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## 3.2 Restructuring knowledge for an electronic encyclopedia

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### **Introduction to Hyperties™**

Hyperties is a powerful, yet simple, new software tool for organizing and presenting information. It has been developed over the past five years at the University of Maryland's Human-Computer Interaction Laboratory and has been used for more than 50 projects (Shneiderman 1987a, 1987b). Hyperties authors can create databases consisting of articles that contain text and illustrations. Without the need for programming, authors can link these articles together so readers can easily browse through them.

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Hyperties can be used for a wide variety of applications, including:

- On-line encyclopedias
- Instruction and dynamic glossaries
- Summaries of products and services
- Regulations and procedures
- On-line help
- Corporate policy manuals
- Newsletters
- Reference manuals
- Employee orientation
- Museum exhibits
- Biographies

The strategies for gaining the benefits of paper texts are well understood, but there is a great need for study of how knowledge must be restructured to take advantage of hypertext environments (Yankelovich, Meyrowitz & Van Dam, 1985; Conklin, 1987; Marchionini & Shneiderman, 1988). This paper provides some guidance for designing Hyperties databases and reports on an exploratory study of comprehension tasks when article length was varied.

### Authoring and browsing

Hyperties consists of two programs: The Authoring System and The Browser. The Authoring System is used to create a database of articles and illustrations. Using the Authoring System is simple — like using a familiar word processor. The author types in the text of the articles and specifies the links or cross references to other articles and illustrations. Hyperties automatically ties the articles and illustrations together into a unified database and constructs an index to the entire database (See Figure 2 of Finding facts vs. browsing (p 108)).

The Browser enables readers to access the Hyperties database of articles and illustrations. Using the browser is extremely easy and requires virtually no training. Readers can access complete articles, definitions of important terms, illustrations and cross references by using only three keys: the left arrow key <—, the right arrow key —>, and the enter key. If the computer is equipped with a touchscreen, readers can browse without the use of a keyboard at all.

### Links

The power of Hyperties comes from the links that tie articles and illustrations together. A link is a cross reference, an indication that more information on a particular word or phrase is available. For example, suppose you were writing an article on the joys of owning pet fish. In a Hyperties article, you might write a sentence such as:

Among the most interesting fish are ~guppies~ and ~goldfish~.

The tildes (~) that surround the words guppies and goldfish inform Hyperties that these words are links to additional information. The additional information may be simply a definition or footnote. Or it may be a complete article, with links of its own. When the Hyperties browser displays text, the tildes are removed and the links are highlighted on the computer screen:

Among the most interesting fish are **guppies** and **goldfish**.

On a monochrome monitor (IBM PC or compatible, or SUN 3 workstation), the links are displayed in boldface, like the example above. On a color monitor the links are displayed in a different color from the rest of the text. The highlighted text signals the reader that more information is available. Figure 2 of Finding facts vs. browsing (p 108) shows highlighted embedded menu items that can be selected by touchscreen or arrow keys. The user can follow a topic of interest, turn pages (NEXT or BACK), RETURN to the previous article, or view the INDEX.

The reader may choose to explore the database by using the links to travel among articles and illustrations. Hyperties automatically keeps track of the path so readers can return to previously seen articles.

### Illustrations

Illustrations for Hyperties databases are prepared using a standard graphics editor. A scanner can be used to capture photographs and drawings. Prototype versions of Hyperties also support video disc.

### Index

Sometimes readers will be looking for a specific article and will not want to browse the database starting with the introductory article. Hyperties automatically creates an index which lists all the articles in the database. Readers may go to the index at any time and access any article in the database directly.

### Synonym

Authors may wish to refer to the same article using different words or phrases as links. This is often a matter of style. For example, suppose you were creating a Hyperties database about the presidents of the United States and included an article on George Washington. Here are three sentences you might write (in the same or different articles) that link to the same article on George Washington:

**George Washington** was the first president of the United States.

A well-known anecdote about **Washington** involves a hatchet, a cherry tree, and his father's wrath.

