Authoring Virtual Gallery Environments via Task-Specific Tools[1]

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Abstract

We introduce an architecture for constructivist learning that engages students in the task of creating individual exhibitions by drawing from objects in an online collection. This "Virtual Gallery" framework allows students to create 3-dimensional exhibits that can be publicly shared. To assist educators in creating such environments, we are constructing a special-purpose authoring environment called VG-Maker. We present an exemplar Virtual Gallery application and the VG-Maker tool it inspired.

Introduction

Software authoring tools currently available to education practitioners provide insufficient support in the creation of pedagogically sound, interactive multimedia applications. Both general-purpose and ITS authoring tools aim to support a broad a range of instructional applications, sacrificing pedagogical power for content flexibility. The Virtual Gallery Maker tool (VG-Maker) demonstrates an approach that remedies this problem by supporting the production of a specific type of instructional software, the Virtual Gallery. By designing exhibits in the Virtual Gallery environment, students become actively engaged with the objects they select for exhibition. VG-Maker helps the non-programming software author capitalize on the Virtual Gallery architecture by providing user-friendly front-ends to two types of databases, the "card catalog", where artifacts, associated facts and reference materials are created and organized, and the "Q&A" database, where content- and context-specific online help is defined. The VG Maker also provides a simulated three-dimensional gallery environment for the author's active experimentation with arranging the artifacts in the gallery space. Although it focuses on the creation of one type of task-driven software, the VG-Maker allows authors flexibility in instructional goals and subject matter and in specifying features of the user's specific task objectives.

Underlying Principles

The Virtual Gallery framework is based on two general principles of learning supported by current educational theory and research: (1) Goals play a central role in learning (Ng & Bereiter, 1991; Schank, 1994); (2) The learning of new knowledge is facilitated when the knowledge can be applied in an authentic context (Brown, Collins, & Duguid, 1989; Whitehead, 1929). Following Schank, Fano, Bell, and Jona's Goal-Based Scenario model (1994), the Virtual Gallery architecture provides a meaningful task environment within which to embed a prescribed set of instructional goals. The learner's mission entails selecting artifacts from a larger collection that, when displayed together in a coherent and engaging exhibit, tell a particular story in a visual and spatial manner.

Case Study: The "Women in Antiquity" Virtual Gallery

Project Overview

To demonstrate the Virtual Gallery framework, we developed the "Women of Greek Antiquity" application (Bell, Dimaraki, & Brown, 1997). This domain is appropriate for illustrating some of the ways in which the study of a culture's artistic legacy can shed light on other aspects of a past society. The study of Classical Greece as it is taught in schools today rarely includes an examination of women's roles in that era. This distorts students' picture of history into one in which women are relatively invisible, encouraging gender biases that may extend into the study of other historical, and even contemporary,

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topics. Recent debate among historians and women's studies scholars can be used to encourage students to think about how our knowledge of the past is created. Students could then explore the process of historical inquiry firsthand using the Virtual Gallery software to examine this somewhat controversial topic. By carefully examining both images and texts, students create and share their own understanding of women's roles in classical Greek society. The richness of the material and the lack of easy answers lend authenticity to the exhibit-building task, and reveal the pedagogical strength of the Virtual Gallery framework.

Rationale

The current tendency to center history and social studies instruction around the content of textbooks creates four specific problems for today's students (Bell, Dimaraki, & Brown, 1997). First, textbooks cast history as a static record of *what happened in the past*, rather than as a pliable product of scholarly interpretation. Secondly, relying upon secondary accounts like textbooks has the effect of distancing students from the historical period under study, depriving them of the opportunity to acquire a deeper understanding of past cultures through the careful examination of primary evidence. As a result of studying only textbooks, the third problem is that students fail to recognize the value of artifacts as rich sources of information. Finally, school-taught History reinforces the distinction between the disciplines of History and those of Art History, Archaeology, and Anthropology, the former incorrectly viewed as exclusively text-based, separate from the latter three in which the primary focus of study is the object.

The Virtual Gallery Design Project seeks to remedy the problems arising from textbook-driven history teaching by engaging students in the process of *doing* history, allowing them to become active participants in historical inquiry by assigning a realistic role to play and authentic task to accomplish. Acting as apprentice curators, students use the Virtual Gallery software to support their creation of an exhibition which provides a coherent presentation of some significant aspect of past culture. Through the interpretation of both artifacts and texts, rather than the absorption of textbook information, students realize that history is not all *objective fact*, nor is it arbitrary storytelling (Bell et al., 1997). Students come face-to-face with antiquity by carefully considering its remains, and learn that artifacts, as well as texts, provide essential historical information. The traditional distinction between History and other fields is blurred as objects become just as important as texts as windows to the past.

