipeline matches the words against WordNet 1.6 to prune the false results out of the previous pipeline stages. The resulting words are then inserted into the graph, together with their respective relations to the objects. Items recovered form Theme files are only included if the record they refer to was previously processed by the system.

The part of the Theme Hunter that is visible to the end user is conceived as a 3-tier application on the graph database. The front end is a GUI based application (Fig. 3) where the user can search for terms to start exploring in the graph, and graphically browse the graph by simple mouse clicks. When interesting objects are discovered, they can be downloaded for processing with the HMPPG by a simple right click on the image. The Theme Hunter and the HMPPG work completely asynchronously, so realization and discovery can be fully intermixed in the creative process.

Behind the scenes the first tier constructs a series of request objects that are passed on to the middle tier. The middle tier interprets these requests and builds database queries out of these. With these queries it extracts the information out of the graph database, and the result is transformed into a reply object and passed back to the first tier, where the result is unpacked and displayed. The protocol governing this interaction is stateless, ensuring that the process is robust to client or server failure and economically scalable on the server side. Furthermore, both the request and reply objects that govern the first-middle tier interaction are serializable, so that the actual physical location of the middle tier is easily changeable. In our current setup we placed the middle tier on the client side, but it can with relatively minor efforts be moved to the server side should the need arise.

Our Theme Hunter implementation uses the Microsoft SQL Server v7.0, and has also been tested with the free Microsoft Data Engine 1.0 for cheaper deployment scenarios. Since the database operations are handled through SQL over a standard ODBC interface, there should be no problem to substitute for these choices. The database is complemented by a standard Web server, in our system Internet Information Server 4.0, for the delivery of the actual multimedia files to the clients. All code for this part of the system was written in Java 2 except for some of the DB conversion code that was written directly in SQL.

Like the Theme Hunter, the Hypermuseum Personal Project Generator also tries to isolate the dependencies on data formats. The HMPPG is a client side program that is constructed as an output-format-agnostic generation framework. Data input into the system can be from Hypermuseum record files that can originate either from interaction with the RDS or from the Theme Hunter, or from raw multimedia data supplied by the user from other sources. Due to its intense local data interaction, this application was developed mainly using the Borland C++ Builder system, since the current instantiations of the Java platform did not deliver the required performance at this point. (The Theme Hunter, being a network-data bound application, is not critically hindered by this). The dependency on the Hypermuseum record format is shielded by locating the parsing and extracting code into a separate program, the FileAcceptor. The responsibility of the FileAcceptor is to extract from a set of Hyper-

r museum records the relevant metadata and the media files, and produce these into an internal format on which the rest of the HMPPG will rely. (Since there is no user interface involved here, we could develop this program in Java 2).

To achieve data format independence on the generation side, two requirements had to be fulfilled.

First, all the operations on the data, apart from the generated representations, had to be implemented as operations on the conceptual structures. Second, the generators could not directly be linked into the rest of the program. Instead, a COM (Rogerson 1997) interface was defined that specifies which services a generator has to provide to the HMPPG. Since the HMPPG acts towards the generators as a COM client, each generator object implementing this interface can be added to the one delivered with the current prototype.

The current HMPPG generators can work with most of the standard formats for audio, video and imagery. Every format supported by the Windows Media Player and the Internet Explorer controls may be used in the prototype. The GeoMap file format for geographical data is supported through the GeoMap Editor tool that also acts as a COM server towards the HMPPG for handling GeoMap operations.

We opted for this defensive position with regards to changing data and output format requirements because of the current absence of stable and dominant standards for this field. Since this situation is currently receiving quite some interest, we hope to be able to incorporate the emerging standards into the system in the future.

Discussion and Results of Initial Experimentation

As stated above, the choice of background ontological resources is critical to the intended use of the system. The choice of the WordNet lexicon was actually one of convenience and availability, but first reactions to the prototype indicate that the choice may have unexpected benefits.

Since WordNet has attempted to model the lexical knowledge of a native speaker of English, its vocabulary is quite broad but non-specific. As a result, the user is generally not confronted with jargon which might have been more accurate or meaningful to the professional user, but could have alienated or derailed our untrained user in the process of making free associations. Secondly, while our present crude word harvesters can extract the words, they cannot disambiguate them to their intended meaning (e.g. it can not distinguish between the use of bank as the place that takes your money as opposed to the bank at the side of the river). Rather than an expected disadvantage, this "feature" in the context of our application surprisingly seems to bepositive, since these mismatches seem to be one of the best sources of theme "triggers". Even the fact that our current main view in the browser (there is a graphical main view and a textual view) does not show the relation types has triggered surprise, reflection and discovery in the first test when users unexpectedly came across links they at first thought were not supposed to be there (e.g. the link between "rich" and "tasteful"). For some instances at least, less could indeed be more when selecting background ontologies.

The previous point is not intended to be a dogmatic principle. We could point to the lack of agentive links (e.g. there is no relation between "baker" and "bread") as an obvious shortcoming of our current system.

Once the background ontology is in place and the graph generated, the choice of how much of it to deploy can only be discovered through experimentation. In our current Theme Hunter, the advanced user can include or exclude both types of relations and sources. Even so, depending on the scenario we can foresee a need to further reduce the amount of presented information. We are currently investigating the introduction of additional retrieval constraints such as a maximal distance rule (words are only included in the graph within at least few "hops" of a media item) to bring more focus on finding themes that will be "realizable" with the HyperMuseum data at hand. These criteria are dependent on the specifics of the usage scenario and will have to be evaluated on a case-by-case basis.

As far as the records themselves are concerned, the HyperMuseum approach of not requiring rigorous data standardization undoubtedly has the ad-

vantage of lowering the threshold for museum participation. The flip side of this coin is, of course, that since there are not yet standard representational formats for things like dates or geographic locations, the correct interpretation of these becomes difficult (time) to very difficult (geographic). A common reference to standardized vocabularies such as the Getty vocabularies (Lanzi 1998) could augment the quality of information extraction by the different tools.

Conclusion

The HyperMuseum Theme Generator System aims to be a contribution to the exploration of new uses of museum online digital information in, among other environments, the secondary education curricula in Europe. By allowing a novel way of exploring collections, supporting both the discovery of new thematic dimensions by the non-professional as well as the rapid creation of the presentation of the theme, we hope to address concrete needs of the intended audience. By localizing the dependencies on specific formats, both on the data delivery side and the document generation side, we hope to have provided a technical platform that can be flexibly adapted for usage in many environments.

Acknowledgements

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Providing Personal Assistance in the SAGRES Virtual Museum

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Abstract

The SAGRES system is an educational environment built on the Web that facilitates the organization of visits to museums, presenting museum information bases in a way adapted to the user's characteristics (capacities and preferences). The system determines the group of links appropriate to the user(s) and shows them in a resultant HTML page. In addition, SAGRES enables cooperative learning by supporting interaction among users and also among members of groups of users.

Users in SAGRES are aided by personal assistants that are software agents, whose purpose is to monitor the visitors' actions, helping them during the navigation. Considering studies in human-computer interaction (Ball et al, 1997) (Koda, 1996) and aiming to provide a friendlier interface for the SAGRES system, the agents have a graphical representation as animate characters. These characters improvise a group of behaviours similar to human behaviours (happiness, satisfaction and vibration), making the interaction more attractive.

In order to evaluate the user's degree of satisfaction with the agents, we developed a questionnaire and obtained some favorable results. This system is developed in the Museu de Ciências e Tecnologia (MCT) at Pontificia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, Brazil.

1. Introduction

Most virtual museums are sites that offer on-line learning resources, inviting the visitor to investigate and explore. The SAGRES system is a virtual museum that seeks cooperation between museum and schools, in order to create a new educational environment that provides continuous education, allowing access to information of the museum by the community at large. Due to the possibility of using the system as a distance-teaching tool, and to the diversity of the school population to be reached, SAGRES was conceived as a flexible and adaptive system, able to pay attention to the different needs and situations of its various visitors. Because presentation of information on the Web is achieved through hypermedia documents, success of virtual museums can be limited by a lack of initial training and by users getting 'lost' during navigation, due to the large number of links available.

In order to overcome these limitations, software agents were used to incorporate personal assistance to the SAGRES' users. These kinds of agents have been used for the development of a large number of applications. They can provide assistance to the user during some systems operations and can execute tasks on the user's behalf (Genesereth and Ketchpel, 1994). As personal assistants they can be responsible for helping in the navigation and operation of the system, overcoming the need for initial training. Besides, software agents are quite useful in analyzing and monitoring the users' actions. Considering this, we believe that agents can help in the system operation both at operational and interface level.

Many systems developed for the Internet have a concern about how to accommodate user needs and preferences and how to provide interfaces that are more comfortable and easy to manage. Some researchers are considering software agents as a good option, because they are adaptable, persistent, semi-autonomous (Maes et all., 1999) and can be represented through animate characters. There are studies that indicate that interaction with computers unavoidably evokes human social answers. People treat computers as humans even if the interface is not explicitly anthropomorphic. In this case, the social metaphor represented through the presence of animate characters (similar to real life people) has reduced anxiety associated with the use of computers.

In order to evaluate the degree of user satisfaction related to the agents, we conducted a study of agent evaluation methods and, based on this research, developed a questionnaire. We applied this questionnaire to partners of the Computer Club in the Museu de Ciências e Tecnologia (MCT) and we obtained some satisfactory results.

2. SAGRES – A Virtual Museum

The SAGRES system (Bertoletti and Costa, 1999) is a virtual museum that seeks to form a partnership between museums and schools, and to build a new educational environment going beyond such partnership by providing information available in the museum to the whole community, through the Web. The system determines the information appropriate to the visitor(s) and shows it in a resultant HTML page.

The information available in the SAGRES is based on the physical structure of MCT. The subjects for consultation are arranged in the system in agreement with their actual location in the MCT exhibitions area, allowing to the visitor to find the experiments in a real visit.

Through the on-line exhibition visitors access the information of the physical museum. The use of such on-line information can happen in several ways (Lewis, 1997): in a set of activities coordinated by teachers in which students participate; in "halls of activities", i.e., series of activities with a central theme open to any visitor, and by individuals as a source for individual studies. In addition, SAGRES provides cooperative learning by supporting interaction among visitors and also among members of groups of visitors.

The system supports different groups of users:

- **A Visitor** accomplishes the interaction with the system individually. He is included in the system by a process of self-registering, where he is responsible for defining his profile, informing the system of his characteristics, capacities and preferences, in order to facilitate the construction of his model.

- **A Teacher** (generally identified as a school teacher whose student groups visit the museum) is responsible for the definition of the profile of the group. By a profile we understand the set of characteristics of the group; that is, the students' backgrounds and preferences, any particular subject being focused in the visit, and the activities. The teacher is also responsible for registering the students, as well as accompanying them and evaluating their performance during the visit, through reports delivered by the system.

- **A Student** is allowed to interchange ideas with colleagues in his group and to work on the activities and subjects determined by the teacher.

One advantage of SAGRES is that it allows visitors to plan their visits to the MCT in advance. Thus, when arriving at the museum, the visitor already knows where to find specific experiments. Later, in their homes, the visitors can get other information related to the experiments visited.

For teachers, SAGRES is a powerful tool to support teaching, because it works as a repository of information from which they can elaborate a library of activities (for example, questionnaires for tests) and share them with other teachers.

3. Integrating Personal Assistance in the SAGRES

Since information is presented on the Web through hypermedia documents, virtual museums are limited by the lack of initial training and by users getting lost during navigation, due to the large number of available links (Yamada et all., 1995). Therefore, software agents were used to incorporate personal assistance in the SAGRES system. As personal assistants they have the responsibility to help the visitors during interaction with the system. These agents are represented as animated characters. According to Hayes-Roth (1998), the introduction of characters on the Internet introduces the sense that people are interacting with "real characters" in virtual worlds. This sense is intensified because characters simulate verbal and physical behaviours similar to humans, such as happiness, satisfaction and greeting. As people are social beings and interact instinctively with each other, the user's interaction with the interface becomes friendlier.

To support independence between the agents, SAGRES adopted a three-layer development model (Kirtland, 1999): presentation, business and data. The layers of data and business meet in the server. Data layer stores the SAGRES's databases and information related to the agents' execution scripts and repertoire of behaviours. The business layer implements the agents' functionalities. The presentation layer is located in the client and contains the SAGRES's HTML pages and agents' pages. This model is visualized in figure 1.

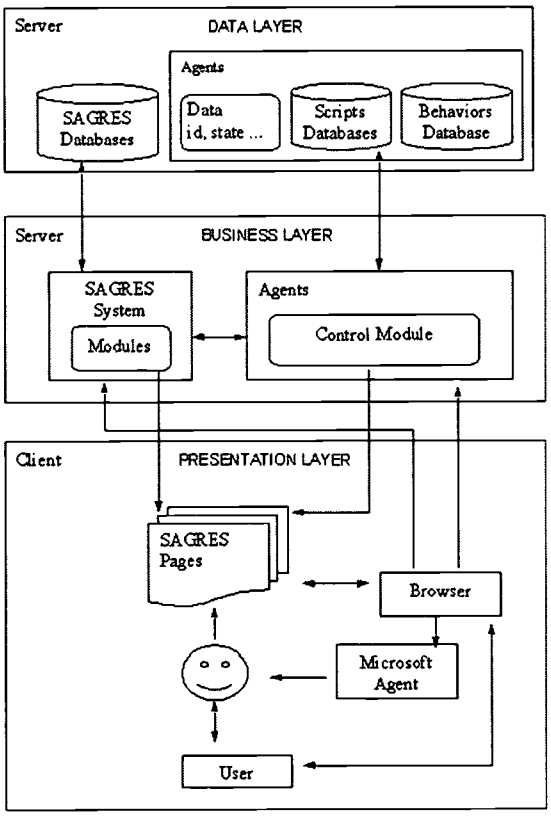

Figure 1: Agents and SAGRES System

Figure 1 shows that agents are structured into two main modules: internal representation (presented in the data and business layers) and interface (presented in the presentation layer). The internal representation module is divided into data and control. Data contains information about the agent such as agent identification, current agent state (idle, execution), script (name of the file that contains the execution's script of the agent), list of neighbours (name of the agents that it will be able to communicate to) and who is communicating (name of the agent that is communicating at the moment). This information is stored in a database. All information in data is updated, according to the process in the control module. The control module contains the personal assistants' functions. Assistants have common knowledge about the world that is implicitly incorporated in the control module. The interface contains graphical representation of the agents that interact with visitors through the execution script incorporated in the HTML pages (Moraes et al., 1999a). An example of this script is illustrated in figure 2.

1. To present to the visitor *(to greet, to wave)*
2. To invite the visitor to make a visit to the museum *(to invite, to dance)*
3. To wait reply of the visitor *(to wait)*
   - 3.1 If visitor selects a consultation
     Looks to presentation agent for content *(researcher)*
     Demonstrates satisfaction *(satisfaction, vibration)*
   - 3.2 Else demonstrates reproof *(to refuse, to disapprove)*
     Stimulates visitor to make a visit *(to stimulate, to move)*
   - 3.3 If visitor requests mural's monitoring
     Monitors communication mural *(investigating, artist)*
   - 3.4 If visitor requests monitoring of document edition
     Monitors edition of document *(research, artist)*

Figure 2: Example of an execution script

This example shows that agent's actions are related to behaviours (physical and verbal). Each one of these behaviours has one to five possibilities of execution. In this way, the agents can improvise behaviours and different possibilities to execute the selected behaviour. This characteristic makes agents more flexible, life-like and believable, increasing the users' satisfaction related to the system operation as we can see in section 5.

4. Visualizing Personal Assistance in the SAGRES

In this section we are going to describe the SAGRES system, as it operates with personal assistants, by illustrating an example of the visitor' interaction. Figure 3 shows the main page of the system.

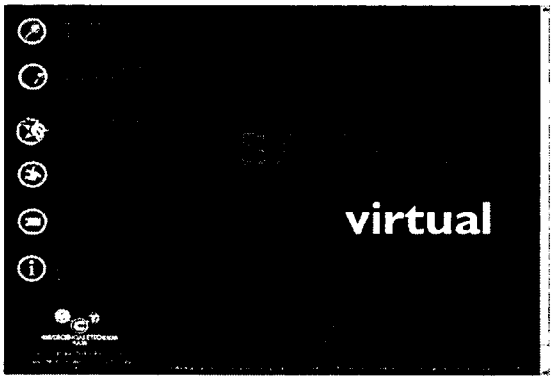

Figure 3: Main Page

After choosing the personal assistant option, the visitor provides his name and password (figure 4).

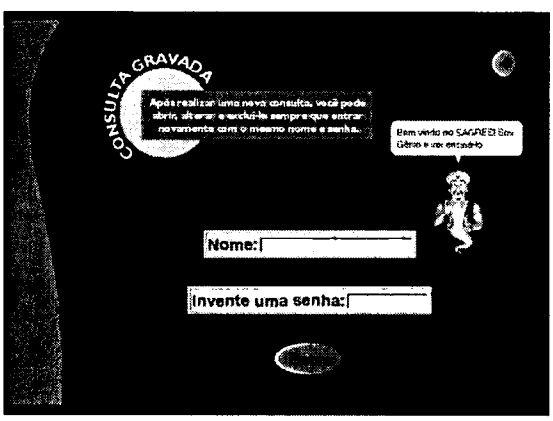

Figure 4: Logon Page

Based on the name and password information the system identifies the user's kind: visitor, student and/or teacher (figure 5).

Figure 5: Kind of User Page

After the user chooses the visitor module, the system loads his visitor's models (figure 6).

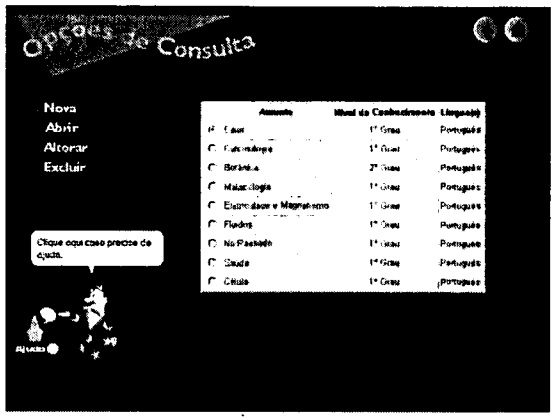

Figure 6: Consultation Options Page

After the user selects a subject, the system builds a presentation page where the user can see the documents about the selected subject and the link for the communication mural and document edition (figure 7).

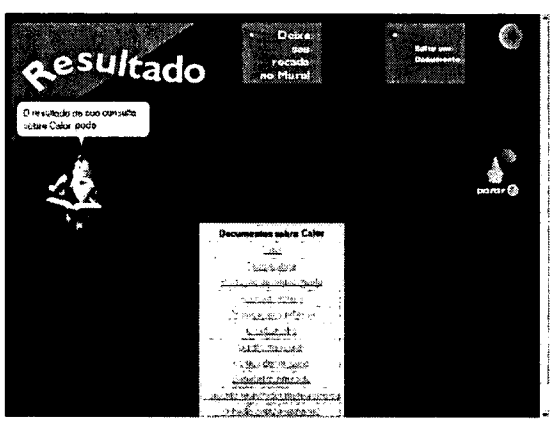

Figure 7: Information Presentation Page

In some pages there is a button related to the personal assistant, as we can see in figures 6 and 7. This button activates the assistant, so when the user needs help, he only has to click on that button. When the user wants to stop the explanation, he clicks on the button again. The user can activate the assistant when the button is green, and he can stop the assistant when the button is red. The explanation provided is in accordance with the pages' context, assistant actions and behaviours. When the button is not present, the assistant acts autonomously. This means that the assistant observes the user's actions and motivates and helps the user when necessary.

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5. Evaluation of Personal Assistance in the SAGRES System

In order to evaluate the user's satisfaction with the degree of personal assistance in the SAGRES system, we researched evaluation approaches for intelligent agents. Hayes-Roth and Doyle (1998) point out that works in intelligent agents inherit the evaluation approaches of Artificial Intelligence and other fields of Computer Science such as Human-Computer Interfaces. These approaches define the desirable qualities of systems. However, as personal assistants are intended to be more similar to people, traditional approaches should be adapted or modified. Hayes-Roth and Doyle (1998) present an adaptation of some important approaches for evaluation of animated characters. As personal assistants are represented through animated characters, these approaches can be applied. The approaches are:

- Reliable becomes variable: to be more human-like and believable the animate characters must display normal variability in their choice and manner of executing behaviours
- Predictable becomes idiosyncratic: animate characters must display roughly predictable patterns of behaviour, punctuated by interesting surprises
- Correct becomes appropriate: rather than behaving correctly, animate characters must behave appropriately, given the roles, their circumstances and their imperfect human-like natures
- Complete becomes effective: animate characters must function effectively, albeit sometimes incompletely, in the roles they play
- Efficient becomes interesting: animate characters must forego efficiency in their paths to goals in favour of paths that are intrinsically interesting
- Optimal becomes distinctively individual: it is important that animate characters be distinctive individuals whose behaviour surprises, delights or provokes us in ways that are unique

Considering the ideas presented by Hayes-Roth and Doyle (1998), we developed a questionnaire to evaluate characteristics related to the agents. The questions are illustrated in figure 8.

Questions	Bad	Regular	Good	Very Good
Did the personal assistant present different behaviors during the execution of particular tasks?				

Table 1: Questions Form

Each question has four alternatives as answers: bad, regular, good and very good. Weights of one to four, for concepts, were associated with answers, as illustrated in tables 1 and 2.

Concept	Weight
Bad	1
Regular	2
Good	3
Very Good	4

Table 2: Concepts ´ Weight

These questions follow the same format presented in table 1, except the last one, where the learner should choose between "with" or "without".

1-Did the personal assistant present different behaviors during the execution of particular tasks?
2-Did the personal assistant present appropriated behavior the each task?
3-Did the personal assistant was useful to help you in the system operation?
4-Did the personal assistant help you in a personalized way and did he encourage you to do your tasks?
5-Did the personal assistant disturb you during the presentation of information?
6-Did the personal assistant help you to concentrate on relevant information?
7-Did the information presented by the personal assistant are easy to understand?
8-Can you begin and interrupt the action of the personal assistant?
9-In the future, if you can choose the presentation with or without the personal assistant, which one you choose?

Figure 8: Agents Questionnaire

The average obtained in the questionnaire was 3.68. We verified that users favour the assistant's behaviours during the execution of tasks, obtaining an average 3.875. It's important to say that the other aspects obtained an average superior to 3.6. So, the assistant reached successfully the approaches proposed by Hayes-Roth and Doyle, displaying normal variability in their choice and manner of executing behaviours, and being attractive and interesting to users. Besides, the guide treats visitors in a personalized way, aiding and motivating them to accomplish tasks.

We can conclude that visitors are satisfied with the use of assistants. This satisfaction is explicit, because all the visitors answered *"with"* to the question *" In the future, if you can choose the presentation with or without the personal assistant, which one will you choose?"* In this way we verified that the personal assistant was an important aid to visitors during

the operation of the system, executing its main functionality and serving as an incentive for future access to the system.

6. Conclusions

The SAGRES system makes the interactive museum of PUCRS remotely available to the public visitor, as well as contributing to the improvement of teaching and promoting the exchange of information among geographically distant visitors.

Personal assistants are used in SAGRES to assist visitors during a visit. They do this by helping visitors in the exploration of information and systems operation, through a friendly interface where visitors interact with animated characters whose behaviours are similar to human behaviours. A questionnaire administered to users of the virtual guide demonstrates that users prefer to operate the system with the virtual guide, because it facilitates navigation, offers personalized help and demonstrates interesting ways to interact with users, achieving its initial aims.

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OPALES: An Environment for Sharing Knowledge among Experts Working on Multimedia Archives

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Abstract

INA, the 'Institut National de l'Audiovisuel' keeps records of national TV and radio production as French patrimonial archives. They are mainly accessed by specialists for research purposes, and by TV producers for inserting archive segments within new productions. INA and several others partners have initiated an R&D project, OPALES, to develop a distributed environment which enhances experts' private work on multimedia archives and enables collaborative knowledge work on the Web. The challenge is to advance knowledge by building digital communities of experts who add value to the archival dataset by annotating items. The environment supports users working on multimedia archives, preserves their data in private workspaces, and helps them to share expertise. Each end-user accesses information within a private workspace. Any document (annotation as well as archive) is handled as a private copy which can virtually be annotated, indexed, linked to other information, edited to be inserted into new documents, and so on. Direct anchoring of annotations within audio or video is supported.

To manage information and knowledge sharing, OPALES introduces the notions of an 'authoring point of view' which identifies annotation categories and of a 'reading point of view' which specifies which categories of annotations a reader wants to see. Any added piece of information always has an author and an 'authoring point of view.' To enable knowledge sharing, any user can 'export' a point of view to make some part of the elaborated knowledge available to others. Exporting a point of view consists of indexing it into the shared ontology to enable other experts to retrieve it easily and import it into their workspaces. A 'reading point of view' defines how a document is enhanced by annotations when presented. It is a mix of imported points of view. For instance, a researcher on sociology may 'import' ('borrow') the knowledge previously elicited and exported by economists, politicians, ethnologists, and so on, to better understand a document or to improve the relevance of queries. The selected annotations and links are displayed with the document. To enable computer activity using shared information, the system provides a mechanism for handling an extensible ontology, including point of view dependant aspects. It provides support for indexing and for searching in annotated documents.

The paper presents the features of OPALES, describes the mixing of points of view on video archives, and discusses some issues raised by knowledge sharing among experts.

Introduction

This paper presents a national initiative currently underway in France to develop a new service at INA. It aims to support work on video archives. The expected result is a step towards knowledge creation through digital communities of experts exchanging their expertise and making their work available to others. Their common work improves knowledge of the archives, thus leading to added value.

This service relies upon three interdependent and integrated features:

- an improved information retrieval system, with more precise recall for most users
- private workspaces in which users work seamlessly with private documents, archives and annotations of their own or of other users.
- a computer supported collaborative environment which enables distant users who do not know each other, but have the same concerns, to cooperate and to share the result of their work.

The project is intended to apply mainly to video and audio archives.