In understanding the political motivation of **the president**, it is important to consider his roots.

Hyperties can treat **George Washington**, **Washington**, and **the president** as synonyms which all link to the same article. The author need not plan this in advance; as Hyperties builds its index it will ask if certain terms are to be considered synonyms or not.

### Highlighting is selective

Just because a word or phrase can be used as a link to an article or illustration does not mean that it must be used that way every time it appears. Authors decide when a word or phrase is a link by enclosing it in tildes. This keeps articles from becoming cluttered with gratuitous highlighted terms. For example, you could write:

~George Washington~ was a military leader and as such commanded political respect. It was said that George Washington was autocratic and it was said that George Washington was a democrat.

When Hyperties displays this text, only the first reference would be highlighted as a link:

**George Washington** was a military leader and as such commanded political respect. It was said that George Washington was autocratic and it was said that George Washington was a democrat.

### Introductory article

In each Hyperties database the author specifies an article as the lead or introductory article. Since many encyclopedia readers will browse the introductory article first, this article should be composed so that it references as many key articles as possible. There are several strategies for composing the introductory article.

One strategy is to fill the introductory article with many references making it a summary of the entire database. By scanning it, the reader can select one of many places to begin browsing.

A second strategy for the introductory article is to confine it to only a few key references. In this strategy, the idea would be to minimize the number of details which the reader must deal with and start him or her down an appropriate path. For example, suppose you were building a policy manual which had many detailed articles on specific policies. Rather than referencing many policies in the introductory article you could develop a more general approach such as the following:

This database contains policies relating to:

**permanent employees, temporary staff, and consultants.** In addition you will find policies which apply to all staff relating to **security, non-disclosure, and dealing with the press.**

A third strategy for the introductory article is to design it as a high level index. Here is an example:

## CORPORATE POLICIES

### Permanent Staff

**Hiring Permanent Staff**  
**Termination Procedures**  
**Benefits and Vacation Policies**

### Temporary Staff

**Approval Policy for Hiring Temps**  
**Approval Policy for Retaining Consultants**

This technique of using the introductory article as an index can be extended to other articles. For example, **Approval Policy for Hiring Temps** could link to a new article that provided a detailed “index” to relevant policies, for example:

## APPROVAL POLICIES FOR HIRING TEMPS

**Hiring Short-term Temporaries from Agencies**  
**Establishing Qualifications of Temporary Staff**  
**Hiring Independent Contractors**

This technique can yield an extensive network of indexes. A particular article could appear in several indexes, so readers can access it from many points. For example, an article on *Vacation Policies for Permanent Staff* could be highlighted under *vacations*, *benefits*, *permanent staff*, or any other relevant area.

### Planning for expansion

The Hyperties browser will not highlight a reference to an article or picture unless the article or picture exists. If you are writing an article and are discussing a topic which may eventually be the subject of its own article, you can put tildes around a link to a word or phrase. Because the referenced article does not exist, Hyperties will not highlight the link. Later, when the article is written, Hyperties will automatically highlight the reference.

### Writing style

In general, it is best to keep articles short, and keep a sharp focus. Instead of discussing a subsidiary topic which is not the main subject of an article, you can merely mention it, delimiting the key word or phrase with tildes. Then you can make that topic the subject of its own article, or at least give the topic a definition which can be called up by the reader.

The same technique can be applied to details. Rather than including detailed information in an article, you can simply reference it and create separate articles for it. This shields the reader from unnecessary details, but provides a path to them

when the reader deems it relevant. This technique can be especially useful when the material contains case studies, experiments or many examples.

### Creating instructional material

Hyperties can be used as a tool to reduce the difficulty of creating educational software and allow authors to focus on content and instructional design, rather than on technical factors. In Hyperties, concepts and information can be entered and linked together. Developing courseware in such an environment is more like writing a book than writing a computer program. With Hyperties, the development of courseware should become an instructional, rather than technical, endeavor.

