
Recent Developments in Cultural Heritage Image Databases: Directions for User-Centered Design

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ABSTRACT

FROM 1995 THROUGH 1997, SEVEN CULTURAL HERITAGE repositories and seven universities collaborated on an extensive demonstration project called the Museum Educational Site Licensing Project (MESL) to explore the administrative, technical, and pedagogical issues involved in making digital museum images and information available to educational audiences. This article reviews the MESL project's methods and findings in a number of areas—descriptive metadata, database design, interface design, and tools for use. It discusses more recent development efforts in extending the model for digital image delivery of visual resources to higher education audiences. Finally, it suggests how to proceed by posing a number of user-centered questions about the design goals for networked access to the vast visual resources of the cultural heritage community. Selected projects from the literature of computer and information science are discussed to stimulate thinking about avenues for research and to focus project design goals.

INTRODUCTION

In his 1996 review article, "Image Databases: The First Decade, the Present, and the Future," Howard Besser (1997b) presented an overview of ten years in the development of image databases designed to provide access to cultural heritage information. How much further have image delivery systems progressed in the past several years of rapid technological change? This article examines the Museum Educational Site Licensing

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Project as well as several more recent projects representing the current state of development of cultural heritage image databases for academic use. It reviews recent literature in areas such as image indexing and retrieval, interface design, and tool development, and urges a reexamination of our efforts in those areas based on a more rigorous analysis of user needs.

THE MUSEUM EDUCATIONAL SITE LICENSING PROJECT (MESL)

In 1995, a boldly envisioned demonstration project was launched which provided new insights into the issues of building large-scale image databases for the delivery of cultural heritage information to higher education audiences. The Museum Educational Site Licensing Project was a collaborative project, involving seven universities and seven cultural heritage repositories, to investigate the administrative, legal, economic, technical, and educational issues involved in providing networked distribution of museum content for educational use. During the two years of the project, the seven museums provided nearly 10,000 digital images and accompanying descriptive metadata records. These were distributed to the seven universities, each of which developed their own local delivery system. Although much of the project focused on the legal and administrative issues of licensing, it also provided a valuable testbed for exploring a range of issues related to the building and subsequent use of large image databases from disparate collections of cultural heritage images and data. Although only limited rigorous research was undertaken within the brief duration of the project (1995-1997), the project participants were able to report a number of useful observations about descriptive metadata, database and system design, interface design, and tools for use of the images and information (Stephenson & McClung, 1998).

Descriptive Metadata

While traditional analog visual resource collections in educational institutions have depended on physical arrangement and local cataloging to provide access, the descriptive metadata provided with the MESL images was extracted from data that already existed in the museum collection management systems—legacy data from systems built primarily to handle the internal informational requirements of the repositories. The first step in the process of providing useful descriptive metadata to the universities was to agree on a common metadata structure to which the individual institutions could map their own data. The MESL Data Dictionary, defining records composed of thirty-two data fields, was developed to serve this purpose. The museums mapped their data to this structure and developed export routines to extract data from their collection management systems and populate the MESL data records. If they did not

have data for a specific field, it was left blank. The completeness of the records varied both within a single institution as well as from institution to institution, depending on the level of documentation any object might have received.

The data populating the various fields in the records were not standardized in any way. Because museums have only recently begun to adopt principles such as authority control, there were many variations in data values for standard entries such as artist names. And very few of the museums had supplied any subject access beyond the most general terms; when present, they were inconsistently applied. The museum data had been created for collection management, not public access; making it available to a new user group, beyond the museum staff for which it was created, revealed its inconsistency and limited usefulness for open ended searching. One can postulate that what was true for the MESL museum data is generalizable to most museum collections' management information (Dowden, 1998).

Database Design

Each of the universities participating in the MESL project designed its own delivery system using local resources and frequently building on existing information systems and infrastructure. A variety of backend databases were used, ranging from Filemaker Pro and Microsoft Access to OpenText (Besser, 1998). This heterogeneity of the system design effort at the universities not only led to differences in the look and feel of the interfaces but also to somewhat surprising differences in the search results when the same queries were posed to each system (e.g., see Figure 1). Besser (1997a) reports on these sometimes dramatic anomalies. They resulted from local decisions about what to index as well as characteristics of the local search engines at each of the sites. Some institutions decided to index only selected data fields while others provided full-text searching across all data (including unstructured full text) as well as field-specific searching. In addition, a number of the search engines handled functions such as phrase searching, truncation, and stemming differently and in ways that were frequently not apparent to users.

The entire MESL data set was mounted locally by each of the participating universities rather than served from a single central distribution point. Each university mounted the MESL data set as a separate database, even when they had other image databases available to their users. Though a number of them expressed the desire to integrate MESL data with image resources from other disparate sources, the limited life span of the MESL project made this infeasible. The experience of mounting the MESL data gave the universities insights into the challenges they would face in such an undertaking. Since the conclusion of the project, several of the participating universities have made strides in this area.

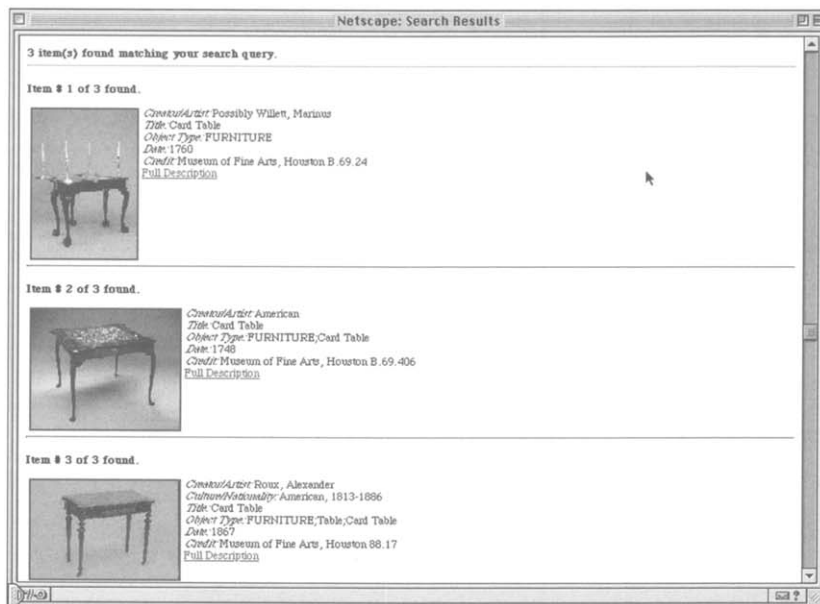


Figure 1. Searches on **card table** in the MESL databases of the University of Virginia (top) and the University of Illinois (bottom). The search at Virginia retrieved 4 records; at Illinois, only 3 records were retrieved. Note that the Virginia system displays multiple views of the same object.

Interface Design

In addition to creating search and retrieval systems for the MESL images and data, each of the participating universities designed their own search and browsing interfaces. Despite independent development, most of the interfaces were very similar in look and feel. The Web browser window provided the basic interface. Standard Web forms were used to present search options. Users could choose between a simple search and complex or Boolean searches and could search one museum collection or across all of the collections. Pull down menus allowed users to specify a particular field to search or they could search all indexes. Each of the universities implemented more or less standard ways of displaying search results within the browser window. For browsing, a grid of thumbnails with brief identifying captions was the most typical presentation; if many thumbnails were returned in response to a query, users had to page through multiple screens. Users could also select a brief record display where screen elements included fielded textual data presented in something like standard bibliographic format with the associated image or images next to it. They also were given the option to view larger versions of the images as well as full textual records showing all data supplied for an object. The University of Virginia implemented a search results display option that returned unlabeled thumbnails, giving the user the ability to scan and mark thumbnails as an initial visual interface for making relevancy judgments (Besser, 1998) (see Figure 2).