The paper first introduces the context of the work, presenting the origin of the video archives and the project. Then the role of the Web in facilitating distant exploration and annotation of video is presented. The focus is placed first on the features available in private workspaces, then on the sharing of knowledge among users. The notion of point of view is described from both the author's and the reader's side.

Working on Multimedia Archives

Many projects deal with video archives analysis (Chang 97, Houghton 99). Very few rely on humans for such a task. For instance, the Informedia project at CMU (Hauptmann 95, Olligschlaeger 99) relies on automated approaches such as language recognition and image recognition to produce on line overviews of audiovisual documents. The OPALES project has a quite different purpose and strategy: it aims to enhance the relevance and the level of detail that already exist in the indexing, with added metadata contributed by users working on the video.

Video Archive Storage Policy in France

The systematic collection of books by National Libraries is now routine. Most great nations keep a record of all of their published information in libraries, and already a part of this is available in digital libraries. By contrast, most movies, TV programs, and radio productions are still collected only by producers. As a consequence, this costly collection effort is often limited only to documents which have great value and a high probability of being reused, either frequently or within a short time. Often the cultural or the patrimonial value of a document is not the main criterion in deciding on its preservation for the long term. Such behavior is explicable in terms of market economy, but it causes much of the history of the audiovisual life of the country to be lost. Therefore, in the future it will not be accessible to researchers studying the evolution of our society. This is why France enacted a law in 1992 making it mandatory that any information producer deposit all published production into a specialized national institution: the Bibliothèque Nationale de France for printed documents, the Centre National de la Cinématographie for films, and the 'INAThèque' of the Institut National de l'Audiovisuel (INA) for audiovisual production broadcast on TV or radio.

This policy for audiovisual archives is even older, although it was initially limited only to the production of national TV. INA was created in 1975 to store the archives of national channels and make its collection available to producers and researchers. At the time of its creation, it inherited all the archives of the earliest national broadcasting company. It now deals with more than one and a half billion hours of TV and radio and more than one billion still pictures stored on more than fifty miles of shelves. Currently INA has started to convert a part of its collection to digital format; about 300 000 hours of radio and 200 000 hours of TV are completed, making it now one of the largest repositories of audio-video archives (Auffret, 2000). Nevertheless, note that INA is just the archivist, not the copyright owner of all the deposited documents. It often just operates as a central clearing house between buyers and information owners. Most of its services are related to indexing and searching for relevant information in this huge quantity of audiovisual data.

INA as a Service Provider

In addition to its storage function, INA is also in charge of promoting cultural heritage by proposing many services to clients. Basically, INA serves as a patrimonial archive. Archives are accessed mainly by specialists; for instance, by TV producers wanting to insert archive segments into a new production: perhaps a brief recall of historic facts within the news. Also, it is well known that journalists use archives to prepare and maintain biographies of most famous people, ready to be broadcast within a few minutes whenever needed. Documentary film series also take advantage of INA's archive.

One less visible application concerns the study of our cultural heritage. Many domain experts (historians, sociologists, economists...), and even teachers, novelists and movie producers study audiovisual archives for research purposes: to better understand some events, to elicit their relationships, as well as to catch authentic tiny details of a past way of life in order to produce more realistic stories. These people typically are the target users of the new service developed in the OPALES project. It is now a challenge for INA to take advantage of the Web to provide better service to these users in order that the institution, as a whole, benefit from their work.

The OPALES Project

In fall 1999, the French Ministry of the Economy initiated the OPALES project within the PRIAM national R&D planning program. OPALES is an acro-

nym for 'Outils pour des Portails AudiovisueLs Éducatifs et Scientifiques' (i.e.: 'Tools for Audiovisual Portals for Education and Science'). Project evaluation is scheduled during the fall of 2001. OPALES aims to develop a distributed environment which boosts private expert work on multimedia archives and provides support for collaborative knowledge construction on the Web. Several institutions and research labs and an industrial partner participate in its elaboration and evaluation. The final system is not specifically dedicated to INA: some similar institutions dealing with patrimonial archives are interested in it and collaborate in the project. The MSH 'Maison des Sciences de l'Homme' in Paris, the 'Cité des Sciences et de l'Industrie', the CNDP 'National Center for Distance Learning', and the BPS 'Program and Service Bank' of the 5th TV Channel, as well as INA, provide both video archives and expert users to work on them. In the first experimental stage of the project, the corpus has been limited to copyright free documents in order to make experimental work cheaper.

The OPALES Project and the Web

OPALES is a private Web portal, open only to registered users. Currently, access is restricted to project staff. It supports expert users' activities when working on multimedia archives, preserves their data in private workspaces, and helps them share expertise. Each end-user accesses information within a private workspace. Any document (annotation as well as archive) is handled as a private copy which can be virtually annotated, indexed, linked to other information, edited to be inserted into new documents, and so on. Direct anchoring of annotations within audio or video is supported. Elicited expertise may remain private in one's workspace or be shared. A shared ontology, coupled with indexing and search techniques (Chein 98) based on conceptual graphs, is used to handle semantically rich annotations.

Overview of Private Workspaces

Exploring video archives on the Web

Until now, end users working on INA's video archives needed to look physically at videotapes, either in the INA building or in their institution using purchased copies. Digital video on the Web and secure transactions now make it possible for the users to work from anywhere and for INA to drastically reduce access costs. A large part of users' work online consists of querying the archive base and then exploring retrieved video sequences to decide which parts are the most relevant. Efficient online work requires fast response time, something which is not currently a strength of video on the Web. Therefore, it has been necessary first to develop specific tools to enable rapid searching of video. Typically, users need to look quickly at video contents and explore them at variable levels of detail, not simply to *play* parts of the videos. Video players are not relevant for this service because they are designed for playing, not for exploring. VideoPlayer or QuickTime rely on stored video: they support immediate seeking, but on the Web, their use is restricted to very short movies. RealPlayer uses streaming. It allows playing a portion of a video before receiving its entire contents. It is well suited for live video on the Web, but does not provide real-time exploration features. Video summaries like image albums enable rough overviews but are not sufficient for exploring videos at a detailed level. A special 'videoExplorer' tool (Nanard, 2001) has been designed and developed at LIRMM in order to minimize information transmission between the server and the client station. The explorer server quickly delivers on-demand computed short overviews of any part of a video at any level of detail. A very simple interaction method is used to seek the overview from the client station and select new segments to explore. This technique enables users quickly to observe videos at any level of detail and to focus on any relevant part, as precisely as at the frame level. Its external appearance and interaction method is very similar to that of a video player.

Working in private spaces on the Web

OPALES provides its users with support for private workspaces. One of the expectations of the project is to induce a feeling of ownership in users' work in order to attract clients, keep them, and make it harder for them to go on working elsewhere. In contrast to most Web sites and portals which enable either passive reading of documents or creation of private sites, OPALES supports active reading of documents. Active reading consists of directly working on documents as if they were private; for instance, directly annotating or editing them. In an

active reading environment, the reader does not distinguish between interacting with an archival document and interacting with private notes. Such annotation features are proposed in many systems, but very few are actually effective.

In OPALES, any document displayed on the user's screen is always a virtual private copy. When a user selects a document to be displayed, automatically the server brings back both the document itself and all the references to the annotations previously attached to this document by the user, plus those explicitly imported, in context, from the shared knowledge bank. Since annotation contents are first class objects, they are handled exactly like other documents. One can annotate annotations at will, thus inducing a private hypermedia structure over the set of documents.

Users can also prepare private documents, including edited segments from archives. For instance, suppose a history teacher prepares a course, including in it selected relevant archival sequences as illustrations, with private comments added on the sound track and with some minor graphical enhancements such as indicating names of persons directly on images. Such documents are handled in OPALES simply as edit lists dynamically interpreted when displayed. They are rebuilt from the archives at playing time. Thus any annotation of the included segments anchored in the archives becomes available also from the private document, including notes created later.

Users can also flatten documents to use them outside of the OPALES environment, but in this case they lose all links to the OPALES environment. Flattening a document also triggers the evaluation of the copyrights of included archival segments.

Annotating documents and videos

An annotation results from an explicit user action. One 'annotates' a document by linking to it metadata that we call the 'annotation contents'. In essence, an annotation references the annotated document. Annotations as such are described separately from the annotation contents by a RDF descriptor. There is no restriction on the nature and contents of the annotation or on the annotated document. Anchoring can be done into the annotated document. Internally it uses an Xpointer notation (http://www.w3c). Anchoring into video documents internally relies upon a very simple SMIL description (htpp://www.w3c) of archival movies that just takes into account the actual segmentation that occurs when indexing the archive in the database. All of the precise anchoring is expressed as time-coded segments, enabling anchors to overlap where there is suitable enabling stratification (Smith 1992) of annotations.

It is important to note the asymmetry introduced in OPALES by using hypermedia typed links. By nature, annotation links are different from other links. A link to a document is not necessarily an annotation link. For instance, it may just be a 'citation' link. Annotation links result from a user explicit annotation action which internally creates the RDF descriptor and registers it in the database. Navigation links are handled in a more classical manner. For instance, the annotation contents can be an HTML document with links to other documents; such links are not considered as defining annotations since they do not result from an annotation action.

Annotations are objects in the sense of OO programming. Specific editors are available for each class of annotation. Among them, on the simplest side, a simple text editor or a XML/HTML editor enables users to produce documents; at the opposite extreme, a specific NCG 'Nested Conceptual Graph' editor enables users to attach semantically rich and computable (Mugnier, 2000) descriptions of documents as indexing annotations.

Overview of Knowledge Sharing in OPALES

Interest in private workspaces would be very limited if they did not communicate. Therefore, the most important aspect of OPALES is its support for knowledge sharing among user communities. It enables any users to export part of their work and to import into their own workspace exported parts of other users' work. The OPALES basic belief is that the more shared metadata bound to a document, the greater the value of that document to users. Typically, exporting and importing annotations provide mechanisms for sharing knowledge and thus eliciting shared knowledge

Lesson Learned from the Web

The Web currently is the largest shared information structure in the world. Studying the evolution from the poorest HTML1 to the XML based language family provides a rich set of lessons.

The most important requirement to enable large-scale collaboration is rigorously to define a simple but powerful shared language, and then support its extensibility. Lack of rigor quickly leads to the Tower of Babel phenomenon. Paradoxically, limited power of expression of a language combined with a lack of extensibility produces the same effect. Simplicity, precision and extensibility are required to enable large-scale collaboration.

To accommodate this observation in knowledge sharing , OPALES provides its users with a very precise but extensible ontology (Gruber 1993, Staab 2000), and with very simple rules to support its evolution. An 'archive' ontology is provided to define precisely all of the vocabulary used in the actual indexing of archival documents. But OPALES aims at capturing new expertise that, by nature, does not yet belong to this ontology. Therefore, it is necessary to provide mechanisms to extend the ontology at will. This is not an easy task; it is even an extremely risky one. The chosen solution relies on 'private and sharable' extensions of the ontology.

Since any extension of the ontology and of the document indexing remains private, it has no consequence on the archive base and cannot introduce messy structures that would be troublesome for other users. On the other hand, if a subgroup of users trusts a given set of extensions, they can use it as a dynamically shared extension to the ontology, just for themselves. The OPALES knowledge-sharing engine enables users to work with dynamically extensible ontology and indexing of documents.

The notion of 'point of view' in OPALES is the key for dynamically managing private and shared extensions, indexing, and annotations, and as a consequence, for building and managing digital communities of experts who add value to the archive.

The Central Notion of 'Points of View' in OPALES

Since OPALES is a private workspace strongly dedicated to supporting digital communities of experts, the management of dynamically evolving virtual communities is a major component of the system. We have chosen to permit the free creation of communities and free access to them. A user may create a community just by specifying a concern. We call it a 'point of view'. That user just has to write an informal document to define the concern and to index it formally in terms of the shared ontology.

In OPALES, any piece of information has a descriptor which identifies its 'point of view'. A point of view is not at all an index of the document, but rather a mark that denotes which category of users might be concerned with this information. Points of view have some weak similarities with 'newsgroups,' but it would be erroneous to push the metaphor too far. For instance, consider annotations of a politician's speech: one user may annotate it from an 'economist's point of view' evaluating long term consequences; another may do it from a 'rhetoric expert's point of view' discussing the speech structure; whilst yet another may focus on details of hand motion and face expression from a 'psychology expert's point of view'. Other psychology experts could be interested in retrieving documents annotated by colleagues in their virtual community. By declaring an annotation with this point of view, the annotator locates it within the concern of this virtual community.

Points of view induce an *a posteriori* classification of users based on their stated concerns. Tagging each piece of data with the author's point of view implicitly defines a partition of information spaces. It is stored in the 'workspaces' database. There is no need to use a partition since the formal indexing by points of view enables the NCG search engine (Chein, 1998) automatically to determine the location of the point of view, especially its specialization (Mugnier, 2000)

A point of view is either private or public. A private point of view makes sense only for its owner. It can be used as a kind of private classification system,

with a personal vocabulary. A point of view becomes public if its owner 'exports' it, making its description and indexing visible to other users. As a consequence, public points of view are retrieved like any other documents, thus enabling users to be aware of declared public points of view that are close to their concerns.

Using points of view is quite simple. Any editor window is assigned a default point of view which tags any new document created in this window. The user may assign to it any other point of view, private as well as public, retrieved either from a favorite point of view list, or from a search of existing ones close to the query. If no point of view matches the query, the user may create one and export it: the query already is a good base for starting to index the point of view. It just has to be informally described more precisely. Since points of view are attached to the window rather than to the user, one may easily handle several points of view, private or public, in a workspace.

Since all pieces of information have a point of view, any extension done to the ontology also has a 'point of view'. Extensions can be private or public. In this case, other users can share it. OPALES also supports regulation mechanisms for points of view, especially 'moderator approved points of view' that are suitable for asserting the consistency of extensions done to the ontology.

OPALES points of view have been designed to enable knowledge sharing. Any displayed document has a 'reader point of view' that specifies enhancements by annotations, indexing, ontology extensions, and so on. The readers' point of view is distinct from the author's, since they may also enjoy reading information stored with other points of view to get a wider understanding of a document; but the readers have no reason to place any writings in such points of views. They read from a point of view that combines several authorial points of view, but write from their own. For instance, let us suppose that a sociologist studies the speeches of a politician in order to write an essay on 'tricks to convince crowds'. This user would benefit from importing into the workspace the points of view of the 'psychologist expert' who has analyzed the details of hand motion as well as those of the 'rhetoric expert', but has no reason to write in those points of view if the user's current writing does not concern these virtual communities.

Any window has a 'reader's current point of view' that is built as a list of imported points of view. When a document is delivered in this window, the system also delivers and displays the document's list of *public* annotations that have been created in the points of view currently included in the reader's point of view. . This enables users to browse any of these annotations and recursively annotate them.

The reader's point of view also acts on the search engine. First, during the query preparation, it filters and expands the ontology to help the user choose the proper vocabulary. Second, the search engine takes into account both the actual indexing done on archive and also any public indexing done with the points of view included in the reader's current point of view. This enables both writing far more precise queries which are domain dependent, and retrieving very short segments matching such queries, since annotations can be anchored freely and precisely into the video archives.

Museums keep track of our history and culture. The Web can help them make the past available to all. The most important thing is not simply to show remarkable crafts, but to make their impact on our culture understandable. Museums are like icebergs; the part of collections made visible is rather small. Museums also preserve huge and rich material in storage, but in most cases, it is poorly used and difficult to study. This typically is the case with huge amounts of digital information that contains a quite continuous record of our social evolution. Paying museum staff to exploit these resources efficiently is far beyond museum budgets. Other solutions are needed. OPALES is one of the solutions. It relies on collaborative work on the Web.

Beyond the well-known role of the Web in information access, a far more important application domain is emerging: collaborative and distance work. The effectiveness of Web users' work is now greater than most analysts of the last decade could have imagined. Breaking encryption keys that were supposed to require mainframes for centuries of work has taken months owing to the shared distributed

power of home computers. Dealing with freely distributed collective knowledge is a great challenge for the new century. The Semantic Web project initiated by Tim Berners-Lee (Berners-Lee 1998) bets on the power and efficiency of freely organized collaboration. Several other initiatives propose techniques for distributed annotation of Web pages based on a RDF schema, to improve the efficiency of search engines (Kahan 2000). On a smaller scale, OPALES bets on mixing distributed work within a centralized environment. The choice depends on the need for a well-balanced solution. Letting users do freely what they want has obviously been a success with the Web: a reliable structure has slowly emerged. But in smaller environments, this strategy lacks statistical regulation mechanisms, so it is known to run out of control easily. Constraining users in order to enforce controlled structures requires external force. It never works in open environments. The solution is a balance in which users both feel free but easily find attractive clusters where their expertise is recognized and can be cumulated with others.

The point of view mechanism in OPALES is easy to use. It is sufficiently free to allow everyone to use it at will, without any regulation mechanism. But by its nature, it leads to the formation of virtual user groups within which knowledge can be elicited in a consistent manner, relying on small and local extensions of a shared ontology. This feature enables people working on the same topics to cumulate their efforts. Furthermore, the 'reader's current point of view' provides the means to trigger interdisciplinary work by importing knowledge from other domains for better understanding.

OPALES currently is a tool for experts, mainly because exploring the storerooms of museums is not yet for end users. But expert work has results which usually are presented to end users. Currently the corpus chosen to bootstrap OPALES contains, among others things, a rich collection of documents about the history of modern mathematics, especially hundreds of hours of records of work meetings of the Bourbaki group. As an example, exploring and annotating these historic documents will benefit the 'archaeology' of science by providing a better understanding of the evolution of this discipline, and will make these enhanced documents accessible to a larger audience.

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Being a Museum, Digitally

"Beyond museum walls" – A critical analysis of emerging approaches to museum web-based education

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Abstract

"An effective educational museum might be described as a collection of labels bearing instructions, each of them illustrated by a carefully selected specimen." George Brown Goode, Assistant Secretary at the Smithsonian, 1896 (Alexander, 1979).

Although Goode's assertion may look naive by contemporary pedagogical and museological standards, I'm sure many of us wish that the process of museum education were indeed that easy. However, we know that such assertions are anathema, as both the primacy of the object and our understanding of learning have advanced considerably in the last 100 years. Since the arrival of photography in the mid nineteenth century, the interpretive pre-eminence of artefacts has been steadily eroded by a succession of media. More recently, interactive multimedia (IMM) have penetrated homes as well as museums, transforming visitor expectations as well as the way modern museums approach education.

The most ubiquitous of contemporary IMM, the Internet, is making steady progress as an interpretive tool within museums. However, its major impact is being felt beyond museum walls. As an outreach agent, the Internet has captivated many museums and particularly their educators. As a communication medium, the Internet allows museum educators to enter the homes and schools of students without their ever needing to visit the museum. So it's not surprising that some museum education products try to simulate the spatial and social experience of visiting a museum. However, this approach is just one of many resource "types" educators have deployed as they grapple with the promise and reality of on-line education.

As part of the research team developing Australian Museums On Line's new Education Gateway, I have spent considerable time examining why and how museums are using the Internet for education outreach. In this paper I will explore these, as well as the diversity of emerging on-line education expressions. I will also review current research into the unique interface, navigation and content preferences of various learners and, just as important, discuss best practice teaching and learning strategies to help museum educators develop more effective on-line educational resources.

Introduction

For all but eight of its first 100 years, my museum - the Powerhouse Museum - was part of the New South Wales Department of Education. Not surprisingly, then, interest in the use of objects in teaching here has a long history, dating back to the 1890s, and still remains a critical component of Powerhouse Museum education practice. However, in the last 100 years our understanding of the complex interplay between visitors and objects that gives rise to learning has changed as epistemological and pedagogical research has evolved. From this, a number of educational theories have developed to explain how learning in object-orientated environments such as museums can take place. Today the direct-experience model is the one widely accepted, particularly in science and technology museums.

Direct-Experience Learning

Direct-experience-based learning divides our world into two distinct realms: the physical world where objects exist and events happen, and our minds which are capable of memory and conscious thought. By allowing visitors to encounter *real* objects, labels and a variety of media, we immerse them in a physical world where they see, hear, touch, taste, smell and do. It is human nature that visitors should then seek to understand these 'direct-experiences.' This means they must use their minds to find regularities and relationships between these new primary experiences and existing concepts and principles. In turn, these experiences help visitors develop a range of skills from observation and reporting to deduction.

However, the direct-experience learning model has limitations. First, the reader (visitor) must be sufficiently stimulated by artefactual encounters to want to engage cognitively with them. This is a problem for information technology objects such as microchips and personal computers, whose form is often uninspiring or masks function (Sumption, 1999). Critically, for contemporary museums, the direct-experience learning model is also restricted to the *real*

museum. The moment we move beyond museum walls and into the realm of photo-mechanical and electronic outreach, where the reality of the object is supplanted by a mediated reality, the fundamental dynamic of the learning experience is changed.

The Outreach Revolution

As with education, outreach has been an integral part of many museums' core business. As early as 1891, my own museum opened its fifth satellite campus on the grounds of the Broken Hill Technical Education College. The Broken Hill branch was established to encourage the use of Australian products and Australian materials in the manufacture of articles for everyday use. To achieve this, Broken Hill was supplied with a series of taxonomic displays, all carefully selected and labelled by the central museum's staff. These were then dispatched, complete with hand-crafted cabinets and 2000 objects, to the remote and inhospitable plains of North Western New South Wales.

In the late Nineteenth Century, the limitations of communication media, combined with the uniqueness of the museum concept, meant that nothing less than a complete reproduction of an exhibit would have sufficed for outreach. But by the turn of the century, photography, and the process of its mass-dissemination - photogravure, had opened up new outreach opportunities and challenges.

Why Use Digital Objects?

Like contemporary travelling exhibitions, the painstaking reproduction of displays such as those used in Broken Hill ensure that museum educators and curators retain authorial control over exhibition content. However, the process of historical production, via print and film, is more problematic. As photography and printing physically supplant the reality of the object with a new mediated reality, curator or educator control is diminished by a set of intermediary authors - the camera, the lens, the film, the photographer and the designer. Also, in the late 1990s, when photo-mechanical outreach was itself transformed through digitisation, a further intermediary author was added. Through interactive digital outreach media, even the reader has become a powerful intermediary author. Nowhere is this more evident than in the latest generation of active learning resources now appearing on museum websites.

Since the privatisation of the Internet here in Australia in 1995, museums have increasingly sought to use the web to service the learning needs of predominantly secondary school students. To do so they have harnessed the computational power of modern personal computers via the World Wide Web to create a plethora of learning environments. Critically, these environments have tried to attract and hold students by supplanting the inherent pedagogically weak 'digital object' with more engaging interactive experiences. As was evident in the first generation of museum web pages, the process of 'object digitisation' can potentially strip artefacts of critical signifiers such as scale, weight, colour and texture. Without these material signifiers, the digital object is distorted in ways that can have a qualitative impact on learning. Therefore it is not surprising that more recently museums have enhanced, or even supplanted 'digital objects' with interactive multimedia affordances such as Java applets, streaming video and IRC, etc. As I will show, this shift has had a liberating effect on many museum educators who can now concentrate on the development of educational products centred not just on the objects, but on the students themselves.

Six 'Active Learning' Typologies

For evidence of this shift, look no further than the education winners of the Best of the Web. In 1998 the *Odyssey* website (http://www.cc.emory.edu/CARLOS/ODYSSEY/index.html), utilised museum object images and stories to 'inform' students of the daily life of Middle Eastern and sub-Saharan peoples. In 2000, the Puppets Action website, (http://www.childrensmuseum.org/artsworkshop/puppetshow.html) equipped students with tools to 'create' their own on-line puppet show. This shift from seeing the web as an information medium to seeing it as an active learning environment has consolidated. Now more than ever, many museums are creating web-based learning environments where users, not educators, are empowered to make decisions about the tasks, content, navigation, presentation and assessment activities they undertake. Thus a range of active learning web typologies has started to emerge. These typologies range from mature

education meta-center products, which continue to utilise digital object images and records, through to immature expository resources, which have only tentatively embraced the active learning philosophy. What distinguishes one typology from the next is not just content and enabling technology, but also the cognitive strategies each employs. These are the generative, problem-based, creative play and expository methodologies that help learners to build on their own knowledge structures (schema) to construct new knowledge and understanding. These schema are consciously, and sometimes unconsciously, deployed by designers and educators with varying success. So by offering the following typological overview, I hope to provide a snapshot of current thinking and practice. In turn, I hope this will help museum educators understand the complexities, pitfalls and challenges of creating 'active learning' web resources for museums.

1. Education Meta-centers

Of the six museum education typologies I have identified, *Education meta-centres*, along *with Creative play resources*, are still primarily concerned with teaching and learning via museum objects and documents. However, as we shall see, best practice in both is now exemplified by activities which enable users to manipulate and interrogate both the physical and intellectual content of artefacts.

Education meta-centres are web-based resources that allow students to explore, investigate, compare and evaluate textual and pictorial information from museum collections and archives. Most utilise Online Public Access Catalogues (OPAC) to make museum information accessible via the web. However, the mere accessibility of such data doesn't in itself guarantee learning. Therefore, many developers of data-rich resources, such as the Museum of Victoria's *Butterfly* site (http://www.museum.vic.gov.au/bioinformatics/butter/), have adopted generative learning methods to help students convert raw data into useful knowledge products.

Supporting generative learning

Museum Victoria's *Butterfly* site allows middle and upper high school students to access a single database of 30,000 Victorian butterfly records via seven discrete searches. Each search is designed for students of a particular age and studying a particular syllabus, and culminates in a series of comparative activities that allow students to mentally experiment (generate ideas) with various data sets. Student experimentation and analysis is via a series of web-based mapping tools. These allow them to plot and overlay the distribution data of butterfly species with Victoria's vegetation, altitude, river and zoogeographic information. The result is a unique schematic of species and topological data which students can endlessly modify and interrogate. This allows them to develop learning outcomes built around their own interests, and in turn can result in deeper conceptual understanding and affinity with the subject.

