User interface design for the Hyperties electronic encyclopedia

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The Dream

Printed books were an enormous stimulus to science, culture, commerce, and entertainment. Electronic books and hypertext systems may produce a similar stimulus in the next century, but current designs are poor. Typical screens are too small, too slow, too complicated, and too hard to read. With careful attention to the user interface and the underlying technology, we have a chance to create a new medium that is potentially more attractive and effective than printed books in many situations.
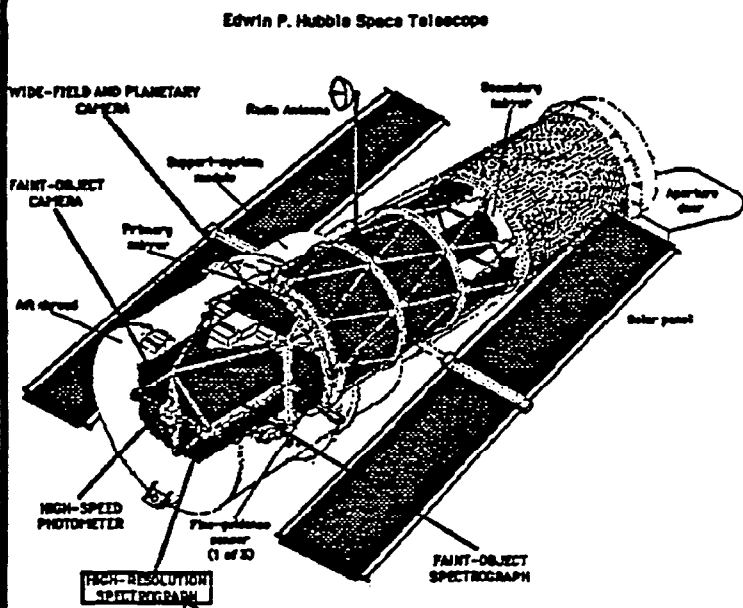
Electronic books can have color, animation, sound, rapid access, compactness, rapid traversal and search, user annotation, electronic dissemination and updating, dynamic text to reflect the user's needs, and other features yet undreamed of.

The Past

Hyperties has been under development at the University of Maryland since Fall 1983. It was orignally called TIES (The Interactive Encylcopedia System), but the new name was chosen to indicate the close relationship with hypertext concepts. Hyperties allows users to explore textual and graphic information resources in an easy and appealing manner. They merely touch (with their fingers or with a mouse or by pressing arrow keys to move a light bar onto) highlighted topics or objects that interest them and a brief definition appears at the bottom of the screen. The users may continue reading or ask for the full entry about the selected topic. An article about a topic may be one or more screens long. As users traverse articles and graphics, Hyperties retains the path and allows easy reversal, building confidence and a sense of control. Users can also select articles and graphics from an index.

Hyperties is attractive for instruction (and entertainment) because the author's ideas and writing style are the focus of attention. Through careful human factors design, the computer aspects have been trimmed to let the author communicate to the students and to allow the students to control their learning. Hyperties has a defined instructional strategy - articles and graphics linked by embedded menus - that simplifies design, permits strong support for authoring, and enables use of previously written materials.

Hyperties can be an addition to a museum exhibit, a browser for information in libraries, a tool for diagnostic problem solving, an environment for novels or mysteries, an online help strategy, a browser for computer program text, a format for cookbooks or self-help manuals, or a way to explore cross referenced materials such as legal documents or an annotated Bible.

Edwin P. Hubble Space Telescope

WIDE-FIELD AND PLANETARY CAMERA

Radio Antenna

Secondary mirror

FAINT-OBJECT CAMERA

Support system module

Primary mirror

Aperture door

Aft shroud

Solar panel

HIGH-SPEED PHOTOMETER

Fine-guidance sensor (1 of 3)

HIGH-RESOLUTION SPECTROGRAPH

FAINT-OBJECT SPECTROGRAPH

Imagine trying to see the clouds from the bottom of a muddy pond. That is how astronomers describe their view of the stars and planets through the Earth's atmosphere. As advanced as astronomical technology has become, our capabilities will be forever limited by the turbulence and brightness of our atmosphere. Even the finest ground observatories, such as the one at Mt. Palomar, California, are restricted by these conditions. In addition, the selective absorption of the atmosphere, which lets in visible light and radio waves emitted by stars and planets, but excludes most other forms of energy, limits our knowledge of celestial bodies.

To open the universe to observation in infrared, ultraviolet, x-ray, gamma-ray, and cosmic ray energies, NASA launched numerous satellites, each helping to explain different processes behind astronomical phenomena. But, to date, the value of these orbiting observatories has been limited by their relatively small size and limited spectral capability.