Tools for Use

Most of the functionality provided by the MESL university participants was constrained by their choice of the Web as a delivery mechanism. The state of Web development at the time as well as local limits on available technology support precluded the development of additional functionality such as Java-based tools. Faculty and student users searched the database and used cut-and-paste methods to create class Web pages or include images and descriptive text in papers or presentations. At the University of Virginia, very simple templates were developed to facilitate the creation of side-by-side image comparisons and online Web exhibitions (<http://jefferson.village.virginia.edu/inote/index.html>), but they, too, depended entirely on the use of cut-and-paste methods (see Figure 3).

At the University of Maryland, however, a variety of factors contributed to the development of a sophisticated software product which simulated the function of a slide library's light table. It supported faculty members in the process of selecting, organizing, and arranging material for delivery in the classroom, mimicking the side-by-side projector environment typically used in teaching art history. Maryland's delivery system, now known as ISIS (Interactive System for Image Searching), was developed by a team of programmers, instructional designers, and the faculty

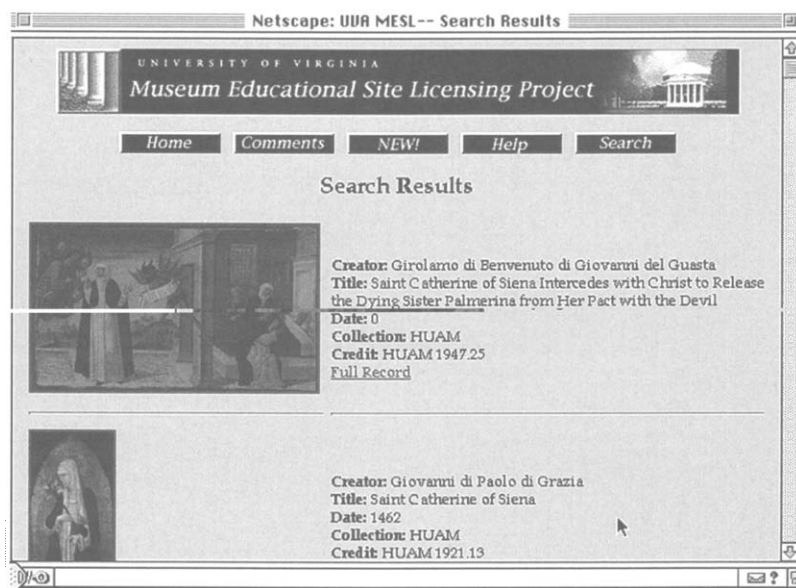
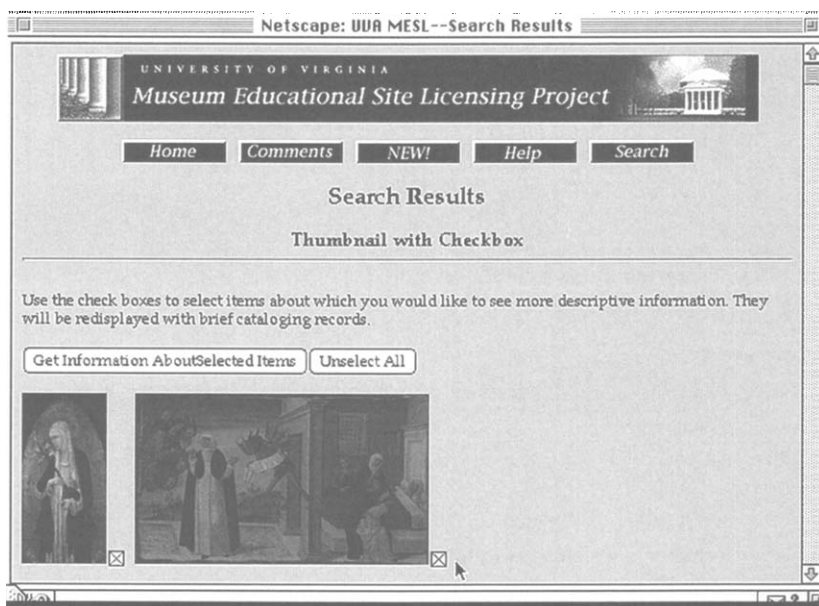


Figure 2. University of Virginia MESL displays—Thumbnail with Checkbox (no captions) and Thumbnail with Brief Record

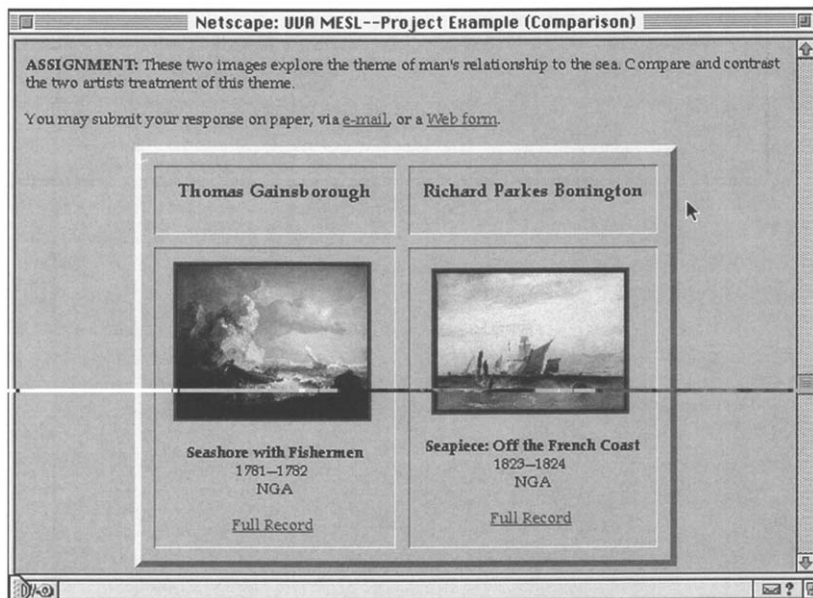


Figure 3. University of Virginia, MESL Comparison Template.

members themselves through an iterative process that continued throughout the duration of the MESL project (Borkowski & Hays, 1998) (see Figure 4). The commitment to this product resulted directly from the early organizational decision to base MESL development in the art department, thereby involving end users in design decisions from the outset. The impact it had on the success of the MESL project at Maryland was remarkable (Promey, 1998).

RECENT FEDERATION AND EXPANSION EFFORTS

Since the end of the MESL project in July 1997, efforts have been underway on a number of campuses to provide federated access to diverse image collections, allowing users to search individual or multiple repositories from a single search interface. This development is the next step in the effort to provide users with broad access to information about cultural heritage objects held locally as well as those licensed or otherwise made available from other sources. Projects at the University of Michigan Library and Harvard University Museums and Libraries serve as representative examples of these undertakings. In addition, the work begun in the MESL project is being continued and expanded by AMICO, the Art Museum Image Consortium, working in cooperation with the Research Libraries Group (RLG).