2. Creative Play Resources

Like nearly all active learning resources, *education meta-centers* are primarily designed for secondary and tertiary students. Currently there are few museums developing active learning resources for under eights. This is surprising as most museum educators agree that young children have just as much right to make sense of their world with digital media as do older children. Although small in number, there are a few examples of what I call *Creative play resources* for under eights. The Museum of Modern Arts' *Art Safari* (artsafari.moma.org/) is exemplary. *Art Safari* uses paintings and sculpture from MOMA's collection to help children develop their observational skills. The site includes creative activities which encourage students to examine and creatively respond to the forms, stories and characters in Rousseau, Kahlo, Rivera and Picasso artworks.

Playing to learn

Early childhood learning research points to the value of activities which stimulate and support creative play. Creative play is an important part of young children's learning and describes those experiences that encourage them to explore and test ideas through the process of making. Most project-based websites offer some degree of creative play if they allow students to create original written or oral compositions. However, for young children, drawing and painting-based activities are often the most effective. *Art Safari* supports this kind of creative play by helping children draw a portrait of a pet or a fantastic animal using a downloadable digital pal-

ette. Ordinarily, young children find this kind of activity very stimulating, particularly as it allows them to explore subjects that are close to their hearts. Pets, parents, brothers and sisters, etc., are all of deep personal interest to young children. These subjects, when combined with creative play, excite children to keep on investigating, listening, talking, designing, constructing, asking questions, reading and writing. (Downes, et al, 1999).

3. Electronic Field Trips

While *Creative play resources* are ideal for helping develop observational and hand- eye coordination skills, *Electronic field trips* are best suited for teaching complex cyclic, structural or relational concepts by immersing students in credible microworlds. Credible microworlds convincingly 'transport' students through time to historical sites; through space to the museum; or through their imagination to fictitious and fantastic worlds. The effectiveness of this transportation is in part dependent on audio-visual materials and interactive technologies to 'realistically' simulate an experience or environment. Be they imaginary planets, tropical rainforest or civil war battlefields, all these microworlds must not only capture the attention of students, but also engage them in stimulating activities for long periods of time. To achieve this, many *electronic field trips* utilise anchored instruction techniques.

Anchored instruction

Anchored instruction activities utilise sets of interconnected problems to encourage users to activate their reasoning, deductive and investigative faculties. An excellent example is Brookfield Zoo's *Go Wild* field trip (http://www.brookfieldzoo.org). *Go Wild* challenges students to solve the problem of finding a safe way through the Ituri forest of central Africa. To help, developers have provided four avatar guides who drive the narrative by bombarding users with questions. As with all anchored instruction activities, *Go Wild* challenges are based on *real* problems like using a compass and map, making barkcloth or choosing suitable forest foods to eat. The realistic nature of these problems is imperative to encourage students to take ownership of their dilemma, and in turn, responsibility for actively overcoming it.

4. Video Conferencing

Like *electronic field trips*, video conferencing activities utilise the connectivity of the web to transport students and teachers beyond their classroom or home. However, unlike current *electronic field trips*, video conferencing can utilise synchronous affordance technologies to connect students and teachers to the *real* museum's staff and exhibits, in real time. Here the microworlds created are not simulated, but utilise the performances and 'scenery' of staff and exhibits. Ultimately it is the photogenic nature of these displays, together with the affability and open-endedness of the student-presenter dialogue, which can determine the level of meaningful engagement.

Unfortunately video conferencing is bandwidth hungry. Therefore, museums need ideally to have access to high-speed networks like that of the New Jersey Department of Education's Distance Learning Network. This state-wide ISDN/ATM network allows schools from across New Jersey to link to the Liberty Science Center's (LSC) 250 exhibits. Currently, access to LSC exhibits is via a series of E-connection programs, e.g. the aquatic ecosystems package. This video conferencing activity links a class of upper primary students studying river ecosystems to a biologist based in the LSC's Hudson River aquarium. After a brief introduction, a camera scans tanks of toadfish, eels and spider crabs. A series of carefully choreographed activities follow, prompting students to ask questions about the habitat and behaviour of each species. Quickly a dialogue begins as the Biologist moves from presenter to conversation facilitator. As well as conversational ability, the presenter needs in-depth knowledge to create an active learning experience built around open-ended dialogue.

The nature of digitally based, open-ended experience is complex and ideally needs to be sufficiently stimulating to children to elicit many and varied responses and questions. To achieve this, research has demonstrated that digital resources need to be sophisticated enough to (1) encourage children to respond in thoughtful ways, (2) offer response to children's answers, (3) offer variations that are child-controlled, and finally (4) cater to each child's ability level, cognitive development and computer skills,

as well as culture/s and language/s (Downes, et al., 1999). For all these reasons, we can see why human facilitation of genuinely open-ended learning experiences is still so necessary, and is a learning attribute of video conferencing unmatched by any other active learning typology.

5. Museum Learning Networks

Museum learning networks have been around, in internet terms, for a relatively long time. But surprisingly, they have yet to flourish, and indeed even today most museums are preoccupied with developing resources for students working independently, either from home or within a classroom, rather than working in teams. This is understandable as the complexities of building resources to accommodate more than one simultaneous user can be immense.

Learning networks like the Science Learning Network (http://sln.org/) or STEM (http://www.nmsi.ac.uk/education/databased3/stem/stem/stemintro.asp) characteristically provide aggregated access to an array of field trip and expository resources themed around a single discipline like science, contemporary art or the environment. Twelve science centres from across Asia, Europe and the Americas provide content and manage The Science Learning Network (http://www.sln.org/), established in 1996. Within SLN, students can conduct a series of genetic, solar, aviation and oceanographic experiments or participate in one of three collaborative projects, including *Monarchs and Migration* (http://www.sci.mus.mn.us/sln/monarchs).

Learning through collaboration

Conceptually *Monarchs and Migration* uses the natural phenomenon of migration to encourage an international community to build a rich textual, artistic and photographic snapshot of Monarch Butterfly migration. Classes in the USA, Mexico, New Zealand and Australia use galleries and tracking studies to share observations and photographs of migrating Monarch Butterflies. Whilst offering excellent content and tools, *Monarchs and Migration,* like many learning network activities, is limited in the 'genuinely' collaborative opportunities it offers. These are ideally activities that foster cooperative problem solving through continuous communication. This kind of collaboration is best facilitated via *real* meetings, or chat rooms and listserves, within which the process of creating a joint product is negotiated. These products can be anything from web-based scrapbooks and photo-albums to reports and diaries, but their design and structure need to be carefully considered to encourage mutual respect and trust amongst collaborators. An excellent example is the National Museum of Science and Industry's STEM project.

Users as authors

The STEM project is a learning network with a difference. Instead of museum educators and curators producing content, students and teachers do. Students and teachers who visit one of the National Museum of Science and Industry's three museums are invited to compete with one another to create a web resource based around their visit. Invariably those teachers and students who take up the challenge work in teams, both *real* and virtual. In this way STEM students create products that explore issues, ideas and problems that have roots in their unique experiences, interests and opinions. As in any active learning experience, given the opportunity to control content directly, students are much more likely to be internally motivated to explore issues and ideas close to their hearts. The bonus is that these very same issues are much more likely to be of interest to the resources' intended audience – other students.

6. Expository Teaching Resources

Often found on science and technology museum websites, *Expository teaching resources* are only now beginning to embrace active learning principles. Primarily developed for children twelve years old or younger, *Expository resources* ordinarily are comprised of a series of highly structured computer-directed activities through which a set of principles, laws or theories is presented (expository).

The Australian National Science and Technology Centre's *Funzone* is typical. *Funzone* (http://www.questacon.edu.au/fun_zone.html) features a series of Macromedia-based puzzles, activities and laboratories where students can conduct web-based experiments. One of these asks students to observe

a series of animated lines moving across their screen. After 60 seconds the lines stop moving; however, students observe a motion-after-effect. That is, the lines 'seem' to continue to move across the screen because the brain is so accustomed to the movement, it 'imagines' they are still moving.

Addressing metacognition problems

Interaction with other students and with the Macromedia animation itself has been deliberately constrained in *Funzone*. While this may seem at odds with active learning principles which traditionally encourage open-ended learning experiences, these 'closed' learning resources are not without merit. Potentially they can alleviate some of the metacognition problems often encountered by young children. Metacognition problems can occur when people lose sight of, or can no longer accurately monitor, the success or failure of their own learning because activities are not stimulating, or are too complex. A number of studies have indicated that poor metacognition can also arise when students fail to develop clear-cut learning goals because they are given total control of their learning experience. However, metacognition problems can be addressed through careful navigation and interface design coupled with rigorous remedial evaluation. While this type of work is often time consuming, it is undoubtedly worthwhile as the vast majority of younger children, like older children, still prefer to control their learning experiences.

Therefore the dilemma for *Expository resource* developers is to find a compromise capable of accommodating both the normal student's desire to explore (active learning) and a specific student's metacognition problems. While there are no easy answers, one possible approach is to try to enrich 'experiments' with layers of additional activity. In the case of *Funzone*, students could have been offered extension exercises with different coloured lines or lines moving at different speeds available under student control. This kind of 'value adding' to expository resources has the potential to lessen the likelihood of metacognition problems, as it supports limited student exploration and at the same time embraces active learning. Critically, this layering also has the potential to expand student understanding, as it more clearly defines the limitations within which phenomena such as motion-after-effect operate. An excellent example of this kind of *Expository* layering is the National Museum of Australia's *Ann Fibian* website (http://www.nma.gov.au/education/ann/index.htm). Here students investigate soil erosion and deforestation phenomenon via a series of expository activities having a carefully set mix of computer and learner controlled activity.

Do They Work?

As these six typologies demonstrate, there is no such thing as a sure-fire way to guarantee learning or teaching, only methods or devices (pedagogic or technical) which together facilitate the individual's endeavour (B. Whalley, 1995). Indeed, the deployment of any one of the cognitive strategies I've discussed is not in itself a guarantee students will even pay attention. The best museum educators and designers can do is to carefully consider these cognitive strategies, along with pedagogically appropriate content, design and affordance strategies. But even then we need to recognise that learning is still a process beyond the total control of museums, and is predominantly invested in the individual learner. So even if the mix has been carefully prepared, work can still be undone by the relatively unknown impact of users' unique cognitive, environmental and cultural characteristics. That is why I wish to close this paper with a plea for further research, particularly remedial and summative evaluation. It is not until we have a better understanding of *real* outcomes, against those intended, that museums will be able to advance the practice of active learning product development. However, I'm mindful that active learning environments are expensive to develop, as are evaluation studies. What's more, I've yet to come across a workable evaluation framework. So in a year when AMOL will be launching its own museum learning gateway, I'm very eager to talk to museums or universities interested in sharing costs and expertise to develop appropriate evaluation frameworks for active learning resources.

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1000 years of the Olympic Games: Treasures of Ancient Greece: Digital Reconstruction at the Home of the Gods

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Abstract

This paper results from a recently completed project that augmented an exhibition at the Powerhouse Museum, Sydney, entitled 1000 Years of the Olympic Games: treasures of ancient Greece (July 18 – November 18, 2000). This Exhibition offered an opportunity to supplement the traditional visitor experience with the introduction of 'virtual reality' components. These include a 3D digital reconstruction of the archaeological site of Olympia in 200 BC; the laser scan of the famous statue of Zeus from the archaeological museum in Athens; and the construction of a large-scale Web (http://www.phm.gov.au/ancient_greek_olympics) that combines the Exhibition components with a host of other information sources.

The paper reflects on the theoretical concerns companion to the processes of digital reconstructions using historical and archaeological data sets. From this position it is possible to examine the curatorial and technical decisions made in creating the works. An outline of the web architecture and design is presented. A statistical analysis of the web since its launch is also examined.

as part of

AN EXHIBITION ORGANIZED AND LENT BY THE HELLENIC MINISTRY OF CULTURE, ATHENS
AS A CONTRIBUTION TO THE CELEBRATION OF THE SYDNEY 2000 OLYMPIC AND PARALYMPIC GAMES.
DEVELOPED BY THE POWERHOUSE MUSEUM
IN CONJUNCTION WITH THE UNIVERSITY OF MELBOURNE.

Introduction

Here we enter the ancient sanctuary of the gods of Olympia, witness Zeus the wielder of the thunderbolts, and walk the archaeological site of Olympia as it appears today. The works under discussion result from a recently completed project that augmented an exhibition at the Powerhouse Museum, Sydney, entitled *1000 Years of the Olympic Games: treasures of ancient Greece* (July 18 – November 18, 2000). This Exhibition offered an opportunity to supplement the traditional visitor experience with the introduction of virtual reality components. These were a 3D digital reconstruction of the archaeological site of Olympia, in 200 BC, the laser scan of the famous statue of Zeus from the archaeological museum in Athens, and the construction of a large scale Web which delivered the Exhibition components together with a host of other information sources and interpretive information.

This paper begins by introducing some of the visions, opportunities and cautionary perspectives that are companion to the processes of archaeological reconstruction using digital tools. Observant to the potential and difficulties inherent in digital reconstruction, the paper will then discuss some the curatorial and technical aspects of creating the information complex: the reconstruction of Olympia; the laser scan of Zeus; and the presentation of materials on the Web.

The paper examines the data acquisition process at the site of Olympia, and the archaeological and historical data considerations that were the basis for creating the 3D visualisation of the site in 200 BC. The scan and display of the statue of Zeus is also outlined. A brief description of the web contents introduces the technical, architectural and curatorial decisions that were used to define the design. This section concludes with a statistical analysis of the Web usage since its launch. Reviews of the Web by industry, and education and research awards that the works have attracted to date, conclude the discussions.

Theory in Digital Archaeological Visualisations

Opportunities

In theory, digital reconstructions represent a paramount tool of enquiry for archaeologists. As Forte (2000) notes, this can occur when:

> ..."interactive-computational simulation" becomes the methodical ideal of the scientist: reason and observation permit the break down of an event into its primary elements and from these it is reconstructed. A tight link is established between computational information and the "architecture of thought", because both embody man's desire to be the "architect" of the "world". A portion of the real is no longer represented by a chain of ideas in which all pertinent information is housed; instead it is reconstructed in a way that the observer can immerse himself, react to it and be reacted to...
>
> ...Through the collection of multiple forms of data otherwise lost, that become homogeneous after calculation, a model of the event can be constructed. This allows for the step-by-step visualisation of all phases, providing humanity with extraordinary predictive power, since each level is the necessary condition for the next one.

The techniques of immersion, interaction, and sensorial interaction are all based on perceptive mechanisms (Gregory, 1998 in Forte, 2000). They represent instruments that permit the user to operate in synthetic space; that is, to be able to understand synthetic space in all of its richness through the shifting of points of view (Forte, 2000). In archaeological enquiries, the richness of the medium for teaching and theory testing in the form of alternate visualisations is potentially unlimited.

To situate digital visualisations of archaeological and historical sites into museums and to translate them for the Internet represents a powerful form of interpretation. It allows for complex datasets to be drawn together forming products that are multisensory and easily accessible.

Colonna (1994) presents his view of the flexible nature of digitally reconstructed environments (as discussed by Barceló).

> A virtual world should be, then a *model*, a set of concepts, laws, tested hypotheses and hypotheses waiting for testing. If in standard theories, concepts are expressed linguistically or mathematically, in virtual environments, theories are expressed computationally, by using images and rendering effects. Nothing should be wrong or "imaginary" in a virtual reconstruction, but should follow what we know, be dynamical, and be interactively modifiable. A virtual experience is then a way of studying a geometrical model – a scientific theory expressed with a geometric language – instead of studying empirical reality. As such it should be related with work on the empirical reality (excavation, laboratory analysis). As a result we can act virtually with inaccessible artefacts, buildings and landscapes through their models (Barceló, 2000).

For the Olympia project, the empirical reality was based on numerous excavation reports and historical and scholastic sources discussed below, and in aerial and geological ground survey data. A considerable component of the project was the acquisition and analysis of source information, especially as a high degree of veracity and verisimilitude was required. The digital reconstruction process attempted at all times to create an archaeologically correct interpretation of the research materials available.

Caution in reconstruction

Increasingly, archaeological reconstructions are used in cinemagraphic-digital formats or 3D interactive environments. These virtual models are criticized for their ability to portray scientific speculation as 'truth'. In general the more advanced the level of technology used in the reconstruction and display, the greater the belief in its authenticity (Emele, 2000). This mechanism is also reinforced when reconstructions are displayed in the context of museums with the inherent authority these institutions confer to the works.

Virtual archaeology has been accused of being more 'an artistic task than an inferential process' (Forte, 2000). Uncritical acceptance of the product has led to a point where 'fundamental questions relating to issues such as what we actually mean by virtual reality, and what our expensively assembled models truly represent have been left largely unexplored' (Emele, 2000).

As Barceló (2000) notes:

> ...future advancement of virtual reality techniques in archaeology should not be restricted to "presentation" techniques, but to explanatory tools...
>
> ...VR techniques [are] not only for description, but for expressing all the explanatory process. An explanation can be presented as a visual model, which is as a virtual dynamic environment, where the user asks questions in the same way a scientist use a theory to understand the empirical world (Barceló, 2000).

The perspectives introduced above were to act as both visionary statements and cautionary notes to the visualisation project. Against the potential of a digitally reconstructed archaeological model, the project was constrained in a number of ways with regard to the final product. Resource restrictions (time and computing power) meant that it was necessary to fix an approximate date in the history of Olympia rather than use the model to examine the changes at Olympia over time. Interactivity was also restricted to force the users to complete a tour of the site (with choices along the way) in 20 minutes, rather than allowing free interaction. Juxtaposition of the reconstruction and the archaeological site was introduced by the use of panoramas from the Olympia site as it appeared in March 2000.

The paper will now introduce the Exhibition that gave the opportunity for the creation of the works and the impetus for the Web.

The Exhibition *1000 years...*

In 2000 Sydney hosted the 25th Olympiad and was also the recipient of the most significant selection of antiquities from ancient Greece ever seen in Australia. Sydney's Powerhouse Museum featured 54 ancient objects – most of them usually on permanent display in their museums of origin in Greece, and many being famous icons of Greek art. The exhibition, *1000 Years of the Olympic Games: treasures of ancient Greece* (July – November 2000) captured some of the magic that constituted the essence of Olympia, and the vibrant ancient Greek society in which it thrived. The majority of objects coming from Greece to the Powerhouse Museum, including sculpture, grave markers, votive offerings, ceramic vessels and sporting equipment, date from around 700 to 200 BC. This slice of time is one of the most energetic periods of human endeavour ever recorded. Subdivided chronologically for our convenience into the Archaic (about 660-480 BC), Classical (480-323 BC) and Hellenistic (323-27 BC) Periods, it was during this time that the essentials of western life were defined – including philosophy, poetry, drama, architecture, art, and sport (Donnelley, 2000).

Due to a significant sponsorship offer by the Intel Corporation, the Exhibition had two interactive components – the digital reconstruction of Olympia and the 3D Zeus – incorporated into it. Most importantly (according to sponsors wishes), both of these works would be translated for the Internet in a state-of-the-art Web. Data acquisition was a major task in creating the initial exhibits.

The site of Olympia – data acquisition

The site of Olympia is in fertile countryside squeezed by the steep and tree covered Mount Kronos into the elbow of two rivers – the Alpheios and Kladeos. Archaeology and historical records show that little has changed at this site over the past few millennia. In the prehistoric period, its verdant topography inspired the worship of nature gods and set it on a course for greatness as one of the glories of ancient Greece. This isolated glade was to spend 1000 years as one of the most important religious sanctuaries in Greece, with its Olympic Games a fundamental component of worship to the supreme deity in the ancient Greek pantheon: Zeus (Donnelley, 2000).

A team comprised of a curator, archaeologist, surveyors and photographers traveled from Australia to Greece early this year to capture the data sets

in high resolution using laser scanning and digital photography. Most of the archaeological remains at Olympia are scattered across the site, the result of two earthquakes of the 6th Century AD and numerous floods. Those foundations that survive date to different periods, from the Archaic, Classical, Hellenistic and Roman times.

The excavations at Olympia were begun in May 1829, by French archaeologists. The initial finds (metopes from the opisthodomus and parts of the metopes from the pronaos of the Temple of Zeus) were transferred to the Louvre where they are still being exhibited. When the Greek government was informed of the looting of artefacts, the excavation was stopped.

Excavations were started again 45 years later by German archaeologists. Research continues today by the German Institute of Archaeology in Athens and the Ephorate of Antiquities in Olympia. The Museum of Olympia associated with the archaeological site houses many of the sculptural and object material that has been recovered from the site. Supplementary material on the archaeological site and its associated Museum can be found on the Hellenic Ministry of Culture's Web (http://www.culture.gr/).

The bibliography on Olympia runs to hundreds of items, although those dealing strictly with the archaeology of the site can be counted in the mere dozens. The most important sets of documents for the reconstructions were some of the oldest. It almost goes without saying that any work on Olympia would be nearly impossible without Pausanias' *Guide to Greece* (2nd AD).

The five text volumes of the earliest German series, *Olympia. Die Ergebnisse der vom Deutschen Reich veranstalteten Ausgrabung* (Adler et. al. (1892-1897); referred to hence as the Adler and Curtius publications) contain incredibly detailed descriptions of buildings and objects, complemented by the hundreds of plans, sections, drawings and reconstructions in the accompanying folio volumes. Subsequent important updates have been published by Ashmole & Yalouris (1967); Grunauer (1971) and (1981); Miller (1971); Mallwitz (1972); Herrmann (1972); Koenigs (1984) (Da Costa et al, 2000).

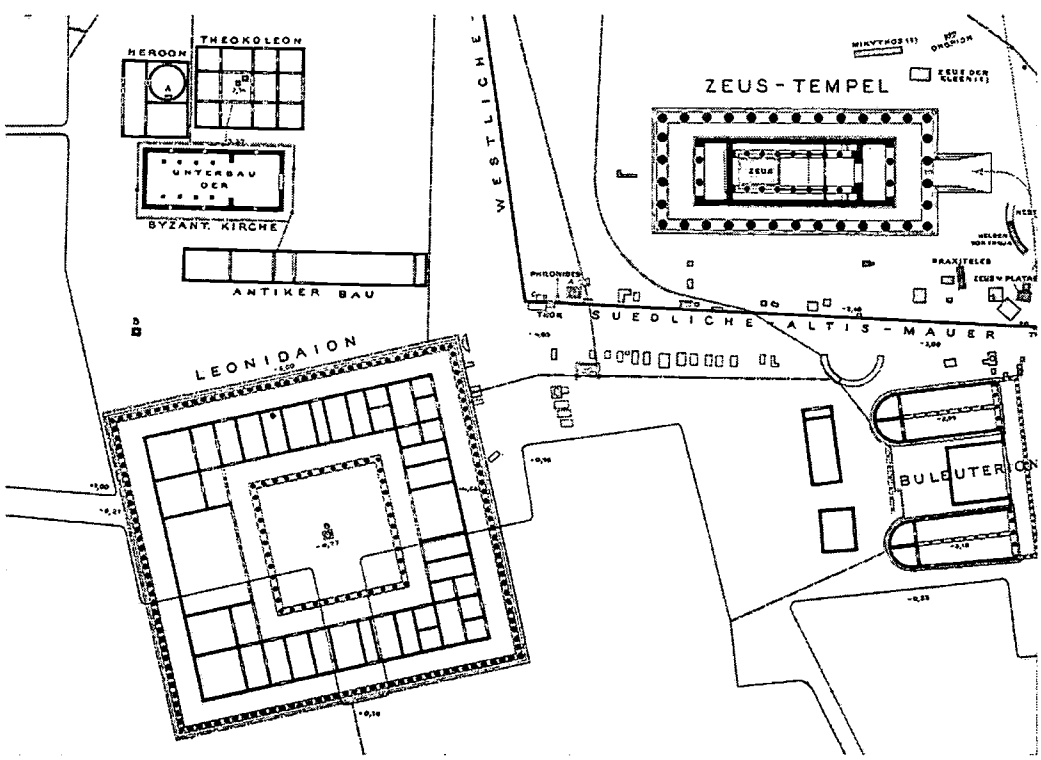

Fig 1: Detail from an excavation map of the site of Olympia, Adler & Curtius 1896.

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Archaeological and historical considerations

The project team decided to attempt to reconstruct Olympia, as it had been around 200 BC. Of course, it is actually impossible to pick a single year to reconstruct an ancient site, given the relative coarseness of archaeological chronology. At a site like Olympia, used without interruption for over a thousand years, almost certainly with frequent refurbishment of quite old buildings, it is really only possible to establish the rough date a building was erected. Whether a building was undergoing renovation in a particular year cannot be stated. The length of time it took to complete buildings is also another issue.

The choice of 200 BC was therefore made for mainly practical reasons: the later the date in the site's history, the more buildings there would be, and the more interesting a virtual tour for modern visitors would be and would more closely correspond to the extant ruins; it was an Olympic year; it was just before the Roman annexation of Greece began. We acknowledge the date was stretched slightly in order to incorporate the entire gymnasium and the *krypte* entrance to the stadium.

Individual buildings

The Adler and Curtius publications provided detailed ground plans of most buildings. As well, the elevations were usually calculated, and the extant decorative elements, mainly terracotta *simae* and *akroteria*, were associated with each building. Major additions or changes to some buildings were taken from the later publications. The drawings were used directly by the modellers to recreate each building. An attempt was made to incorporate as much small detail as possible given the limits of time and computing power (both in rendering and delivering the animated tour). For example, the Adler and Curtius volumes contained the differing capitals and columns of the Heraion, and these were included in the model.

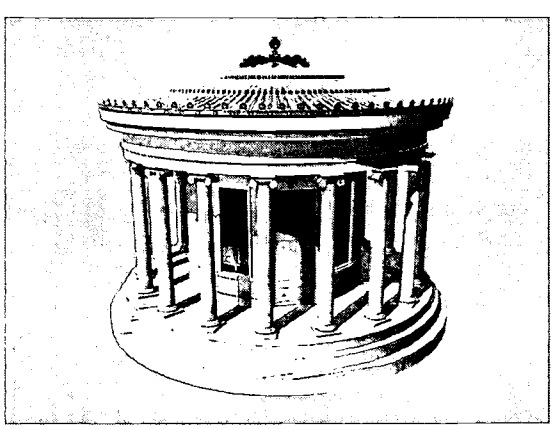

Fig 2. Work in progress, rendering the Pryaneion. © Powerhouse Museum.

