The Educational Uses of Intermedia

Julie Launhardt
Boeing Commercial Airplanes Group
Paul Kahn
Brown University

ABSTRACT

THIS ESSAY discusses the use of Intermedia as an educational tool. After briefly describing the kinds of educational problems the software was intended to address, we shall survey some of the materials created using Intermedia and compare how the tools have been used in a variety of educational contexts. Based on this survey and our own experience as Intermedia authors and editors, we will offer some conclusions concerning the effectiveness of the Intermedia tools themselves. An annotated bibliography lists relevant IRIS technical papers and publications by Intermedia users.

IN THE FALL OF 1990, *The Dickens Web,* a set of materials about Charles Dickens and his novel *Great Expectations* created with Intermedia, was awarded "Best Curriculum Innovation—Humanities" by EDUCOM/NCRIPTL. The award was shared by George P. Landow, Professor of English and Art, and the Institute for Research in Information and Scholarship (IRIS). The Intermedia software, available on a network of two dozen Macintosh II workstations in a classroom at Brown's Center for Information Technology, was entering its fourth academic year as a teaching tool at Brown. The same software was being used as part of the learning environ-

ment, as both a teaching and a research tool, in English Literature, Biology, American Civilization, Mathematics, Sociology, Philosophy, Human-Computer Interface Design, Graphic Design, and Computer Science at schools both large and small, both liberal arts and technical, in North America and Europe.

Beginning in the 1960s, a number of educational experiments at Brown University involved the use of computer software to teach science and humanities subjects. These experiments, which involved both hypertext and graphics software, formed the foundation on which a team at IRIS began to develop Intermedia in 1985. At this time the computing environment had begun to change in ways that had dramatic potential for educational applications. First, a shift began from time-shared computers with terminals to computer workstations on a network. Second, computer displays grew from the 24-column-by-80-row terminal into the megapel bitmap display. Finally, the human-computer interface evolved from a simple command line into direct manipulation of graphic icons that represented programs and files and that permitted the selection of commands from menus. Although the personal computers of the period lacked computing power, multi-user/multi-tasking operating systems, high-speed network support, and large graphic displays, the fledgling Unix-workstation market offered all this capacities, and more. All the pieces were at hand to create a hypertext system for education.

IRIS created Intermedia as a proof of concept on three different levels: as a general educational tool, as an example of object-oriented programming methodology, and as a model of what the computing environment or operating system should be like. This essay will discuss how Intermedia has been used as an educational tool. After briefly describing the kinds of educational problems the software addressed, we shall survey some of the materials that have been created using Intermedia and compare how specific system features have been used in a variety of educational contexts. Based on this survey and our own experience as Intermedia authors and editors, we will offer some conclusions concerning the effectiveness of the

Intermedia tools themselves. An annotated bibliography lists relevant IRIS technical papers and publications by Intermedia users.

EDUCATIONAL ISSUES

CONNECTIVITY AND VISUALIZATION

A BASIC GOAL OF INTERMEDIA is to help instructors and students express the connectivity of concepts among the materials being studied. A fundamental problem faced by instructors is the limitations of linear presentation of materials in both text book and lecture form. Concepts such as the aesthetics of British neoclassicism, the place of women in Babylonian mythology, or the stages of cell division are multi-faceted and need to be understood in a variety of contexts. Yet the instructor is often forced to reduce the complexity of concepts by presenting them in a linear fashion, as the focus of a single lecture or the topic of a single seminar discussion. The relationships between the topic of a particular lecture or discussion and other topics from previous or later classes are too easily forgotten or overlooked. In a survey course, for example, be the subject literature, religion, or philosophy, it is too easy for the students to move the focus of their study from one author or work to the next without seeing the relationships that exist among these parts in a larger whole.

Another basic goal is to provide support for visualization in learning. Instructors present students with graphic representations using a variety of means in the classroom, from chalkboards to slide projectors. Contemplation of these visual aids is often fundamental to the learning process. But from the student point of view, these visual aids are particularly ephemeral, since the student encounters them chiefly during class and can often take them away only in notes. Image banks, such as photographic slide collections, are difficult to reproduce and distribute outside of class. Furthermore, the source of

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the images presented in a single class may be spread across a dozen books. More importantly, a diagram or image may relate to many concepts, only one of which might be the topic of a particular class.