Brief Description of the Software

The student's goal is to select and study artifacts from a larger collection that, when displayed together in a coherent and engaging exhibit, tell a particular story about the past. The student's related tasks include, in no particular order, comparing the physical characteristics of the artifacts, researching primary texts for information that would contextualize the artifacts, and integrating this artifactual and textual evidence to create logical links between the selected objects (Spiro & Jehgn, 1990). In accomplishing these tasks, the student is not learning to be a curator, but to think like a curatorial scholar engaged in the active process of applying the knowledge of a culture's heritage (Fantham et. al., 1994; Pierce, 1994; Morris, 1995).

The Virtual Gallery software supports the student/curatorial scholar's multiple tasks by providing the spaces and tools essential to reaching her goal. A virtual office, based on the metaphor of a museum's backstage workroom, provides an authentic workspace from which the student may conduct a historical inquiry. This office features a research desk with a specialized curatorial notebook to help guide the student through a set of related steps, like identifying the title and structure of the exhibit, composing descriptive essays about each object, preparing wall text for the visitors, and assigning objects to specific display locations. From the research desk, the student may browse the photo-archive catalog. This searchable set of cards contains roughly 60 images and descriptions of Ancient Greek Art, from relief and pedimental sculptures to painted vases and repousse metalwork, in an effort to exemplify the range of possible representations of women of this era. The archive catalog displays low-resolution images of each object along with basic archival information and brief curatorial notes. The student may browse the collection card by card, or categorically search for artifacts of interest by name, date, material, location, origin, or note.

The virtual office also provides a bookshelf containing topically relevant reference materials. These materials may include selected excerpts from primary and secondary texts as well as maps and diagrams. Such resources help the student in the act of visual and historical interpretation, identifying physical details of artifacts, and discovering the objects' cultural relevance. The reference materials may be available in static, stored format, or may exist as links to specific sites on the World Wide Web.

A specially-marked door leads from the virtual office to the basement, where the student may examine full-size, high resolution images of each object in the museum's collection. The basement interface is text-free, focusing the student's effort on studying the physical features of the artifacts. A series of still photographs captures multiple points of view for some of the objects. Audio explanation

from the Senior Curator is also available for some works of art, to highlight particularly relevant physical details. The student may toggle freely between photo archive cards and basement views, providing quick access to associated label information and curatorial notes.

While reviewing an object's entry in the photo archive, examining its high-resolution imagery in the basement, researching its features in the reference materials, and taking notes using the research desk's structured notebooks, the student may wish to experiment with the artifact's placement in the gallery. Such a task is easily accomplished using the three-dimensional gallery grid, a virtual space revealing the layout of the gallery rooms where the student may arrange artifacts by dragging and dropping them from place to place.

At any point during her progression through these tasks, the student may need expert guidance. The Virtual Gallery provides this support in the guise of a "Senior Curator" who dispatches advice and commentary at the student's request. The student can ask the expert questions by selecting from a context-sensitive list of questions, and the curator responds by presenting possible strategies and suggestions appropriate to the current phase of the interaction. A written copy of the student's mission is posted on the office bulletin board throughout the interaction.

Finally, the virtual office features the curator's cabinet which contains a set of exhibit design ideas. These exemplars demonstrate possible ways to organize an exhibit following commonly employed design principles (e.g. chronologically or thematically). The curator's cabinet exemplars provide a more structured approach to exhibit design tasks for those who are uncomfortable with unfettered exploration. They also serve as a resource for students who wish to refine or evaluate their own design ideas.

Generalizing the Architecture

The "Women in Antiquity" application hold promise as an engaging and powerful way for students to learn about (1) the roles played by women in ancient Greek cultures; (2) the nature of historical knowledge and the processes which govern its genesis. For the Virtual Gallery approach to have any impact on education, however, we need dozens, if not hundreds, of Virtual Gallery environments. Fortunately, the general principles that emerged from the Women in Antiquity prototype are readily applicable in other domains. For instance, a biology teacher may set her students about the task of constructing virtual science exhibitions about AIDS, influenza, and so on, in the course of a unit on viruses. A history teacher might assign students to curate virtual holocaust exhibitions, while studying genocidal actions in various historical periods. Students in a social studies class could even explore race and gender inequalities by designing their own virtual "Baseball Hall of Fame".

Authoring Tools

To fully capitalize on the flexible nature of the Virtual Gallery architecture, which can accommodate artifacts and text covering a wide array of subjects, teachers and curriculum developers (who are not presumed to be programmers) must have tools available to assist in the construction of Virtual Gallery environments. Although most such authoring tools aim to partially or entirely automate the creation of interactive, multimedia applications, differences among researchers remain regarding how such tools should be structured and what functions they should serve (Bell & Luckhart, in press).