Inevitably, there was missing information, and the limited timeframe meant that not every known detail could be incorporated. The application of colour, which is now standard in our concept of ancient Greek architecture and art, is still difficult because of the lack of evidence. One particular difficulty in using the early German work is that the colour plate published (Volume II, plate CXII) does not correspond with the text description of colours or placement, even though it is supposed to be the template for the painting of Doric buildings at Olympia. This is partly a factor of colour printing techniques in 1896 and the fact that we had the 1966 reprint, and also due to the difficulty of really knowing what colours such as "mild whitish cobalt blue" or "a strong but at the same time transparent blue" actually were. However, we followed the Adler and Curtius publications as closely as possible in terms of applying colour to the buildings, and the evidence of the terracotta roof decorations excavated at the site was particularly helpful in this regard.

Buildings which must have had pedimental sculpture or for which some fragments of sculpture remain, such as the Metroon, were given pale blue pediments, rather than attempting a poor reconstruction. Doors and lattice screens were based on those depicted on black and red figure vases.

Probably the least satisfactory outcome, given the time restrictions on the project, related to the addition of statuary to the Altis area of Olympia. Literally hundreds of dedicatory statues and objects would have been placed into the sacred area, but we were able to reconstruct only a handful, modelled on excavated statue bases and the descriptions in Pausanias.

Our most ambitious reconstruction was the interior of the Temple of Zeus. This was based only on

Fig 3. Metope X from the Temple of Zeus. The Apples of the Hesperides. Archaeological Museum at Olympia. Photograph Powerhouse Museum. © Hellenic Ministry of Culture.

Pausanias' descriptions as no evidence remains. It is thought that some coins and Christian icons reflect the seated Zeus figure, once one of the wonders of the ancient world, but they have already past through the filter of later cultural biases.

A further discussion on the basis for reconstruction is available from the project Web (http://www.phm.gov.au /greek/4/pdf/archaeological_basis.pdf).

The digital model

The topography of the site and the locations of key structures were surveyed by members of the team so that the present surface (which approximates the original ground level of the site) could be used in the visualisations. This was performed using surveying equipment loaned by the National Technical University in Athens. A digital elevation model was prepared from this data, and combined with a detailed terrain model of Kronos Hill obtained from large-scale topographic maps. In addition, the surrounding landscape was also modelled from smaller scale topographic series maps. As a result, the landscape of ancient Olympia used in the visualisations is a very close approximation to the terrain of the period.

Fig 4. Colour interpretation Metope X from the Temple of Zeus, The Apples of the Hesperides. Drawing David Loong. © Powerhouse Museum.

Every graphic element was created for the project. Existing digital Greek architectural elements would not have allowed us to maintain a sufficiently high level of contextual accuracy. For example, the Temple of Hera (where the Olympic torch is ignited) has every column different as it was constructed and reconstructed over a long period of time. Standard commercial digital library elements did not easily modify; in all cases it was easier to create new elements. The human figures and statues were modelled originally in Poser V4, and modified in 3D Max.

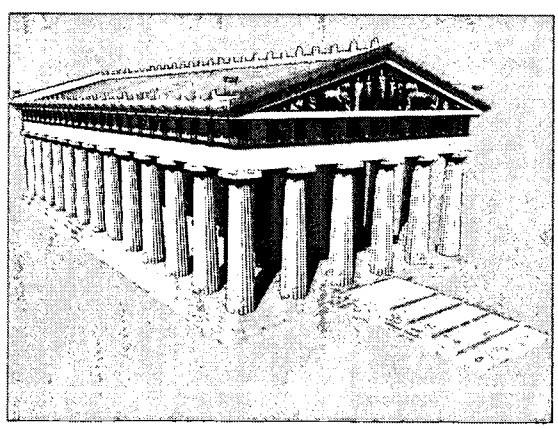

Fig 5. Reconstruction of the Temple of Zeus. © Powerhouse Museum.

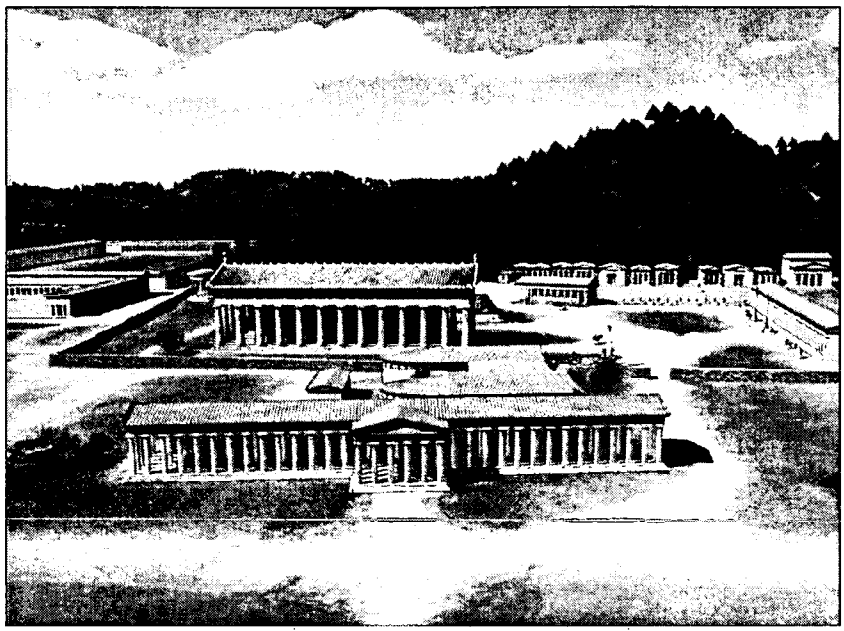

Fig. 6. South-south-east aerial view of the reconstruction. © Powerhouse Museum.

Display

The delivery of the VR reconstruction posed many challenges. The intention was to provide a 3D 'experience' of Olympia to an audience of up to 20 people at a time using affordable technology. A rear-projection polarised projection system with inexpensive plastic glasses was developed. Two JVC DLA-C15 rear projection capable projectors were used to overlap the left and right channel images onto a 3m wide screen in a 5m square room.

Future

The virtual reconstruction of Olympia was intended for the general public (with limited interactivity) rather than for use as a teaching tool. However, the underlying dataset of the model does allow for scientific use. Some areas for investigation include

- Modelling sun in relation to temples
- Modelling the earthquake effect on the Temple of Zeus
- Model allows for further research about the use of the sanctuary and liturgical practice
- Choices for colour applications invite responses from the academic community.

Statue of Zeus

One of the most significant sculptures in the National Archaeological Museum in Athens is the statue of Zeus from Artemision (Artemesium), also considered to be perhaps a statue of Poseidon. This bronze sculpture is slightly larger than life size, and was found in 1926 in the sea off Cape Artemision. It is one of the few surviving examples of Early Classical statuary. The laser scan of the Zeus allowed this object to travel, in a virtual sense, from Athens to Sydney.

A laser scan

A Modelmaker Laser Scanner mounted on a Faro 3D Coordinate Measurement Arm was used to create high-resolution point clouds of the surface of the statue. A purpose-built scaffold was fabricated in Athens to enable elevation of the scanner to the top of the statue while ensuring a stable fixture. The entire sculpture was digitised over several daytime sessions in multiple parts. There were considerable restrictions on this part of the project, which included no method of re-orienting the scanning system datum and a very short working period in the Museum.

The data resulting from the laser scanning operation consisted of very dense clouds of points rep-

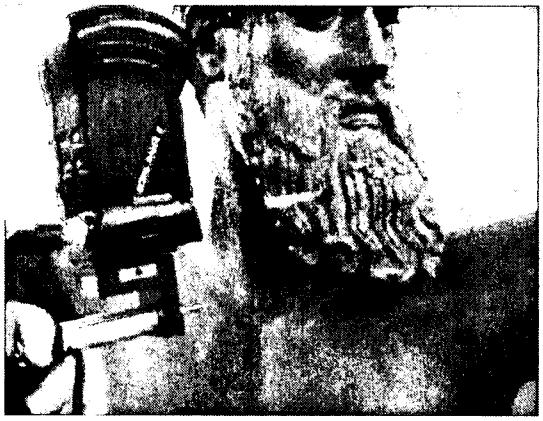

Fig 7. Laser scanning the statue of Zeus at the National Archaeological Museum in Athens, March 2000. Photo University of Melbourne. © Powerhouse Museum.

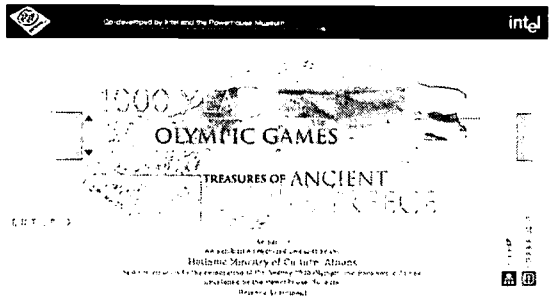

Fig 8. Screen grab from the homepage of the web, 1000 years of the Olympics Games: treasures of ancient Greece, 2000. (http://www.phm.gov.au/ancient_greek_olympics). © Powerhouse Museum.

resenting the surface of the statue with a coordinate accuracy of around 0.2mm. This presented many difficulties as the data sets were huge and needed substantial filtering before they were useful. The decimation process reduced the density of the data points without reducing the high level of detail in the model. The process used a variety of software packages, finally resulting in 3D Studio Max model of the statue. This contained over 2 million polygons.

Presentation

The Zeus model was presented in a separate virtual reality booth at the Exhibition. It was displayed using shuttered glasses technology driven by proprietary software running on Intergraph hardware.

A limited amount of interactivity was provided where users could rotate the model about its vertical axis, and zoom in and out. A higher degree of interactivity was not appropriate given the respect accorded the actual object itself, and therefore, its facsimile! (Da Costa et al, 2000).

The aforementioned works – Olympia and the Zeus – were both then translated into the products for a state-of-the-art Web.

Web site (http://www.phm.gov.au/ancient_greek_olympics)

Despite the great opportunity to produce these aforementioned interactive Exhibition materials, the sponsors of the project (Intel Corporation) and the Museums' main interest involved the production of a state-of-the-art Web. This Web was intended to augment the Exhibition, and to demonstrate the viability of the Internet to supplement and extend materials offered locally in the Museum. The ability to give access to this material to wide audiences and the fact that it will eventually outlive the Exhibition by two years is also the advantage of this medium.

To meet the sponsors' expectations, this Web was constructed to demonstrate the use of state-of-the-art technologies for the delivery of rich cultural content. The web was designed with a two-week exclusive period for the Intel Web Outfitter Service in the United States, where subscribers have a minimum of a PIII chip and are regularly updated with the latest plugins. From the Museum's perspective the opportunity to design a product with a high degree of sophistication outweighed the concerns over download times and minimum browser specifications. The Web was ultimately intended for academic, school and researcher markets.

Architecture, design and programming

The web was scripted as active server packages. A flash based navigation system was used. There was high use of 360° panoramas constructed with Live Picture from Reality Studio. Apart from the standard plugins such as Abode Acrobat Reader, the main plugin is the Zoom Viewer by MGISoft. The latter has two main utilities: it allows the high-resolution images to be stored on the server and streamed to

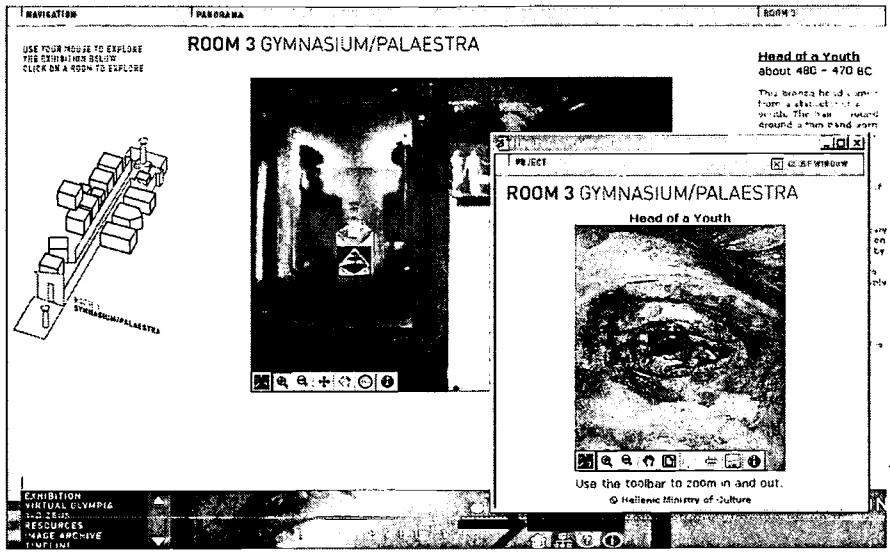

Fig 9. Screen grab from the virtual Exhibition of the web, 1000 years of the Olympics Games: treasures of ancient Greece, 2000. (http://www.phm.gov.au/ancient_greek_olympics). © Powerhouse Museum.

the user on demand; and it prevents the users from saving the materials to their hard drives. This last feature is of extreme importance to the Greek Hellenic Ministry of Culture and the Museum who wish to protect copyright. As noted, none of the Exhibition artefacts (also on display on the Web) had travelled outside Greece before. With a history of contentious international relations over Greek antiquities, it was very important to all those involved that every measure be taken to prevent unwanted use of the digital materials. VRML was not considered to be a robust or user-friendly environment for translation of the Olympia reconstruction. However visualisation in 3D is certainly the way forward for the display of these materials in the future, and major developments continue in this field.

The web is constructed in six sections. These are:

1. The Exhibition: a series of zoomable panoramas of the Exhibition at the Powerhouse Museum augmented by 3D object movies and high-resolution zoomable images of objects, and supplemented with object information as text.

2. Virtual Olympia: this section contains a rich collection of materials separated into 4 sub-sections, including:

- Archaeological and geographic maps of Olympia
- A panoramic tour of the digital reconstruction of Olympia presented as 360° zoomable panoramas (viewable at full screen) with audio files. The option to download individual buildings to complement scholarly research is also available. Essays available as PDF files
- 29 zoomable 360° panoramas of the archaeological site at Olympia taken in March 2000 (viewable at full screen). Essays available as PDF files
- The statues from the Temple of Zeus shown as a 360° panorama of a room at the Museum of Olympia, and a series of zoomable object movies. The metopes are further supplemented by reconstructed line drawings and colour interpretations using archaeological and historical records as sources for reconstruction.

3. 3-D Zeus: a web version of the laser scan of the Zeus of Artemision, with the option to view as a 3D anaglyph through downloadable anaglyph glasses.

Resources:
- 14 researched PDF articles
- Education programmes
- Glossary of terms linked to the PDF articles
- A nodal genealogy of the gods
- Supplementary programme of events to complement the Exhibition at the Powerhouse Museum
- All audio files are listed.

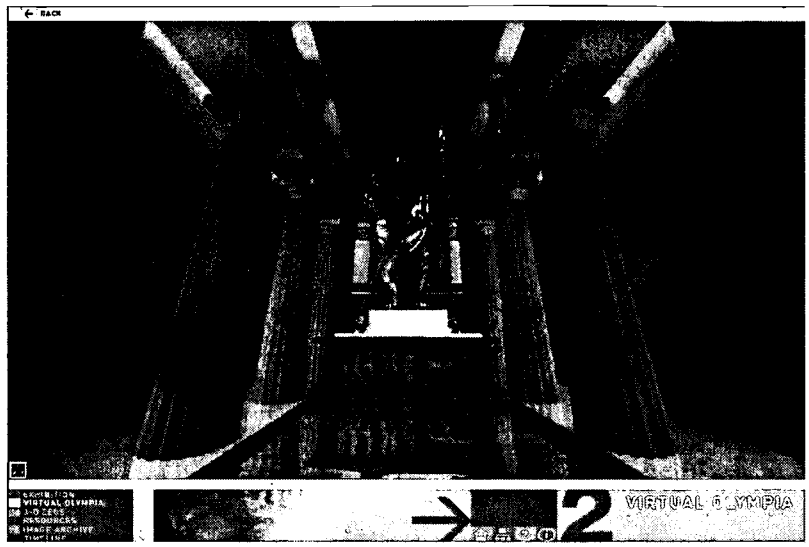

Fig 10. Screen gab from the Temple of Zeus statues as displayed in the Museum of Olympia, 1000 years of the Olympics Games: treasures of ancient Greece web, 2000. (http://www.phm.gov.au/ ancient_greek_olympics). © Powerhouse Museum.

5. Image archive: because of the extensive visual components in the web, this section offers a quick entry to all the individual panoramas, zoomable images, object movies and jpegs. Selected buildings from the digital reconstruction of Olympia are available here, for research purposes, to download and print.

6. Timeline: a timeline of events at Olympia over a 1000-year-period is organised into three categories:

- Events specific to the Games at Olympia (events added after 200 BC not included)
- Events relevant to Olympia itself (building programme until end of Hellenistic period only)
- Events, political, around the Mediterranean world – after 200 BC only events directly relevant to Greece or Olympia included: politics, arts & sciences.

The Web also contains extensive project information, help information, plugins and downloads pages.

Promotion and marketing

The Web was launched just prior to the Olympic Games. It benefited from a high degree of marketing through its association with the Intel Web Outfitter Services and was featured on the homepage for the Intel.com Web for a short time in the United States and Australia. The site was translated into three other languages: Korean, Chinese and Japanese. In conjunction with children, the Premier of the State for New South Wales launched it. There was a high degree of media coverage derived from the Web launch and also from the Exhibition itself.

Analysis

Statistical data has so far been analysed for the four-month period of the Exhibition – from the beginning of August, 2000 until the end of November, 2000. The author acknowledges the restricted nature of basic statistics to determine true use of the Web. However, general statistics are presented here to demonstrate several observable trends.

The average number of hits per day over this period totalled 18,500. Other broad general-level statistics include these: the average number of visitor sessions of 52, 582, and the average visitor length of 12 minutes. The majority of visitors were from outside Australia (international at 55% and unknown at 29%).

A more thorough examination of the period shows a predictable variation in the data display. The most active day of use was during the Olympic period

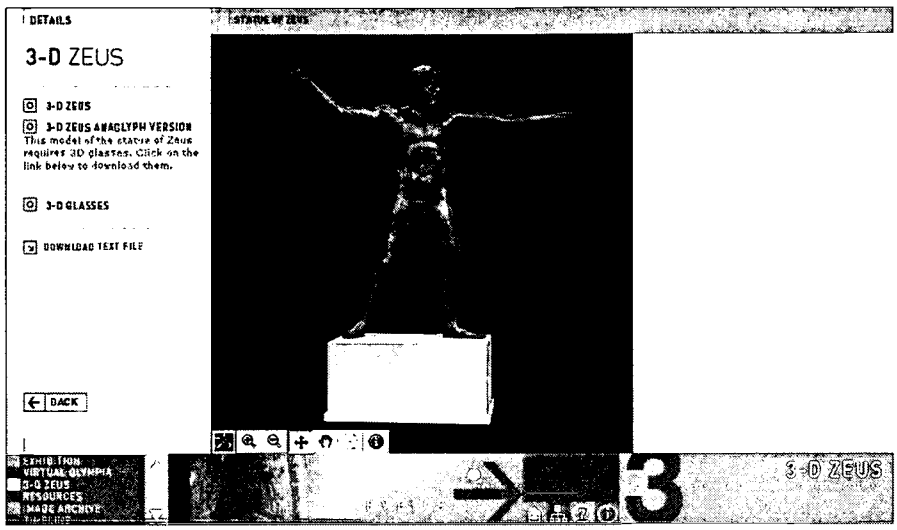

Fig 11. Screen grab from the 3D Zeus, 1000 years of the Olympics Games: treasures of ancient Greece web, 2000. (http://www.phm.gov.au/ancient_greek_olympics). © Powerhouse Museum.

and on September 16, 2000 with 92,352 hits. Weekdays rather than weekends showed a larger number of hits although it was after-hours that numbers were marginally higher. This contradicts our initial expectations that the high bandwidth required to access the site would preclude extensive home use.

What is potentially of more interest is the length of stay by each visitor: 45% of visitors accessed just the first two pages of the Web. There was a corresponding drop off as the number of pages increasesd. However, a relatively high proportion (8% of the visitors) was staying over 20 minutes to access 43% of the total page views. This last statistic would suggest that those visitors who were interested in the site found rich and rewarding content. At one point in the 4-month period over 18% of the visitors were staying more than 20 minutes. In Web lingo this has been referred to as Web "stick-ability" (and hopefully not a measure of slow content download!).

The Web will be hosted on the Museum server for two years. As is so often the case, the overall development time for the entire project was just 4 months – including the Exhibition 3D materials. This prevented extensive usability testing before launch, and represents a classic scenario in museum projects. During the upcoming period it will be possible to further analyse the Web use in schools and tertiary institutions. There have been numerous complimentary emails from such organisations about the quality of the scholastic research, although there have also been requests for a CD ROM version to allay the heavy bandwidth requirements.

Awards

The overall project has won many awards in the short time since its launch. The most important of these include a Virtual System and Multimedia award for the Best Virtual World Heritage reconstruction; the Best of the Best web for the Australian Interactive Multimedia Industry Awards; the Best Interface Design at AIMIA; Hitwise Top 10 for Education and Research 2000; and the Web was a finalist in the British Association for Film and Television Interactive Entertainment Awards 2000 (short-listed to one of three along with the multi-million dollar 'Walking with Dinosaurs'). The judges described it:

> A fascinating and highly interactive site, this is elegantly designed and technically impressive and brings you closer to Olympian Greece with effortless navigation and appropriate use of all media, including superb panoramic photography and walk through 3D architecture. It is a state-of-the-art web with

an excellent interface and very high-quality content. A technical tour de force deploying a broad range of impressive plig-ins to good effect (BAFTA awards catalog, 2000).

Conclusion

Any project of this nature is concerned with how to balance 'realism' with 'reality', and the decisions made in the creation of digital reconstruction were further constrained by the goals of the project, the intended audience, the desired product, the quality of archaeological information, and technological capabilities. In the construction of the Web, a further caveat on design decisions included the use of state-of-the-art technologies, which must demonstrate impressive content development and display for a sophisticated Web user demographic. This questioned the Museum's role as a provider of 'access for all', but at the same allowed for the Museum to push limits in Internet design and technology using rich cultural content.

The Web and its contents are being re-purposed for a DVD ROM which will be distributed free of charge to all schools in the State of New South Wales, Australia, and in limited numbers for other markets. The 3D version of the digital reconstruction of Olympia has been sold to three international Olympic museums, and is to be used in university teaching in some form.

The project is an example of a digital reconstruction project that has been repurposed for a highly successful Web. It also demonstrates that rigorous scholarship is a worthwhile investment and can command a significant audience. The repurposing of the underlying content has enabled the works to be developed for different platforms and delivery mechanisms. The challenge lies in providing users with the ability to alter input data to test their own hypotheses. The development of VRML worlds on the Internet (ones that are robust in implementation) will hold much value for museum Web developments.

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[Sections of this paper have been included in the project information available on the web (http://www.phm.gov.au/greek/4/pdf/Grecian2000weba.pdf) and (http://www.phm.gov.au /greek/4/pdf/archaeological_basis.pdf)]. With regard to these documents the author would like to acknowledge co-authors Kate Da Costa, Cliff Ogleby and John Ristevski].

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Thanks to co-developers Cliff Ogleby and John Ristevski from the Geomatics Department at Melbourne University for their work on the digital reconstruction of Olympia and the Zeus; to Vu Nguyen and Asher Graham of Osmosis for their excellent rendering and animation skills; to Kate Da Costa, archaeological advisor on the project, who was an invaluable and seriously hardworking talent, without whom we would have retired to Disney....

The Web was conceived by the Powerhouse Museum. The photographic work at the archaeological site was undertaken by Peter Murphy, Sydney. It is his genius also that enabled much of the data that is displayed on the Web. The overlays for the metopes were draw by a meticulous David Loong.

The sonorous tones of David Rutledge were recorded for the tour and used for a number of audio files on the Web site.

Thanks also go to Lefki Pavlidis for her assistance with the data collection and laser scanning in Greece; and to Sebastain Chan and Jessie for the installation tweeks that needed to be undertaken for the virtual Olympia model.

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Engaging Museums, Content Specialists, Educators, and Information Specialists: A Model and Examples

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Abstract

This paper describes a model for the use of the Web to engage communities in better understanding and appreciation of cultures through partnership among a knowledge organization, K-12 teachers and learners, museums, and regional and virtual communities. Museums and other content providers offer artefacts for object-based learning. Content specialists contribute specialized content expertise and evaluate resources. Education specialists develop, evaluate, and use materials for instruction. Information specialists identify, evaluate, organize, and promote the use of web-based and other information resources. They also develop tools to capture and display content, to engage the teachers and learners in dialogue, and to reach out and extend the content and resources to both local and virtual communities. Communication tools enable members of the local as well as virtual communities to provide reflections and engage in dialogue, as well as to contribute their own content. Two recent projects developed from the model are described, in addition to four previous projects developed by the project team, that exemplify earlier applications of the model. Lessons learned from the project work are identified, and the paper discusses ways in which this type of project work reflects new roles for the professionals participating in the projects, as well as changes in the mission of their organizations and professions.

Introduction

Successful partnerships among different institutions or disciplines are an attractive way of providing complementary expertise in addressing needs of common concern and tasks that require a range of knowledge areas. As professions evolve in their missions and their roles expand and intersect with those of other disciplines, the potential for effective synergistic partnerships increases. Professionals in museums, libraries, the performing arts, and K-12 education have all undergone profound misson changes which have resulted in greater emphasis on outreach and new connections with members of other professional communities. At the University of Michigan, some interesting and fruitful partnerships have engaged members of the arts community, museum and library specialists, faculty scholars, K-12 educators, and students from the School of Information. From these has emerged a partnership model utilizing the information and technology skills of librarians and information professionals, the content knowledge of curators and scholars, and the expertise of K-12 teachers and other youth educators. The partnerships developed have broadened the reach of arts and cultural heritage content by taking advantage of the unique potential of information technology to disseminate content, knowledge and ideas to a wide array of audiences, to provide context to increase the understanding of cultural content, and to provide a means of interactive and cross-cultural exchange of ideas and new creative work.