By providing the ability to create links between selections in documents, Intermedia supports connectivity that could solve these problems. Anything that can be typed in a text document or drawn in a graphics document can link to anything else on the system. Each document appears in its own rectangular window on the screen. Following links from the label of a diagram to a specific sentence in an essay to the caption of an illustration can reinforce the students' sense of how the ideas in each document are related.

STUDENT/FACULTY AND STUDENT/STUDENT COLLABORATION

Intermedia was designed to support collaboration between and among faculty and students, and we also hoped to make it easier for faculty to develop materials with their colleagues. We also sought to make it both easy and inviting for students to add to and modify the materials presented to them by their instructors.

To do this we needed a multi-user system that identified each student and faculty member and assigned various levels of permission to each. We also needed a system that allowed many users to share the same materials at the same time. The workstation computing environment in which Intermedia was therefore built is based on a high-speed ethernet network and shared-file system. The management of *read/write* permissions and the management of the link information was supported by a data-base management system. To allow users to make links among read-only documents (that is, documents they did not have permission to edit), we introduced a separate level of *annotate* permission. These tools allowed groups of faculty authors working on separate machines on a network to connect materials together into a single collection. Students could also add materials to the collection and share their comments and links with their fellow students and the faculty.

EXPLORATORY LEARNING

Much computer-aided instruction (CAI) has resulted in pro-grammed learning modules that require a student to follow a pre-determined set of steps when interacting with the computer. Such software assumes that the student must be led through the material in a fixed sequence and must prove competency before moving on to the next step.

In contrast, Intermedia was designed with the assumption that the computer can go beyond CAI to support student-directed explor-atory learning as well. The multiple methods of navigating through materials supported by the system, the ability to support many links among documents, and the lack of restrictions on a student's path through the materials, are all intentional aspects of the software design.

This design. therefore, is as much a response to the restrictions of the majority of CAI software as it is a reflection of the kind of student-centered instruction common at Brown University. The jour-ney of exploring the materials is intended to be directed primarily by the learner.

DESCRIPTION OF COLLECTIONS

Although Intermedia 3.0 has been used to create a number of collections, our discussion will focus only on the teaching collec-tions, which divide chronologically into *Pre-3.0*, which were created with earliest versions of the Intermedia software, and *3.0*, which evolved from, or were created for, teaching courses after the final software was released. During 1991 and 1992, the novelist Robert Coover taught his fiction workshops (English 20 and 24) on Intermedia, and students have produced several dozen webs, some consisting of novel-length works. Since using Intermedia to write hypertext fiction differs fundamentally from using it to teach critical thinking in other disciplines, we shall not survey work created by Coover's classes here, though we recommend the interested reader consult Coover's essay on hypertext fiction (Coover, 1992).

TEACHING COLLECTIONS: PRE 3.0

Context32 (George Landow, Brown University). Context32, the Intermedia collection used in George Landow's English 32, English Literature from 1700 to the Present, at Brown University, in its first inception contained approximately 300 text documents, 500 graphics, and 40 timelines, all created by Landow and his graduate-student assistants. The text documents fell into three categories: biographical sketches of each author studied in the course, essays on particular aspects of the author (e.g., "Tennyson and Evolutionary Theory"), and brief explanatory essays on various pertinent topics that relate to more than one author (e.g., "The Ode," "Victorianism"). Many of the graphic documents were scanned images of art works, architecture, portraits, and so on. Index diagrams, or overviews, were the other type of graphic document included. These diagrams, which represented a central subject surrounded by pertinent related subjects, were designed to help students explore *Context32.* For instance, each author overview includes links to all the material in the corpus related to that author, thus providing entry points into the materials (Landow, 1991b). Landow used the overviews to emphasize a major point of the course, that any author or literary phenomenon exists surrounded by a number of contributing phenomena, and that there are many equally interesting and valid ways of approaching the subject. You will note in our descriptions of the other Intermedia collections below that every author has recognized the need for using overviews of some sort, and in fact many have made use of Landow's model. The timelines included either focus on the life and works of one particular author, or focus on an historical period or topic.