For example, an introductory psychology module might contain the following text:

The basic process in **behavioral psychology** was presumed to be **conditioning**. Two types of conditioning were extensively studied: **operant conditioning**, the more powerful form is most associated with **John Watson**; the less powerful paradigm of **respondent conditioning** is most frequently associated with the studies of **Ivan Pavlov**.

The highlighted words and phrases in boldface indicate to the student that additional information is available on the topics: **behavioral psychology, conditioning, operant conditioning, John Watson, respondent conditioning, and Ivan Pavlov**. This additional information might be: a definition (for example, a definition of behavioral psychology), a new article (for example, an article on operant conditioning), an illustration (for example, a graph of conditioning and extinction), or a videodisc sequence (a brief biography of Ivan Pavlov).

Implicit within Hyperties is a cognitive model based on associative relationships. Articles in Hyperties explain concepts and tie articles, illustrations, and videodisc sequences together to create relationships among concepts. A Hyperties database may therefore be viewed as an associative network of concepts and examples at various levels. The power of this simple structure is attractive. Instructors can express the relationships among ideas by the manner in which articles are linked. Concepts can be expressed at multiple levels, with high level concepts linked to more specific concepts and specific concepts linked to examples.

Because a Hyperties database is organized according to the relationships inherent in the instructional material, it may help students learn the material in an integrated, holistic fashion. One of the most difficult instructional tasks in any content area is conveying the systems and interrelationships which underlie the facts. Memorization of isolated facts leads to rote learning; integration of concepts and their relationship into the learner's cognitive structure should lead to meaningful, useful learning.

Hyperties also creates materials that are learner-controlled. Much computer-based instruction is based on a dialogue model in which the computer constantly prompts the student to respond to questions. This can be a powerful instructional model but is often implemented in a fashion which forces the student to accommo-

date to the pace and presentation units of the software. It is this factor which makes so much computer-based education unappealing to the student. In Hyperties, the student has greater control. Learning proceeds according to the pace and paths selected by the student. Students need not waste time on material they already know and they can pursue a topic of interest to any depth desired.

We do not suggest that Hyperties is ideal for all forms of instruction; rather, we suggest that it is excellent for certain types of instruction. In particular, Hyperties, we believe, will be extremely effective in the following areas:

- familiarization - situations in which a person is introduced to a new content area and needs to become familiar with the key concepts which underlie it and their relationships.
- annotation - situations in such areas as literature, poetry, art, law, and politics in which student read source material which may be heavily annotated. The annotations remain "hidden" behind the links and so do not interrupt the flow of primary material but are instantly available for reference
- dynamic glossaries - glossaries prepared in Hyperties not only define terms but provide links to related concepts. This enables the reader to more fully understand the key terms.
- diagnosis and review - coupled with objective test items, Hyperties becomes a powerful diagnostic and review technique for any achievement test. Students answer questions. If they are correct, the software moves on to the next item. If the student answers incorrectly, Hyperties presents an explanation which serves as an entry to the database. Students can browse the database until they feel confident they understand the area and then return to the diagnostic test.
- diagnostic problem-solving- maintenance problems fit the Hyperties structure conveniently. The reader can select model numbers, problem features, symptoms, or other conditions and receive further information about how to proceed. This strategy has potential for machine repair, business procedures, medical diagnosis, etc.
- organizational information - when there is a need to teach organizational relationships (for example, the structure of government) Hyperties can represent the relationships by linking informational articles together. Hyperties is also useful in presenting the facilities and services of an organization. For example, it can be used to create orientation courses for new college students.

### **Newsletters**

Hyperties can be used to create efficient newsletters. The essence of a newsletter is that the reader wants to obtain up-to-date information efficiently. In Hyperties, you can create a series of "headlines" or short abstracts which let the reader know what information is available. If the information is of interest, the

reader can then select the article for more information. For example, the first page of a newsletter for personnel departments might be structured as follows:

NEW COURT RULING ON MATERNITY LEAVE. A federal court recently ruled that corporations must provide maternity leave to long term temporary employees. See **Higgins vs Retco**.