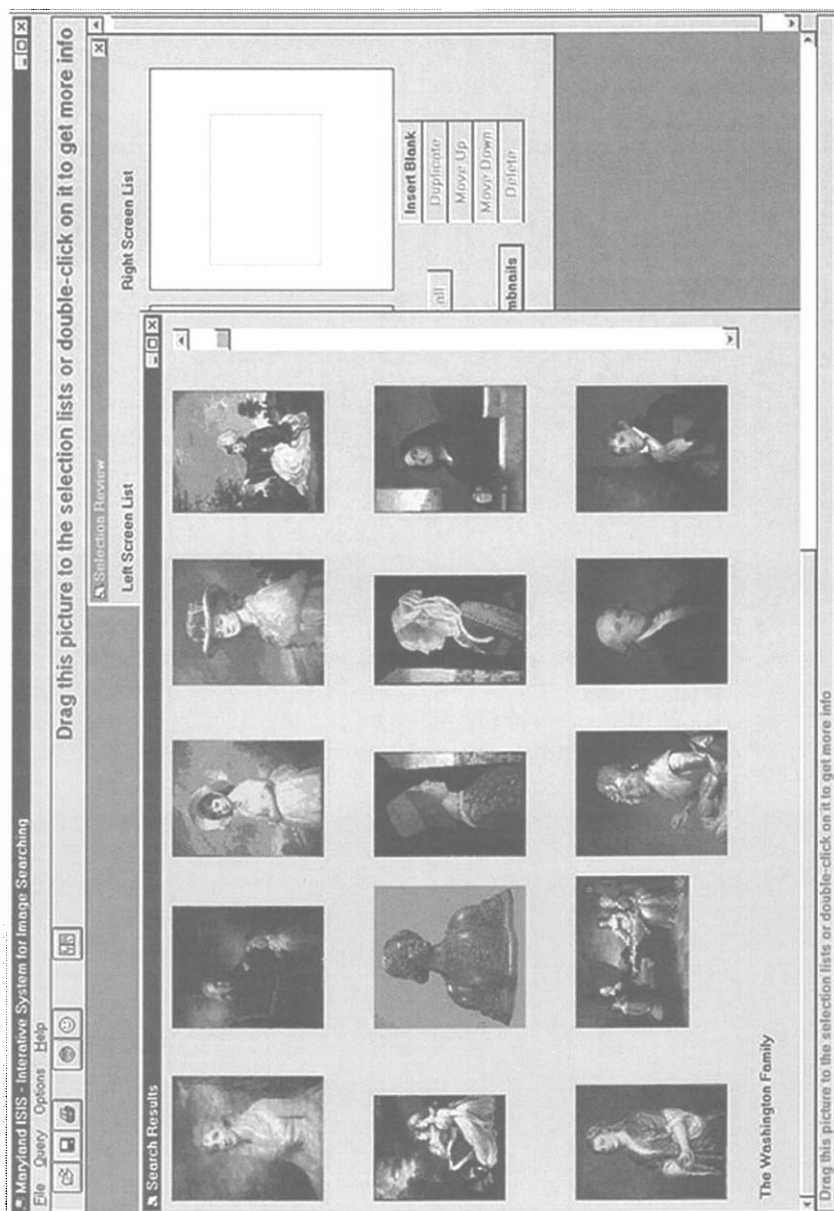


Figure 4. Maryland ISIS: Image Selection Screen.

University of Michigan

In 1997, the University of Michigan Library began to create an architecture for federating access to image databases through the Image Services component of its Digital Library Production Service (DLPS) unit. Among their stated goals, they seek to "provide to faculty, staff, and departments a standardized, base level, extensible architecture for putting images online" (<http://images.umdl.umich.edu/dlps/is.html>). The staff of the Image Services group established a core metadata set for visual images by analyzing existing metadata schemes. The Michigan Image Access System merges data drawn from the collection management databases of a number of campus visual resource and museum collections, as well as that provided with licensed image collections. Data are extracted from each of the separate management databases, mapped to the shared metadata scheme, marked up in SGML, and indexed using OpenText. Users are provided with the option of searching any individual collection by the metadata elements in its own data or multiple databases by a more limited number of common metadata elements.

The system design is based on the fundamental assumption that image or object databases are created to meet the management needs of the particular repositories and should remain independent from the provision of public access. Standardization of public access through the DLPS provides consistent service to meet instructional and research needs. Image Services provides a standard interface for searching all collections as well as a search form customized to each collection (see Figure 5). They have articulated a set of incremental improvements to the system, including the ability to create "personal collections" (http://images.umdl.umich.edu/info/arch/arch_summ.html).

Harvard University

Harvard University has over 8 million objects and images in its libraries, archives, and museums. Its diverse institutional environment is a challenging testbed for providing integrated access to cultural resources collections. Over the past two years, representatives from museums, libraries, and archives at Harvard and Radcliffe, working together with the Library Office of Information Systems, have been engaged in a process to build a shared union catalog of visual resources. The goal of the union catalog project is to create a common database where users can discover Harvard's wealth of visual resources and be directed to the holding repository for more detailed information or access to materials.

To date, this project, known as Visual Image Access (VIA), has devoted much of its effort to the process of agreeing on a common data structure for its union catalog as well as reaching consensus on the scope and functionality of the catalog. In the first phase of the project, currently underway, object and collection records from six diverse collections

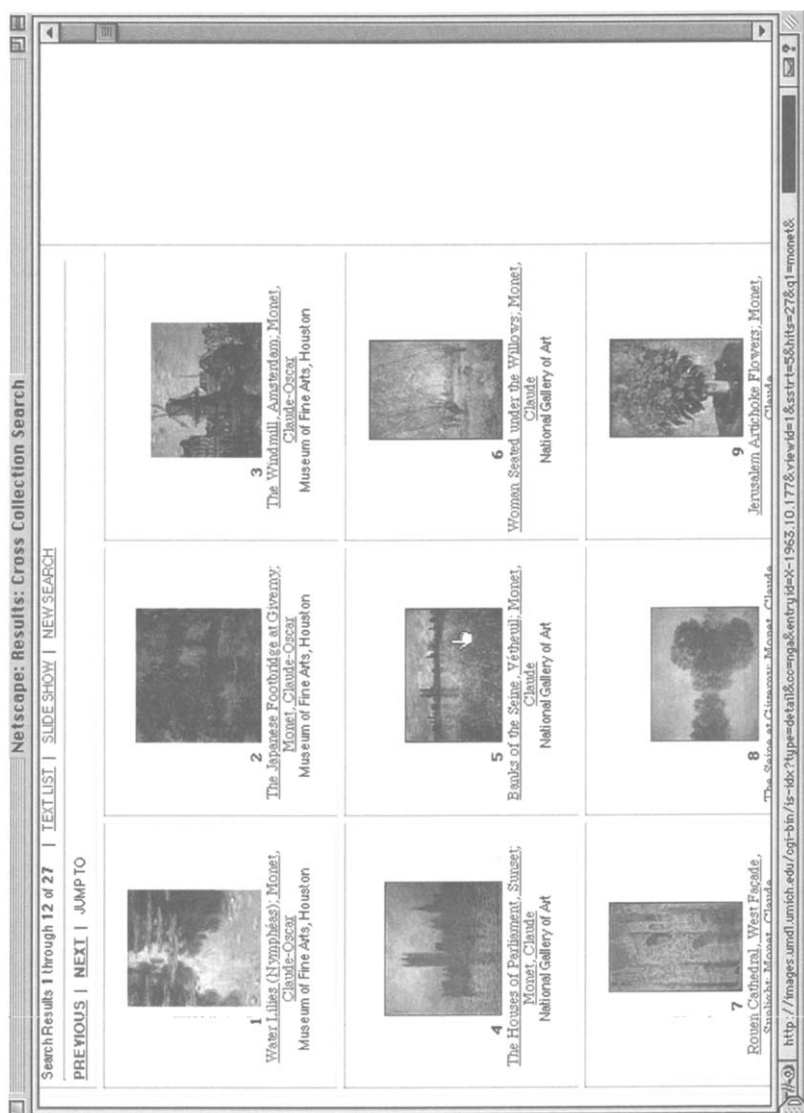


Figure 5. University of Michigan Library Image Services; cross collection multiple image retrieval display.

