

# Where's the Hypertext?

## *The Dickens Web as a System-Independent Hypertext*

George P. Landow and Paul Kahn  
*Institute for Research in Information and Scholarship*  
*Brown University, Providence RI 02912 USA*

### Abstract

This paper reports the comparative evaluations by fifteen experienced hypertext users of three hypertext systems (Intermedia, Interleaf WorldView, and Storyspace) to carry out both simple information retrieval and more complex cognitive tasks. In contrast to approaches that compare hypertext versions of print documents to print documents, our research began with materials originally created for an electronic environment—the award-winning *Dickens Web*. The evaluators' detailed narratives, which show that hypertext documents can exist independently of specific hypertext systems, also suggest points that designers of hypertext systems and hypertext authors must take into account. These points include the value of full-text search vs. link following, and the importance of content expertise. Finally, we report on the importance of single- vs. bi-directional thinking, multiple linking from a single point, and web views.

### 1 Introduction

What is a hypertext? Theodor H. Nelson's definition of his neologism, "a body of written or pictorial material interconnected in such a complex way that it could not conveniently be presented or represented on paper" [1], predates any actual software that could embody it. In those early days of hypertext theory, the hypertext was always a *thing*, a collection of non-sequential writing.

Two decades later, as the computer industry caught up with these ideas in the mid-1980s, hypertext transformed from a *thing* to a *technology*. When Jeff Conklin set out to introduce and survey hypertext, he defined his terms by describing software features: hypertext is "machine-supported links" [2] with or without multiple windows in which to display link content.

In addition to Hypertext the Thing and Hypertext the Technology, the third meaning of the term to evolve is Hypertext the System. Hypertext *systems* were programs that used hypertext technology to create hypertext collections.

Separating a hypertext system from its underlying technology in order to identify the essential aspects of a hypertext collection might appear a marginally interesting exercise in epistemology. In our case it was a matter of necessity brought on by the termination of the hypertext system we have used for the past seven years, Intermedia [3, 4]. Death comes to software in many ways, and for Intermedia it was brought on by changes to Apple's A/UX that made the software incompatible with the current version of the operating system. All development of Intermedia ended in August 1990, and by the 1991-92 academic year it was also clear that our use of Intermedia would have to end as well. To save the considerable amount of hypertext materials developed for teaching at Brown University, we had to convert them from Intermedia to some other form of hypertext.

We can still say as Conklin had that hypertext technology consists of machine-supported links. Given that definition we could choose from among a dozen or so programs for the Macintosh, DOS, or Unix operating systems that were self-described hypertext systems or documentation systems with hypertext features. However, none of these systems offered an exact equivalent of the hypertext technology supported by Intermedia. In addition we knew from the outset that more than machine-supported links had to be converted and preserved. In developing these materials

---

Permission to copy without fee all or part of this material is granted provided that copies are not made or distributed for direct commercial advantage, the ACM copyright notice and the title of the publication and its date appear, and notice is given that copying is by permission of the Association for Computing Machinery. To copy otherwise, or to republish, requires a fee and/or specific permission.  
©1992 ACM 0-89791-547-X/92/0011/0149/ \$1.50

with Intermedia we sought to define a specific approach to the use of hypertext technology in literary studies [5]. The materials themselves had been designed around the Intermedia system's unique way of providing context and orientation clues to the user and its support for the user's visualization of hypertext connectivity. Therefore, in seeking an adequate replacement for Intermedia we also sought to answer two other questions. Was there in the collection we wanted to preserve a hypertext distinct from the hypertext system used to create it? Furthermore, what could we learn about hypertext system design and its educational affects by comparing the same hypertext collection presented in several hypertext systems?

This paper reports the comparative evaluations by fifteen experienced hypertext users of three hypertext systems (Intermedia, Interleaf WorldView, and Storyspace) to carry out both simple information retrieval and more complex cognitive tasks. In contrast to approaches that compare hypertext versions of print documents to print documents, our research began with materials originally created for an electronic environment. The evaluators' detailed narratives, which show that hypertext documents can exist independently of specific hypertext systems, also suggest points that designers of hypertext systems and hypertext authors must take into account.

## 2 The Dickens Web

For the experiment we chose *The Dickens Web*. IRIS had published this hypertext in 1989 to provide an example of the way Intermedia supported the teaching of literature, and the following year *The Dickens Web* received the 1990 award for "Best Curriculum Innovation—Humanities" from EDUCOM/NCRIPTL. The web consists of essays and visual images about Charles Dickens, his novel *Great Expectations*, and many related subjects such as Victorian history, public health issues, and religion. It containing 250 documents and 680 links which occupy 2.5 megabytes. The average text document is 600-1000 words, though many are considerably longer.

In Intermedia the term web indicates a set of links joining documents on a similar topic. The organization of the collection does not follow a simple b-tree hierarchy. To provide clear entry points into the collection, Landow created two main overviews, one focusing on Dickens as an author and the other focusing on the central literary work, *Great Expectations* (For a discussion of the design of these overviews see [6]). These overviews contain a central image surrounded

by text labels organizing the links into significant groups.

From either overview, users find links to second-level overviews such as those focusing on religion, public health issues, Victorian history, Dickens's literary relations, and so on, as well as to many of the documents in the collection. Both *The Dickens Web* and *Context32*, the larger hypertext from which it was drawn, emphasize conceptual connections among the various subjects contained in the collection. The authors expected that users would take advantage of the web's interconnectivity and reach a particular document by many different paths.