General-purpose Tools

Commercially available products like Director and Authorware are general-purpose authoring tools that support the creation of a broad range of software applications by offering a user-friendly interface, usually based on card, screen, or sequencing metaphors, and ready-made interactive elements, like buttons and menus. These sophisticated tools, though flexible in their potential uses, offer little in the way of design constraints or content-specific guidance, and do not explicitly support the creation of software centered around a specific pedagogical model.

ITS Tools

Researchers have developed more specialized authoring tools that are based on specific models of instruction (Macmillan, Emme & Berkowitz, 1988; Murray & Woolf, 1992; Russell, Moran, & Jordan, 1988). These ITS tools aim to enable non-programmers, like classroom teachers, to create instructional computer programs by following a predefined template. Despite their focus on educational software construction, ITS tools are still relatively generalized in that they aim to support the creation of a broad range of instruction. These tools provide guidance to authors in very general terms, based on general models of instruction, which are most likely too general to serve as a specification for a piece of educational software. As with their commercial counterparts, ITS authoring tools often sacrifice pedagogical power for content flexibility.

Task-specific Authoring Tools

Another approach is to develop an authoring tool that mirrors a task structure common to a specialized category of instructional applications. Such a tool would support a specific instructional model (and only that model) and the creation of software fitting that particular framework. Such a tool should also enable the author to create a task-specific coaching mechanism that predicts end users' actions, anticipates problems, and offers solutions. The trade-off is, of course, that such tools support the creation of a limited range of applications and so we are sacrificing flexibility for power. In previous work, we report findings that suggest the advantages of such a trade-off (Bell, in press).

The Virtual Gallery Maker

The Virtual Gallery Maker (VG-Maker) is one such task-specific authoring tool. VG-Maker is a tool that supports (non-programming) design of Virtual Gallery environments. Authors use the tool to create Virtual Gallery applications for *their* end-users in some specific domain. VG-Maker assists authors in all the tasks required to meet this goal, from gathering and organizing content material to creating and displaying sample exhibitions.

How do authors author?

Authoring is a process that is part conceptual and part technical. Authors of instructional software are responsible not only for providing the subject matter their product covers, but also for delivering the instruction in a pedagogically sound manner. Further, authors are often required to possess the technical expertise necessary to produce a fully-functioning, engaging, and interactive computer program. Depending upon the author's resources (tools), the level of technical expertise required to build such software can range from expert fluency in a structured programming language to beginner-level competency manipulating hidden-scripted objects.