Now, for the first time, a ground-sized observatory will be placed in orbit to view the universe in visible and ultraviolet light unobscured by Earth's atmosphere.

Called the Edwin P. Hubble Space Telescope, the new observatory is a NASA-wide and international cooperative effort. Its name honors Edwin P. Hubble (1889-1953), who discovered that the universe extends far beyond the Milky Way galaxy.

The Hubble Space Telescope will weigh about 25,000 pounds (11,300kg) and will have a length of 43 feet (13.1 m) and a diameter of 14 feet (4.26 m). Its major components are an optical telescope assembly, five scientific instruments, and a support systems module.

Austria(see map) holds a special place in the history of the Holocaust.

Situated between Eastern and Western Europe, possessing a vibrant and

culturally creative Jewish community on the eve of World War II,

Austria had also provided the young Adolf Hitler, himself an Austrian

raised near Linz, with important lessons in the political uses of

antisemitism. Leading Nazis came from Austria: the names of Adolf

Hitler, Adolf Eichmann, who organized the deportations of the Jews to

the death camps, and Ernst Kaltenbrunner, the head of the

Reich Main Office for Security, 1943-45, readily come to mind.   As

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Linz - city in northern Austria; childhood home of Adolf Hitler and other

leading Nazis

Above: SUN 3 version shows two pages with text and graphics items selectable by mouse to obtain more information.

Left: PC version enables touchscreen or arrow key selection of highlighted items (embedded menus) in text only, but graphics can be shown.

Hyperties

Hyperties consists of:

- Browser
- Authoring tool for composing new articles and editing
- Databases for browsing.

Databases already created include:
Austria and the Holocaust (106 articles)
Adele Stamp Student Union (42 articles)
Hyperties Tour (68 articles)
FULCRUM Project (30 articles)
Online Maintenance Manual (52 articles)
Managing your Credit (23 articles)
David Seymour (1911-1956): Photographer (30 articles)
Wines (40 articles)
UM Office of Minority Student Education (41 articles)
Introduction to the Computer Science Department (76 articles)
Introduction to Online Database Searching at the National Agricultural Library (178 articles)

Hyperties is appealing to authors because of the explicit instructional model, the reduction of computer-related concepts, the focus on content, and the lively user interface. It allows authors to create a network of conceptual knowledge in which concepts are linked associatively and the learner is free to explore pathways based on their needs and interests. There is a great sense of satisfaction in composing articles and seeing the linkages come to life as they are used by students in novel ways.

The Hyperties authoring software guides the author in writing a title, brief definition (5-35 words), text (50-1000 words, typically), and synonyms for each article title. The author marks references in the text by surrounding them with a pair of tildes. Hyperties collects all references, prompts the user for synonym relationships, maintains a list of articles, and allows editing, addition, and deletion of articles. The author tool displays TO/FROM citations for each article and allows authors to keep notes on each article. A simple word processor is embedded in the authoring software, but users can create articles on their own word processor, if they wish. There are no commands to memorize, operations are done by selection from options on the screen.

Hyperties runs on a standard IBM PC (monochrome or color) and on IBM PCs, XTs, or ATs with or without touchscreens. We are attracted to the possibility of eliminating the keyboard while still providing substantial exploratory power. Hyperties was first written in APL and has been rewritten in the C programming language. Dan Ostroff, a graduate student in computer science, did the implementation and a major portion of the user interface design. Janis Morariu and Charles Kreitzberg contributed substantially to the design. Jacob Lifshitz, Susan Flynn, Richard Potter, William Weiland, and Catherine Plaisant-Schwenn did major maintenance and enhancements during 1985-87. The SUN 3 version with multiple windows and touchable graphics (graphic embedded menus) was implemented by Jacob Lifshitz and William Weiland.

Empirical Studies

More than a dozen experimental studies have been conducted to test out design alternatives and observe user behavior. Over 400 subjects participated in these controlled experiments. In addition, more than three hundred novices and experts have tried and commented informally on the current design.

In the study comparing the arrow keys (maybe better termed "jump" keys because the cursor would jump to the closest target in the direction pressed) to the mouse, the arrow-jump keys proved to be an average of 15% faster and preferred by almost 90% of the subjects. We conjecture that when there are a small number

of targets on the screen and when arrow-jump keys can be implemented, they provide a rapid, predictable, and appealing mechanism for selection.