Landow's scheme for linking the material together, which combined a hierarchical with a non-hierarchical structure, placed a strong emphasis on consistency. Therefore, every author overview linked to a standard set of documents: a biography, essays about individual works, social and cultural background information, pictures, all the pertinent general timelines, and one or more diagrams showing the author's literary relationship to other authors. In turn, the biography always linked to the biographical timeline, and so on. Students thus

could assume that a similar structure existed for each author and therefore they could reach the information they wanted quickly. All the other links in *Context32*, however, were designed to be non-hierarchical; any one document could be reached by numerous paths (see Figure 1).
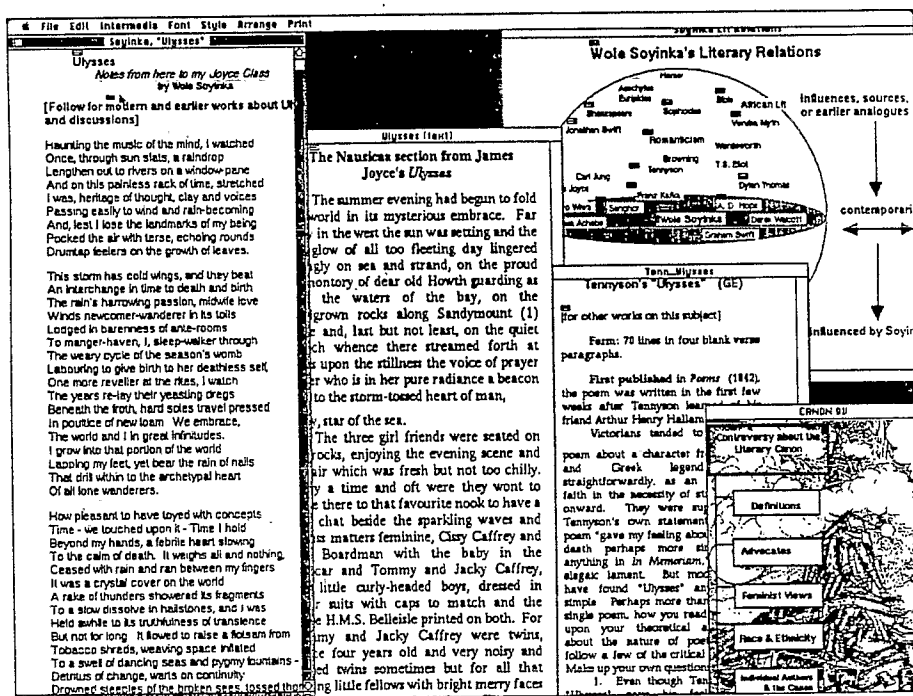
Figure 1: Context 32, Survey of English Literature. This screen image from Intermedia version 3.0 illustrates how Context 32 leads students through relationships between authors, in this case Tennyson, Joyce, and Soyinka who all shared a fascination with the story of Ulysses. The text of a poem by Soyinka is linked to an essay on Joyce's Ulysses and commentary on Tennyson's poem of the same name. The diagram in the upper right illustrates the literary influences that surround Soykina's writing. This and much of the Soyinka materials were re-used in Context 34, Postcolonial English Literature described below.

Context32 has always been treated as an open-ended work in progress. Landow and his students have added new materials each semester the course has been taught; by October of 1990, the collection had grown to 1350 documents and 2600 links.

Biology 106 (Peter Heywood, Brown University). A Plant Cell Biology collection was created by Peter Heywood and his undergraduate students at Brown at the same time Landow was working on *Context32*. Unlike *Context32*, which emphasized supplementary material, the Biology 106 collection focused more on providing online materials also covered in the classroom. This approach helped solve a problem common in science courses: students have to study such a large amount of material that they fail to perceive relationships among the materials covered in different weeks. In week three, the student may be so overwhelmed that she cannot look ahead to see how week three's topics relate to week thirteen's. The linked hypermedia materials, which make these relationships much easier to find and examine, solved this problem. The original materials in the *Biology 106* web contained text documents summarizing key aspects of different lecture topics (in effect, Heywood's lecture notes), reproductions of light-micrographs and electron-micrographs, diagrams, chronological timelines, and animations created with the InterSpect application (which was not available in later versions of Intermedia). The InterSpect application was used to create three-dimensional reconstructions of cells from serial sections of transmission electron-micrographs. Students could manipulate the three-dimensional models, and could also examine each two-dimensional cross-section used to create the three dimensional model. The three-dimensional model could be manipulated in a number of ways including rotation, component isolation and detail hiding, facilitating students' ability to conceptualize cell structures (Yankelovich, 1987), (see Figure 2).