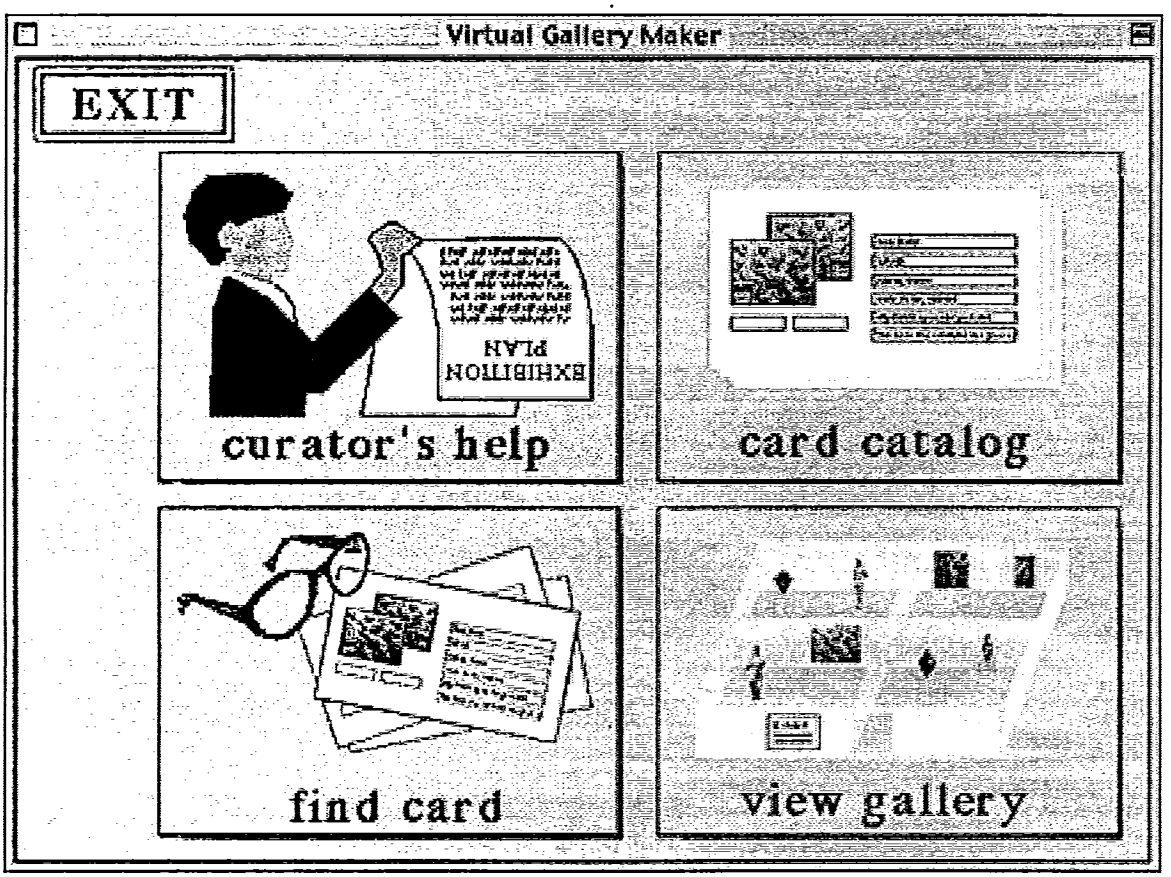

Figure 1. Main menu for the Virtual Gallery Maker

The process by which authors typically create instructional software involves determining what content material to cover, which instructional model to follow, and which authoring tool to use. Ideally, the first two decisions should determine the third; that is, an author might start with a particular instructional model and subject area in mind and envision the "perfect" instructional application, and then select the tool to help her easily create software that behaves according to her plan.

Unfortunately, the optimal authoring tool (or even an adequate one) is seldom available. To exercise the greatest power in developing an application, an author could learn a programming language well enough to create sophisticated multimedia applications, though this approach seems needlessly time consuming. Commercial off-the-shelf tools are easy to use but lack the instructional models required to support the creation of effective educational software. VG-Maker can be seen as a compromise between these conflicting ideals. The tool makes it possible for an author with minimal computer skills to create a Virtual Gallery application, affords the author some control over the design, and offers some limited assurances as to the instructional design by adhering to the Virtual Gallery architecture. The VG-Maker tool presumes that the author has already determined that the subject matter and instructional goals are appropriately taught by engaging students in the creation of virtual exhibitions (and as mentioned above, the flexibility of the framework rules out few instructional circumstances).

Description of the Tool

The main menu uses buttons to provide authors with quick access to the tool's major task components: the card catalog, the online expert, and the gallery space (Figure 1). The mapping between what the author sees and how the resulting application looks is intuitive: The card catalog corresponds to the Virtual Gallery's photo-archive catalog, the online expert to the Senior Curator, and the gallery space to the gallery grid.

One of the most crucial tasks in customizing a Virtual Gallery is to provide end-users with unique artifacts and texts to analyze. To assist authors in assembling content, VG- Maker provides a card catalog interface that looks similar to the Virtual Gallery's photo-archive (Figure 2).