This paper describes partnerships in two recent projects which build on the model, as well as lessons learned in these and related projects which exemplify earlier applications of the model. Finally, some observations are offered on the ways in which this type of project work offers the opportunity for professionals to assume some of the new roles which are emerging as a result of the evolving missions of their organizations.

The Projects

The two projects which illustrate the partnership model described in this paper are ones in which a faculty member and graduate students at the University of Michigan School of Information play organizing roles as part of the CHICO project (Cultural Heritage Initiative for Community Outreach (http://www.si.umich.edu/CHICO/). CHICO has as its mission to broaden the reach of cultural heritage resources through the innovative use of information technology and through partnerships with museums, schools, libraries, content specialists, and community arts programs. CHICO collaborated with campus partners to provide a digital showcase for events and exhibits in the arts. The resources were augmented with contextual enrichment provided by content specialists. The site was targeted to general audiences, with a focus on K-12 users. Delivery included both Web-based resources as well as public

events and activities in the classroom with the partnership of K-12 educators.

Royal Shakespeare Company Project (RSC)
http://www.si.umich.edu/chico/rsc/

A landmark performance event at the University of Michigan is the appearance in March 2001 of The Royal Shakespeare Company from London for a three-week residency on campus and in the surrounding region. The Company's performance of the complete cycle of Shakespeare's eight historical plays and the residency of the actors, stage crew, and education department engage University scholars and students, regional community groups , K-12 schools, theaters, and local museums and libraries. Educational and outreach activities developed for the event help K-12 teachers and learners learn not only about the plays themselves, but also about the relevance the themes in the plays have in their everyday lives. School of Information graduate students in the CHICO project have a role in developing web resources to help increase appreciation and understanding of the plays.

Food/Animals in Ancient Cultures Project
http://www.si.umich.edu/CHICO/AncientFood/ and
http://www.si.umich.edu/CHICO/Animals/

A University of Michigan professor who has done pioneering work in providing a multidisciplinary approach to the study of classics and archaeology worked with CHICO students to develop a web resource to help K-12 students understand the role of food in ancient culture through examination of artefacts in a local museum. SI graduate students had a role in developing resources and tools to build a virtual and local community of scholars, K-12 teachers and learners, museum experts, and other interested people in the community with the goal of understanding how people lived in ancient cultures and how these cultures have relevance in today's times.

Collaboration roles

With a collaboration among museums, content specialists, K-12 and outreach educators, and information specialists, there are roles for partners providing service to the end-user, as well as roles for end-users engaging with the content. Individual partners can play different roles according to their degree of expertise, level of commitment, and ability to participate in terms of time and resources. For us, the role distribution was as follows:

Content provision

- creation of content (curators, scholars, information specialists)
- resource discovery of information on related topics (information specialists)
- interpretation of content (curators, scholars, information specialists)

Content organization and distribution

- selection and organization of content (information specialists)
- mounting and display of content in digital form (information specialists)
- provision of contextual information and background for learning purposes (information specialists, curators, scholars)
- site design and implementation (information specialists)

Organization of project activities

- liaison (information specialists)
- identification of relevant content specialists (information specialists)
- recruitment of content specialists and partners (information specialists)

Activity creation

- providing web-based activities to engage in and connect with the content (information specialists)
- providing on-site activities which link to the physical and virtual exhibits (museums, performing arts agency)
- coordinating activities among the various partners (information specialists)

Audience

For the end-users and audiences, roles include:

- engagement with peer learners
- creation of artefacts and content which build upon the collection

- feedback on the usability and usefulness of the site

Engagement with Content Specialists

In creating web-based materials for both projects, the team's goals were to create interest in and understanding of the topic; augment the performance or museum visit experience; provide a means for further study of the topic; provide mechanisms to engage in dialogue; and provide a means for participatory experiences.

The broad themes for structuring the sites included Relevance and Connections; Context and History Background; and Behind the Scenes (stagecraft, or mounting a museum exhibit). In both projects, CHICO team members were able to take advantage of local content specialists, as well as resources and events, all which contributee to content of the web-sites and built upon the broad themes.

Content specialists in the Royal Shakespeare Company project

The visit of the Royal Shakespeare Company, organized by the University Musical Society, provided a ready-made infrastructure, including a collocation of content specialists and a wide array of planned educational outreach activities, including public lectures, museum exhibits, seminars, university class sessions open to the public, interviews, workshops, and in-school visits. The audiences for the events include the general public, university students, K-12 teachers and learners, and theater groups throughout the area of Southeast Michigan and central Canada.

In designing the site to establish relevance and connection, the CHICO students envisioned a resource containing information, enriched by images, maps, and links, to make clear the relevance of these plays to a contemporary audience. The site would also contain material to encourage people to make their own connections to the plays. An example is showcasing adaptations of Shakespeare's plays that have been set in modern times yet maintain the integrity of the text while framing the play in a contemporary setting. The site would also provide context and history background for the plays themselves, as well as provide information, images and links to elucidate the history in the plays; for example, a historical timeline and comparisons with instances of civil strife in the United States. Behind the scenes information would provide background on the art of the play in general, and specific information about the art of staging these plays in particular.

The CHICO student team members were interested in including content about the political climate of the time when the plays were written and showing how that related to the histories portrayed in plays to be staged in Ann Arbor by the RSC. The team first attempted to do their own research and compile materials from generalist sources to be presented from a generalist's perspective. Upon encouragement, they looked for expert help and were successful in recruiting assistance from specialists to write key pieces. A widely-renowned English professor involved in the RSC residency program will be giving a series of public lectures and agreed to contribute content on the play's historical and literary significance. This professor had just spent a week in England sitting in on rehearsals of the plays and talking with the plays' director. A doctoral student in theater, who coordinates the Shakespeare reading group on campus, also agreed to contribute. The content specialists were also asked to write short essays about Shakespeare's life, the history plays, and the relevance of the history plays for a contemporary audience.

The Royal Shakespeare Company submitted images of costume designs and other materials; included was a file of photographs depicting rehearsal shots and images of historical engravings. The students were also successful in garnering permission to include ten essays requisitioned by the University Musical Society for the event. In conjunction with the project, the Curator of Special Collections at the Graduate Library prepared an exhibit on costumes used in Shakespearean plays, to be on display before and during the time that the RSC is in residence. The exhibit contains costumes, prints, photographs, rare books and drawings illustrating the clothing crafted for performances of Shakespeare's historical dramas from the mid-18th century to the present. With the assistance of the curator, CHICO team members selected and photographed materials from the exhibit to include on the website. The Curator also gave the students guidance on how to do research for other background content on the project. In addition to providing their own original content, the content specialists reviewed content developed by the students and evaluated parts of

the website to make sure the historical content of the website is accurate.

Content specialists in the Ancient Food/ Animals project

Through a university committee assignment, the CHICO director made the acquaintance of a faculty colleague in archaeology and classical studies, and the two exchanged information about their work. The classics professor was teaching an undergraduate class in Classical Civilizations called "Food in the Ancient World: Subsistence and Symbol." The students were planning to use themes from the class to create an exhibit at the archaeological museum on campus. The undergraduate students selected artefacts and photographs from the museum, created display labels, and helped do research for a website that would showcase the new exhibit.

A partnership was quickly begun, and CHICO team members were recruited to work with the professor and her class to help them with the design and creation of a website to be targeted to K-12 teachers and learners. The professor continues to get inquiries from visitors to an earlier site on the topic created for a similar class four years ago, and still receives frequent e-mail from K-12 students and teachers asking for more information: "Are more reading materials available?" "Are there recipes?" "And did they really eat peacock?" The professor responds when she has time, but is not always able to keep up with the demand for further information. She felt the interest was clearly there for an enhancement of the existing foods web site as well as the creation of a new site on animals in the ancient world. The new site would continue the theme of Food in the Ancient World but would focus on animals: in hunting, as food, as symbol and myth, as pets, and in relationships with humans, with K-12 as the primary audience.

For the professor, time was an issue, since she was involved in supervising the museum study for her undergraduate students and developing signage for the exhibit. She felt it would be helpful if team members could work independently or in tandem with the undergraduates. At the same time, the team members wanted to work closely with the professor and her students in creating the content material. They believed it would be difficult, and even counterproductive, to create the content for the website in isolation from the structure and design that the site would have. Therefore, it was agreed that the team members would visit the class and spend time observing the professor and her students

For the Context and History part of the exhibit, CHICO team members gained insight into the background of the content from the professor and were provided with readings. In turn, CHICO gave presentations to the professor's class about signage and labels for the exhibit artefacts, and also shared information from the Education Curator at the UM Art Museum about signage practices at that museum. A local radio station provided digital versions of an interview with the professor conducted at the opening of the Animals exhibit of the interview (in .WAV and RealAudio format) to be mounted on the Web site.

CHICO team members added new features to the existing Ancient Foods site and updated the revised site to include both a regular HTML version and a version in Shockwave format, with a link provided for viewers to download Shockwave if needed. A Web site was created to accompany the Animals exhibit that opened at the end of the term and would run for several more months. The Museum had just acquired a touch-screen kiosk for the 'in gallery' activities, and the team members created a related resource for the kiosk, preparing a Director movie to use at the Museum's kiosk based on the revised Foods site. A day was planned for families to visit the museum, and this would be an opportunity to advertise the project.

For the Behind the Scenes component, team members photographed the undergraduate students and some of the exhibit installation and exhibit-building process. Students also met with the Associate Curator of Slides and Photos at the Museum and were given background on the animal exhibit. This will be included in a part of the site devoted to "Building an Exhibit" and will provide a behind-the-scenes look at exhibition design and creation.

To incorporate a Relevance and Connections dimension for the site, CHICO worked closely with a sixth grade teacher and her class, as described below.

Engagement with K-12 Audiences

Ancient Foods/Animals Project

One of the CHICO team members was enrolled in a class on digital resources for K-12, a school media methods course. She was interested in "test driving" ideas learned in class with K-12 students and teachers, and as part of the course, the student was required to teach some aspect of information skills to K-12 students. Through her class instructor, the CHICO student was connected with a local middle school sixth grade teacher who had expressed interest in participating in the Ancient Foods project.

The sixth grade teacher had begun by asking her students if anyone was interested in "old things, really old things." From the initial response, twelve students were identified, drawn from several classes. The team member and teacher agreed upon three different project parts which could be explored using Eisenberg's model of the Big Six skills (Eisenberg & Berkowitz, 1990). The CHICO team member helped the students find sites with information about animals in the ancient world and worked with the sixth graders as fellow researchers. Together they searched the web for appropriate sites from the new Web site that could be used as resources for the project. The learners participated as collaborators on researching the site, and the CHICO team member worked with them on task definition, information seeking strategies, use of information, appropriate citing of sources, organizing the information and putting it together, and evaluation of the information found.

An important activity was creating stories and materials from the information gained in the research process. Once the students had done preliminary Web research about the ancient works (specifically on themes the UM undergraduate class was exploring for the project), they explored ways that information could be used and interpreted by having the students create stories and draw pictures based on their findings. Some of these stories and pictures could then be included in the final Website created for the Ancient Foods projects. The sixth graders are creating clay models of ancient coins containing animal images, and these will be included on the site as an example of student work. The first step involved pencil sketches to be used as guides for the clay models of animals. The team member photographed the art work with a digital camera for inclusion on the site. The sixth graders have also found a number of interesting sites related to animals in the ancient world. They may be included in a resource section for teachers.

The sixth graders will also be providing feedback on the animal site as it develops. A key role for the K-12 learners is evaluating the Website under construction for usability. Learners "test" the new Website while under construction to determine whether it meets their information needs. For the School of Information student, this provides a good opportunity to apply usability assessment skills learned in coursework.

CHICO also arranged a field trip to the Museum for the teacher and students from the local middle school. The group was accompanied by a team member who took photographs for later posting on the Animals Website. The sixth grade teacher helped the team member organize the project activities and made arrangements for a computer lab. The connection with the middle school, the resources for museum education directed to youth, will be useful to the museum as it focuses on becoming more oriented to youth audiences.

Royal Shakespeare Company project

Engagement with K-12 in the RSC project was built on a wide array of activities organized around the event by the University Musical Society and its Education program. The RSC project afforded a number of opportunities for engagement with schools and youth-centered activities. These included

- youth performances
- workshops with K-6 and K-12 teachers
- activities taking place at K-12 schools
- RSC visits with local schools
- workshops for museum curators

Working with these groups, CHICO is gaining feedback on the development of its site, as well as an opportunity to promote the site's existence and to encourage audience participation by submitting essays and artwork to be included on the site.

CHICO students are developing a word game feature which will allow K-12 learners to interact with the text of Shakespeare's plays and get insight into

its meaning. A map feature will allow learners to look at a map of Great Britain and see where the various characters and events in the plays are situated. The interactive map of cities helps visitors to the site explore the theater scene. A participatory feature of the site will encourage audiences to submit their own content, reflecting on their own experiences with the plays, and creating new material – essays, drawings – inspired from the plays. Content will be reviewed, edited if necessary, and posted on the site.

Partnership on a Base of Mutual Self Interest

A key factor contributing to the success of generating and sustaining commitment to the partnership is that there be a high degree of mutual self-interest underpinning the participation of each partner. We have found it critical that there be a "win" for each participating party.

Museums

For the participating museums or other content providers, the benefits include

- Rreaching out to a wider audience through digital display of artefacts and increased visibility and access for the collection
- providing a marketing vehicle which sparks interest in the museum's content, promotes the museum's mission and has the potential to build a new user base
- providing contextualization which enhances appreciation of objects, and provides interpretation for their understanding
- providing enhancements to viewing objects, supplementing but not replacing the physical museum visit.

Information Specialists

For students preparing for careers in the information professions and their educators, the benefits include

- real-world experiences which bring together multiple dimensions of information service
- an opportunity to act in a service role
- an opportunity to apply technical skills to humanistic endeavours
- the opportunity to apply a range of information skills: selecting, acquiring, organizing, presenting, and evaluating information
- contact with end-users in museum and K-12 venues
- project-based learning from an interdisciplinary perspective

K-12 communities

For K-12 educators and learners, the benefits include:

- gaining access to a broad array of objects and information in distributed form and thus expanding the base of learning resources
- the opportunity for learners to take what they have seen and have read about an artistic experience and engage in dialog with others
- the opportunity to create their own artistic and information content, building on what they have seen and heard.
- the chance to apply critical thinking skills
- the chance to extend an artistic experience beyond the initial performance or museum visit

Content specialists

For content specialists, the benefits include

- engaging with a broader audience in discussion of their topic
- an opportunity to provide outreach and service
- a chance to think about their topic from a different perspective and share that perspective with others outside the academy or immediate scholarly or specialist community.

Changing Roles

The benefits of partnership will most likely appeal to those who are exemplars of the changing boundaries of their profession. Each type of institution represented by the partners has undergone some degree of change in its mission, and a key part of the value of the partnership can lie in its ability to offer opportunity to test some of the new roles emerging in each of the professions represented.

Information professions

Education for information professions has been undergoing profound changes recently, and at the heart of the changes are the changing roles within the information professions themselves. Librarians, for example, are now recognized increasingly as facilitators of learning and information discovery, as providers of distributed content to users in remote venues, and as practitioners whose skills are of value in a variety of information venues. In addition, the delivery of instruction has changed to provide more project-based, experiential learning. More explicit attention is being paid to long-standing fundamentals of library and information service, with greater emphasis on the end-user. As a result, schools educating library and other information professionals must now provide educational experiences which integrate classroom learning, technology, and practice, deal with real organizational settings, are client-centered, and have a strong service philosophy.

While technology has recently been a driving force in the profession, there is recognition that digital technology is at once an enabling tool which makes different kinds of learning possible, and an object of study itself, with impacts reaching into almost every branch of human experience. Students of the information professions gain not only from assisting many different types of clients in the use of information and information technology, but also from observing the impacts of information and information technology on environments such as museums and K-12 classes (Frost, 1998).

While technical challenges are daunting, more challenging still are the human challenges brought about by information technology. Students need to become acquainted with issues such as technology acceptance, intellectual property, and information access. The project-based experiences working with museum and K-12 clients can provide excellent examples of these issues.

In addition, projects with an arts and technology connection are effective in attracting students who have learned technical skills and want to apply them to interesting problems. Added to this is the opportunity to provide a real service with a human dimension. These projects have attracted students across the spectrum of our curriculum, from archivists, librarians, and information policy specialists to human-factors and usability experts and e-commerce specialists.

When invited to participate in the Royal Shakespeare project, one student exclaimed,

> I'm so eager to work on this project! In addition to being a chronic Anglophile, I would feel honored to contribute to a website that will provide such a valuable service to the community. What makes my skill set especially applicable to this project is diversity. Usually one finds programming proficiency in one person, creative/graphic ability in another person, and writing skills in a third. My background, however, includes all of the above.

Museums

Museum professionals also find themselves at a time of change, with changes in their professional missions, an expansion of their target audience, and new options for delivery of their content. Many museum staff have not grown up with computers, but now find that technology has the potential to fundamentally change the way in which museum content is delivered. At the present time, web surfers can visit over five thousand online museum sites (Davis, 2000), and for many, the digital experience may become the primary way a visitor comes into contact with a museum exhibit. At the same time, the digital experience differs in many fundamental ways from the experience of the original, and this difference can vary with adult viewers (Taylor, 2000) and younger viewers (Thompson, 1982).

While it is obvious that the images seen by viewers on their computer screens will vary in significant ways from those seen by viewers in their visits to museums, perhaps less apparent is the way in which different digital representations can also vary, depending on method of image compression, screen resolution, and the like. Visitors scanning a screenful of thumbnail images or pursuing a series of hyperlinked images will browse the collection differently from those who are visiting the physical collection in a sequential way (Frost, 2000). And of course the experience of walking through a museum exhibit provides a whole array of sensory effects of smell, sound, touch and institutional aura which can at best be found in a computer experience in only a limited and experimental way

(Greenman, 2000). Added to this mix of questions is the social dimension of museum viewing and its related impacts on individual and group experiences both within and outside the museum (Chadwick, 1992, 1999, Falk & Dierking, 1992). With the potential for interactive communication, will museums be able to engage audiences in new ways? What is the role for computers within museums? What are the curators' roles in interpreting museum content, and how are these roles now being shared with educators? (Roberts, 1997)

Similar to "talk-back" areas in a museum, where visitors can post comments and questions about an exhibit, the Web offers opportunity, for example through a Web-board, for visitors to respond to what they have seen and to have questions answered by museum staff. How does this new form of interaction affect the viewer's experience and relationship with the museum?

All of these new and interesting questions will require that museums have direct experience in offering their collections in digital form, in providing complementary and interconnected experiences, and in giving viewers an opportunity to interact with both physical and online forms of the exhibit. This will help museums address questions such as the role of physical and virtual objects, and whether the virtual medium will serve to promote or deter visits to the physical collection. How can the virtual exhibit promote the afterlife of an exhibit, and how can it help users become more informed before visiting the museum?

At the same time that the technology revolution has been changing museum practice, there has also been a change among many museums in their core mission. Whereas the mission used to be to solely to collect, preserve and exhibit works of art, that mission has now expanded to include education and outreach to new audiences, especially for youth and populations which have been historically underserved. Museum professionals' roles have expanded from curators and directors to include educators, marketing officers, and technology specialists. Educators may be more closely involved in the planning of an exhibition. New vehicles exist for displaying or enhancing the exhibits to include video, audio guides, games, printed guides, CD ROMs, and Websites.

Content specialists

For the scholar, faculty member or other content specialist, there is the opportunity to expand the reach for the topic of research, to provide opportunity for engagement with new audiences, and to provide an outreach service to the community. It gives an opportunity to bring together the three key missions of teaching, research, and service. It gives the scholar a chance for interdisciplinary engagement with content specialists in related areas. It also allows the faculty member, along with the students, to explore new means of knowledge work using digital technologies. While this type of involvement is not typical for faculty members, developing on-line resources gives interested faculty an opportunity to expand their roles as universities begin to place greater emphasis on interdisciplinarity, outreach, and the integration of service into teaching and research.

K-12

Several decades ago, Dewey pointed out the importance of experience in helping give meaning to abstract concepts and saw a special place for museums and objects in education (Dewey, 1938), ideas which still remain a force in contemporary K-12 museum education activities (Hein, 1998). With the appearance of Web-based museums and the ability of access to primary resources and background materials, these concepts take on new significance. In addition, new opportunities are afforded for learners to interact with content and with other interested learners, and to create and make sense of their own content.

Previous Projects Exemplifying the Model

The Ancient Foods/Animals and the Royal Shakespeare Projects build upon a base of pilot activities which were examples of similar collaborations with museums, K-12, information specialists, and content specialists.

CHICO team members worked with museum curators to develop a Website called Mummies of Ancient Egypt. This resource is aimed at K-12 students studying ancient Egyptian culture and is intended to complement visits to local archaeological collections. (http://www.si.umich.edu/CHICO/

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mummy/). While we did not directly involve K-12 communities in the development of the projects, the site has generated years of correspondence from K-12 teachers and learners offering feedback.

"Harlem 1900-1940: An African-American Community" is a collaboration between CHICO and the Schomburg Center for Research in Black Culture at the New York Public Library. The Schomburg asked CHICO to provide an online virtual exhibit of one of its most popular collections, a photographic portfolio depicting the Harlem Renaissance. At the core of the exhibit is an online presentation of the Schomburg's compelling portfolio, "Harlem 1900-1940," featuring more than 30 archival photographs. A section for educators, with lesson plans and discussion guides, is aimed at K-12 teachers and learners. (http://www.si.umich.edu/CHICO/Harlem/) A similar partnership with the Schomburg resulted in the creation of a site called The African Presence in the Americas (http://www.si.umich.edu/CHICO/Schomburg/).

In partnership with the Smithsonian's National Museum of the American Indian (NMAI), CHICO team members helped transform a site-specific exhibit into an interactive, multimedia resource available to global audiences. CHICO staff developed the exhibit based on content developed by Alaskan Native American Yup'ik Elders, with an NMAI exhibit curator (http://www.si.umich.edu/CHICO/Yupik). Building on this resource, a faculty member and graduate student in the University of Michigan School of Education developed an interactive educational resource with content provided by Yup'ik students and educators. Yup'ik elders also worked with CHICO staff to transform the online exhibit into a CD ROM featuring additional oral histories and audio resources.

CHICO and the UM Museum of Art (UMMA) joined forces in a collaborative project with local middle-school students, art and technology teachers, the museum director of UMMA, and the outreach coordinator of CHICO to collectively enhance the learning process through an experimental elective course. In the Stylistic Journey Project, CHICO developed a Webboard which was used extensively to facilitate online discussions among teachers, curators and students (http://www.si.umich.edu/CHICO/Emerson/).

In a CHICO partnership with the University of Michigan Museum of Art and a local school, a set of fifth graders from a local school were engaged in developing an exhibit guide which would reflect their perspective but also have its content reviewed and validated by UMMA curators. Together with the UMMA museum professionals, the students, their art teacher and the school's technology specialist, CHICO helped create "Monet at Vetheuil", an online, interactive exhibit guide. Youngsters were able to research specific artistic resources and painting techniques in consultation with curatorial experts, and to create their own works of art based on their experiences and learning. A bulletin board and online quiz facilitated communication among students, educators and the exhibit curator, and welcomed responses from a global audience (http://www.si.umich.edu/CHICO/monet).

Lessons Learned

In the course of implementing and evaluating the projects, a number of recurring themes and issues have surfaced to assist us in future development of similar sites.

Intellectual Property issues

Since copyright takes on new dimensions in the digital world, many of the assumptions to which we had become accustomed are changed or no longer valid; many old assumptions are challenged. One example is the ownership of items in the collection of a museum or archive and our ability to use them in collections. For example, if a museum educator wants to create a site for teachers in which she uses images from her local museum, and if that museum "owns" all the material in its collections, and with it all donated items, does that mean that the museum is free to make images of these items universally available through the Internet? Although a museum or other repository may "own" a photograph, painting or statues, and may have been given the right by the donor to display that object in the collection, that does not necessarily entitle the institution to post images of the item on the Web. Instead, such "ownership" conditions needed to be re-negotiated, and securing permission to use digital objects may involve going beyond their original "owner."

In addition, we found it critical that agreements be worked out in advance and in writing indicating the ownership and disposition of the intellectual property of the content provider, as well as how the project team may use or distribute the content in the course of the project work.

Rules of disengagement

The CHICO projects have as one of their main goals the provision of educational experiences for information students. While the development of Websites is a key means of providing these experiences, the project is not serving primarily as a production unit, and decisions must be made in a way which balances the educational needs of the students with the needs of the project partners. Staff change each year, with new students entering, graduating, or moving on to other projects. Staff skill levels vary. Accordingly, decisions must be made as to when to move a site to the CHICO archives (and notify viewers that the site is no longer being actively maintained), when to continue maintenance and upgrading, and when to remove a site outright. Ideally, a site would be handed off to the participating project partner for maintenance, but this is not always feasible. If a site is to be continued, how can it be kept active and fresh while new projects are developed? This can be a key problem since student participation is voluntary. Students are more likely to be attracted to the development of a new site in which they have a stake, and for which they can take credit and can cite in their job search portfolio.

Coordinating schedules and goals

University course projects need to be coordinated within the framework of the academic term or semester, but in real life, project activity does not always fit neatly within this timeframe. Project expectations and deliverables need to be managed within these constraints, without penalizing students for difficulties beyond their control. Difficulties in coordinating meetings are to be expected, and this can cause a lag in project work, yet the students expect to be actively involved in a project in the course of a term. If the project experiences a serious delay, the students are encouraged to try to fill in this time with project activities within their control (e.g., developing background information, locating information resources, or preparing draft proposals of work for reaction from the project partners). If the student teams experience a major setback, the project goals need to be adjusted, and in the unlikely event that the problem is not correctable, the students are encouraged to focus instead on an evaluation and assessment, with recommendations based on lessons learned.