will be merged into a single database; digital images may be associated with the records but are not required. At the outset, VIA will include only cultural heritage materials based on the existence of similar metadata structures and distinct functionality required for use. Like the Michigan Image Server Program, VIA acknowledges the separate and primary functions

of each repository's collection management or access system; it does not intend to dictate local practice but to federate local records. And as at Michigan, the intent is to provide access not only to locally held images or objects but to licensed image content as well. Implementation of the VIA system was scheduled to begin in early 1999 (<http://sylvia.harvard.edu/~robin/viascope.htm>).

Art Museum Image Consortium (AMICO)

The Art Museum Image Consortium, founded in 1997, is in many respects the successor to the MESL Project. In its project description, AMICO is characterized as "a not-for-profit consortium dedicated to creating a digital library" documenting the collections of its members and making that library available for educational use. It currently includes over 20,000 images and object records from over twenty contributing institutions and anticipates a growth rate of about 50,000 objects a year (<http://www.amn.org/AMICO/>). At present, those resources are being distributed to twenty universities participating in a year-long testbed project. Unlike MESL, where all the data were distributed to each of the participating universities, AMICO is currently providing centralized distribution to the testbed participants through the Research Libraries Group. As in MESL, the AMICO data set uses existing collections management information extracted from the contributors' systems and mapped to a common data dictionary. The data set and images are made available to AMICO testbed users through a modified version of RLG's Eureka interface (see Figure 6) (<http://www.rlg.org/amicolib.html>).

Although each of these projects has slightly differing goals, all of them attempt to provide unified access to images and information from diverse collections. In time, each may develop or adopt a system architecture that facilitates network-distributed discovery. However, at present, all are still merging data locally. Though they incorporate more sophisticated design elements than the MESL delivery systems, the underlying data are similar in their lack of consistency, and the interfaces are quite similar to those developed by the MESL participants. Each of these systems will likely challenge and frustrate users in many of the same ways that the MESL implementations did.

UNDERSTANDING USER NEEDS AND EXPECTATIONS: NEXT STEPS

In looking ahead, it seems clear that there are numerous obstacles to overcome in order to realize our ambitious goals for digital image delivery systems. While some of these lie clearly in the realm of technology, many depend on collaboration between human-computer interaction specialists, librarians and collection managers, evaluation specialists, and end users, both sophisticated and naïve. In his 1996 article, Howard Besser

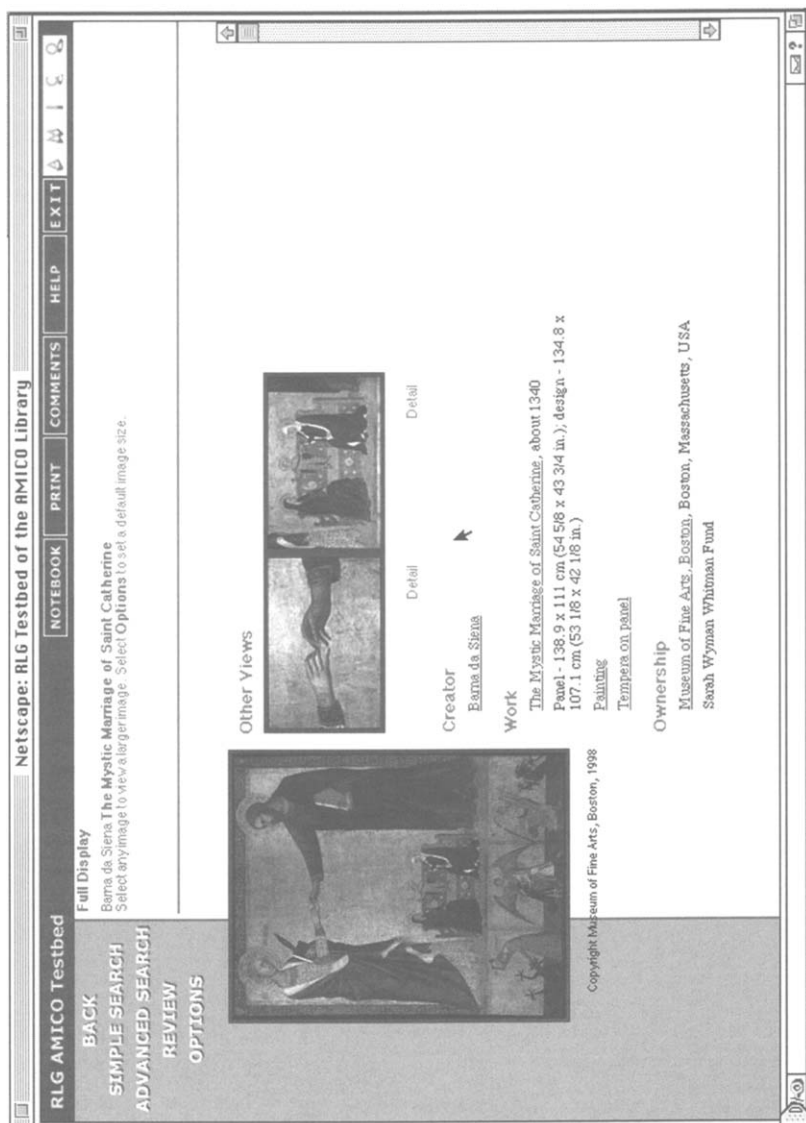


Figure 6. Sample Screen from the RLG AMICO/Eureka Interface.

(1997b) focused his articulation of next steps in a number of technical areas: preservation, authenticity, and integrity of information; image standards; image quality issues; and retrieval. Rather than revisit and reassess our progress on each of those issues during the intervening years, it may be useful to look ahead through a different lens—one that puts user needs

and expectations, rather than technology, at the fore. Although the creation of image rich digital resources certainly represents a series of technological challenges, it is critical to give adequate attention as well to the fundamental questions of audience, user behavior, and use.

The examination of several broad questions can assist in developing a user-based model for directing development of image delivery systems and guiding future research:

- For whom are we building our image delivery system?
- What is it that we are building and for what purposes do those users want to use it?
- What functionality do our users need to use what we build?

This kind of design model, called User-Task-System or U-T-S (Lindermeier & Stein, 1991) helps ensure that system design does not limit users and uses. Instead, a thorough analysis of user characteristics and requirements will drive sound system design.

DEFINING THE PRIMARY USER GROUP

Moving from the analog to the digital world, it becomes increasingly difficult to characterize the users of our image delivery systems. In the past, it was possible to know much about our users by restricting physical access to collections to a specific group or requiring registration prior to use. The closest parallel in the digital world is to allow access only from a specific set of workstations. But as a general rule, one of our overriding principles in the digital realm is to *extend* access, not restrict it. This means our systems are likely to serve both traditional and new users of image resources; local and remote users; sophisticated and naïve computer users; users supported by on-site assistance and who will interact unmediated with our systems; children and adult learners; and so on.