### 2.1 Translation Considerations

Two practical considerations drove the conversion of *The Dickens Web* to another software platform. First, we wanted a final result that could be used by our own students as well as by those at other institutions. We therefore sought commercially available hypertext software for either of the two personal computer platforms, Macintosh and DOS/Microsoft Windows. Second, wanting to preserve as much as possible of the original hypertext, we tried to change the appearance of the information on the screen as little as possible and to maintain the navigational possibilities supported by Intermedia. For these reasons we looked for hypertext software with a document and linking model similar to the one found in Intermedia, which has (1) a scrolling area of text or graphics, (2) each document appearing in its own window, and (3) capacity to open many documents simultaneously. We therefore rejected hypertext systems that required cutting text up into fixed-length pieces and single-window displays. We wanted to maintain the multi-window strategy encouraged by Intermedia, since we believed it supported the user's sense of visual connection and ability to compare elements of the hypertext.

A link in Intermedia is a navigational connection between two selections (called *anchors*) in two documents. Since we believe that freedom and precision of linking between selections were essential to the hypertext's design, we did not want to use a hypertext system that only supported movement from selection to document or from screen to screen. Intermedia links are also bi-directional and can be one-to-one or one-to-many. We had taken advantage of both of these features in designing *The Dickens Web* but did not know how important they were to the integrity of the hypertext.

It is important to point out that we were not concerned with trying to reproduce all features of Interme-

dia. We ignored two important issues that figured in the Intermedia design: multi-user access and network support. For the purposes of this experiment we considered *The Dickens Web* to be a read-only hypertext, a collection of information to be read and considered, not to be added to or otherwise modified. We did not attempt to recreate the seamless integration of authoring and browsing functions so important to the Intermedia system design.

After we had chosen the hypertext systems for our new versions of *The Dickens Web*, a third consideration entered into our thinking: the combination of hypertext browsing and full-text searching. The version of Intermedia used by students at Brown did not support any form of full-text searching and so this had not affected our original design. Full-text searching had been added to the research version of Intermedia [7] and our experience with this had convinced us that locating information by word search complemented navigating through information by following hypertext links. Since both of the hypertext systems we chose provided some full-text searching support, we sought to measure how it was used and how it affected a reader's experience of the hypertext.

## 2.2 Translating the hypertext

Given these criteria, we chose to use two hypertext programs: Storyspace for the Macintosh, published by Eastgate Systems, and WorldView for Microsoft Windows, a part of the Interleaf 5 document preparation system published by Interleaf, Inc. Beginning in the fall 1991 we translated *The Dickens Web* into both a Storyspace document and a WorldView collection. The text and graphics files that made up the Intermedia documents were translated into the new document formats. We preserved as much of the style information as we could for text documents and translated graphic object and bitmap wherever possible.

*Eastgate Systems Storyspace*: Storyspace, which runs on the full range of Macintosh computers, provided many of the same basic hypertext features as Intermedia. The program supports multiple documents (which it calls *spaces*) open on the screen at the same time, as well as several views of how all the *spaces* are connected. Links are made between selections and can have one or many destinations [8].

During the authoring process we found creating links in Storyspace was easier than the analogous procedure in Intermedia. As in Intermedia, the person creating a link identifies its extent by dragging the cursor across an area of text or graphics in an open

document. By default, Intermedia names each anchor with a sequential number. To distinguish links in a clear manner requires an additional step to name each anchor with a descriptive word or phrase. In contrast, Storyspace simplifies the process by not supporting a name for the individual anchor and supplying the name of the entire space. Encouraged by this simplified authoring, we increased the number of links in the hypertext by a small percentage, from 680 to 730.

Storyspace does not permit the kind of structured graphics we used to create overview diagrams. In its place, Storyspace allowed a combination of bitmap images imported from scanned illustrations and text. Using this technique, we managed to create spaces for all the original Intermedia overviews in a less diagrammatic form, the sole exception being Literary Relations diagrams, which require structured graphics. These we had to reduce to textual lists. On the other hand, we found the process of importing bitmaps from scanned images into Storyspace so easy that we added a number of new illustrations to the hypertext. (Figure 1a & 1b)

Storyspace consists of a full authoring and browsing program as well as a number of read-only browsing programs, called Storyspace Readers. We designed the Storyspace version of *The Dickens Web* to be viewed using the full Storyspace program, largely to take advantage of its numerous navigation features. However, during our experiment we did not encourage or expect the users to engage any of the authoring tools to modify to the hypertext.

*Interleaf WorldView*: The second system we chose, Interleaf WorldView (formerly called Viewstation), consists of two separate programs [9], the first of which, WorldView Press, takes the form of an authoring system that runs on the Sun version Interleaf 5 (I5). A set of LISP extensions built on top of I5, it exemplifies Interleaf's "active document" philosophy [10]. I5 supports a special book directory that contains a series of documents arranged in a linear sequence. Tools exist for generating page numbers in cross-references, a table of contents, and a topic index from tokens in the *book* documents. To these features WorldView Press adds the ability to follow these page references in electronic form as hypertext links. In addition, a link editor supports point-to-point link creation. As in Intermedia, links are bi-directional, but unlike both Intermedia and Storyspace, each link is limited to a single endpoint.

WorldView Press is used to "publish" the contents of the *book* directory in the form of a WorldView *collection*. This collection consists of a read-only print

Figure 1a: Intermedia—Literary Relations Diagram

This screen image from Intermedia version 3.0 illustrates how literary relations diagrams were constructed. The link to documents about Darwin is highlighted in the Web View (lower left) and the two linked documents are open on the right.