When this web was moved to the Macintosh version of Intermedia, the InterSpect application was lost and the three-dimensional models were not replaced. The web in its current form contains 115 documents and 210 links.
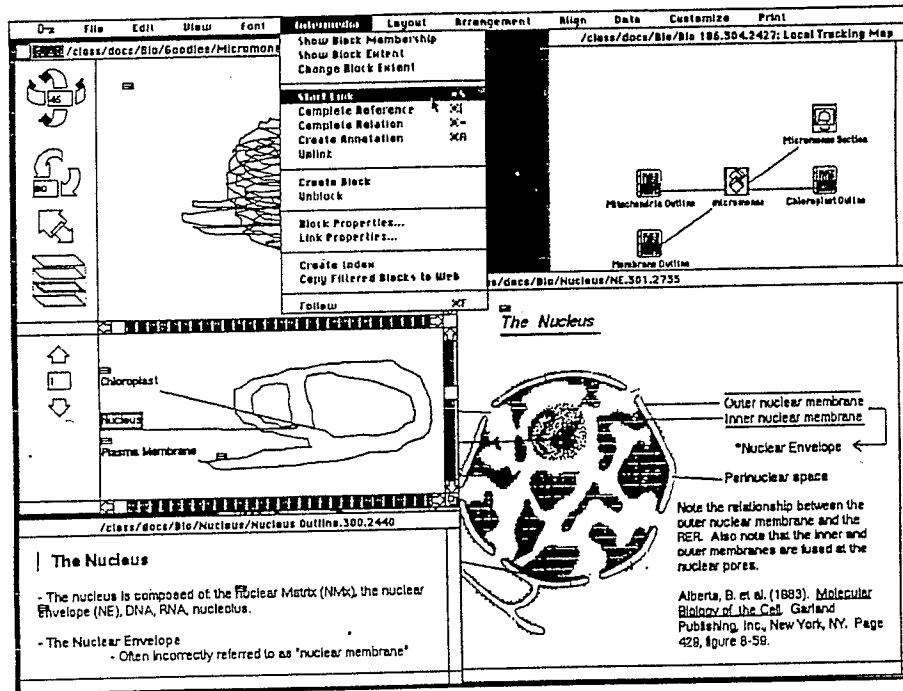
Figure 2: Biology 106, Plant Cell Biology. This screen image from the RT PC-version of Intermedia shows material used to support the cell biology course. The double window in the upper left is the InterSpec application which allowed students to rotate and view wire-frame models of plant cells. This was linked to text (lower left) and diagrams (lower right). The original Local Tracking Map (later called the Web View) is shown in the upper right.

Program for Liberal Medical Education (PLME)

The PLME Seminars, run by Brown's Medical School, are designed to give pre-medical students a small group setting in which to develop problem solving and critical thinking skills using case study and library research materials. In the spring of 1988, as an experiment, two seminars, one run by Professor Lucile Newman of Community Health and Robert Westlake of Psychiatry and Human Behavior, the other by Professor John Roberts of Orthopedics, used

Intermedia to address topics in medical ethics. James M. Nyce assisted with material selection, seminar design and the experiment's evaluation.

In the seminars, three medical ethics cases were studied: Sudden Unexplained Death Syndrome (SUDS) in the Hmong community where conflicts between values of a minority and majority cultures were at issue; the Clare Conroy Case, in which withdrawal of a feeding tube from a patient whom the guardian argued had reached a point where life was "impossibly and permanently burdensome" was discussed; and the Ezra Pound Case in which the reasons for Pound's incarceration in a mental hospital after the Second World War were examined.

Throughout the semester, students used Intermedia as a tool for organizing and presenting materials to their classmates. In the first week of the experiment, students read the text of the case assigned to them, identified the issues raised by the case, decided which issues should be researched, and then pursued the subject, entering material into Intermedia as it became available. In the second week, the students presented their initial findings to their classmates and then based on class discussion, decided which issues needed further work or clarification. In addition, the students prepared a short paper using Intermedia summarizing the case and the issues involved. In the final week of the experiment, students completed their case summaries and discussed the cases in detail.