In the MESL project, the difficulty in serving these diverse user groups effectively was demonstrated even when access was limited to a specific university community. Traditional users of images, primarily art history students and faculty members, were frustrated by the absence of particular works of art. Nontraditional image users were often stymied by the lack of subject access to the works in the database. Both groups were sometimes frustrated by the limited functionality of the delivery systems that relied on relatively simple Web design.

At least in the short term, it is unlikely that systems can be built that serve all user groups equally effectively. Ideally, good system design would isolate digital objects in a repository, and any number of front-ends could be customized for specialized user groups. However, the initial design effort is likely to focus on a specific set of users and uses. Even if the resource is aimed at a broadly defined generic user group and a relatively

use-neutral presentation such as search and retrieval, it is possible to define some basic characteristics of the user population. As a part of a rigorous planning process, the characteristics of the intended primary user group can and should be articulated and assumptions about them enumerated. Mechanisms to test those assumptions can be built into the iterative system design process. Those mechanisms might include a variety of quantitative and qualitative techniques including log analysis, online user surveys, usability studies, interviews, and focus groups. By focusing on the needs of clearly defined user groups, it will be possible to better understand system requirements, better target development efforts, and more reliably test design decisions.

One outstanding example of such a model is embodied in the work undertaken by a research team from the University of Maryland, working with the Library of Congress National Digital Library Program (Marchionini et al., 1998). The goal of the research was to develop interfaces for NDL content (much of it consisting of visual images) "guided by an assessment of user needs and aimed to maximize interaction with primary resources and support both browsing and analytical search strategies" (p. 535). The project consisted of several phases: problem identification and team development, interface design and prototyping, and tool development. The Maryland team emphasizes the importance of developing and testing principles and guidelines for user-centered iterative design for delivering digital library content to a variety of end-user communities (p. 553).

UNDERSTANDING ANTICIPATED USES

Once the primary user group or groups are explicitly described, the next challenge is to articulate the range of uses that need to be supported and to understand the implications for system and interface design. In the higher education setting, local image collections have primarily consisted of collections of surrogates, usually slides, built to serve a curriculum support function. In addition, library special collections departments and museums have built collections of images or objects. The functional roles of these collections may be less clearly articulated than those of the visual resources collection, making it more challenging to develop appropriate design criteria for delivery and use.

As we begin to digitize these collections, a number of questions must be confronted. What are our goals as we build digital image delivery systems? Are we replacing local slide libraries with digital image collections with curriculum support as their primary goal? Perhaps we are creating collections of document surrogates, with item level description, to obviate the need for handling precious or fragile originals. Or are we digitizing quantities of images for which we will never be able to provide item level description to facilitate access to underused collections? Are we building union catalogs of records about objects and image collections, primarily

as location devices, leading users to repositories and originals? Are we licensing image databases and making them available as we would our many bibliographic databases as a use-neutral electronic resource? Or are we building hybrid systems, merging collections created for some or all of these purposes, into large supersets, where audience and aims become increasingly indeterminate?

Depending on the answers to these questions, it is possible to begin to articulate the range of functionality needed to discover, retrieve, and use images in a collection and to focus development on supporting the stated system goals. In the case of the MESL project, the product was arguably a hybrid collection built to explore a range of issues rather than to serve a specific articulated goal. The project sought to document and assess the ways in which images and their associated information were used to further our understanding of searching strategies, image quality needs, user tolerance levels, and adequacy of access vocabularies. The participants were also committed to understanding the system requirements necessary to facilitate pedagogical uses of the images and information. Although unable to conduct detailed log analysis and other focused research, the participants did engage these questions and report rich anecdotal evidence about a number of them. In order to build on the MESL experience, it is useful to examine our findings in relation to selected current research in computer and information science. This review suggests additional avenues of exploration which may help future system developers to more successfully deliver the necessary functionality to end users.

SUPPORTING DISCOVERY AND RETRIEVAL

In hybrid systems such as MESL, the Michigan federated image server, or a distributed networked delivery system, what are the requirements that must be met to support discovery and retrieval? Writing in 1995, Hinda Sklar (1995) articulated three of the elements of basic functionality for image databases. These are: (1) to perform a range of searches, formulating both simple and complex queries, and searching using both controlled vocabularies and keywords; (2) to search many collections in a single search from one location; and (3) to discover unknown resources. Achieving this functionality depends on descriptive metadata structure and data interchange architecture, metadata values, the search and retrieval system itself, and the interaction of the user and that system.

Metadata Structure and Data Interchange

A thoroughgoing discussion of the current state of emerging descriptive metadata and data interchange standards for images is beyond the scope of this article. There are numerous testbed projects underway focusing on metadata and interoperability requirements, particularly the Dublin

Core and Z39.50 development work undertaken by the Consortium for the Interchange of Museum Information (CIMI).

Metadata Values

Much anecdotal evidence was gathered in the course of the MESL project to indicate that both the lack of descriptive metadata for subject access and the lack of standardization across existing metadata values will continue to frustrate users trying to locate images. Although museums are beginning to recognize the need for standards to facilitate information interchange, the paucity of controlled access points will continue to adversely affect certain uses of our growing image databases. And large numbers of images will never be described at the item level, further frustrating users.

Rasmussen, writing in 1997, reviews the growing body of research addressing users of images and image databases, query analysis, and user needs and behaviors. A few of those projects are highlighted here. Since strategies must be developed for dealing with the lack of descriptive metadata for image access, even more effort could be made to incorporate and extend research on the behaviors of image seekers and image indexing practice. By better understanding how images are sought, it should be possible to prioritize efforts to augment subject access in the ways that will have the greatest impact on user satisfaction.

Query Analysis

There have been surprisingly few studies on user queries. Rasmussen (1997) reviews several query analysis projects from the early 1990s. Several more recent projects include that of Collins (1998), who studied user queries in two historical photographic collections. She found that generic subject terms appeared most often in those queries followed by terms referring to time and place. Armitage and Enser (1997) collected queries from seven picture collections and sought to develop a general purpose schema for categorizing user requests for images. Janney and Sledge (http://www.cimi.org/documents/z3950_app_profile_0995.html) analyzed 1,500 queries made in museums (not necessarily image queries) in order to develop an attribute set for information retrieval for museum information. Hastings (1995) studied and categorized queries of art historians working with a database of digitized images and associated text. Additional query analysis is fundamental to understanding and improving access to images.

Evaluating Indexing Methods

Having acquired a better understanding of query structure, the next step is to evaluate the effectiveness of image indexing in answering those queries. Again, there seems to be little empirical research in this area. A number of authors make a strong case for additional quantitative research

on the effectiveness of various indexing methods (e.g., Layne, 1994; Tibbo, 1994). For instance, Layne (1994) makes a case for identifying and indexing attributes which provide groupings of images rather than access to individual images, allowing the user to visually scan results to make comparisons or relevance judgments. Jorgensen (1998) recommends that "assumptions underlying controlled vocabularies and newer descriptive tools...should be tested [and] that new ways of indexing images would perhaps improve the process of image retrieval" (p. 171). In her research, she found a disjunction between user image-seeking behavior and current image indexing schemes. Where funding to augment subject analysis is scarce, this kind of research-based information will assist in assessing whether free-text pre-iconographic description might be a more effective (and cost-effective) method of providing subject access than careful selected controlled vocabulary.