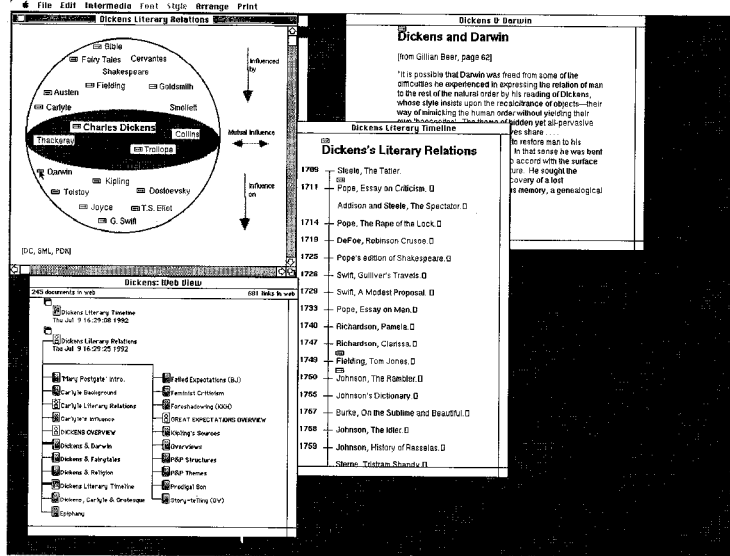


Figure 1b: Storyspace—Literary Relations

This screen image from Storyspace shows the revised literary relations diagram in the form of a text outline. One of several documents linked to “Harriet Martineau” is open on the lower left and a second linked to “Thomas Carlyle” is open on the right. The Carlyle document includes a scanned image added to the Storyspace edition.

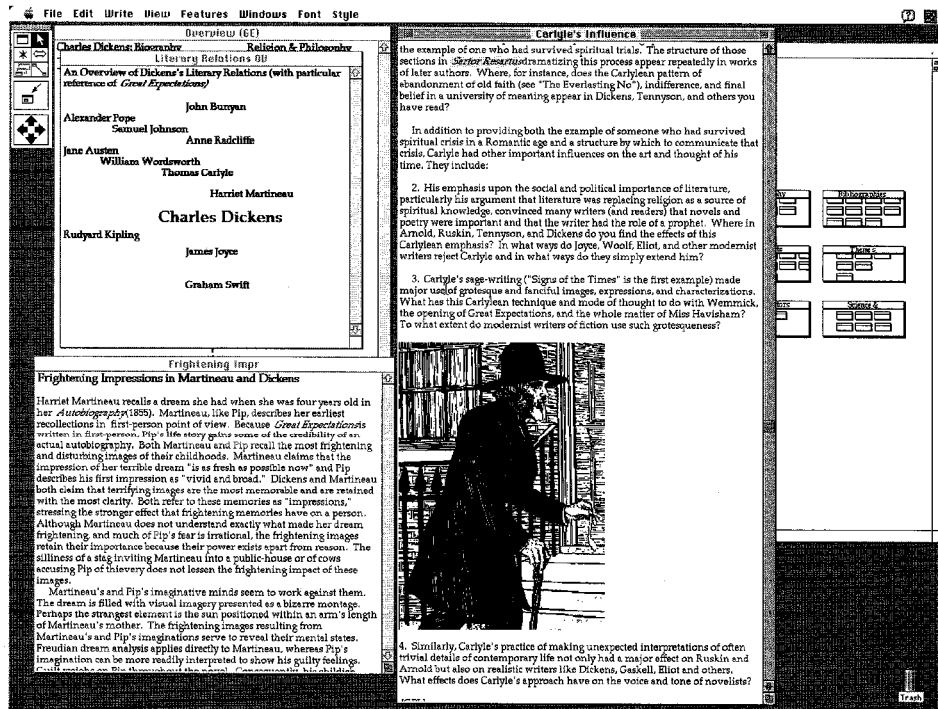


image of the documents that make up the book linked to a table of contents. In addition, WorldView creates a full text index of the collection. This collection is then viewed using the WorldView program, a stand-alone program that requires much less processing power and memory than the I5 program. Versions of the WorldView viewer run on both the Sun workstation and on machines running DOS/Microsoft Windows. We used WorldView Press on a Sun SPARCstation 2 and then published the resulting collection on an IBM PS/2 Model 80 running Microsoft Windows 3.1.

The biggest challenge in WorldView was the absence of one-to-many linking. The organization of *The Dickens Web* relied on overview documents that summarized the information available on specific topics in the form of diagrams. The individual elements in these diagrams were most often linked to several different documents. Similarly, many words or phrases in the essays are linked to more than one overview topic or phrase in another essay.

Our solution involved creating new documents that listed the choices of links for most of the one-to-many links. These documents, which the team assisting us at Interleaf later named "crossroads" documents, provided a concise summary of choices to the user. However, since this procedure took longer than making direct one-to-many links, we created crossroads documents only when we thought them necessary, most often in the overviews, and we did not translate many of the one-to-many links between essays. We limited these crossroad links in part because WorldView also offered two forms of access to each document not included in the Intermedia version of the hypertext—a table of contents and a full-text index. (Figure 2a & 2b)

Creating the WorldView collection also required us to linearize the contents of *The Dickens Web* for the first time. The Intermedia version organized material in folders and subfolders presented to the user in the form of icons. We had always considered the folder organization significant and useful for locating types of information in the hypertext, but the order of the folders, subfolders, and document titles within the folders was alphabetical, not topical or in any sense book-like. WorldView required creating a single order for all documents, and this procedure forced us to make the same kind of ordering decision all authors and editors must make when publishing a printed book. This organization generated a table of contents document consisting of the title of each document in the hypertext, with each of the titles linked to that

section of the collection. Thus, every document in the book could be located by browsing the table of contents document and following a link.

Any document could also be located by searching for any portion of its text. The full-text search function presents the user with a list of document titles (not DOS filenames) containing the target word or phrase. The user could then locate the word within any document on the list. We felt that these additional features made some of the one-to-many links unnecessary.

Because WorldView supported a mixture of text, graphics and bitmaps in the manner of Intermedia, all of the overview diagrams translated directly. Modifications to the design were made to account for the size of the VGA monitor on the target system, which is much smaller than the 19" monitors used on the Macintosh systems.