In an early study conductesd by David Powell, subjects traversed a database with 42 articles about the University of Maryland Student Union. The embedded menus technique reduced the number of screens viewed when compared with an explicit menu strategy. There were significant reductions in the times for task performance, and the subjective preference was strongly for the embedded menus.

The embedded menus idea was also used for two experiments with online maintenance manuals for electronic equipment. A tree structured and linear form of a 52 page maintenance manual was prepared for screen presentation and in paper form. Experimental subjects had to perform 12 tasks using one of the manuals. Significant differences were found showing that time was reduced using the paper versions. No significant differences were found between the tree and linear versions for speed or error rates. When a pruning algorithm was applied to the text to allow users to trim text unrelated to their task, the time was cut in half. This latter experiment used only the computer condition and demonstrated one of the advantages of screens over printed text. This is important, since for many applications printed manuals are still easier to use and approximately 30% faster to read than computer displays.

Four selection strategies (mouse, arrow-jump, touchscreen, and numbered keys) were compared in a study in which each of 24 subjects used each strategy to follow prescribed paths through the database. The touchscreen resulted in the fastest time and highest preference, but also the highest error rate. Improved strategies for touchscreen and the mouse were proposed.

Two studies were conducted to better understand how novice users traverse a database when seeking to answer historical fact questions. Judin Sukri compared a paper version of the Austria database (about 150 pages) with the Hyperties version. For simple fact queries paper was faster but Hyperties matched paper with more complex queries that required information from several articles. Subjects strongly preferred Hyperties even though it may have taken more time. Steve Versteeg compared performance with Hyperties versions showing 9, 18, and 34 lines of text (all single spaced) on the Enhanced Graphics Adapter display. The dense 34 line version was least preferred and performance times did not significantly differ across versions. Anecdotal evidence from both these studies helped shape our understanding of how people use Hyperties.

A study with 24 subjects compared the speed, accuracy, and user satisfaction of three touchscreen strategies designed for Hyperties. The "lift-off" strategy that enabled users to drag a cursor just above their fingers, produced statistically significantly lower error rates than the traditional "land-on" strategy. The lift-off strategy is implemented on the Microtouch touchscreen. We also have implemented Hyperties to run on the IBM Infowindows system.

On May 21, 1986 a version of Hyperties was installed in downtown Washington, DC in conjunction with an exhibit of the photographs of David Seymour. On November 14, 1986 a similar version of Hyperties was installed in the International Center of Photography at 94th Street and Fifth Avenue in New York City with another exhibit of David Seymour's photos. We collected usage data to understand reading patterns for patrons of these exhibits and are currently preparing a report. Index usage was much heavier than expected.

Studies currently being carried out focus on user strategies of using the index versus using the embeded menus, the advantages of four large versus forty-five short articles, the merits of three color coding styles, the impact of varying margin sizes and vertical spacing, and the impact of larger windows. Dependent variables include time to find answers to factual questions, comprehension scores on questions presented after reading, and subjective satisfaction.

Current Directions

In October 1987 we completed version 2.3 with revisions to many messages, repairs to some bugs, and many small improvements to the author tool. It also enables users to set their own colors for text

highlights and the cursor. Current design efforts focus on importation of large databases, browsing of computer programs, videodisc usage, and integration with other software. We have arranged for input from an IBM scanner in the proper format to support CGA and EGA graphics on the IBM PC. Bit-mapped display images for the SUN 3 workstation are generated on a Macintosh with Thunderscanner.

An advanced browser with string search, various bookmarks, multiple windows, user annotation, printing, etc. is being designed and parts are being implemented. An advanced authoring tool with automatic reference marking and sophisticated editing/formatting is planned.

The SUN 3 versions support our exploration of highlighting techniques for touchable graphics. In the current version the selectable regions pop up as the mouse cursor passes over them. This is a good start and makes for a dramatic experience, but some mechanism seems necessary to enable users to reveal all selectable regions without a great deal of mouse exploration. Possibly a single key or a on-screen button would cause all selectable regions to become highlighted. Highlighting might be done by blinking, color coding, hash marks, or various borders.

The multiple window strategies include a traditional independent arrangement of windows and a simple panning motion in which selections are always made in one window and older pages migrate to other windows in an orderly predictable manner. A more flexible strategy is to enable users to indicate which window is to receive the next page of text or graphics. Then backups are done by each window independently. An empirical evaluation of the benefits and problems in underway.

Availability

The University of Maryland has contracted with a software development firm to support commercial applications and distribution of Hyperties. The IBM PC version of Hyperties 2.3 is available, but the SUN 3 version is still in the research and development phase. To find out more, contact:

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Princeton Junction, NJ 08550

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