Explaining Search and Retrieval Mechanisms to Users

As we continue to grow and develop systems, it is critical that we share more information with users about how indexing is implemented in those systems. Howard Besser's (1997a) investigation of the seven implementations of the MESL project, by seven different institutions, using seven different indexing/search systems, underscores this point. This observation is validated by Shneiderman (1997), who states that in many systems there is little or no indication of how the system interprets a search request, so users have a difficult time interpreting search results.

Using Other Retrieval Mechanisms to Compensate for Lack of Semantic Indexing

In addition to conducting more empirical research into the effectiveness of semantic indexing, it would be useful to work more directly with computer scientists to evaluate the effectiveness of emerging computer-based retrieval mechanisms. This is an area of extremely active research in both universities and the commercial sector. During the MESL project, at least two research units at participating sites—Columbia University and the University of Illinois—did some experimentation with content-based retrieval that included the project's images. The potential for this kind of retrieval can be seen in Columbia's trio of projects—VisualSeek, WebSeek, and MetaSeek—which employ a variety of techniques for visual information retrieval, including incorporating user examples as input and matching them according to features such as color and texture (VisualSeek), combining text and color histogram searching (WebSeek), and using both visual content and keywords to search remote image collections with their own search engines (MetaSeek) (Benitez et al., 1998). There are few instances where research has been undertaken solely with images from cultural heritage collections.

Of even more potential impact on retrieval success, a number of

hybrid visual and semantic retrieval systems have been proposed or developed. Enser (1995) sets forth a conceptual model consisting of what he calls linguistic and visual search and query modes and explains how they might interact to improve search results. In such a system, a user could submit a search, select relevant images, and resubmit them to find related images based on the keyword associated with the visual surrogates (Mostafa, 1994). Other systems under development combine traditional text-based retrieval with elements of content-based retrieval; one such system is called SEMCOG or SEMantics and COGnition-based image retrieval (Li et al., 1997). In this model, a user may pose a query by combining textual descriptors, image content, and spatial relationships between objects. A similar experimental system has been built recently that draws on a test data set of cultural heritage information. The tool, called ARThur, was developed by the Getty Information Institute in cooperation with NEC using their Amore content-based retrieval system (<http://www.isi.edu/cct/arthur/>). ARThur allows a user to search by image content, contextual similarity (proximity between selected image and text on Web page), as well as by keyword. Keywords can be used to qualify queries by content to improve retrieval precision. The keyword searching is enhanced by allowing users to formulate queries using the Getty vocabulary tools, the *Union List of Artist Names* (ULAN), the *Getty Thesaurus of Geographic Names* (Getty TGN), and the *Art & Architecture Thesaurus* (AAT).

Capitalizing on Human Perceptual Capabilities

Writing in 1995, Donna Romer stated:

Consistent and psychologically informed search models for multimedia retrieval are neither readily available nor obvious. The search models found in both early products and the research literature appear to be driven by what technology is able to do, rather than how people make perceptual sense of different modalities (pp. 50-51). . . . We have been proceeding into the multimedia age assuming that people "read" and understand images in the same way that they "read" and understand documents. (p. 50)

Current constraints on screen size and resolution limit the number of images that can be displayed at once; users are forced to page through screen after screen of thumbnails. The potential of the human eye/brain to make rapid relevancy judgments on images without reference to text needs to be exploited. Mechanisms to support "I'll know it when I see it" behavior could be developed to allow users to browse through large numbers of images quickly. The exploratory work done by the Maryland team with the National Digital Library (Marchionini, 1998), for instance, allows users to select viewing options to display up to fifty thumbnails at a time.

SUPPORTING FUNCTIONALITY—INTERFACE DESIGN AND TOOL DEVELOPMENT

Beyond the workings of discovery and retrieval, effective user interface design is critical in facilitating the use of the visual information returned by our image delivery systems. Returning to Sklar's (1995) functionality characteristics, she asserts that it is necessary to gain direct access to digital surrogates and be able to display a number of images on screen at once, allowing rapid and easy comparison (p. 14). If that functionality is characteristic of a "generic" interface, what other kinds of features of specialized interfaces might need to be developed to support specific users and uses?

Generic Interface Design Issues

Most of the Web-based image databases developed to date, including those developed in the MESL project, provide a series of common interfaces for returning search results to users. The Web browser serves as the basic interface with several more or less standard ways of displaying search results within the browser window. For browsing, a grid of thumbnails with brief identifying captions below is the most typical presentation; users must page through multiple screens if many thumbnails are returned in response to a query. For a more complete display, screen elements include fielded textual data presented in something like standard bibliographic format (brief display) with the associated image or images next to it. Options for viewing larger images and more textual information (full record) are often provided as well. Because many of these delivery systems have been designed in libraries and visual resource collections, it is not surprising that the general design grows directly from the library catalog tradition.

Lansdale et al. (1996) characterize this kind of design as "craft design," that is, evolutionary, developed by trial and error, where successful elements are incorporated and carried forward and unsuccessful ones drop away. They distinguish it from design grounded in scientific theoretical knowledge. Plaisant et al. (1995) note that designing image browsers involves many choices and requires more controlled experiments, prototyping, and validation. Mostafa (1994) also remarks on the rarity of theoretical and empirical research on user interface design in image retrieval systems. He urges additional exploration of our ability to process visual information rapidly, processing it only as visual information without reference to verbal descriptions (p. 118). More cooperation with human-computer interaction specialists as well as empirical research and usability testing will help validate effective design decisions and generate new models to be tested.

Functionality

In addition to displaying images in response to user queries, we need

to provide certain very basic tools to accompany the generic interface. For instance, the user needs to be able to select or "mark" records or images and to save them for later arrangement and manipulation. Providing the user with the ability to customize or choose display options is also useful. In the student and instructor evaluation of the MESL project, both instructors and students indicated "zooming in and out" and "comparing two images" as the most desirable display and manipulation features they wanted in future image databases. Instructors also expressed an interest in tools which would allow them to "save search results" and "sort and mark sets of images" (Sandore & Shaik, 1997).

A few of these functional tools are available in recently developed delivery systems. The AMICO interface, developed by RLG, includes the shopping cart function—called a "notebook" in the RLG system—where records and images can be saved during a session and then printed or downloaded. In addition, a menu selection called "Options" takes the user to a screen where they can select default viewing options for a session, including maximum image dimensions, sort order, number of items in each search result screen, and various other display options (see Figure 7). It is critical that the effectiveness of these kinds of basic tools be evaluated as well as determining whether others would add significantly to the functionality of our most basic interfaces. For instance, one could imagine the usefulness of extending user controls over interface options. Different interfaces might be selected depending on the information need (known item search versus browsing) or based on the number of hits in response to a query. Or an intelligent interface could be built that could respond to user input by selecting the most appropriate displays based on the user's path through the material.

Special Tools for Specific Users and Uses

In addition to investigating the effectiveness of search forms, browsing interfaces, and search result displays for generic applications such as union catalogs, further research is needed into the kinds of functionality, interfaces, and tools specific user groups need to enable specific uses of image databases.

The development of the ISIS software at Maryland in the MESL project clearly demonstrated that putting appropriate tools in the hands of faculty users greatly enhanced their ability to use both the visual information and the textual information in the database. This software successfully translated the process of selecting and arranging slides on a light table and placing them into slide carousels for classroom projection onto the computer screen (see Figure 8). Faculty members were presented with a familiar metaphor for their analog working environment and were therefore much more willing and able to utilize the underlying information in the data set.