Matching skill levels with project needs

The projects are designed to allow student participation at various skill levels. Projects start off by doing a skills inventory to determine what skills students have and need. Students are then pointed to resources, on campus and elsewhere, that can assist them in gaining new skills. Students are paired with experienced team members, and novices of one year become seasoned trainers in their second year. Where possible, projects are matched with skill level and interest. SI students generally have a variety of backgrounds, with both content and technical expertise reflected in the team membership at any given time.

Conclusion

This paper has described a model for community partnerships involving information specialists in training, museums and other content providers, content specialists, and K-12 teachers and learners. The focus has been on two recent activities involving partnerships with museums, libraries, and a performing arts group. The experiences have provided a valuable opportunity for information specialists, museum curators, and K-12 educators to gain insight into new roles in their changing professions.

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Unseen Discussions: artist@hotmail.com

Anthony Huberman P.S.1 Contemporary Art Center, USA

Abstract

For the recent exhibition Greater New York: New Art in New York Now, the Education Department at P.S.1 Contemporary Art Center organized a unique email-based discussion. The museum set up an e-mail address for most participating artists using the free Hotmail.com service. These addresses were displayed on P.S.1's website, where each artist had his/her own Web-page, and on sheets available in the museum lobby; and most importantly, the addresses were printed directly on to the wall labels in the galleries. This established a platform where public and artist could discuss the work and exchange ideas. The forum was easy, free, international, immediate, private, and almost intimate. The museum relinquished its monopoly over the interpretation of the art by opening up unmediated channels of communication between artist and public.

P.S.1 Contemporary Art Center

P.S.1 Contemporary Art Center is a large museum located in the Long Island City section of Queens, New York. Since 1971 under the direction of Founding Director Alanna Heiss, P.S.1 has showcased the work of thousands of local and international emerging artists and has been a defining force in New York's cultural life. Housed in a 100-year old school building, the museum organizes critically acclaimed solo and group exhibitions year-round and a summer outdoor live DJ Series. Since 1997, P.S.1's renovated building has been the largest contemporary art center in the world. The museum combines a world-class exhibition program, a prestigious National and International Artist Studio Residency Program, and a broad spectrum of education and public programs that serve its many audiences. In early 2000, P.S.1 became an affiliate of The Museum of Modern Art, New York, and looks forward to exploring the many possible collaborations with MoMA over the next years.

The education program

Since 1985, P.S.1's Education Department has offered its various audiences opportunities to get involved with the museum, the exhibitions, and the artists. Continuing P.S.1's commitment towards working closely with artists, the education program reflects a particularly active effort to bring a wide public in contact with the emerging artist community. Youth and family programs include art classes and art-making workshops with artists included in P.S.1 exhibitions. School programs include tours and art-making workshops with artists, collaborative online project development with artists, and a Teen Curators Series. Adult programs include panels and discussions bringing artists, writers, and curators in contact with the public, a Writers Series showcasing texts by emerging writers on pieces in the museum galleries, brochures and print materials with artist statements and interviews, and interactive Web projects.

Greater New York

In February 2000, P.S.1 and MoMA presented the result of their first curatorial collaboration. The exhibition *Greater New York: New Art in New York Now* began as an open-call for submissions, and several thousands portfolio submissions and hundreds of studio visits later, became a massive building-wide show for which 30 P.S.1 and MoMA curators brought together the work of over 140 New York-based artists who have emerged as vital, creative voices in their fields over the past five years. The exhibition turned out to be one of the most successful shows in the history of P.S.1, drawing thousands of visitors and critical acclaim. Hits to P.S.1's website, http://www.ps1.org, tripled over the course of the exhibition, as the museum hosted its most ambitious on-line exhibition to date, now on view at http://www.ps1.org/cut/tours.html. The many components that made up the exhibition contributed to its unprecedented success.

The E-Mail Project

One of the components initiated by the museum's Education Department was dubbed the E-Mail Project. A month before the opening of the exhibi-

tion, museum staff set up an e-mail address for each artist using the free Hotmail.com service. To better distinguish the newly created e-mail addresses, the following format was used:

lastname_greaterny@hotmail.com.

After receiving a long explanation of what the project required and the responsibilities that accompanied it, over 80 of the 146 artists included in the Greater New York exhibition agreed to join. All artists were shown how to use the service and how to access their private account. As an important step to ensure the success of the project, the artists were strongly warned that their participation required them to check the account several times a week and to respond to all relevant messages. Those not able to make that commitment were excluded from the project.

Each artist was made aware that the dialogue that occurred through the e-mails would not be screened by the museum and would be seen by the artist alone. Different from a "chat room" or a "bulletin board," the messages would not be posted on the museum website but would remain in the private Hotmail inboxes of the recipient artist. Since no institutional control was possible, all were warned of the possibility for "spam" or other unwanted or unwelcome messages. Furthermore, since there was no precedent for the project, the quantity and quality of the messages remained completely unknown and impossible to predict. The museum was eager to showcase selected messages on the P.S.1 Greater New York Website, and artists were encouraged to forward particularly interesting messages to the museum Web site staff.

The e-mail addresses were then displayed in three places:

- on P.S.1's Website, where each artist had his/her own personal Web page
- on sheets available in the museum lobby for visitors to take away
- on the wall labels of the artists' works in the galleries

Through the Website, a local and international audience was able to contact the artists directly by sending them direct and private e-mail messages. In the Greater New York site, each artist had his or her personal Web page, complete with an image, an exhibition history, a selected bibliography, an artist statement, and an e-mail address. When and if they were forwarded to museum staff, excerpts from e-mail correspondence were also posted in the artist's page, adding new insight to what was an invaluable resource for information about significant up-and-coming artists.

Visitors to the museum could take home with them an "address book" of e-mail addresses for the artists. One computer was placed in the museum lobby, but was meant for browsing the Web site, not for sending e-mails. Since e-mail correspondence requires users to log into a personal home or office account, visitors could not use the computer on-site at P.S.1 to correspond with the artists. Instead, museum-goers could take home a free pamphlet with the complete lists of existing e-mail addresses for Greater New York artists and compose a message at a more comfortable time and place.

Most importantly, visitors in the galleries, when consulting the wall label for the usual name and title information, were confronted with the possibility of communicating directly with the artists in the exhibition. By simply adding a line to the standard museum wall label, the presence of the E-Mail Project was carried from the digital world of the Internet to the physical world of the galleries themselves, an exercise which remains unusual for many web projects.

Jeremy Blake

Angel Dust, 1999

Digital projection

Courtesy Feigen Contemporary, NY

blake_greaterny@hotmail.com

Fig. 1: A sample wall label from the exhibition, including an email address

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Results

Several factors played a part in evaluating the results of the project. First of all, since there exists no pre-existing model with which to compare it, a comprehensive understanding of its successes and shortcomings is difficult. In addition, the very nature of the project, and indeed one of its most significant and characteristic traits, was that the messages were kept in private e-mail accounts, inaccessible to museum staff. Any assessment was possible only by asking the participants to discuss what they had received.

Once the exhibition closed, Education staff did indeed interview many of the artists in order to get an idea of the results. An important question was that of identifying the different types of users. Feedback from the artists revealed that e-mail messages could be divided into 5 roughly defined categories, here listed in no particular order:

- curators and gallery owners
- collectors
- writers participating in the Greater New York Writing Project
- the "unidentified" general public
- teachers

An obvious – but admittedly unanticipated – group of e-mail corresponders were local and international curators and gallerists. Partly due to its sheer size, to the involvement of The Museum of Modern Art, to an aggressive publicity campaign, and naturally, to the quality of the works, the exhibition received a significant amount of press in national and international papers and art magazines. Many curators, from New York galleries to prestigious institutions around the world, visited the exhibition and the exhibition Web site. Many of them took advantage of the E-Mail Project to contact artists and request additional information about their work, images, CVs, or studio visits. Artists engaged in continuous dialogue with curators and became involved in exhibitions in other spaces, from Houston to Berlin, London and Tokyo. Important to keep in mind is that many of the artists included in Greater New York were not yet represented by a commercial gallery, and this direct and facilitated link to curators proved very promising and helpful. A particularly potent example is that of a young and unrepresented artist receiving a personal message of interest from the Director of the Brooklyn Museum of Art, Arnold Lehman. Of course, artists already working with commercial galleries referred the interested curator to the appropriate person at the gallery to continue the correspondence. E-mails from curators, in the case of some artists, made up more than half of all messages received during the course of the show. This impressive tally was certainly a welcome by-product of the E-Mail Project, especially from the artists' point of view. Nevertheless, the project was conceptualized by the P.S.1 Education team more as a tool for outreach and for encouraging an open unmediated exchange of ideas and interpretations between a general public and the artists rather than as a way to further careers. This particular outcome of the project was not among the intended or sought-after goals, yet it stands undeniably as a prominent one.

Another frequent user of the e-mail addresses was the art collector. Once again, this audience is one which the initiative did not aim for, but was nevertheless significant. As with curators, artists were only too pleased to receive messages from collectors. One young artist, who had shown her work very little before her inclusion in Greater New York – she is now frequently featured in exhibitions in many New York galleries – was quite unprepared for the response from collectors, and sold all of her pieces within the first few weeks. She then spent the next many weeks telling collectors from across the country that all her work had been sold and that she was working on new pieces (as fast as she could, presumably). An issue that becomes immediately apparent is that of artists selling their work without going through the gallery that represents them. Of course, it is difficult to convince artists to divulge details concerning the sales of their artworks, but the opportunity to by-pass the gallery is one which surely crossed the mind of several.

The Greater New York Writers Project was another initiative of the Education Department and whose full description deserves a paper in itself. To accompany the open-call for artist submissions, the museum organized an open-call for writer submissions.

Given the difficulty of articulating a cohesive theme and a concise curatorial essay for a show so heterogeneous in content, the exhibition catalogue was made up of texts selected from the group of emerging writers from the Writers Project. Approximately 100 texts were selected by a screening committee at P.S.1 and MoMA, giving the exhibition a broad scope of interpretation and insight. Texts varied from the art-historical to the creative, as theoretical essays appeared alongside more creative short stories or poems. The e-mail addresses proved to be an invaluable resource for many writers. Artists received messages filled with questions about their work, and later on, drafts of essays-in-progress. Eager that the text be included in the catalogue, artists responded to the questions generously and participated in what could be called an e-mail interview. Following is the beginning of one such response:

> Dear Brian, thanks for writing. I've had some contact through the P.S.1 e-mail address. Actually, more than I thought and a few helpful things for the future. I will see what I can fax to you. I will copy my bio and a review of one of my CDs. The Wire article you can find through my label – JDK. If you do a search on Radiantslab and JDK, you should be able to find the site. You can find some articles reprinted there. Attached to this e-mail is the bio, etc. If you can, also check out my small piece at Postmasters on W. 19th. Thanks a lot.

Given the artist's accessibility through the E-Mail Project, several writers who would not have done so otherwise decided to contribute a text. Indeed, many artists and writers, over e-mail of course, arranged to meet in person to further discuss ideas for the essay. Having the Greater New York e-mail addresses as resources for private exchanges that guaranteed a personal, tailored response prompted many young writers to move beyond the often paralyzing intimidation that is so common among people uninitiated in, and unfamiliar with, the New York art world.

The last two segments of the E-Mail Project audience were those that the project most aimed to reach. Most artists confirmed that about a third of the messages they received were from a more general public, unaffiliated with the professional art world. Art students, local residents, tourists, and the simply curious found the opportunity to communicate directly with the artist to be an unusual exercise in sharing thoughts, impressions, opinions, and suggestions. For example, for a piece involving a fully functional sauna in the museum's courtyard where visitors were invited to disrobe and join in, responses varied from the simply helpful:

> There is a good article on nudity in Austin at www.austinchronicle.com that you might be interested in.

to the more profuse:

> the next morning I woke up thinking about my experience and how it was that you managed to coax total public nudity out of me in such a short time. what was at play in your piece that made it so easy for me? and for my girlfriend as well for that matter? And more importantly, do those factors aproximate [sic] the culture of public bathing you described in Finland? You see, to us, the fact that the curtain is slightly parted, the changing room door does not actualy [sic] connect with the curtain, the ability to see people outside from behing [sic] the door, the clear plastic of the ventilation slot etc... all those elements created a kind of kinkyness. they all played on the notion of voyeurism. it was all a kind of game where the bather plays with how much or how little he is willing to show. every time he moves, he has to consiously [sic] decide to be descrete [sic](prudeish?) or not. Every time he notices an opportunity for exposure he is confronted with either exitement [sic] or fear or a realization of shame about that fear. It is therefore key to the experience that it be a repetition of the same series of decisions. with each cycle, the bather may become more daring (or less so). that daring evolves very quickly over those forty five minutes because the bather has to make those kinds of decisions so often. In any case, I would really appreciate it if you could write me back and tell me a little bit about what role you think sexuality plays is your piece.

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People seemed to be unusually frank and almost vulnerable in their responses:

> Your video piece was very endearing. Well, that makes it sound almost cuddly. It was also kind of frightening. There was some suggestion of violence, to me. Maybe I associate circuses and carnivals with mayhem.
>
> Do you consider this work to be a product of your Colombian heritage, or is it strictly an illustration/embodiment of the five physical dimensions?

Straight-forward "fan letters" were also very common. Instead of feeling the need to ask questions, people enjoyed being able to simply express their enthusiasm for the piece. Artists read these letters with great appreciation. Repeatedly, artists mentioned that these types of letters are a missing component in the art world: rarely does an artist receive a letter of praise from an unknown exhibition visitor. Most of the time, feedback exists only in critical reviews in the press or through friends. Indeed, many artists saved and treasured these short "fan e-mails." Following is one of the favorite notes received by one of the artists. It is written by a young student who visited the museum on a class trip:

> To Artist,
>
> I recently visited P.S. 1 with my school, I go to The Ursuline School in New Rochelle. I choose your piece as my favorite. I thought it was very creative and calming. I enjoyed the way the cotton candy actually moved with the music. I also liked the split screen which made it look like it was a mirror image. The music was soothing and watching the cotton candy was amusing. I think your idea was very original and creative. I didn't understand the music so i was happy that there was a translation. Please write back. Thank you.

In addition to their students, many teachers used the e-mail address to get in touch with artists in order to better prepare lectures or workshops for their classes. Several artists sent teachers ideas for workshop projects or provided them with a more elaborate explanation of their work. After a class visit to the museum, a teacher gave her students an assignment to use the e-mails to contact an artist of their choice and ask him or her a specific set of questions. Some artists were bombarded with 20 messages from 8-year old children and patiently answered their questions. One curious and courageous artist, taking advantage of the anonymity of e-mail, actually attended the lecture of a college professor who had been in touch with her about her work, simply to hear what the lesson would discuss.

Used to more ordinary and "safer" responses to artworks that appear in Bulletin Boards or are heard at panel discussions and public forums, the P.S. 1 Education Department was pleased to see an exchange of ideas that seemed less inhibited than in many other systems and strategies for gathering audience feedback.

A reporter for the online zine FEED, Claire Barliant, independently interviewed several participating artists for an article. Noting the absence of Web art in Greater New York, the reporter named the E-Mail Project as the museum's stab at including the Internet in the exhibition. Her conversations with artists suggested a mixed result, some artists receiving a significant amount of correspondence, but others voicing disappointment in the turnout. The article noted a particularly intriguing occurrence, "prov[ing] the elasticity of the e-mail project" (Barliant, 2000), where an artist not included in the exhibition nevertheless created a greaterny@hotmail.com account for himself.

Implications for Museum Outreach

The Greater New York E-Mail Project is an intelligent and effective strategy for engaging an exhibition audience. Museums across the world have tried many different methods and systems to foster a relationship with their visitors, ranging from docent tours, art classes for children, and museum-school partnerships to scholarly lectures and film screenings, not to mention merchandise and brand names. Rarer, however, are attempts to put the public, or rather, the publics, in direct contact with the artists. This is a commitment that P.S. 1 has always maintained.

The strongest aspect of the E-Mail Project is what it stands for. The FEED magazine article mentioned above determined that since artists did not receive an overwhelming amount of insightful and intellectually provoking messages, the project as a whole failed in its purpose as an effective forum for dialogue. On the contrary, the project succeeded even before anyone put fingers to keyboard. Whether they were consulting the wall label, visiting the website, or taking the e-mail address book home, viewers of Greater New York were confronted with an exhibition interested less in convincing its public of a specific curatorial viewpoint or appreciation of art, than in providing a stimulus for others to consider and interpret. By adding e-mail addresses into the exhibition, Greater New York curators opened up important channels of personal and private interpretation and evaluation.

Curators, and the museums that legitimize them, have traditionally been the authors of "correct" and "incorrect" understanding of art and gatekeepers of good and bad taste. Exhibitions have been vehicles and frameworks through which curators and their museums tell their viewers how to think about art. Little or no room is left for the visitor to develop, much less articulate, his or her own meaning for the works. In recent years, an increased interest on the part of museums and curators in seeking the participation of the audience has spawned non-linear exhibition design and layout, education and outreach programs, including bulletin boards (both physical and digital), interactive website projects, and "meet the artist" events, among other many examples. More and more, especially in contemporary art museums, the visitor's input is sought after and legitimized. This trend is fueled by the belief that leaving space for public participation makes the museum less of an intimidating fortress for the elite and more of an appealing and accessible center for shared ideas.

The E-Mail Project functions with similar goals and post-modern theoretical roots but brings new energy to an overly-saturated world of museum outreach initiatives. The project's simplicity is deceiving: the mere appearance of the e-mail address on the wall label, on the website, or in the lobby has the symbolic effect of encouraging discussion and debate. Viewer opinions and impressions are suddenly acknowledged and legitimized before any such opinion or impression has even been written down. The negotiations around the content of the exhibition are removed from the hands of the curator alone and extended to include anyone interested in joining. The project provides visitors with an open channel for the pursuit and development of their own personal interpretations and associations. Indeed, the personal e-mail addresses were communication tools as much as they were symbols for a democratization of the understanding of art. In effect, the simple act of displaying the artist's availability to discuss the work, unsupervised by museum staff – in the shape of an e-mail address – points to the willingness on the part of the curators to relinquish their monopoly over a "correct" interpretation of the artworks.

Setting this project apart from other systems of audience outreach is its invisibility. E-mail correspondence provides both sender and recipient with a private, immediate and almost intimate medium of communication. Being part of over 140 included in the exhibition, many artists welcomed the intimacy the e-mails brought to their experience as participants in Greater New York. In a show of its scale, one-on-one communication and channels for feedback are difficult to establish, and the exchange of private e-mails provided a way for artists and audience to maintain a relationship with the show. As already noted, privacy helped audience members feel more comfortable about communicating with the artists. As is often the case in public forums and panel discussions, visitors can find it intimidating to voice their opinions, questions, or personal associations and interpretations, a difficulty easily overcome by the unmediated nature of e-mail messages. Especially important was the assurance that their comment would be heard and responded to. In the more public bulletin boards or feedback notebooks common in many museums, viewer contributions are rarely, if ever, answered or acknowledged. In this case, the corresponder had the luxury of a specific listener and could look forward to a reaction to an opinion or an answer to a question. This aspect of the project heavily contributed to the volume of messages sent and helped the museum position itself as the host for a tailored and careful platform for meaningful exchange. As many pedagogues have stated, education works best if it occurs through dialogue rather than monologue. Indeed, the E-Mail Project transformed the museum experience from

monologue to dialogue: from quietly absorbing a curatorial stance (in public) to actively negotiating the importance and meaning of the works (in private). It seems as if museums can use the Internet, or more specifically, e-mail, as an appropriate "tool for the task." Interestingly, museum education can be left as a private experience.

Other significant traits of the project are its cost-efficiency, its international reach, and its role in the actual gallery display of the exhibition. First, the E-Mail Project was completely free of cost. The museum could set up e-mail accounts on the free Hotmail.com service, after which the project was left in the hands of the public and of the artists. During the private exchange of messages, museum staff members were not involved in screening, editing, or maintaining the correspondence and could let it run its course. Second, by including the addresses on the museum Web site, the project was international in scope. Initiated by a comprehensive site which included images, bios, analytical and creative essays, and streaming sound and video, web-surfers from around the world sent artists their impressions and questions. Many artists noted that the wide reach of the website led to an exciting variety of opinions and remarks. While some artists received invitations to participate in exhibitions abroad, others heard from people with surprising reactions, sometimes written in a foreign language. This characteristic also suggests that one could set up a similar project for an exhibition in any location. Being in New York certainly helped keep attendance figures high, but an e-mail based dialogue could be an effective and successful component to exhibitions in any city in the world.

As briefly mentioned above, a final aspect rich in implications is the role played by the project in the galleries themselves. Including the addresses on the wall labels on one hand disrupted, or rather, redefined a traditional relationship between artwork and its viewer, and secondly, fully integrated the Internet as a central component in the exhibition. As one artist emphasized, the insertion of the e-mail address on the wall label adds new life to a long-standing standard in the techniques of museum display. A document which usually contains nothing more than factual information suddenly gains a certain open-endedness that can powerfully alter the viewer's experience with the work of art itself. Furthermore, the introduction of the universally understood "@" sign into the gallery space highlights the role played by the Internet in the physical experience of the works. No longer a marginal subsidiary to the physical display of the show in the form of an online-only project, the Internet is woven into the fabric of the exhibition itself. In addition to the e-mail addresses, selected texts from the Writers Project, all submitted to the screening committee over e-mail, were on view in the galleries. Interestingly, in her article for FEED magazine, Claire Barliant, noting that Greater New York did not include any artists who use the Web as their chosen medium, names the E-Mail Project as the Net.art segment of the exhibition (Barliant, 2000).

Limitations

Far from flawless, the project gained from its first incarnation several insights as to its limitations and possible improvements. A first limitation is that it may only be possible with relatively emerging artists. Since its success depends on the reliability of the artists to check their e-mail accounts and to respond to any mail, it is difficult to expect that world-renowned artists would be willing to invest the time and energy necessary. Immediately following Greater New York, P.S. 1 presented Around 1984: A Look at Art in the Eighties, with artists such as Peter Halley, Jenny Holzer, Julian Schnabel, Sophie Calle, and Anish Kapoor, among others. With very busy schedules and near-celebrity status, these artists would surely not have agreed to maintain an e-mail address. Artists in the beginning of their career, on the other hand, are more likely to take on the responsibility of corresponding with the general public over e-mail on an on-going basis.

Another problem lay in the quality and quantity of the e-mail messages themselves. For example, many artists complained of "spam" mail. Artists received dozens of messages from various mailing lists. Some artists took advantage of the network of e-mail addresses to publicize shows of which they were part, and many exhibition announcements were sent out. This problem is one that plagues all e-mail users and seems to be an unfortunate by-product, and one difficult to avoid, of the technology. Also, some artists received significantly more mail than others. With a show of its scale, it was impossible to guarantee that each artist would get an equal

number of messages. Perhaps a smaller exhibition would lead to a more equal distribution of correspondence.Additional publicity might also have been helpful. Had the E-Mail Project been announced more formally on the exhibition print materials (press release, brochure, postcards), or even better, had it profited from its own press release or announcement card, it might have attracted more users. Again, the existence of the project was visible on the wall labels, on the Web site, and as a take-away pamphlet in the lobby, and not in any mailed or otherwise distributed materials.

One last suggested improvement is to stress the importance to artists of forwarding excerpts of particularly interesting messages to the museum staff, for Web posting. With artists acting as gatekeepers, the project could have profited from a larger amount of excerpted correspondences being made public. Not only would these short texts highlight the dynamic interaction going on behind the closed doors of the Hotmail addresses, but they also would act as a bulletin board moderated by the artists, and surely prompt more people to respond and react to the postings by sending messages of their own.

Conclusion

Greater New York and its use of the Internet and e-mail was an exciting and unique experience for all involved: museum staff, artists, and audiences. Emphasizing a space for an open, free, and private interpretation of the works on view, yielding unintended but beneficial results such as exhibition and sale opportunities for artists, reaching audiences of all ages and nationalities, and bringing new media to the forefront of museum outreach techniques, the E-Mail Project combined the complexities of the museum experience with the enthusiasms of the museum audience to create a one-of-a-kind synthesis of art and communication. It is surely a strategy that deserves the attention and consideration of education, curatorial, and new media museum professionals.

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Matthew Buckingham
Beth Campbell
Jordan Crandall
Hope Ginsburg
Gareth James
Julian Laverdiere
Pia Lindman
Jennifer and Kevin McCoy
Mick O'Shea
Paul Pfeiffer
John Pilson
Javier Tellez
Anton Vidokle
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A Curatorial Resource for Upstart Media Bliss

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Abstract

Using resources gathered for the CRUMB website (http://www.newmedia.sunderland.ac.uk/crumb/), this paper presents some key information and debates regarding the curating of new media art, both on the web and in conventional gallery spaces. Including quotes from Sarah Diamond, Steve Dietz, Peter Weibel, Benjamin Weil and Kathy Rae Huffman, the paper discusses issues of how artists are paid, how new media art is archived, how audiences might respond to new media art, and the aesthetics concerning the presentation of new media genres. Practical examples from the authors' experience of curating new media art are also given.

> *Museums consider having web presence as obligatory – as membership, information, e.commerce, etc. and then eventually an art space. The art space is not quite an afterthought, but it is not the prime focus. (Weil, Sins of Change 2000)*

> *... the Susan Collins artwork Audio Zone is spread around the exhibition space. The audience must wear infra-red headphones, which at certain points receive seductive voices urging you to 'touch' and 'stroke' the triggered video projections of nipples, lips and keyboard buttons. The desk staff who issue the headphones quickly noticed a very common misconception in the audience, and now carefully explain to each person that this is NOT 'a guide to the exhibition.' (Graham, 1994)*

The problem with curating new media art is that the fascinating range of challenges is matched only by the dearth of data and material available to help curators. Comparatively, the field of museum interpretative and educational new media is well resourced and debated. On seeing a piece of new technology in a gallery or museum, a member of the public is justifiably likely to assume that it is some kind of interpretative aid rather than an artwork in itself.

General new media theory seems to be in plentiful supply; so much so, that the few accomplished new media artworks which manage to get produced tend to emerge staggering under the weight of eager academics. When it comes to the practical issues of presenting new media to the public, however, even Peter Weibel of ZKM admits that it is "difficult not to make an error because there is not much information ..." (Weibel, 2000). There have been some conferences and some skirmishing on discussion lists concerning new media art curating in particular, but nothing like the regular, archived, published events devoted to the web as interpretation.