LIABILITY ON ALCOHOL-RELATED ACCIDENTS. An employee, who became drunk at a company sponsored party and later was injured in an auto accident, sued the company. For details of this case see **Carnevale vs. Rapido Trucking**. For a review of the legal issues see **Alcohol and Corporate Liability**.

### Creating reading sequences

A final authoring strategy is the development of reading sequences in Hyperties. By its nature, the articles in a Hyperties database can be randomly accessed. However, sometimes it is desirable to provide readers with a path to read the articles in sequential order.

For example, suppose a set of materials was organized into five key articles. These articles contain the main ideas that your readers should encounter. In addition, there are a number of more detailed articles, that expand upon the key articles. What you want the reader to do is:

- (1) read all five key articles in sequence
- (2) within a key article, use the browser to explore the details of any concepts for which (s)he wants more information.

You can accomplish this in at least two ways. The first way would be to use the introductory article to list the five key articles:

Please read the following key articles, in sequence:

- Article 1: Buying Your Fishtank
- Article 2: Selecting Your Fish
- Article 3: Setting Up Your Tank
- Article 4: Feeding Your Fish
- Article 5: Care of Fish Babies

The reader would select each article in turn. Within each article, the reader could browse related articles of interest, and ultimately return to the introductory article to select the next article.

The second technique is to create a link at the end of each article to the next article which you want the reader to see. For example, the first article, Buying Your Fishtank, might end as follows:

Congratulations! Having followed the instructions in this article, you are now the proud owner of a fishtank. But what is a fishtank without fish? To move on to this exciting step, please read *Selecting Your Fish*, next.

This technique can be expanded to create several paths through the material, if you desire.

### **Article length: an exploratory experiment**

One design issue about this environment is the appropriate size of articles. Since following a reference by turning to another article is more rapid than on paper, smaller fragments of text may be more suitable. Also, considering the small size of many computer screens, slow page turning, and possibly poor readability, some designers suggest that hypertext articles should be brief. To test this conjecture an exploratory study was run by Dana Miller and Anna Williams under the direction of the second author.

Thirty-two psychology student volunteers were given brief instructions and ten minutes of practice with a Hyperties database dealing with personality types. Then the subjects were given 30 minutes to answer as many multiple-choice questions as they could. A typical question was: What are introverts interested in at their work? A) the procedures. B) the results. C) the idea behind the job.

The major independent variable was article size. The short database had 46 articles from 4 to 83 lines, while the long database had 5 articles of 104 to 150 lines. A second independent variable was personality type of the subjects, but the measurement instrument was ad hoc and this variable failed to produce statistically significant results. Therefore the remainder of the discussion focuses on the article length variable and performance time data.

The 16 subjects working with the short articles answered an average of 10.1 questions correctly while the 16 subjects working with the long articles answered an average of only 7.2 questions correctly ( $F(3,30)=4.73$ ,  $p < .01$ ). The average time per correct answer was 125 seconds with the short articles and rose to 178 seconds for the long articles ( $F(3,30)=9.22$ ,  $p < .001$ ).

While these results support the conjecture that short articles facilitate fact finding in a hypertext environment, they need replication with other databases, questions, subjects, and screen environments (e.g. larger or multiple windows). Longer practice sessions, an effective subjective satisfaction questionnaire, and within-subjects design would be useful improvements in a new study.

### **Conclusion**

The new opportunities offered by hypertext systems call for a re-thinking of the presentation of knowledge. Hyper-chaos is a serious danger and effective guidelines will be necessary to assist authors in creating useful materials. Empirical studies can be a great aid in sharpening thinking, developing appropriate guidelines, and formulating new theories of how people seek and acquire knowledge.

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