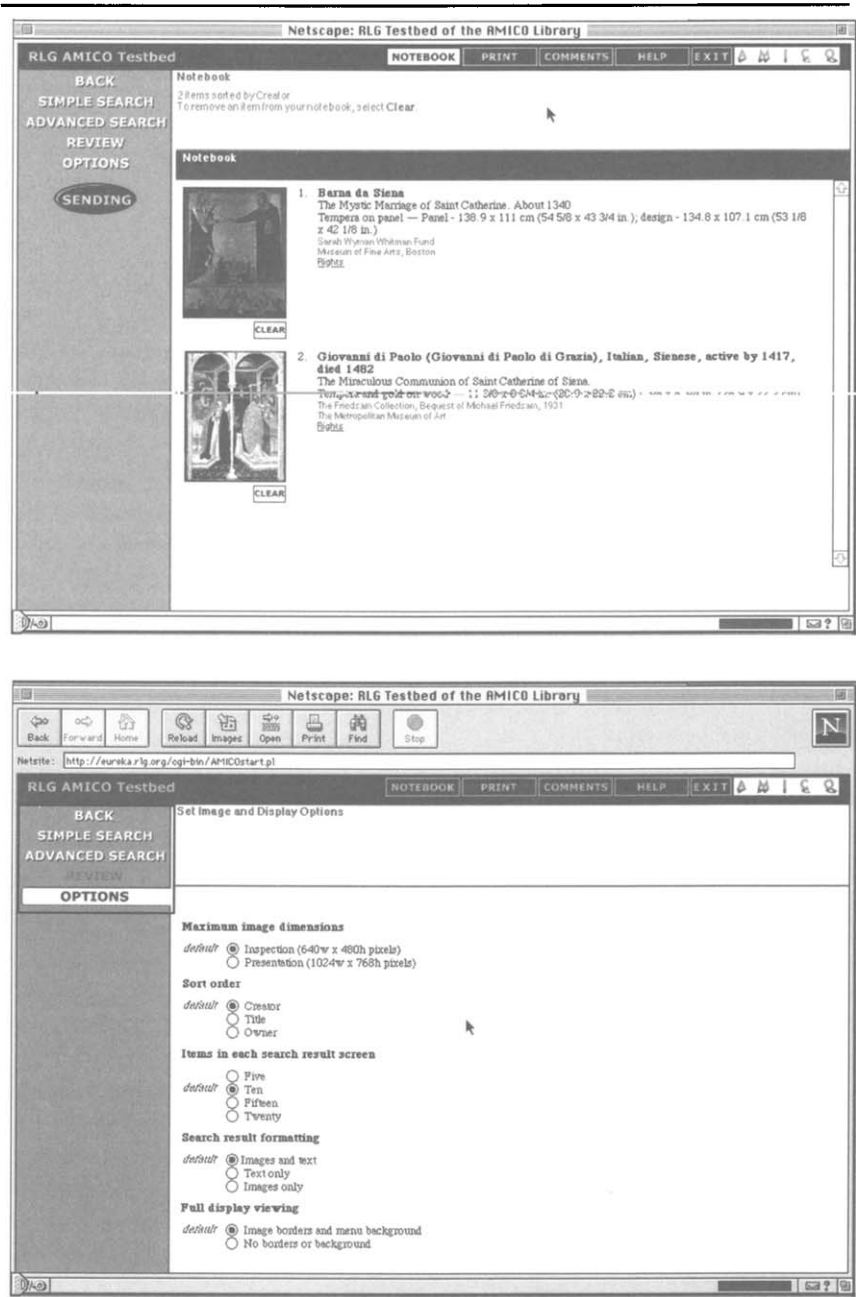


Figure 7. Screen Shots from RLG/AMICO Showing Notebook and Viewing Options.

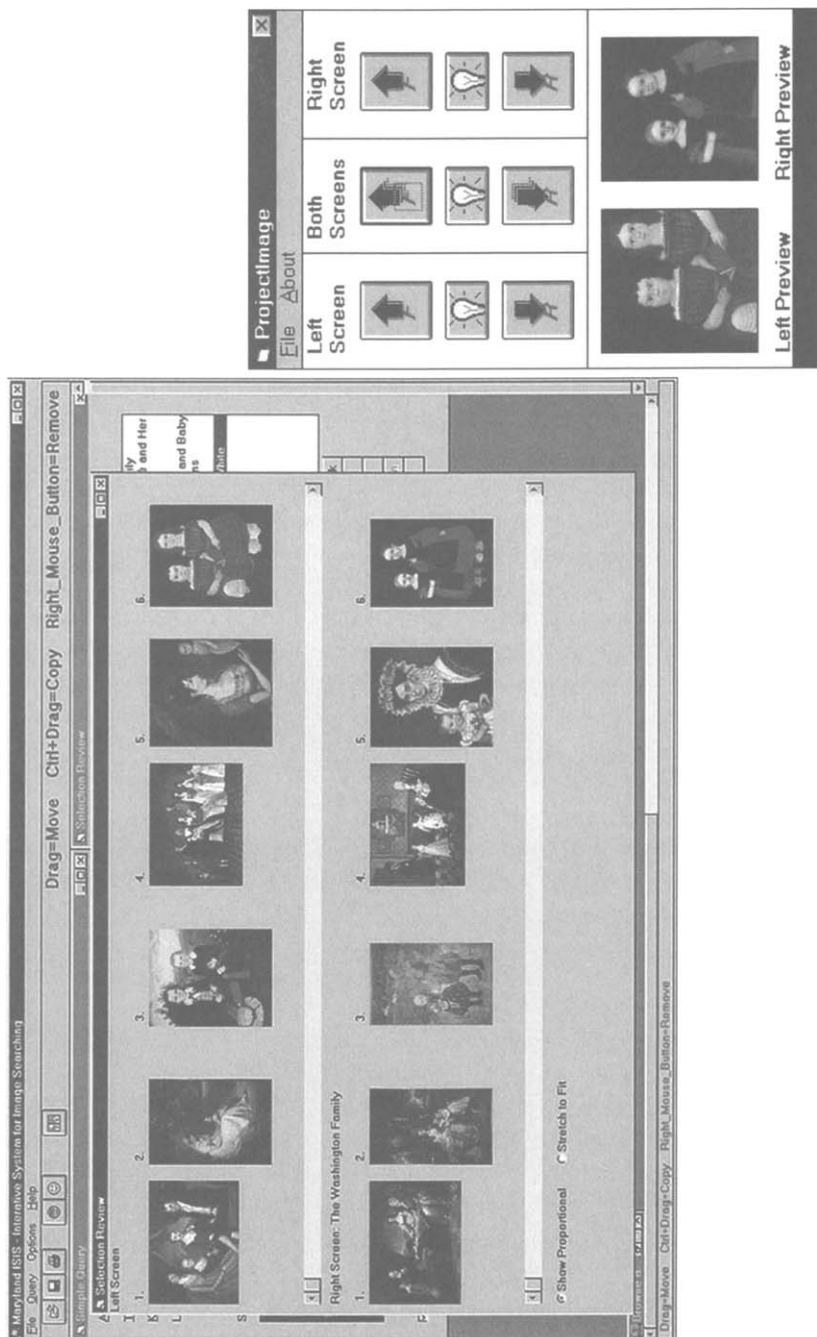


Figure 8. Maryland ISIS: Tools for Ordering Image Presentation in the Classroom and Controlling Projection.