The two new versions were completed by March 1992, and students used them during April and May.

### 3 Methodology of Comparative Exercise and Nature of Evaluative Sample

We wanted to devise an exercise that would compare the three instantiations in an interesting way. We also wanted to question the nature of a hypertext document from the critical or philosophical perspective, asking "Where does the hypertext reside?"

Both of these questions can be approached by setting tasks for student users and then analyzing the results of their actions. We asked the students to locate similar information in the three embodiments of the "same" hypertext. Since all text documents occur in each version, we expected the results to tell us how the different system features effect the students' ability to complete the assignment.

Beginning with Intermedia and then continuing with Storyspace and WorldView, we asked the students to answer two three-part questions and explain how they arrived at their answer, how long it took to locate the necessary information, and what features of the hypertext system they used. The first question asked them to locate all documents written by three different critics. The second question asked them to display understanding of three issues: the influence of Dickens' life experience on his novel, Dickens' attitude toward Evangelical Protestant Christianity, and the relationship between actual sanitation and public health conditions in nineteenth-century London and the "realistic" descriptions in *Great Expectations*. In addition to answering these questions, students were encouraged

Figure 2a: Intermedia—Multiple Linking

Selecting the “Religion and Philosophy” link marker in the *Great Expectations Overview* in Intermedia presents a dialog box listing the document name and anchor explainer for each of the links emanating from that marker. The map on the right gives a partial view of all the documents linked to the overview diagram.

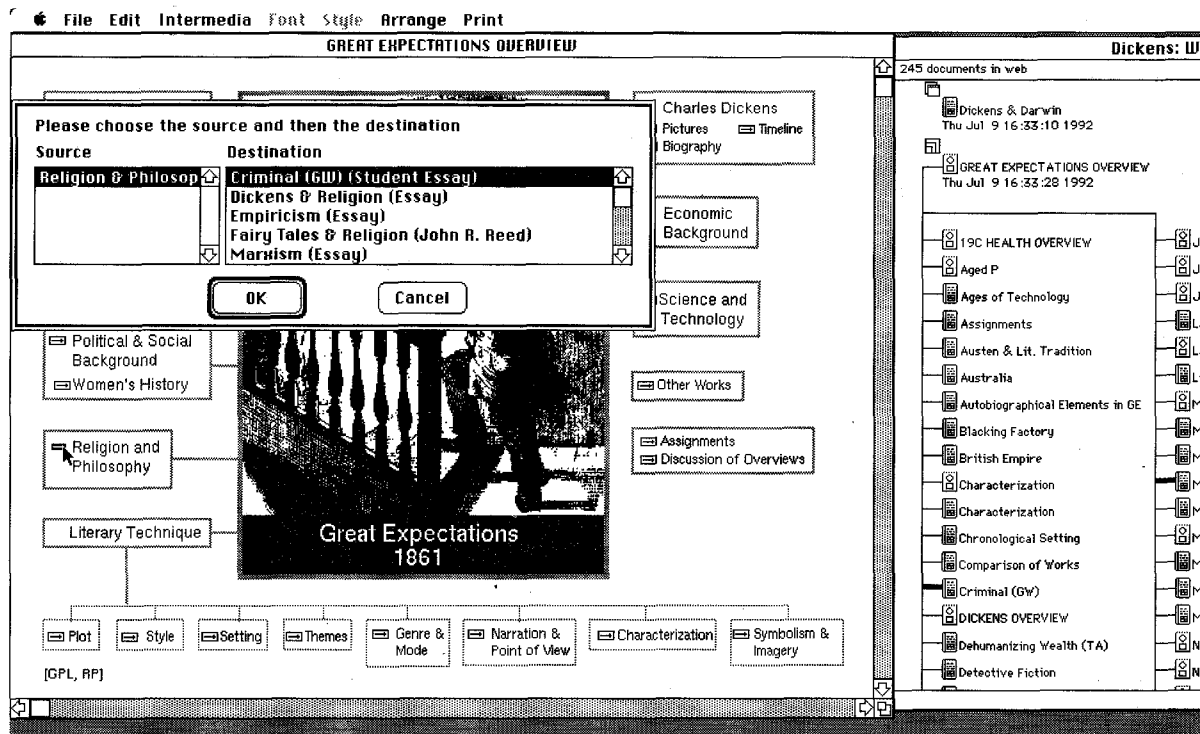
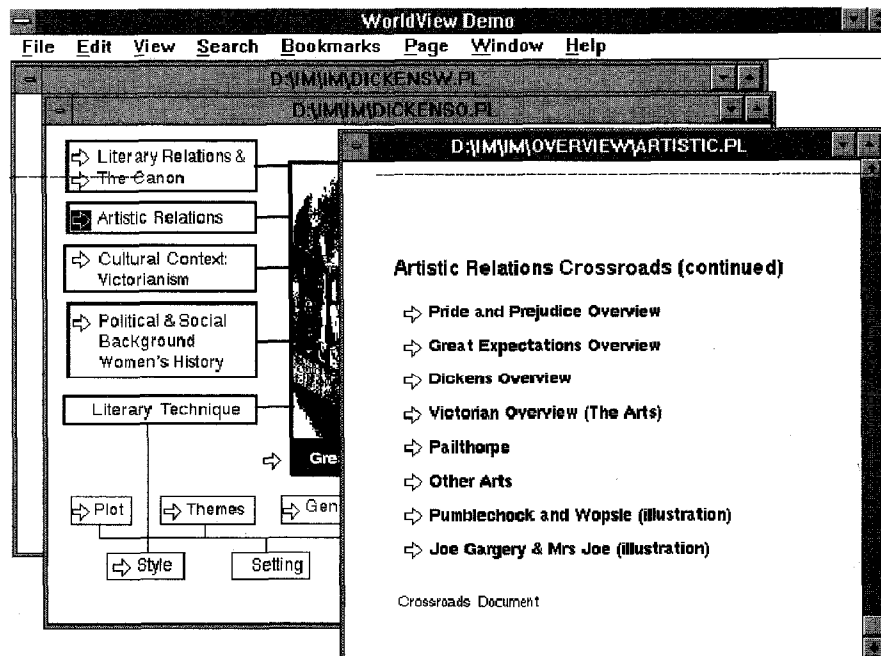