TEACHING COLLECTIONS: 3.0

The In Memoriam Web. During the second year he used Intermedia (1988-89), Landow added a large body of material on Tennyson for a graduate seminar in Victorian poetry, that in its latest versions included the complete text of Tennyson's *In Memoriam,* a long poem written in 133 sections. This is one of several cases in which Landow placed the full text of the literature studied on Intermedia. Landow, his students, and research assistants entered each stanza as a separate Intermedia document and then linked passages in the stanzas to various overviews and commentaries, thereby cre-

ating indexes of the imagery and themes of the poem. Although originally created as part of *Context32* in its pre-3.0 version, *In Memoriam* was recast as a separate web and has since been used in courses that include the departmental survey, undergraduate and graduate seminars on Victorian literature, and a course on hypertext and literary theory.

The Graham Swift Materials (Barry J. Fishman). In the Spring of 1989 Barry J. Fishman, one of the students in the first class to use Intermedia, created his honors thesis on the contemporary English novelist, Graham Swift. The thesis, which takes the form of a subset of *Context32*, contains reviews of all Swift's writing, a letter from the novelist, and a series of essays on the novelist and the themes and techniques of his works. Working on the original IBM-based version of Intermedia, Fishman entered and linked all materials himself. His work was later transferred to Intermedia 3.0 and has been used by students in both the survey courses and that on postcolonial literature.

Context32: Emblem Literature (George P. Landow & Gary S. Weissman). This subset of *Context32*, which focuses on Renaissance and later emblem literature, was created by Gary S. Weissman (Brown University, class of '90), one of Landow's undergraduate students, as part of an independent summer research project. The collection, 55 documents and 73 links, contains original documents written by Weissman (and edited by Landow), many scanned images of emblems, and some documents written by Landow for *Context32* that Weissman included. The organization resembles that employed in *Context32*, though in this case the central subject is not an author or a period, but a kind of literature. The traditional Landow-created author overview with a central image and radiating spokes of connected ideas has been used for an "Emblem OV." From this main overview users can reach many of the documents in the collection. The user can also choose to go to lower level overviews, for instance one that focuses on Francis Quarles, who was a major figure

in British emblem literature. This overview leads to many of the same documents as the main Emblem overview, but will also take the user to documents on Quarles's life and work. Two other authors who made extensive use of emblems, Emily Dickinson and Ruskin, are also represented well, and in fact, like Quarles, are given a folder each in the top level folder of the collection.

Context34: Postcolonial English Literature (Landow students). To a large degree, students created *Context34*, the web used in English 34, Landow's course in postcolonial English literature. The organization of the materials, the overviews, and some crucial documents were created by the professor; virtually all of the rest of the documents were contributed by graduate and undergraduate students from a number of different courses over several semesters.

The collection began as a small web focusing on Wolé Soyinka. Soyinka, a contemporary Nigerian poet writing in English, is studied near the end of Landow's survey course (see above discussion of *Context32*). As a final Intermedia assignment, Landow provided the students with basic organizational documents (an author overview, a list of works, a chronology, and some graphic documents, including maps of Nigeria), and then asked that each student produce two documents, one a close reading of any poem by Soyinka and the other any aspect of the writer's context, political, historical, religious, and so on. By this point in the semester, Landow's students were already familiar with similar materials that had been created for the dozens of other authors they had been studying. The resulting web developed over the course of three semesters (fall 1989, spring and fall 1990) by three groups of students consisted of 70 documents and 130 links. Landow's direct supervision of the students was limited to copy-editing their essays and rejecting materials that did not meet basic standards (Landow, 1992c, pp. 145-149; 1992a).

In spring 1991, when Landow taught a new course on recent postcolonial literature, which includes the work of thirteen Australian, British, Indian, Nigerian, and Pakistani authors, he expanded the *Soyinka Web* into *Context34*. In about two weeks Landow was

able to create the new web by repurposing existing materials in several ways. Materials on Soyinka and Graham Swift originally created for the general English survey course, which formed the first parts of *Context34*, now appeared in the context of new authors. For Chinua Achebe, another Nigerian writer, he made links to supporting materials about Nigerian culture created by students about Soyinka. He created graphic overviews for each of the thirteen authors read in the course and for related topics, such as Women in India, Pakistan, and Bangladesh and Nigeria, edited student documents where necessary, and linked them to these overviews. Although most of the building of the web involved linking up student-created materials, Landow also created what he refers to as mini-essays, prose documents containing excerpts from the primary texts, brief commentary, and questions. Similar materials for several authors were created by a graduate assistant, Randall H. Bass.