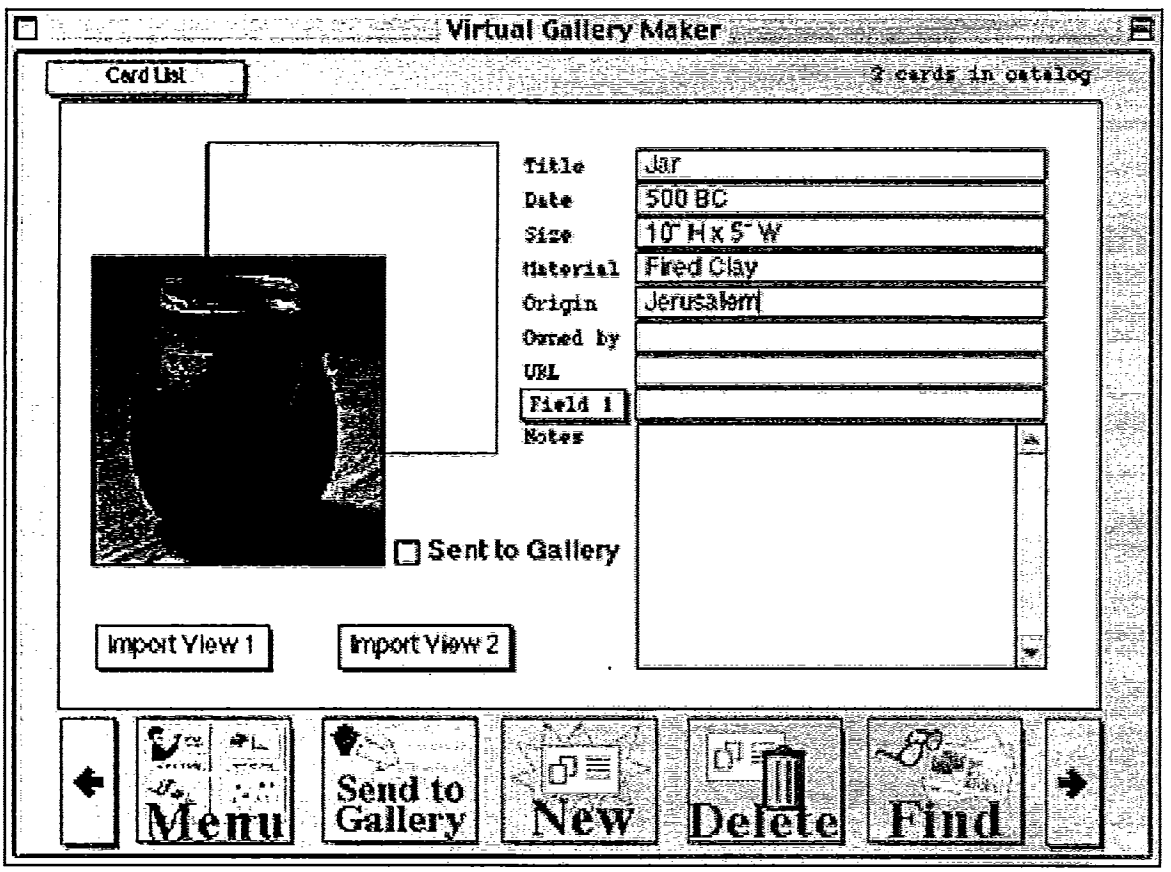

Figure 2. Virtual Gallery Maker card catalog screen

The card catalog interface helps the author specify digitized images of artifacts and their associated basic labeling information, including title, date, material, and a related URL. By selecting one of the "import view" buttons, the author is guided through the process of uploading images and associated label information. The author may also title one of the fields (called "field 1" by default) to accommodate information deemed relevant that does not fit in the pre-defined fields. The card is named according to the artifact's title, so that the author may keep track of which artifacts have been defined.

The card catalog interface is actually a specialized front-end to a database which stores the information for each artifact. A new card represents a new record in the database. From the card catalog interface, the user add these new records, or cards, by simply pushing the "new card" button at the bottom center of the screen. The author may also delete the card, and corresponding database record, at the push of the "delete card" button. Arrow keys at the bottom left and right of the card catalog screen enable the author to browse through the cards, and the find button at the bottom allows for keyword searching and nonlinear card access. Two organizational devices reside on the top of the card catalog screen; the upper right "card list" button links to a listing of each card entered by title, and the upper left "cards in catalog" field shows the author how many cards have been entered into the database. Because the catalog is a database, the author may easily search through the card catalog or browse the cards defined thus far.

Using either the "Send to Gallery" button on the card catalog screen, or the main menu's "View Gallery" button, the author may access the Virtual Gallery Maker's gallery screens. This succession of screens begins with an overhead, three-dimensional sketch of a gallery with four interconnected rooms. If the author clicks on one of the rooms, a close-up overhead view of that room alone appears. One more level of zoom is provided from this single-room screen; if the author clicks on a wall of the room she is presented with a screen showing that wall alone. Arrow buttons on the bottom of the single-wall screen allow the user to pan from to adjacent right and left walls, and a small graphic in the lower right-hand corner of the screen uses a thumbnail-size overhead view of the entire room overlaid with a red arrow indicating the presently shown wall for navigational help.