It is this relative absence which the Curatorial Resource for Upstart Media Bliss attempts to address, starting with the collection and presentation of some pithy information and opinion relevant to overworked new media curators. CRUMB forages beneath the tables of education, museum evaluation and media theory for tasty morsels, as well as going straight to the horses' mouths of curators and artists for useful experience and hindsight. The website includes bibliographies, links, interviews with leading curators, and some useful nitty-gritty concerning contracts, etc. The CRUMB website, and this paper, draw from a wider research interest in new media curating at the University of Sunderland, and particularly from the experience of the curators. Working both in new media and mixed visual arts contexts, between us we have experience in working with budgets from £200 to £200,000, and in doing research in places from Banff and Minneapolis to Bangalore and Ljubljana. Having worked with institutions from artists-run centres to local authority galleries, we have sympathy with various devils, and can commiserate with Barbara London when she says that "It's tough to get museums to change, to keep moving in new directions. In early days of

video we didn't have access– parcel post is how they got around." (*Sins of Change* 2000).

It is very much early days for any discussion of new media art curatorship. At times the debate seems to move very fast, and at others it seems fossilized, with huge disparities in awareness and expectations. In Britain in 1997, the announcement of the Turner Prize nominees unleashed a surprising flood of popular press puzzlement that video could be considered to be art. On the other hand, in India, a healthily hybrid approach means that artists like Shilpa Gupta (http://members.tripod.com/shilpagupta/) can move between sculptural installation and Internet-based art fairly comfortably. The field of 'new', newish or upstart media is rather difficult to discuss when neither the terminology nor the genres are fixed. The conference *Computing Culture: Defining New Media Genres* (1998) suggested that artefacts could be considered within the genres of Database, Interface, Spatialization and Navigation. Festivals and institutions do seem to be starting to divide their calls for work into rough categories of Net.Art, Single Screen, Performative, and some variety of interactive or non-interactive Installation (Public Art and 2D Digital Images being occasional orbiting companions). Whilst net.art has netted the majority of debate and controversy, CRUMB also covers physical new media works in conventional gallery spaces.

This paper uses some resources from the CRUMB website to consider some current debates for curating new media art, falling under four headings: Artists, Archives, Audiences, and Aesthetics.

Artists

> *His idea was clear: a museum has to follow what artists are doing. Art history has to follow art. Not the opposite. Too much today the museum wants to prescribe what art is. (Weibel ,2000, referring to Alfred H. Barr of MOMA)*

> *Curatorial decisions are made through a need to justify hardware and software investments. Artists are a test case. (Vuk Cosic, net.art pioneer, Sins of Change 2000)*

Art and science institutions have sometimes invited artists in to play with their equipment, only to find them fundamentally challenging their whole value systems:

> *[new media art] practice challenges the notion of authorship, has to do with collective authorship; non western ideas of discourse is something the museum has always had trouble with. And what has happened on the net is a brain of a social collectivity, that allows discursive practice ... How do you support and preserve a critical practice that is inclusive ... how can you do that when it is difficult to pin down authorship? (Sara Diamond, Banff Centre for the Arts, Sins of Change 2000)*

Artists, whether individually or collectively, have not only presented museums with major conceptual headaches, but also been implicated in major shifts in how educational and commercial research institutions think about what they do. As Lynn Hershman says: "digital artists have to adopt interdisciplinary ways of researching" (*Sins of Change* 2000), not least in order to get access to equipment. In the USA, for example, the Xerox PARC experience (Harris, 1999) openly explores the creative conflicts between art and science research, whilst in the UK the development of 'art-practice-led' PhDs has been involved with a fundamental questioning of 'what is research?' (Malins and Gray, 1999). It is the artists who make and push the new forms of media art, even if these forms are risky, challenging or an unfinished process: "... only the net allows us to make these works in progress. If you are a curator it is a crime not to use it." (Olia Lialina, net.art pioneer, *Sins of Change* 2000). Certain generous and brave curators have benefited from the spirit of this openness by making their research trips public (such as Barbara London's Japan journal http://media.moma.org/dot.jp/) or by sharing their process and knowledge (very notably, Steve Dietz's publications at http://www.yproductions.com/).

Concerning audience, archiving and economics, artists tend to ask the most difficult questions, such as Ester Robinson's queries: "Who is paying for what you are doing? ... Does it live in a place that no one should care about it? ...Who has ownership? ... How does it give the audience sustenance?" (*Sins of Change*, 2000). Of obvious importance to artists is the whole question of how they can make a living.

Olia Lialina has stated that "My contribution to this discussion was the first net art gallery, Teleportica. It was to show that net artists are not the cheapest artists on the market." *(Sins of Change*, 2000). Should museums be paying 'per screening' like video or cinema,? Should they be funding co-productions like films? How do web artists fit into the Exhibition Payment Right (UK) or CARFAC schedules (Canada)? Media artists can't survive

> *... unless museums start to pay artists fair amounts for linking to their work... amounts that are comparable with what any other artist showing in a gallery space in the museum would expect to receive for a whole body of work... one net site is usually not the equivalent to one painting ... more like a major body of work – [such as] a large installation, a substantial video, a series of sculptures. (Rackham, 2000)*

Other artists may see the more popular debate concerning payment and intellectual property as part of the commercialization of the Internet rather than as an art debate per se (but these may, of course, be artists with other sources of income):

> *I'm always struck by how the mainstream press is obsessed with the question of how Internet artists are ever going to make a buck ... I recently plodded through stacks of reviews from the '60s of Fluxus artists smashing violins and pissing in buckets. At the time plenty of journalists asked 'Why is this art?' or 'Is it theater?' or 'Is it any good?', but I never saw a single article that raised the question of how these artists were going to make a living. (Ippolito, 2000)*

The struggle for artists' access to money, resources and presentation facilities will no doubt continue, but as artists are the ones who are making the debate as well as the work, they may be "a test case" in a positive as well as a negative sense – testing the institutions in unpredictable and productive ways.

Archives

> *How can we address the preservation of ideas as opposed to objects? (Weil, 2000)*

> *Lev Manovich: I understand your position regarding museums, art institutions, preserving, archiving, databasing – but it's so different from the Futurists who said, 'shoot the painters, burn the museum.' Here we are – the avant-garde – and we want to keep all the stuff. (...) Maybe we should be looking towards the future.*

> *Sara Diamond: It's different when a canon is being created, as opposed to a movement. (Sins of Change 2000)*

It seems that every media art festival of the past year had a panel to address the question of archiving – often as art (for example, the panel at ISEA2000 moderated by Karen O'Rourke with Patricia d'Isola, Christophe Le Francois, Eduardo Kac, Georges Legrady, and Lev Manovich), but also as a curatorial strategy. Yet despite all the discussions there remains an ambivalence toward the notion of archiving – we don't know what to keep yet, but we need to be able to refer to it.

> *We either let it decay online and that's fine or we preserve the memory and find a form to represent it in a manner that makes sense. Who in this room has seen the Spiral Jetty? But we all know about it, at least we have a sense of what the intent was. Going backwards to understand how this work was produced is a good lesson. (Weil, 2000).*

> *... art critics have suddenly found pioneering figures in video installation, all from the early 90s. There is in fact a half-century of pioneers, and now we have to get the word out, not just the work out. ... the genesis of this conference was to address the amnesia of recent art critics. You must get up and think about them [the early media artists], teach them, write about them, make people watch them. (Bruce Jenkins, film and video curator at Harvard University, Sins of Change 2000).*

Furthermore, we're aware that technologically, we're using media which have, in Bruce Sterling's words, "the life-span of a hamster" (1995). Showing the work in order to keep it alive, in order to make it part of a canon, is in fact destroying the work. In the case of film and video, the work is deteriorating as we watch and learn about it.

So, if we can't count on being able to keep the obsolescent technology, we need to be able to keep the intent, the words. Yet the question of archiving even the discourse which surrounds new media practice (which we anticipate will be useful to future curators) is itself debated. For every book published by MIT press, for example, there are a thousand e-mails on listservs across the globe that get read and deleted. Jennifer Crowe is constantly revising the guidelines for submissions of projects and information to the Rhizome database (http://www.rhizome.org). Then there's the question of whether the discourse exists in the first place:

> *... people in art worlds didn't know how to look at my work, or treat it. So I wrote my own reviews [under the pseudonym of] Prudence Juris. The reviews would talk about and argue about the work. Then I would take those articles and show them to the galleries to develop my own credibility. You have to create the language yourself to promote, historicize your work. Just doing the work isn't enough. You have to create preservation on your own. (Lynn Hershman, artist, Sins of Change, 2000).*

E-mail has made even the museum tradition of filing correspondence with artists more complicated (few people in the museum world are consistently diligent enough to print and file a letter about the making or exhibiting of even a painting, let alone the details of a web commission).

The Walker and other museums have been questioning the feasibility of offering open source, shared server space to artists. Oliver Grau at the University of Humboldt in Berlin (http:// www.arthist.hu-berlin.de) is developing a database of virtual art that documents not only the work of art but also all its different versions, each time it was presented, what the publicity/criticism of its exhibition was, even who the technicians who worked on it were. This is an academic (and highly theoretical) endeavour, but once online could be a model for the preservation of ideas as well as of the documentation of inherently transitory work.

This, after all, is the mandate of the ZKM. But on that front there is also the curatorial dilemma of the authority of authoring through the practice of archiving. How many future new media curators will see the exhibition *net_condition* produced by the ZKM as the official history of net.art? Why aren't Heath Bunting and Irational.org in the show?

> *They [ZKM] had a show on Internet art – I'd like this to go on the record – very, very late in the game. They came very late to discover Internet art. They trailed on the coattails of other curators. They picked up and accumulated the choices of other curators. They accumulated them in their show. (Huffman, 2000)*

> *Sarah Cook: So then what is the future of a new media curator?*

> *Peter Weibel: to protect media art against the takeover of the historical art world. Seriously. It's not an easy job.*

> *Sarah Cook: But the historical art world is founded in part on museums where they collect art. That is why you have new media institutions like the one we're in now, ZKM, which also collects, so how is that protecting media art from the art world if museums the world over are collecting new media art?*

> *Weibel: By two things. First by emphasizing production, of contemporary, risky, young artists, and then by preserving the work which is discounted and marginalized by the art institutions. (Weibel, 2000).*

In the field of new media art, the canons are beginning to appear amongst the hand -to-hand combat concerning archiving. Dust may continue to obscure the view for some time, but if we archive documents and records of the early exhibitions as well as recording the work itself, the history of new media may perhaps be usefully retained. By utilising the possibilities of new media, the archives may even be creative tools in their own right.

Audience

> *Who wants to walk around a gallery if it's full of toffee-nosed elitists? (James Bloom of Wired magazine at the First UK Internet Art Festival, quoted in Cavendish, 1995, 23)*

> *If interactive art simply mirrors the game – its themes and values – it becomes symptomatic of uncritical postmodernism where there is no difference between entertainment and art, where consumerism reigns. And when, loaded down as amusement, it knocks on the museum door, it insists on altering how and why museums function, further institutionalizing art as consumer fun. (Cornwell, 1933, 12)*

In the early nineties, the utopian excitement about new and different audiences contrasted sharply with fears that the allure of 'hands-on technology fun' might be deeply implicated in the 'Disneyfication' of museums. Some time later, the debate is perhaps less polarized, but still rather contradictory. Shankar Barua (2000) summarised a situation that has international resonance: "In India the audience for art galleries is a thin elite. The audience for new media art is also an elite, but a different one."

Is the audience for net.art a new audience or just the regular art audience logging on when they should be doing something else? How does the audience find the site? How does the number of hits to a website relate to actual use, benefit and pleasure? Is it more about participation than audience anyway? And how about 'hacktivist' net.art, which may be deliberately anonymous and covert in its baiting of multinationals, rather than seeking an audience? For all the internationalist rhetoric, how does the Internet cope with the practicalities of cross-cultural art communication? For all of these questions, certain exhibitions and artefacts provide particular examples, but there is much less information available from curators and artists about behind-the-scenes data, illuminating failures, or audience feedback. Those who design museum interpretative sites have been gathering information for some time on those who use the sites, how and when. Artists may have very different parameters for judging the 'success' of their sites, but some data on who visit, and whether they stay for two seconds or two hours, might be useful, even if only to discover how best to shock and appall.

As for new media art installations displayed in conventional gallery and museum spaces, there are some scattered items of information concerning audience demographics. For example, for one exhibition of interactive installations in a regional British art museum, the show, when compared to other contemporary and historical art exhibitions in the same year, showed little difference in gender numbers, but a significantly higher proportion of visitors from the "under-20" age bracket (Graham, 1997, 102).

Gathering demographic information is one thing, but judging the subtleties of audience interaction is another. The entry of new media art into museums was very much spearheaded by 'the romance of interactivity'.

The word *interactive* sounds like it will alleviate the alienation of modern life by generating a dynamic alliance between artists and their audiences, joining them together in a splendid waltz that lets viewers become equal partners with artists in creating art (Wooster, 1991, 294). Since then, the romance has been tempered by some more critical views on exactly how interactive artefacts are: "For a multimedia program, a human audience is just a random number generator." (Cubitt, 1999) The knowledge of those designing educational exhibits has also become pertinent: "To interact is to act reciprocally, to act on each other. ... not merely a machine that the visitor operates ...'Non-interactive mechanisms' perhaps sums them up adequately." (Miles, 1988, 95). Although artists are understandably wary of 'audience evaluation', they may be interested in, for example, the results of Stevenson's (1994) research into hands-on science exhibits which indicates that there are significant impacts on the long-term memories and understanding of the audience, rather than merely a case of 'running around pushing things'.

Some of the commentary on the audience's use of interactive artworks in galleries has come from critics: "... you really need an hour alone with the thing, which is impossible under the circumstances of everyday museum attendance." (Coleman, 1994, 14). Some has come from artists themselves, such as David Rokeby's detailed observations on "command" gestures versus "tentative questioning gestures" in his interactive art systems (1995, 148). Weinbren (1995) and Feingold (1995, 401) have also made useful observations on 'control' and 'mastery' in their own artworks. Research into interactive artworks in galleries (Graham; 1997, 1999) expected interesting gender differences, but uncovered instead a surprising tendency for groups to want to use artworks together, even when this meant squashing

uncomfortably into spaces designed for an individual. This led to a particular interest in artworks which encourage interaction between audience members, rather than solely between artwork and audience.

There is still a great deal of uncertainty amongst curators (and the audience) as to what *kind* of experience is being offered by new media art: Quick-fire game pleasure? Information pleasure? Sculptural pleasure? Sit-on-a-hard-chair-and-watch-a-video pleasure? (Graham, 2001). As with the *Audio Zone* artwork using infra-red headphones, this confusion may be used creatively, but the incredibly diverse range of expectations about new media art means that it's more than usually important to try to get some kind of feedback. Matthew Gansallo (2000), when interviewed about the Mongrel commission for the Tate (http://www.tate.org.uk/webart/), revealed a wide range of reactions:

> *... we got a lot of responses back: 'who did it?' and 'how scary!', and 'is this a site for knowledge?' and 'what is it?' and 'anyone can put this typically Tate shock tactics crap [up]!' And we got responses that were 'gosh this is interesting,' and 'I'm glad they've done this,' and 'it's good the Tate is large enough to say what you want.'*

Whoever the target audience for new media art may be, and whatever the feedback, Robert Atkins has some pithy parting advice:

> *The Top Five strategies for overcoming sloth in your artistic/curatorial practice in relation to the issue of having your audience gain access to the work:*
>
> *5. Don't think technological barriers will fall – there are ever-increasing barriers of technology business ...*
>
> *4. Focus your energy on technology that is beginning to arise, something not too far away ...*
>
> *3. Don't lose sight of producers and of quality for audiences; the more you watch the less you know.*
>
> *2. Do think hybrid, not just hardware or software. Digital culture can be simultaneously many things at once; producers and audiences can both be content creators ...The art-world mix of producers [can create] another form of knowledge – from media into media art. (i.e. Muntadas' Archive Project and mediachannel.org)*
>
> *1. Don't censor yourself, don't wimp out, don't think anyone knows more than you do ... Find niche opportunities ..."*
>
> *(Robert Atkins, art historian, writer, media content producer, Sins of Change 2000)*

Aesthetics

> *User experience is what art does best. To change the interface is to dramatically change the work. (Lee Manovich, artist and theorist, Sins of Change 2000)*
>
> *It's only under huge pressure that a visual arts curator would agree to hang a video projector, and only if it is agreed the projector will project an image on the wall and take us back to painting. Only under threat of torture will a visual arts curator put a computer in the galleries. (Philippe Verge, Walker Art Center, Sins of Change 2000)*

The aesthetics of new media art is easily ignored in favour of its function. Moreover, the way a piece of new media art looks and holds up within the realm of aesthetics is usually masked behind a whack of media and communication theory – about networks, about spectacle, about invisible architectures. Aesthetics, as a philosophy, is an old-fashioned one, and certainly not one taught in most media schools. It is, however, a philosophy taught to curators. Hegel taught that to each age there is an art form, from painting to sculpture to the architecture of the temple itself; from this we learned not to see art as separate from the age in which it was produced. New media's very nature – interactivity being one aspect – has demanded of curators different criteria for the aesthetic evaluation of the works. Would Hegel have placed net.art as the highest art form for our age?

In his article "The Death of Computer Art", Lev Manovich (1996) made a distinction between two worlds where art is made and shown, but where

the social definitions of art differ enormously. The first he called "Duchamp-land" and defined it as: "galleries, major museums, prestigious art journals"; the second he called "Turing-land" and defined its parameters as "ISEA, Ars Electronica, SIGGRAPH art shows, etc." Manovich's point was that the two worlds would not converge, that we should not expect what is being made in Turing-land to be shown in Duchamp-land. The reason for this, he surmised, was that the typical object admitted to Duchamp-land prioritizes content and fits within a discourse of irony, self-referentiality and other things generally postmodern, but that the objects being made in Turing-land are not ironic because they are oriented towards ever-new technology rather than content, they are simple in ideas, and they take their technology very seriously.

This distinction is still valid. Manovich established criteria for the type of art *accepted* in each land, but what he didn't mention then, and what has become paramount now in 2001, are the criteria for art to be *shown* in each land– namely, the questions of exhibition practices and the field of curatorship. For art to be shown in Turing-land, it need only apply. All that is needed is some money, a truck, a power-bar, a plug, a network connection plus a space in a fair in a convention center, or maybe none of that but ftp and a server. For art to be shown in Duchamp-land it has to have the interest of a curator, and with that comes the backing of an institution, a board of directors, a funding body, an intellectual mass. Unlike the art made in Turing-land, art in Duchamp-land goes through some process of curatorial legitimization before it is shown. Curators make regular visits to Turing-land in order to find things to bring to Duchamp-land (that's how Lev Manovich ended up in the Walker Art Center – one of the powerhouses of Duchamp-land). So in that respect, it might have very little to do with what the work is actually about. While the two worlds may not have converged, the way curators move between them has had an effect on the work being produced in each. Where do you think curators have learned the communication theory behind which they can hide the lackluster aesthetics of much of new media art? What is found readymade in Turing-land can always be signed and exhibited in Duchamp-land.

And has this curatorial "research" had an effect on the way the work is presented in each? You betcha. Curators beware: 'changing interface' can change the work. One only has to think of the different experience of visiting a convention center from visiting a white cube to realize that the interface is the interaction. The same is the case on the web – seeing art in the context of a commercial product-based site and seeing it in the context of a cultural content-based site can drastically affect how that work is interpreted.

The best recent example of this was Vivian Selbo's design for the exhibition *Art Entertainment Network* (http://aen.walkerart.org). Creating a customizable interface for the works on view was the artwork in itself. There was a place to shop, a place to read, a place to listen, a place to chat ... all things we expect from our web-experience, whether commercial or cultural. These types of interfaces are clearly needed as curators have recognized that Duchamp-land-type media art simply doesn't fly in any place where its irony and content-based form is subsumed by the pressures of the bottom line.

Though who says aesthetic culture isn't commercial anyway? Obviously it always has been. Nevertheless, the curating of media art into Duchamp-land has caused a number of Turing-land artists to reconsider how they want their work to evolve in the world. Why should it be self-referential and postmodern just to get the money to be shown in Duchamp-land when now they can get a lot more money by masking the irony and selling their skills to the market (which is neither Duchamp nor Turing aware) instead? As such, a number of web-based artists have turned the lion's share of their attention away from simply making works of net.art to starting dot.coms: Vuk Cosic and the Slovenian start-up Literal (http://www.literal.si), the boys from etoy selling shares as art (http://www.etoy.com), hans_extrem and his self-professed very expensive consulting company, Ubermorgen (http://www.ubermorgen.com).

This has created a third problem and brings us back to the beginning of the vicious circle. How do curators present this type of overtly commercial and yet slyly Duchampian practice when museums structures have traditionally dictated that the art shown is not explicitly commercial, and when at the same time the commercial galleries won't touch new media art with a ten-foot pole because they can't

see its inherent ephemerality as an investment? Should they even exhibit it? Until Turing-land and Duchamp-land (and now perhaps Monopoly-land) get themselves sorted out, the answer seems to be that curators tend to go back to their philosophies of aesthetics and mask the work behind more theory: beauty with seduction always sells.

In Conclusion

The reason curators expose themselves to the confusion and challenge (and carping) of newmedia art might be that the whole mess is undeniably fascinating and offers opportunities for trying a bold experiment,and getting it right (or more right than anyone so far). CRUMB aims to provide some information which might help avoid the alternative of getting it spectacularly wrong (in a way that someone else has previously got it wrong). We aim to extend the life-span of the media art hamster by filling our cheeks with crumbs dropped by curators and others, and all thanks should go to those who share the knowledge (Steve Dietz and Sara Diamond particularly), and to all those who agreed to be interviewed about awkward subjects.

The Museums and the Web conference is one of the few occasions on which educators and archivists get to meet artists and art curators and to share information from their varied experience.We hope that people will contribute to the CRUMB site and discussion list, and add to the public body of knowledge concerning new media curating.

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Maintaining the Magic ...

The Virtual Aura - Is There Space for Enchantment in a Technological World?

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Abstract

As Walter Benjamin described in his famous essay, "The Work of Art in the Age of Mechanical Reproduction", the role of art in society and the notion that art has become modified through mechanical reproduction has engaged not only artists, but also curators and the museum public. Benjamin embraced the severing of the quasi-mystical 'aura' from the original as a potentially liberating phenomenon, both for the reproduction of works of art and for the art of film, thereby making works of art widely available, introducing new forms of perception in film and photography and allowing art to move from private to public, from the elite to the masses. While the loss of the aura for Benjamin represented new possibilities, what was forfeited in this process were the 'aura' and the authority of the object containing within it the values of cultural heritage and tradition. This paper evaluates the different ways that museums are responding to life on the Net, and will look to three models of museum Web-sites: the documentation of traditional collections through online databases, the virtual museum with no concrete counterpart to resonate the online experience and the proliferation of Web based contemporary art. This attempt to map out the different ways that museums formulate their identity on the Net will address the notion of the lost aura or perhaps the emergence of new cultural phenomena, the virtual aura.

There are as many reasons to seek out an online museum as there are to visit the real museum, and museum Web sites are addressing a wide range of these experiences. While some Web sites demand that we sit upright in our chairs for a traditional, pedagogical kind of experience, at other times, we are less focused and enjoy a more passive, relaxed kind of interaction with the screen. In much the same way as we may watch a film or a television program in a state of distraction, we act as observer, but an absent-minded one. As we sit in front of the monitor and connect to the dancing images in front of us, we allow electronic images and sounds to radiate from the screen and seep into our inner world. In a post-modern, wired society, the online museum brings the virtual image from remote locations into the foreground. This paper will investigate different models of online museum and the cultural processes involved when objects in the concrete museum are not only represented by surrogates, but also have been liberated or dispelled from their rhizome and distributed in electronic packets to remote locations in a networked world.

This paper evaluates the different ways museums are responding to life on the Net, and will explore three models of museum Web sites. The first model provides a metaphor for the traditional museum which provides access to digital collections through online databases such as the Thinker ImageBase, (http://www.thinker.org/) of the Fine Arts Museums of San Francisco (the de Young Museum and the Legion of Honor), USA. In the second model, the virtual museum metaphor is explored in **MUVA, El Pais Virtual Museum of Art** (http://www.diarioelpais.com/muva2/). The El Pais site exemplifies a virtual construction which maintains a tenuous base in reality. For the third model I have selected two further web sites, both net art projects: **Uncomfortable Proximity** (http://www.tate.org.uk) at the Tate Modern Web site, and **Geist**, (http://www.mediascot.org/geist). Where the 'real' Tate provides floor plans, the Tate Mongrel project, created by Harwood, takes us under the floor of the Tate. The Geist Project, by Colin Andrews of the New Media Group, Scotland, presents an eerie Web site involving ghosts.

This paper will attempt to map out the different ways museums formulate their identities on the Net and will address the notion of the lost aura or perhaps the emergence of a new cultural phenomenon, the virtual aura.

The Age of Mechanical Reproduction

Walter Benjamin, writing against the backdrop of the Nazi era in 1936, in his famous essay, "The Work of Art in the Age of Mechanical Reproduction", described the role of art in society and the way in which art had become modified through mechanical reproduction. Benjamin embraced the severing of the quasi-mystical 'aura' from the original as a potentially liberating phenomenon. Making works

of art widely available opened new forms of perception in film and photography, and the accessibility of art could move from private to public, from the elite to the masses. While at the same time questioning the need for authenticity, Benjamin welcomed the close-ups and slow motion of the moving image in that they opened up new art values that were no longer so dependant on cult values or ritual. Thus Benjamin's work was seminal in bringing into focus the notion of art as politic. This insight, according to Benjamin, meant that

> for the first time in world history, mechanical reproduction emancipates the work of art from its parasitical dependence on ritual. (Benjamin: 1935, 1992).