With the exception of the small essays and overviews created by Landow, this new web, like the Soyinka web, is designed primarily to include student work, and he carefully designs assignments to allow students to produce short essays that will contribute to the web (Landow, 1989b). By the end of the first term that students used *Context34,* this web consisted of 569 documents, many one or more single-spaced pages in length, and 1060 links. Landow encourages his students to do their work directly in Intermedia or with other Macintosh software, thus enabling them to hand in both printed and electronic copies of papers. If the student originally created the work in the Intermedia environment, Landow simply copy-edits and then links it when the student has not done so already. If the student submits work on a Macintosh diskette, he or a student assistant imports the paper into Intermedia, copy-edits it, and links it. (A small number of students each semester volunteer to help Landow import materials and link them.) Landow discusses with each of these students an area of the collection that needs work, or a new topic that could be added, and then the students work semi-independently, notifying Landow as work is completed so that he can check it.

The intention is to emphasize both to the students who write the essays and to those who read them later in Intermedia that the works being discussed were not written in a vacuum, nor can they be read in a vacuum (see Figure 3). *Context34* itself emphasizes this point, that literature must be read within a context. In many documents in the web, students will find references to other webs, especially *Context32*, with a suggestion that if they are interested in pursuing
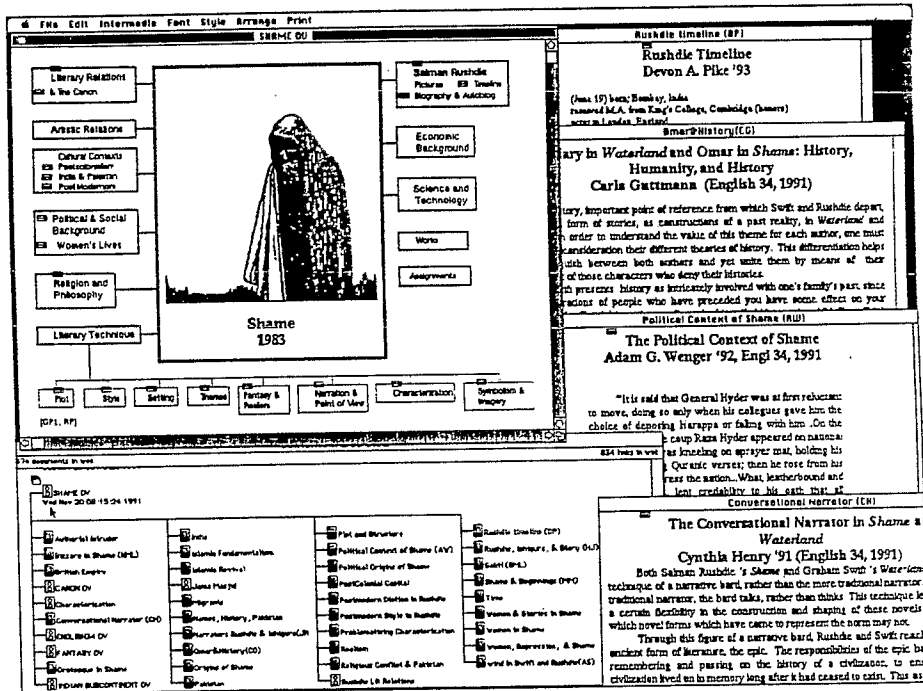

Figure 3: Context 34, Postcolonial English Literature. This screen image from Intermedia version 3.0 shows material about Rushdie's Shame, one of the novels taught in the course. The overview diagram (upper left) outlines the topics available. This is linked to nearly 40 essays and other topic overviews, as shown in the map drawn by the Web View in the lower left. Four student essays linked to various topics in the overview are shown open on the right.

a certain subject, they should close *Context34*, open a different web, and thus take off in an entirely different, but still connected, direction.

Literary Theory (George P. Landow & Students). This web of 391 documents and 902 links, which Landow used to support English 116, *Hypertext and Literary Theory,* during Spring 1992 semester, marks the last use of Intermedia for teaching at Brown University. *Literary Theory* originally took form as the Intermedia version of Landow's *Hypertext: The Convergence of Contemporary Theory and Technology* (1992c), but as students added documents and links from the first week of the course, the web took on a life of its own. Five of the twenty students in the course were Intermedia veterans, and almost all the others were extremely sophisticated computer users. The class immediately adapted to the system and began producing large numbers of documents, which included materials on the theory and practice of hypertext, poststructuralist theory, translations of print documents into hypertext, student-created works of hypertext fiction, and combinations of the preceding. The members of this course, who provided the perfect constituency for Intermedia, nonetheless do not represent its usual educational users at Brown or other institutions.