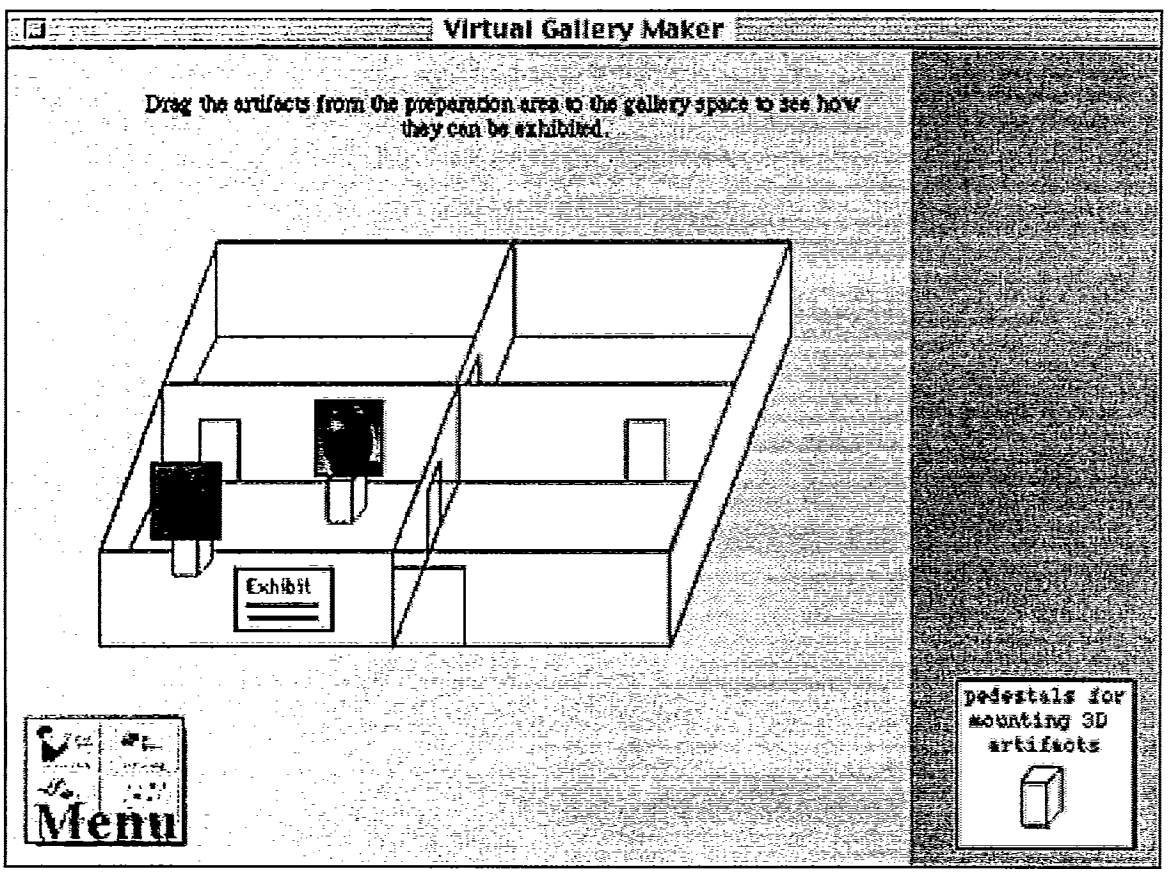

Figure 3. The gallery space

If an author wishes to experiment with arranging artifacts in the gallery space, perhaps to produce a sample exhibit, she must first be able to move selected images of artifacts into the gallery. Such a function is easily accomplished from each card in the card catalog; once the author uploads an image of an artifact, all she must do is click the "Send to Gallery" button on the lower portion of the card catalog screen to instantly see the opening overhead gallery screen (Figure 3).

On the right hand side of the screen, in a rectangular, shaded area, a thumbnail-sized copy of the artifact automatically appears. The author then simply drags the thumbnail from this holding space to the desired location on the gallery sketch. The image can be rearranged indefinitely throughout the gallery by simply dragging and dropping it in various rooms. If the artifact is a piece of sculpture, and requires a pedestal for display, the overhead gallery screen provides an endless supply of pedestals, which can be dragged and dropped much from the holding area to the gallery space. If, at any point during this process, the author wants to see her arrangement close up, she may click on individual rooms and walls as described previously. An appropriately-sized image of each artifact will appear in the rooms and on the walls corresponding to their opening screen placement (Figure 4).

The third major task in authoring a custom Virtual Gallery exercise is providing context- and content-sensitive help to the end user. In the Virtual Gallery Design Project, such help is available through an online agent called the Senior Curator. The user selects a question from a list that changes dynamically to reflect appropriate questions at each point in the interaction. The Senior Curator then reveals the answer to the end user's question, usually in text format. The Virtual Gallery Maker tool enables the author to select and/or script the Senior Curator's questions and answers. From the main menu, the author selects the "Curator's Help" button, and then follows the directions on the succeeding screens.