What had been forfeited in this process, were the 'aura' and the authority of the object, scarred, yet also embellished with the patina of time and prismatic with the marks of human endeavour. It was the aura that contained within it the values of cultural heritage and tradition. Even though for Benjamin, the loss of the aura meant the loss of the original, the transformation or liberation of the art object to the ordinary represented a gain. For Benjamin, what had then replaced the original at that time was the illusion of the moving image, and the duplication of the photograph. For post-modern society, it has become the digital image. While Benjamin celebrated the magical aura that had been forfeited as a *liberating phenomenon*, one cannot help but speculate whether there is still a need for a space of wonder or enchantment in a technological world. Perhaps society still craves such a space, now more than ever, and seeks it in extraordinary places, such as in the museum. If so, then can this lost aura be compensated for or reconstituted in any way in a virtual environment in a networked society?

Click to Go!

The speed with which we are able to access remote museums and pull them up side by side on the screen is alarmingly immediate. We do this at the click of a mouse, and in a nano-instant of time. Scott Lash and John Urry, (1994), argue that in the wake of organized capitalism, the flows of objects (goods, capital, money, communications, commodities) as well as subjects (labor, immigrants, tourists) are accelerating in ever widening trajectories. According to Lash and Urry, this has disturbing implications for society. As social relations are 'distanciated', it 'compresses' time and space, and is leading to an emptying out of both subjects and objects. This accelerated mobility causes objects to become disposable and to decline in significance, while social relationships are emptied of meaning (Llash and Urry, 1994). With one click we can access an entire museum. We are able in one glimpse to visualize in miniature all of its multi-functions represented on its home page. While there is no doubt that this provides efficient and meaningful information for remote visitors regarding potential visits, should we query what kind of experience visitors gain when they view the digital collections represented as tiny, two dimensional, electronic reflections of the original works? Should we conclude that this medium is orientated exclusively towards information and interpretation, or could there be more to it?

Anthony Giddens, (1994), argues that in post modern society there has been a separation of time and space, and their recombination in forms which permit precise time-spacing "zoning" of social life, but which has consequently led to the disembedding of social systems (Giddens, 1990). Giddens points to this severing of time as the cause of place becoming increasingly *phantasmagoric* in that locales are thoroughly penetrated by and shaped in terms of social influences that are, in fact, quite distant from them (Giddens, 1990). Giddens emphasizes that

> what structures the locale is not simply that which is present on the scene; the "visible form" of the locale but what is present is also the relations concealed in the distance, and it is the remote relations that is determining the nature of the local (Giddens, 1990)

For example, the city with numbered houses based on boulevards and a grid structure, in which the high street has its Benettons, McDonalds, and Nexts, is more abstract, more emptied out than the pre-modern city of winding streets and numberless houses. The remotely accessed database of museum collections seems to offer a similarly disembedded experience. The vast distance covered in mere nano-seconds acts to dissolve the concrete-ness of the

real museum in front of our eyes, resulting in an emptying out of the traditional visitor/museum experience and the disembedding of cultural systems reflected in the museum.

Living In-Vitro

In post-modern society, our participation in the public sphere, understanding of current events, entertainment, and life long education have come to depend more and more on mediated resources rather than first hand, *getting our boots dirty* experience. The second hand, virtual narratives, either through television or digital interaction, cause us not merely to reflect on these experiences but to actively construct our daily lives through them. We cannot be physically present at every national celebration, and we do not want to be present in a war-zone. We are content to let the camera be our eye and the anchorman our mouthpiece. Where much of our life is *lived* through mediated rather than first hand experience, much of our daily interaction is becoming more vitreous than visceral. Over the last 40 years, most of the world's populations have spent countless hours watching the world *in vivo, in vitro* on screens in their living rooms, bedrooms and classrooms. We are content to watch live sporting events from the comfort of an armchair; we receive the daily fix of news on the allotted time slot; and we are faithful voyeurs of other people's lives, some real, some not, playing out on weekly dramas on the screen. Marc Auge reminds us of

> the false familiarity the small screen establishes between the viewers and the actors of big-scale history, whose profiles become as well known to us as those of soap-opera heroes and international artistic or sporting stars (Auge, 1995).

On the screen, the remote players become miniaturized in our own personal microcosm, and as these tiny, yet familiar images flicker into our internal vistas, they penetrate our lives just as potently as other daily interactions and are often just as persuasive in their messages. How often have we put down a book only to be rudely awakened to the reality that we are sitting in our favorite armchair? How is it that we are shocked by the brutality of the house lights turning on as the last scene of a film fades away from our inner eye? Margaret Morse, (1998), describes this state of distraction as the *fiction effect*; that is, the partial loss of touch with the here and now, a state of distraction experienced on the freeway, in shopping malls, and in television viewing (Morse, 1998). Can digital images and messages be just as compelling as the magic of literary space and cinematic experience? Can the tiny electronic stage, set for one person and for one person only, be a convincing space of enchantment?

Seeking the Sacred Space

According to Michel Foucault, (1964) we live our lives within many kinds of intersecting social relations that overlap yet remain discrete. He argues that while social space has been moving towards de-sacralization since the time of Galileo, this process has been mainly theoretical. Where once there was a hierarchy of sacred and profane spaces, as Foucault describes, "all laden with qualities and haunted by fantasy", in practical terms, both in private and public space, relations are still being controlled by an unspoken sacralization (Foucault, 1964). In order to fulfill this desire for the sacred, contemporary society seeks to define spaces, separate from mundane, everyday living. Foucault describes these spaces as **utopias**, as spaces having no real place, as fundamentally and essentially unreal where they act as an analogy with the real space of society. However, according to Foucault, every civilization creates *real* places, actual places, that serve to stage experiences, and consequently sets them aside for extraordinary action. Despite Benjamin's celebration of the mechanical reproduction that caused the separation of art from cult values and ritual, we cannot deny that there is still a need for the sacred in post-modern society. The liminal spaces that Foucault calls **heterotopias**, while based in objective reality, act as the mirror that reflects. While this reflected space may be concrete, in that it exists in a real location, its social function at the same time serves to provide society with an abstract locale to act out experiences at a time of crisis; a locale for adolescents, menstruating women, women in labor, old people and so on (Foucault, 1964). A derivation of the heterotopian space, according to Foucault, is the heterochronia of time that accumulates indefinitely - for example, museums and libraries.

> Museums and libraries are heterotopias in which time never ceases to pile up and perch on its own summit, whereas in the seventeenth century, and up to the end of the seventeenth century still, museums were the expression of an individual choice. By contrast, the idea of accumulating every-thing, the idea of constituting a sort of general archive, the desire to contain all times, all ages, all forms, all tastes in one place, the idea of constituting a place of all times that is itself outside time and protected from its erosion, the project of thus organizing a kind of perpetual and indefinite accumulation of time in a place that will nor move - well, in fact, all of this belongs to our modernity (Foucault, 1964).

If we follow Foucault's argument that the museum is already an exceptional space, set aside by society for extraordinary activity, when we view this already fabricated construction remotely through the glass of the television or computer monitor, we surely will encounter a further dislocation. In order to separate technological determination from aesthetic experience, it would be useful to look to Alfred Gell's approach on what it is that makes an artwork compelling in the first place.

Enchanting Technology

In his essay, '*The Technology of Enchantment and the Enchantment of Technology*' (1992), Gell attempted to evaluate this mystical yet nebulous trait from a socio-anthropological perspective. He looked to the technological processes of **evolution of the artwork** to ascertain what it was that was inspiring enchantment in the beholder. Gell determined an essential property imbued within the art object that served as a component of social systems. In his search for an overarching anthropological theory to explain not only Western art, but what he terms non-Western art, he implied that art objects cannot be evaluated when dislocated from their social systems, but need to be seen in light of their circulation in society. In this circulatory format, art is thought of as agency, invoking a series of responses or interpretations perceived as indexes of relations to the object, the artist, and the recipient (Gell, 1998, in the foreword by Thomas, ix). Gell does not deny the aesthetic component of art, but considers art as a technical system producing social consequences in much the same way as a religion or belief system weaves the social fabric of a community. This he calls *the technology of enchantment* and proposes that art-systems be considered networks in society where neither the individual creator, nor the agent, nor the *enchanting* art object itself, can be separated from the collective process. This over-arching technical system, contributing to the dynamic of culture, embodies a mystical process that "*casts a spell over us so that we see the real world in an enchanted form*".

The technology of an art object differs from other objects valued by society, such as beautiful horses, beautiful people, (Gell: 1992, 43) in that it is *man made*, emerging from the alchemy of the occult technician, and reflects what Gell defines as the '*enchantment of technology*.' The magic, or the aura of the art object, is brought into being through the technological process itself. He illustrated the universal attributes of technology common to all categories of man made art objects, including classical oil paintings, sculptures by Picasso and Matisse, as well as the canoe prow-board of the Trobriande Islands of Papua New Guinea (Gell: 1992, 44). Gell emphasizes the technological process whereby all of these artefacts came into being and suggests that these 'outcomes of the technical process' have all been produced by magical means. It is through this magic that the object evokes a profound sense of awe in the beholder, a potent visceral response that Gell identifies as the 'halo-effect' and Benjamin would connote the aura. But how does the artist/sculptor/carver produce this magical 'halo-effect'? Gell reminds us in discussing J.F. Petos' *Old Time Letter Rack*, 1894, that:

> People have great difficulty in working out how colored pigments (substances with which everybody is broadly familiar) can be applied to a surface so as to become an apparently different set of substances, namely, the ones which enter into the composition of letters, ribbons, drawing pins, stamps, bits of string, and so on (Gell, 1992, 49).

Gell acknowledges that this mystical process does occur, but questions if it is simply a matter of a fascination with colored pigments. As Gell goes on to explain, it is in this process, the way in which the object has come-into-being, which eludes us, and

forces us to interpret it as magical (Gell: 1992, 49). Gell compares other technological processes as having *more* or *less prestige* and cites the *lowly button-pressing* of the photographer as having *'no prestige'* unless there is perceived to be virtuosity in the photographic process and sophistically produced image. Only then would the photograph reflect a skill that exists beyond the beholders' capabilities. Gell identifies 'concept' art within his 'interpretive' theory of art, as being more attuned to the realities of the present-day art world which, according to Gell, has long abandoned the making of 'beautiful'-looking pictures and sculptures in favor of 'concept' art. Gell points to Damien Hirst's dead shark, in a tank of formaldehyde, "The Impossibility of Death in the Mind of Someone Living", 1992, as,

> an object that could not be called appealing, nor a work of any excellence in terms of craftsmanship. But Hirst's shark is a highly intelligible gesture in terms of contemporary art-making and thoroughly grounded in the post-Duchampian tradition of concept art, and, as such, is capable of being evaluated as good art, bad art, middling art, but definitely art of some kind (Gell, 1996).

Fredric Jameson, (1992), describes conceptual art as "perceptual paradoxes that we cannot think or unravel by way of conscious abstractions and which bring us up short against the visual occasions". Jameson compares conceptual art to some of the classic texts of deconstruction and anchors conceptual art to the spatial relationship of the gallery space. The art form creates a material pretext to make a mental circuit from the institution, into its network of trustees, their affiliations with multiple corporations, and finally the global system of late capitalism proper (Jameson, 1991).

In trying to explain the source of this magical potency, Gell describes how the Trobiande carvers spiritually prepare themselves in order to overcome technical obstacles in the carving process. Only then can this magic be transposed through channels of exchange into the perfect 'performance' of the canoe-board, allowing it to slip effortlessly through the water. Carvers undergo *magical procedures* which open up the channels of their minds, so that both the carved designs and the canoe will flow smoothly. This was accomplished, according to Gell, by means of the metaphoric use of water and other liquids, especially blood and bespelled betel-juice (Gell. 1992). Gell compares this moment to a musician in our culture getting technically prepared to give a perfect performance of an already existing composition, such as the 'Moonlight' Sonata (Gell, 1992). Gell acquiesces to Duchamp's accomplishments, in spite of the banality of the urinal, and recognizes the alchemy of the artist, in that he had the capacity to transform, which Gell describes as

The essential alchemy of art, which is to make what is not out of what is, and to make what is out of what is not (Gell, 1992).

Museumification

The visitor in a museum is responding to cultural processes that are reflected through the trajectories of the aggregated and contextualized objects. These sometimes precious, sometimes mundane objects are modified in the exhibition context where they go through a process of *museumification*, extracted from distant locations and placed on a spotlighted pedestal, or isolated in a glass cage. They become re-conceptualized and re-contextualized and serve to petrify cultural values in much the same way as the theatre projects the human condition through metaphor and allegory. While both the theatre and the heterochronical spaces of a museum are both artificial and temporary projections, the structure of the exhibition relies on 'real', culturally robust objects. Could this wonder resonate in the digital image of the new media? Could there even be such a thing as a virtual aura?

While the exhibition is a discursive space of a mediated message or sets of messages, visitors traditionally expect to encounter the '*real*' object. If visitors come to the museum and find, say, videos, why would they even need to come into the museum in the first place when they could enjoy the work equally well from the comfort of home on private television sets or video players? In a media saturated society we are bombarded with a surfeit of images that have been mechanically reproduced all around us: advertising on the street, art posters in public institutions and art catalogues in school and home. If the museum were to be relied on as a location of culturally robust objects, the exhibiting of videos, electronic interactives, and virtual reality

installations would seem to defeat the purpose of the art museum experience.

The history of photography has long left behind the notion of the photograph as historical document, and through aesthetic appreciation it has come to be a theoretical object, no longer perceived merely as a stand-alone simulacrum, eventually attaining a status of its own. This ontological evolution took almost a century and we now recognize the capacity of the photographic image to stir emotions and evoke wonder. Roland Barthes (Barthes, 1981, 2000) affirmed that photographs do radiate a certain kind of 'aura.' The aura of the lost in *me* and of lost memories act in much the same way that Proust's textual reminiscences of the Madeleine pastry and the potency of its smell served to evoke buried memory. Barthes distinguishes the "*punctum*" as that accident of photographic detail that pricked him, bruised him and was so poignant to him that it evoked an almost transcendental experience, conjuring up poignant lost memories of his mother. The historical process of the photographic image emerged from *window* to artefact, much as video has migrated from documentation tool to art form. Perhaps we need to maintain aesthetic distance from the World Wide Web to distinguish the parameters of this still new medium, in order to identify new spaces of enchantment amongst the cacophony of information.

Culturally robust objects serve as referents to cultural discourses and historical processes, and we are all aware of the many ways they evoke wonder in us. For the majority of society, without the capital to surround themselves with the original, the museum, the zoo, and the botanical garden offer a public space to languish in the authentic. However, with leisure time a limited asset, we depend on the mediated experiences and the surrogate to fill in the gaps. For many years, our reliance on the signifier rather than the signified, the Baudrillard simulacra, a duplicate without an original, has been constantly debated. It has even caused us to take actions in surprising ways that are not based in objective reality. The alarm over the Y2K bug that increased as the new millennium drew closer was an example of the fear of the signifier, a mere numerical representation, rather than of a concrete historical event. According to Kevin Robins,

> The idea that we are already living in a simulation culture has now almost become a cliche. We have actually come to feel rather comfortable with our new condition of derealisation (Robins, 1996).

In order to ascertain if the potency of Gell's enchantment, the Barthes "*punctum*" or the resonance of Benjamin's lost aura can be found online, I will turn to the online projects and investigate how they have made their screen debuts.

Ghosts, Magic and Enchantment

The Thinker ImageBase, from the collections of **The Fine Arts Museums of San Francisco** (the de Young Museum and the Legion of Honor), USA, represents the traditional museum metaphor, including activities, visitor information, membership, education activities and online shopping at the museum store. At the same time, the site offers the visitor or surfer access to the digital holdings of the real museums. While the de Young Museum is closed to the public until Spring, 2005, the databases provide authoritative background material both on the exhibitions on display as well as the collections behind the scenes. According to the Web site, the collections belong to the public, and because the museum is able to show less than 5% of the collections in the galleries at any given time, they feel a special responsibility to make them accessible in other ways. The ImageBase is a fully keyword searchable database containing 110,000 images from the collections and is promoted as an expression of the museum's mission to provide meaningful public access to the collections. It behaves more like a resource and less like a repository. The database offers a compelling educational experience, and recalls Andre Malraux's message of universality in his "*Museum Without Walls*." Just as Malraux predicted and applauded the globalization process that was yet to evolve, both he and Walter Benjamin would undoubtedly have celebrated the unrestricted distribution of art resources that are now freely bestowed upon remote visitors by such museums over the Internet. While the educational value of such a site is indisputable, in that it effectively replaces the traditional learning tool of slides or exhibition catalogue, I would question the notion of 'meaningful

access.' While Web authors invest considerable time and energy in making images speedily accessible through limiting to low resolution and cropping, it is precisely this immediacy of access that makes the process so alarmingly effortless. The speed factor, the 'click to go' phenomenon, may actually act as a disservice to the collections and act as the antithesis of the enchantment of technology, that in fact causes the disembedding of cultural systems.

A museum that does not exist in objective reality and is exclusively constructed electronically on the World Wide Web is the **MUVA, El Pais Virtual Museum of Art**. This museum is a virtual fabrication, and maintains only a tenuous connection to reality. MUVA utilizes a 3D technique, Web2mil, to conjure up a magic environment. Alicia Haber, the Director of the museum, welcomes visitors to the museum, which specializes in contemporary Uraguayan and Latin American art, and hosts extensive collections of paintings by leading Uraguayan artists. Four architects, Jaime Lores, Raul Nazur, Daniel Colominas and Marcelo Mezzottoni, were commissioned to prepare the plans for the building, on Avenida 18 de Julio, the main artery of Uruguay's capital, Montevideo. They created a fine arts museum consisting of galleries for permanent and temporary exhibitions, as well as spaces for informal shows, sculpture garden, restoration workshops, and administrative service areas. The building has five main floors where galleries are open to the public, twenty-four hours a day... virtually that is! Some sixteen graphic and Web designers, programmers, photographers and system managers modeled textures of the walls, stairways, windows, sidewalks, roofs and elevator, pixel by pixel, to provide a sense of 'reality' for the visitors. Intuitive navigation tools, allowing for fluid exploration around the galleries and collections, were studiously hung and discretely lit. Through embedded 'hot-spots' in the paintings, click-able links refer to in-depth studies of the artists' work, biographies and further information on the thematic presentation of the exhibition.

To construct the same museum in concrete, steel and glass would have cost over 100 million dollars, a prohibitive sum for the Uruguayan reality. Due to the efforts of this highly motivated and imaginative team, Uruguay's artists can now show their works collectively, substituting their own virtual museum for that impossible museum. This echoes Gell's comment that the essential alchemy of art is to make what is not out of what is, and to make what is out of what is not. In this case one is not describing an art object, but an entire museum. But we might also be reminded of Lash, Urry and Giddens' dubious implications for society and discern that the virtual metaphor of a museum might be a reflection of the emptying out of subject and object. Even so, while we do recognize a substantial loss, we might also side with Benjamin that, in this loss, there is also a welcome gain. The liberation of the original object and its distribution over the Internet opens up, for the first time, the availability of Uruguayan art for remote visitors and the opportunity for these artists to reach a broader audience.

"**Uncomfortable Proximity**" is the project created by Harwood, a member of the Mongrel collective with critical texts by Mathew Fuller and commissioned by the Tate. While the 'real' Tate provides floor plans, the Mongrel version takes us to what is beneath the floorboards of the Tate. The texts and images introduce us to the precarious foundations of the Tate galleries, the Millbank penitentiary, the filth of the Thames and the hidden history of the slave trade. The accrual of wealth through the slave trade had implications for generations of British aristocracy that inevitably translated into the currency of art, some of which found its way into the Tate collections. The Web site may be accessed via the main Tate site, where it kind of sneaks up on you with what appears to be a clone of the specific page you intended to visit on the Tate web-site. The extra windows need no invitation. They unscrupulously appear on your browser in the background as you click your way through the site, and take you into the underbelly of this institution of Britain's national heritage and the decaying matter of the 20th Century. This challenge to the very institution that is partner to the project and acts as host to the scathing message is remarkable in itself. However, what this project does is to limelight the very foundations of the Tate *cathedral*, the circulatory system of art in society, and specifically the sacredness of the British art system. This recalls Gell's observation that art objects cannot be evaluated

when dislocated from their social systems but need to be seen in light of their circulation in society, where art, as art agency, the object, the artist, and the recipient, invokes a series of responses or interpretations. The use of this media is resourceful, perniciously using the electronic stage to challenge all that is embedded in the mythological nature of the circulatory art system, and symbiotically located inside of the very fabric of its embodiment, the official Web site.

The Geist Project, by Colin Andrews, of the New Media Group, Scotland, is an eerie Web site involving ghosts, and was exhibited at The Pier Art Centre, Stromness, in November, 2000. Four remote sites across Scottish, traditionally 'haunted locations' are networked and act as nodes, gathering data such as changes in temperature and fluctuations in electromagnetic radiation. The information is then relayed via electronic networks to the library at the Pier Arts Centre, Stromness, Orkney where it is used to 'feed' an audio installation. The audio is derived from traces of 'voices' recorded at each location. The work is experienced as a four channel audio installation, with each of the four channels representing one of the four remote 'haunted' locations. The audio is derived from traces of 'voices' extracted from recordings made at each location at an earlier time. According to the New Media Scotland Commission, Geist is not about the existence or otherwise of ghosts, but rather about ghost or spectrality as metaphor. It attempts to explore our contemporary condition of omnipresent absence - presence through the use of haunted locations, recorded sound, and network technology. This spine-chilling project reminds us that contemporary communications technologies belong to unseen places - they connect us instantaneously across vast distances yet make our words, impulses and feelings pass through an uninhabited and invisible domain.

> Geist is about being and not being here and there simultaneously. It is about communication through the exchange of electrical energy, about recording and playback, about returns and repetition. It is the domain of specters and spirits, of slippages in time and space and communications across boundaries.
>
> *(From the New Media Scotland Commission electronic promotion).*

The World Wide Web offers many kinds of spaces, and while the traditional museum flows through and into many kinds of cultural discourses, the art and the artistic processes provide the vehicles of enchantment for society. Artists are beginning to realize the potential of the interconnectivity of the medium and respond to its resonance. Geist is a project that clearly articulates these phenomena. The enchanting technological processes of networked art, firmly embedded in circulatory, social systems, propel sacred spaces from remote locations across vast distances into our foreground at the blink of an eye. We recognize the inextricable link between art and culture, yet we are awed by what we do not fully understand. When we are able to step back and maintain critical distance from these experiences and appreciate the craftsmanship of the new medium, we might even be able to discern the patina of human endeavour and regain in some way the lost aura; the virtual aura.

The next time you sit in front of your computer and crank up the pixels, don't be surprised if you find a poltergeist hanging out there inside your hard disk, dancing across the fiber optic connections, or lurking somewhere out there online, waiting to find you!

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About the Authors

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Susan Edwards is currently continuing work with the curators at SAM as a Research Associate and is also a PhD candidate in the History of Art at the University of Michigan. For two years Susan worked as the Curatorial Associate involved with the Growing Up With Art project at the Seattle Art Museum. She worked with curators and museum educators, and Seattle Public School teachers during this grant period to bring 6th graders from two Seattle Public Middle Schools into the museum to curate their own exhibitions. Susan helped students select objects from SAM's permanent collection, developed lesson plans with museum educators, and traveled with SAM educators to the schools to teach these lessons on how to curate an exhibition. The lessons on the web site are the same lessons that these Seattle students learned in the process of creating their own exhibition at the Seattle Art Museum. It is this experience that the "My Art Gallery" web site attempts to keep alive by bringing it to the web. She continues to bring web design, illustration and organizational skills to the various web projects at the Seattle Art Museum.

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Claudio Pinhanez recently got his Ph.D. from the MIT Media Laboratory, working on the design and construction of physically interactive environments and in computer theater. He also researched new paradigms for computational representation of human action and scripting of interactive stories, using Allen's interval algebra as the underlying representational structure. He is currently working at IBM TJ Watson Research Center on web-based cultural and entertainment experiences and on physical interfaces to information.

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Jim Spadaccini is the founder of Ideum (www.ideum.com), a multimedia design and production company which specializes in educational and museum Web sites. Before that he was Director of Interactive Media at the Exploratorium in San Francisco. He was the major contributor to, lead designer, and manager of the three-time Webby Award winning Exploratorium Web site (Best Science Site 1997-99). In 1995, Jim worked with Apple Computers, where he authored a book, two CD-ROMS, and an educational Web site. Along with developing educational Web resources, Jim has been teaching Internet and Multimedia classes at San Francisco State since 1994.

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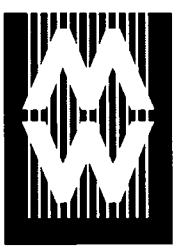

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Papers from the Fifth International Cultural Heritage Informatics Meeting, **ichim99** in Washington DC, have been edited for this print publication. Sections reflect the major themes of the conference: interactivity, converging technologies, user involvement, and new models for museum multimedia.

Museum Interactive Multimedia: Cultural Heritage Systems Design and Interfaces

Edited by David Bearman and Jennifer Trant
ISBN 1-885626-14-2 (1997), 233 pp., $30.00

A decade of progress in interactive multimedia in museums forms the basis for papers on systems design and user interface from the Fourth International Conference on Hyper-media and Interactivity in Museums (le Louvre, Paris 1997). These papers focus on design systems development and evaluation methodologies), interfaces (visitor aware systems and inter-actives providing geographical and chronological views of data), and case studies of museum ew multimedia ranging from collection catalogs to 3D environments.

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Edited by David Bearman
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Volume 1 of selected essays from the Third International Conference on Hypermedia & Interactivity in Museums (ICHIM 95 / MCN 95) on the technological, cultural and intellectual issues raised by the use of multimedia technologies to represent cultural heritage. Papers profile the iimpact of technologies on museum applications and audiences, and on the relationship of museums to society.

Hands on: Hypermedia and Interactivity in Museums

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ISBN 1-885626-12-6 (1995) 293 pp., $20.00

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Museums and Interactive Multimedia

Edited by Diane Lees
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The proceedings of the Second International Conference on Hypermedia & Interactivity in Museums (ICHIM 93) include over sixty presentations by authors from over twenty nations on the issues of design and implementation of museum interactives.

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By David Bearman

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Electronic Records Management Program Strategies

Edited by Margaret Hedstrom

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