Figure 2b: Interleaf WorldView—Crossroads Documents

This screen image from Interleaf WorldView shows how point to point links in the WorldView version of the *Great Expectations Overview* lead to Crossroads documents, such as the one shown here linked to “Artistic Relations.” Each line in this document is linked to another document on this topic.



to provide us with comparative evaluations, comments, or criticisms of individual systems and related matters.

Along with the assignment, we provided the students with brief user documentation for each of the hypertext systems, giving them instructions on how to begin each hypertext. This documentation also pointed out what we felt were relevant system features.

The first question was intended to test the student's strategy for locating facts within the hypertext. In contrast, the second question required locating a number of separate pieces of information and then constructing an answer from them. We expected the question on realism, for example, to lead students to consider essays that defined realism as a literary mode as well as essays that discussed Dickens's use of that mode in his art. These materials had, in turn, to be compared to other material describing the public health conditions in nineteenth-century London. Constructing an answer to any part of the second question required exercising higher-level cognitive skills than simple fact retrieval.

### 3.1 Nature of the sample and potential methodological difficulties

Evaluations of hypertext often measure the performance of subjects who have never previously used the technology. This approach suffers from two major problems. First, insufficient account is taken of the learning curve involved when encountering any new technology. Second, by implicitly comparing novices' performance with hypertext to that with printed matter, such studies "naturalize" book technology as an unexamined baseline. A related point is the nature of the material being used to measure user performance, which is most often material designed for printed media, such as a book or journal. A useful example of this are the studies done with SuperBook on the Chemistry Online Retrieval Experiment [11] which compare user performance with printed and electronic versions of material originally published in scientific journals. In contrast, we sought to measure hypertext reading and information gathering among sophisticated users, and to use material originally designed for electronic presentation.

The participants in this evaluation were fifteen Brown University students in English 116, Landow's upperclass course in hypertext and literary theory who had read extensively in hypertext environments before undertaking this comparative exercise. All participants had experience with one or more hypertext systems, including HyperCard, Intermedia, and Sto-

ryspace. All had used Storyspace for at least a month, creating and linking spaces in this environment as well. All participants, in other words, had extensive use reading, writing and linking with at least two hypertext systems.

Although *The Dickens Web* itself was new to almost all participants, they did have experience using two of the three environments, Intermedia and Storyspace, and the question arises, could such familiarity bias the results. Furthermore, could one compare general reading and information retrieval using *The Dickens Web* in three environments once users became familiar with the contents of one version of the web? Obviously, anyone familiar with *The Dickens Web* in one system might be able to use that familiarity as a source of time-saving short-cuts in the other versions. One student explained, for example: "*Since I spent a long time browsing in the Storyspace Dickens Web, and knew what sorts of documents are on it, navigating the Intermedia version did not take as long, because here I was simply looking for particular pieces of information*" (DF) [We identify comments by individual student participants by initials throughout this paper]. Does such familiarity with the material destroy the effectiveness of such an exercise? We think not for the following reasons.

From one vantage point, such familiarity destroys any chance of effectively comparing the systems. The system new to the user (WorldView) could appear at a great disadvantage because users feel far more accustomed and more comfortable with the other two. Conversely, WorldView might appear at a great advantage because users could capitalize on their previous experience of the document set in the other environments to find information more quickly in the new system.

There are two obvious responses to such concerns, one methodological and the other theoretical. The first, methodological response simply requires posing similar questions and information-retrieval tasks for each environment. The second response, which possesses greater theoretical significance, answers affirmatively the first question we posed: Is a hypertext system-independent, and, specifically, is *The Dickens Web* a system-independent hypertext? To the extent that participants successfully draw upon their knowledge of *The Dickens Web* in one environment while reading it in another, they clearly demonstrate that they experience it as system-independent.

## 4 Results

### 4.1 Evaluator's reactions with general implications

Students carried out the exercise at their own convenience during a three-week period. During that time Intermedia, which had run essentially without maintenance for over two years in a public classroom, was unstable and some evaluators reported frequent crashes. Furthermore, Intermedia's client-server model made it dependent upon a network in heavy use by other systems. As a result Intermedia always ran slower than WorldView, which ran on a stand-alone machine in the IRIS lab. Storyspace was sometimes run off a server in the public classroom, where network load caused it to start slowly, and sometimes run on a stand-alone machine. Given the relative inconvenience of using Intermedia (one had to start up a complex operating system, the system occasionally crashed, and the network often was slow), the positive remarks about it therefore become particularly notable.

In general students found the requested information on all three systems with relative ease, and they reacted positively to features of all three systems. Each system had its advocates. They found Intermedia to be "the most direct" and appreciated the way this system highlighted destination anchors when following links. The "outline-like organization" of the overviews in Storyspace were dubbed useful. Students who liked WorldView commented on browsing with the table of contents file, the quick response time, and locating titles with the Full-Text Query feature. However, even the advocates commented on the disadvantage of the uni-directional links in WorldView and its lack of any graphic link browser. Following links in WorldView "leads to a window explosion, which is not necessarily a great evil, but coupled with other defects becomes really tedious. . . . In [WorldView], it was simply a blind jump ahead into the unknown" (SW).