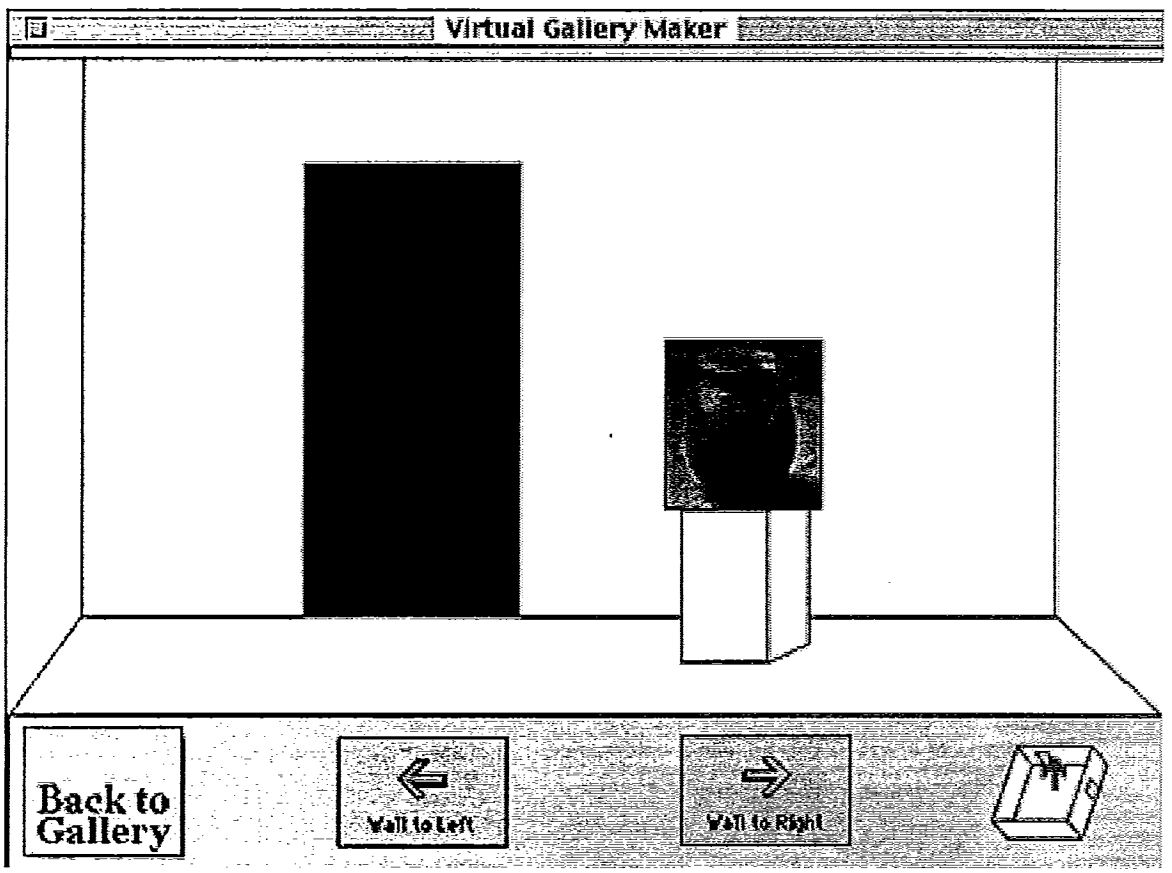

Figure 4. Close-up view of one wall in a virtual gallery

The Senior Curator provides an interface to another kind of database, but instead of being containing artifacts and information like the card catalog, the Senior Curator database consists of a list of questions and answers that will be made available to the end user at certain points in the interaction. The author's main job is to build this database so that it is helpful to the students eventually using the Virtual Gallery software. The author builds this database by either selecting ready-made question and answer pairs, or writing her own.

Since there are some general questions that probably apply to all Virtual Gallery exercises, the Senior Curator provides sample questions and answers about basic topics like what labels, text panels, and other common exhibiting devices are, and tips on how to get started designing an exhibit. By pressing the "Sample Q&A" button on the Senior Curator screen, the author is presented with a scrolling list of these questions and answers (Figure 5). If a pair appeals to the author, she may select it by clicking on the question, and then pressing the "Select Q&A" button.

If the author is not able to find a specific question on the sample list, she can compose her own by pressing the "New Q&A" button. This function is especially crucial to composing content-specific questions, which are important if the author would like to convey some information about the specific subject matter she is providing through the card catalog.

At any point during the program, if the author wants to review the questions and answers selected for the database, she just presses the "Q&A Database" button and scrolls through a list of question and answer pairs. The author can then edit the questions and answers directly on this list, changing one or more words, deleting, or even rewriting entire pairs. When she has finished reviewing and editing the question and answer database, she presses the "Save Database Changes" button at the bottom of the screen to ensure that the Senior Curator is equipped with the appropriate questions and answers.