For art historical research, other sets of tools would be required. Some of the modeling for these tools was undertaken in a joint project of the Getty Art History Information Program and Brown University's Institute for Research and Information (Bakewell et al., 1988). In a two-pronged study, the researchers investigated what art historians say they do in their research and observed what the art historians actually do in order to better understand what kinds of automated tools would enhance their work. The interview subjects reported a number of behaviors around which functionality could be built. They reported frequently writing in the margins of photocopies of works of art; collecting and arranging information by topic, not by format, commingling clippings, photographs, sales catalogs, and letters. They reported on building personal collections of images and frequently interfiling them with notes for a specific project. Rhyne (1998), in reviewing various image databases and museum sites on the Web, enumerates a list of basic requirements a scholar would expect from such sites. Although somewhat different in focus, Rhyne's article is an important example of the way specialist users can contribute to the articulation of system requirements.

For art historians, some of the behaviors that would need to be supported would be comparison, annotation, and the ability to examine details. Some of this functionality has begun to emerge in the past few years. Both the RLG/AMICO system and the Michigan Image Server give users instructions or tools to do side-by-side image comparison (see Figure 9).

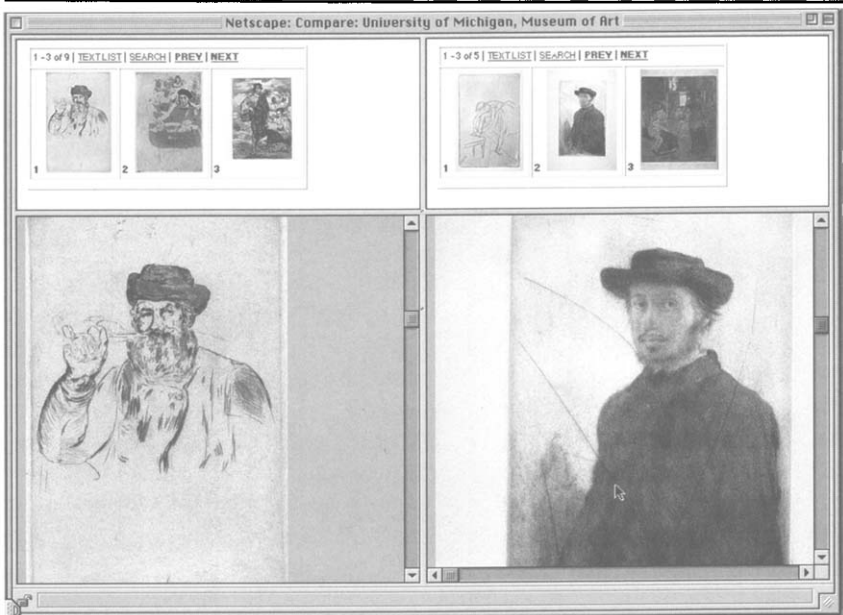


Figure 9. Michigan Image Services, Side by Side Comparison.

A JAVA-based image annotation tool, called I-NOTE, has been developed by the Institute for Advanced Technology in the Humanities at the University of Virginia (University of Virginia, 1998) (see Figure 10). Michigan is using Mr. SID, the wavelet compression software developed by LizardTech, to enable panning and zooming to examine image details.

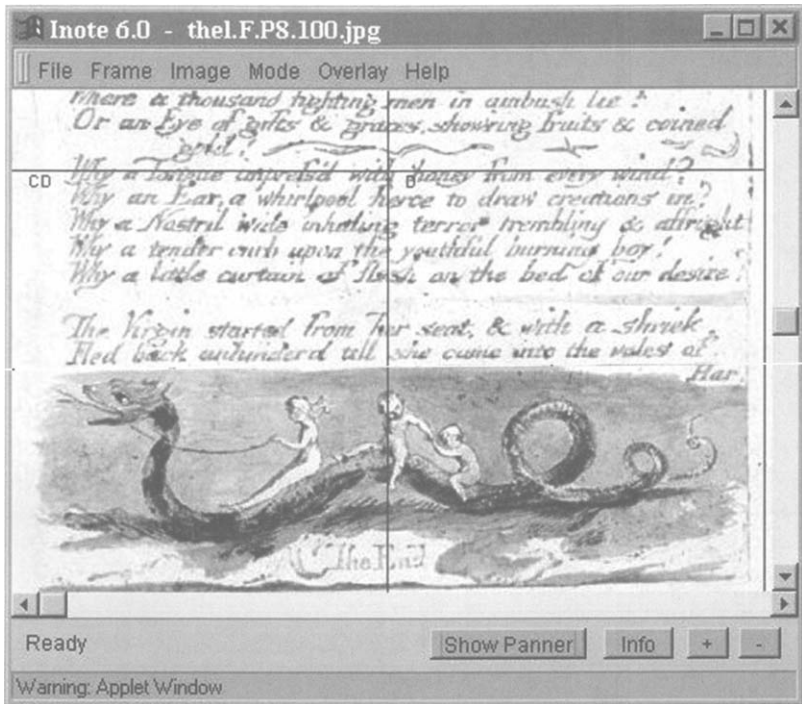


Figure 10. University of Virginia, Institute for Advanced Technology in the Humanities (IATH): I-Note, Image Annotation Tool, Screen Shot.

In the commercial sector, Luna Imaging, a digital imaging service provider founded by Michael Ester (formerly director of the Getty Art History Information Program), has developed an image management product called *Insight* aimed at the cultural heritage community. Presumably the design attempts to support some of the functionality identified in the AHIP/IRIS study. Luna's product literature states that *Insight* is designed with the image user, not the collection manager, in mind. It allows users to "look through materials, examine and compare images, view details, organize images into groups around ideas or events, and save subsets of images for particular applications." While products such as *Insight* may begin to meet users' functional requirements, it is important that as a

community we acknowledge the need to develop nonproprietary tool sets which can be put in the hands of all end-users.

As these functional tools continue to develop, we can envision the creation of customized tool sets appropriate for particular uses like personal research, courseware creation, organizing exhibitions, and the like. This is not simply a technical challenge; it is imperative that developers work closely with end-users, modeling and understanding how they work in the analog world and then engaging in an iterative development process in the digital environment. We need to acknowledge that "information systems and indexing tools designed for specific disciplines need to fit the needs of those fields rather than the 'typical' humanist scholar" (Tibbo, 1994, p. 608).

The process undertaken in the Getty AHIP/Brown IRIS project to understand the behaviors of art historians in their research needs to be extended to other disciplines where scholars make intensive use of visual materials so that those behaviors can be effectively supported by specialized interfaces and tool sets. As Ester and Shipp observed in their foreword to the AHIP/IRIS study: "Considering the magnitude of the commitments that institutions are making to automation, we would be well advised to improve our comprehension of the constituency we intend to serve" (Bakewell et al., 1988, p. xi). It seems likely that broad based transformations of scholarly research and teaching will be possible only after considerably more functionality is built into digital delivery systems.

CONCLUSION

The past few years have seen rapid growth in the development of image delivery systems to provide access to the wealth of cultural heritage information. The Museum Educational Site Licensing Project served as an important testbed, and successor projects are building on its successes and incorporating new functionality in their own systems. As the process of iterative development continues, it is critical that developers focus on users and uses and be explicit about the assumptions, biases, and limitations of their processes and their systems. In so doing, users will be better served and the documentation of system goals and design decisions will better inform future system development. In addition, more collaboration between information professionals, computer scientists, human-computer interaction specialists, instructional designers, and end-users (students, teachers, and scholars) will enrich and accelerate the development process. Those collaborations must include more quantitative and qualitative research, widely disseminated, in order to focus limited resources on those development efforts which will have the greatest impact on user success.

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