### 4.2 Approaches to information-retrieval problems in hypertext environments—following links vs. full-text search

Since the assignment in general and Question 1 in particular emphasized retrieving information from the various versions of *The Dickens Web*, we shall begin our discussion of specific results by examining the various approaches participants took to solving the problems posed by the assignment. As previously noted, Storyspace and WorldView both have full-text

searching capacities that the version of Intermedia used by the students lacked. As one might expect, student evaluators remarked on this distinction: "*The lack of a full-text search*," DH claimed, "*definitely left Intermedia behind both Storyspace and Interleaf (unless I just wasn't aware of the capability in Intermedia) but for general search and web navigation, I found all of the systems similar. In terms of the actual text searches, I found [WorldView]'s search menu more self explanatory than Storyspace's for the particular sort of search the assignment called for.*"

### 4.3 Following links only

Nonetheless, almost all participants were able to find the information requested in all three systems. The following narratives about how students explored the relation of Dickens's life to *Great Expectations*, which show in detail how experienced hypertext readers actually proceed, demonstrate that most users successfully locate information by following links. To do so, moreover, they follow varying methods.

Comparing the Intermedia and Storyspace versions of the web, one participant explained that his approach centered on using author-generated graphic overviews: "*Basically I obtained this information by wandering around in the Great Expectations Overview. After a bit of browsing it only took me twenty or so minutes to get this little bit on Allen and Dickens's childhood days in the factory. Essentially, I followed links, but found the link following process a bit more cumbersome [in Storyspace] than in Intermedia. In the latter link following is a very intuitive process besides just being a matter of two mouse clicks. But in Storyspace, following links is more involved (you have to think more), which is not conducive to rapid link following (assuming that the more rapid, the more automatic the process of link following is, the more it becomes like our own thought patterns and processes). To put it bluntly, it seems to me that following a link should be more like remote control work*" (DF).

### 4.4 Full-text searches

A second student evaluator using Intermedia reported "*I spent about 40 minutes working on this part of the assignment [this same question about autobiographical elements in Dickens]. Familiarity with the system made the process fairly straightforward, although I felt that I wondered if there might be an index or text search option that I had missed somehow.*" (AM) In contrast, using Storyspace to answer one of the simpler information retrieval questions (about bibliographical

information), a student reported that he found its full-text search capacity useful *"especially in seeking specific lexia by specific authors,"* particularly in contrast to Intermedia which *"facilitates only a very haphazard approach"* to such specific problems. *"I started with full-text search which came up with two articles. I clicked on 'History' in the web view [a reference to one of the space browsers in Storyspace]. Hit the link marker on 'Gillian Beer' which led to 'Works Cited', a list of articles attributed to her. No problem."* (AM)

AP found using the similar feature in WorldView even easier and more convenient than the other two systems. *"In [WorldView] I obtained this information using the Full Text Query. It would have taken just 5 seconds or so but I typed EDH Johnson first and came up empty-handed and then typed Johnson and ended up in Samuel Johnson's Work List. Finally I typed E.D.H. Johnson and found a list of his works, with links to them . . . In Storyspace I used the Pathbuilder option under the Features menu and typed Walter Allen. Figuring the whole process out took about 30 seconds. . . . Needless to say finding all of the above information was much easier in the two systems that supported full-text searching, Interleaf and Storyspace. The text-search interface in Storyspace proved more confusing than that of Interleaf, though perhaps it had an enhanced functionality. "Get" and "Keep" hardly seemed intuitive menu options for a text search."* (AP)

Another student reported that he found the documents written by E.D.H. Johnson *"using the Path Builder menu as described in the assignment, the commands were not very self-explanatory in the menu. Also, the way I was keeping these notes, I couldn't exit from the text search window to this window, so I had to copy the answers to paper and then type them in, Points off for Storyspace. Total Time: 9 min."* (DH)

Using another approach, one respondent explained how he took advantage of WorldView's Table of Contents in solving one of the bibliographic questions. *"I had no previous knowledge of the documents by Allen, so I simply went to the Titles on the File menu and paged down to the Dickens TOC. From here, I searched until I found "Critics Quoted in the Dickens Intermedia Web," where, in turn, I found Walter Allen's work The English Novel: A Short Critical History. I followed the link from this and found that he contributed the document "The Blacking Factory and Dickens' Imaginative World." This was far easier than my previous searches for critic's works in Intermedia and Storyspace. The TOC assisted me perfectly. Allen may have contributed other articles, however, and unlike Intermedia and Storyspace, I was unable to*

*follow this link to other Allen articles, if they do indeed exist. This took about ten minutes."* (AW) In this case the student was expecting a link to take him to other works by Allen, rather than using a full-text search to present an inclusive list of titles containing Allen's name. (Figure 3a and 3b)

## 5 Conclusion: Lessons for Designers of Hypertext and Hypertext Systems

In addition to producing narratives that detail the way relatively experienced users employ various strategies to locate information in different hypertext environments, our evaluative exercise also led to remarks of value both to authors of hypertext and designers of hypertext systems. Some of these observations have special relevance because they concern particular features of Intermedia not found in other systems. Students of hypertext should note which Intermedia-unique features proved useful enough to warrant preserving in other systems.