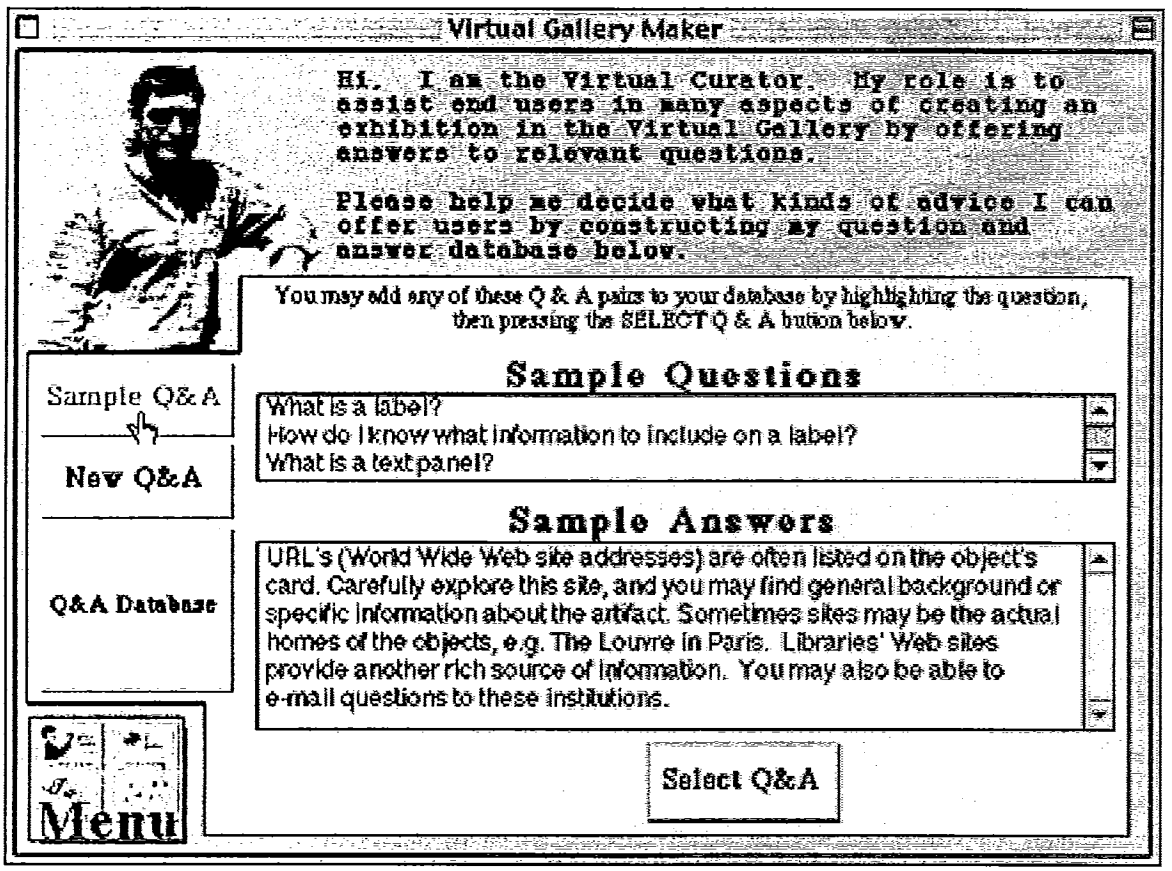

Figure 5. Question-and-answer authoring interface

In addition to creating a database containing the questions a user may ask and their answers, and author must also be able to tell the tool which questions are available during which phases in an interaction (and which answers; asking "what now?" for instance should trigger different answers in different segments of an interaction). For content-oriented questions the author can link questions with objects in the database. For general and help-oriented questions we can take advantage of the fact that the task model remains the same with each application. An author can thus associate individual questions (and answers) in the database with specific points within the task model.

Conclusion

The VG-Maker tool is based on the Virtual Gallery architecture, which is both a specific approach to instruction and a framework that accommodates a broad range of content goals. The tool will allow non-programmers to easily author Virtual Gallery software tailored to specific curricular needs. Although Virtual Gallery subject matter may vary, the strength of the underlying architecture assures that all Virtual Gallery experiences are those in which students are actively engaged in the process creating exhibits that reflect their analysis of artifacts and related text to share a coherent story.

The version of the VG-Maker described in this paper is preliminary. Major areas of work include integration of the interface with web-compliant databases, and a visualization utility to offer 3-dimensional walkthroughs of students' completed gallery projects. Another important area is installation of user-tracking procedures, so that end-users actions will influence the presentation of succeeding questions and answers pairs. Last, but by no means least, the VG-Maker tool and resultant Virtual Gallery applications will be subject to empirical testing to examine both the effectiveness of VG-Maker as an authoring tool and the value of exhibit-building as an approach to instruction.

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