### 5.1 One-way versus two-way linking

The first of these recommendation to the designers of systems concerns Intermedia's use of two-way links, whose value several of the evaluators commented upon. For example, describing his experiences with Storyspace (in which environment, incidentally, he has created several large, extremely complex documents), HL remarked: *"Having only one-way links made it difficult to circle back through previous texts (although one could sometimes simply click on the window of the previous text). While the overviews were functional and separated material quite well, I sometimes found myself wading through a series of them in order to find material while in Intermedia, the three or four major overviews were sufficient to cover all the material."*

### 5.2 Multiple linking from a single point

Second, all users found essential the ability to link multiple documents to a single point (or anchor), which appears in both Intermedia and Storyspace. Some noted its absence in WorldView as a serious practical objection to that system: *"[WorldView] was easy to use, but the inability of the links to have more than one destination and the necessity of "Crossroads" documents did slow the reading process"* (HL). In contrast, KK found this system's lack of multiple linking from a single point a major theoretical objection: *"The most primitive aspect of Interleaf*

Figure 3a: Interleaf WorldView—Full-text Searching

A search for a word or phrase in WorldView creates a Query Results window containing the name of the target documents and the number of times the words occur. The documents can be opened from this window. The search for "Gillian Beer" found the two documents where that critic was quoted, but did not locate the *Critics Quoted* document where her name appears as "Beer, Gillian."

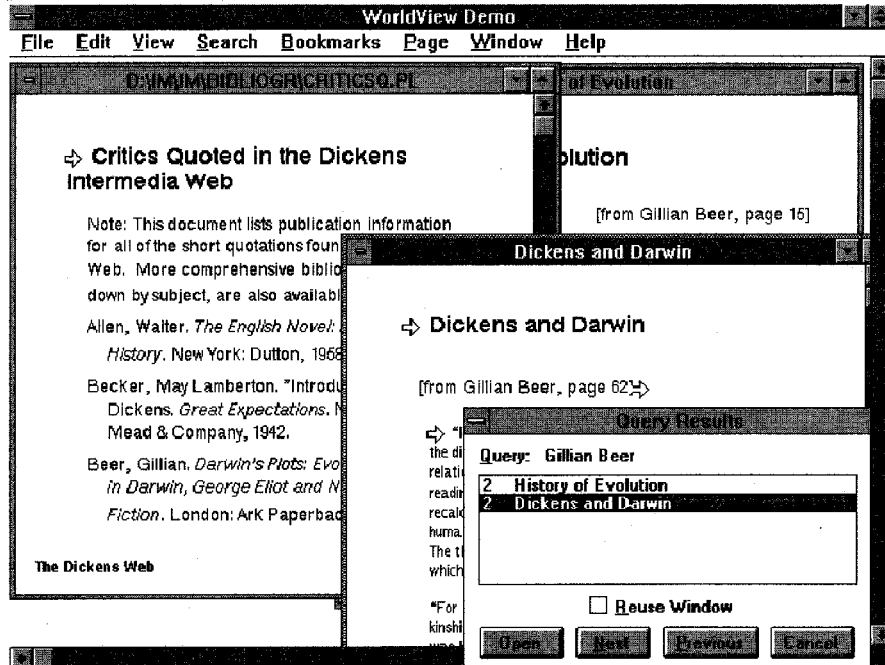
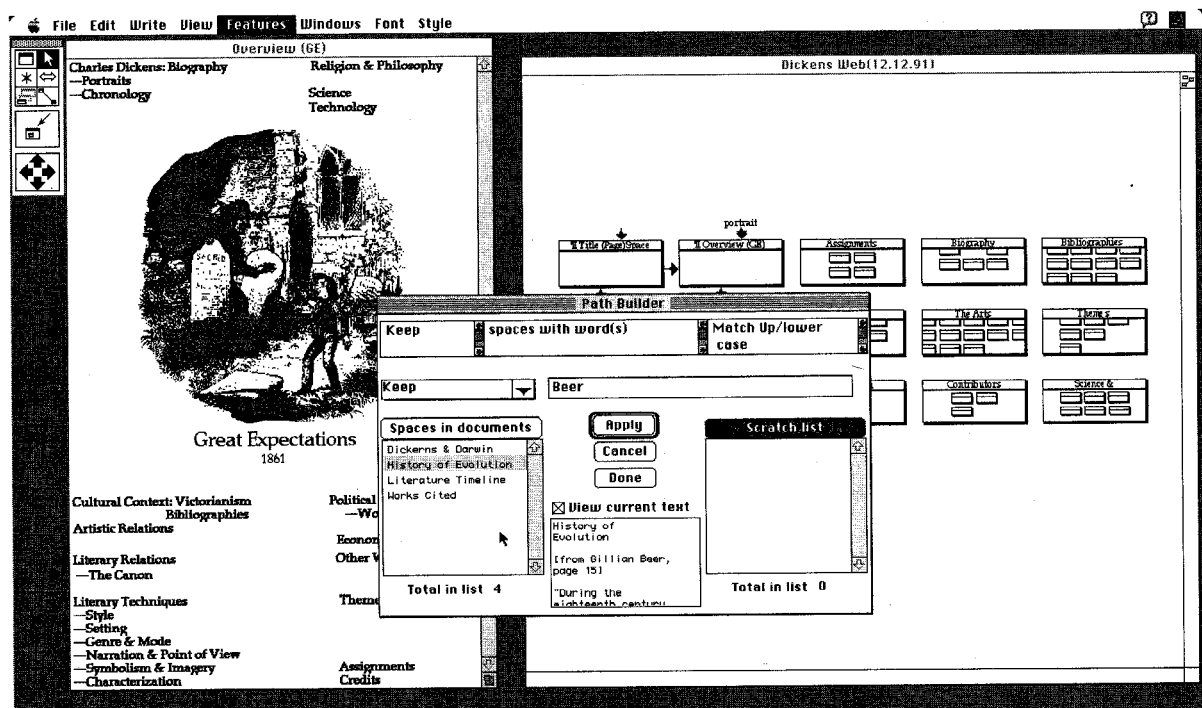


Figure 3b: Storyspace—Path Builder

A search for "Beer" in the Storyspace Path Builder locates four *spaces* containing this word. The user can view the beginning of the spaces in the list but cannot open them from the Path Builder. The Storyspace version of the *Great Expectations* overview is shown on the left.



[WorldView] seems to be its links having only one destination. This seems to limit the use of links, an important aspect of a hypertext system" as did, she observed, the system's lack of labels or titles on individual blocks: "Intermedia has a more direct and easy-to-follow path of finding the list of documents. The anchor feature of Intermedia is very helpful for the user to organize the different materials that the web has to offer." In other words, when one has multiple destinations possible from a single link site or link marker, one needs some indication of the nature of each destination. The ability of the author in Intermedia to label these anchors within a document—Storyspace provides the title of the entire linked document—greatly assists the reader.

### 5.3 Web View

Perhaps the greatest lesson to be learned from Intermedia, according to these evaluators, lies in the Web View. The web view is a combination of a history list of the user's interactions with the documents and a local map showing all links to and from the current document. This view is updated each time a user moves from one document to another [12]. According to AW, "Perhaps it is because I've worked the longest on Intermedia, but I definitely like this system better than Interleaf or Storyspace—in that order. I think that, in terms of visual organization, Intermedia is easier to follow. . . . I like the fact that the overview leads directly to the links. And, to top it all off, the web view—simultaneously with the overview—is the most valuable tool a reader can have."

SW makes a similar point in his explanation of how the Web View works when he works in Intermedia. "Intermedia was the best system for providing a horizon to movement: the Web View singled out possible destinations for a link after one click, providing for easier and more educated movement. . . . Although the actual movement takes longer, more choices are always open in Intermedia than either of the other two systems. At any one time there are more immediate choices available on the Intermedia screen. The greatest facilitator of this is the Web View. While having diminutive analogs in the other systems (the closest being the title list of Interleaf), the Web View offers a compression of temporal movement in hyperspace. At any moment, the subject may choose to directly move to a textual location that it has inhabited at any time. Paths do not have to be retraced, as they painfully have to be done in Storyspace. Each individual movement may take more time, but considering the overall topog-

raphy of Intermedia, it provides the most comprehensive and sophisticated hypertextual travel service. It took me only a brief four moves to gain the Walter Allen information. Although maybe it is result of my enraptured attitude toward Intermedia, but there also seems to be more total links in existence. This may be again a function of Intermedia's multiple paths of hypertextual travel." (SW)

### Acknowledgments

The Intermedia version of *The Dickens Web* was created with the editorial assistance of Julie Launhardt, now with Boeing Corp., and design guidance from Ronnie Peters, now art director at Dynamic Diagrams. Assistance from both software engineering and technical documentation at Interleaf in creating the WorldView version came from H. David Scarbro, Jon Waldron, Marilyn Kerschen, Fran Keutmann, Larry Kessenich, Craig Burket, David Fristrom, and Jim Giza.

### References

- [1] Nelson, Theodor H. "A File Structure for the Complex, the Changing and the Indeterminate." *Association for Computing Machinery, Proceedings of the National Conference, 20th*. New York: ACM, 1965. 84-100.
- [2] Conklin, Jeff. "Hypertext: An Introduction and Survey." *IEEE Computer*, Vol. 20, No. 9 (September, 1987): 17-41.
- [3] Yankelovich, Nicole, Bernard J. Haan, Norman Meyrowitz and Steven M. Drucker. "Intermedia: The Concept and the Construction of a Seamless Information Environment." *IEEE Computer*, Vol. 21, No. 1 (January 1988): 81-96.
- [4] Haan, Bernard J., Paul Kahn, Victor A. Riley, James H. Coombs and Norman K. Meyrowitz. "IRIS Hypermedia Services." *Communications of the ACM*, Vol. 35, No. 1 (January 1992): 36-51.
- [5] Landow, George P. *Hypertext: The Convergence of Contemporary Critical Theory and Technology*. Baltimore: The Johns Hopkins University Press, 1992

- 
- [6] Kahn, Paul, Julie Launhardt, Krzysztof Lenk and Ronnie Peters. "Design of Hypermedia Publications: Issues and Solutions" *EP90, Proceedings for the International Conference on Electronic Publishing, Document Manipulation & Typography*, R. Furuta (ed.) Cambridge: Cambridge University Press, 1990. 107-124.
- [7] Coombs, James H. "Hypertext, Full Text, and Automatic Linking." *International Conference on Research and Development in Information Retrieval (SIGIR '90)*, September 5-7, 1990, Brussels, Belgium. 83-98.
- [8] Bolter, Jay David and Michael Joyce. *Storyspace: A Computer System for Reading and Writing*, 1985.
- [9] Interleaf, Inc. "WorldView Press User's Guide." Waltham MA 02154, 1992.
- [10] English, Paul M., Ethan Jacobson, Robert A. Morris, Kimbo B. Mundy, Stephen D. Pelletier, Thomas A. Polucci, and H. David Scarbro. "An Extensible, Object-Oriented System for Active Documents." *EP90, Proceedings for the International Conference on Electronic Publishing, Document Manipulation & Typography*, R. Furuta (ed.) Cambridge: Cambridge University Press, 1990. 263-276.
- [11] Egan, Dennis E., Michael E. Lesk, R. Daniel Ketchum, Carol C. Lockbaum, Joel R. Remde, Michael Littman and Thomas K. Landauer. "Hypertext for the Electronic Library? CORE Sample Results." *Third ACM Conference on Hypertext Proceedings (Hypertext '91)*. December 15-18, 1991, San Antonio, Texas. New York: ACM, 1991. 299-312.
- [12] Utting, Kenneth and Nicole Yankelovich. "Context and Orientation in Hypermedia Networks." *ACM Transactions on Information Systems*, Vol. 7, No. 1 (January, 1989): 58-84.