Wood (Pat Malone & Cooper Abbott). The collection on wood technology was created by Cooper Abbott, a student working with Professor Pat Malone in Brown's American Civilization department, for use in a course entitled Industrial Archaeology. By the end of the course the collection, Abbott's semester project, had grown to 70 documents and 101 links. After working with Malone to determine how to organize and connect the materials, Abbott scanned, input, and linked the necessary documents. At the outset neither Malone nor Abbott were experienced Intermedia users, since they had neither created their own materials on the computer nor used Landow's extensive *Context32* materials. Abbott's organization and use of the Intermedia editors resembles the HyperCard model of cards that a

user looks at by following a one-direction path through the stack of cards. Many of the documents, for example, are formatted to be a uniform size. More importantly, rather than designing links to take advantage of Intermedia's bi-directional linking, Abbott has in many cases set paths through the collection with specific arrival and departure links. When a user follows a link to a document, she arrives at an anchor near the top of the document. Near the bottom of the document (where presumably the user's eyes will be once all the text has been read) is another anchor, and following this link will take the user to the next document in the path. For example, a small overview called "The Very Beginning" contains text labels such as "Brief History of Wood and Its Usage" and "Biological Aspects of Wood." The user, clicking on the link marker in front of the words "Brief History of Wood and Its Usage," will arrive at a graphic document showing Egyptians sawing wood, with text below the image explaining it. Next to the text is another link marker, which when followed takes the user to the next historical instance of wood use, and so on along the path until the user returns again to "The Very Beginning," arriving at an anchor placed at the *end* of the text label "Brief History of Wood and Its Usage." In this fashion Abbot creates a circular one-direction path. Abbott has created large overview documents as well as the "card-like" documents; the overviews such as "The Very Beginning," serve as indices leading users to the various paths that will describe the sub-topics covered by each index's main topic (e.g. gunstocks, patents, sculpture, etc.).

The collection has some minor problems. For instance, although the overviews are graphically pleasing, their size and graphic complexity hinder the system's performance by taking up large quantities of memory. By not making use of Intermedia's bi-directional linking, Abbott has potentially caused disorientation problems for the user who chooses to veer from his paths. It is possible, however, that due to the popularity and availability of HyperCard, Abbott's Intermedia collection may be more immediately accessible and understandable to a novice Intermedia user.

This collection, after a portion of a semester of work, is not complete. There has been no time spent yet on organizing documents within the folder hierarchy, and in fact many documents in the collection are work-in-progress documents that have been abandoned but not yet deleted. An additional component of the collection planned, but not completed, is a number of links between the discussions of wood use to descriptions of wood cells in Peter Heywood's Biology 106 materials. The availability of these Biology materials led Malone and Abbott to focus on this particular subject.

Flatland (Tom Banchoff & David John Burrowes). Another collection created at Brown University is *Flatland,* used in Professor Tom Banchoff's Math 08, *Mathematics as a Creative Process: The 4th Dimension.* The Victorian novel *Flatland* provided the subject of the course for about three weeks early in the semester. The students using the collection encountered the text of the novel on Intermedia and then were encouraged to add their own documents and make connections, in effect annotating the novel. Assignments included identifying scientific or literary figures who may have had some connection to *Flatland* or impact on it, and conducting research on any aspect of the study of higher-dimensional mathematics in Victorian England. Much of the resulting student work was then added to the Intermedia materials. Banchoff also encouraged students to write their papers in Intermedia (both papers about *Flatland* and other papers due later in the semester, including a final project).

The collection is organized around the text of the novel itself. Sections of approximately 3 chapters each (about 10 pages) have been made. Each section links to a "Table of Contents" document, and an anchor at the bottom of each section connects to the top of the next section. In most cases the anchors at the bottom of each section are attached to text that reads "Go to Section X," but this convention has not been followed rigorously. There are few links from within the body of the text to other portions of text. Links exist from the text of the novel to commentary and explanation of specific parts of the novel, such as graphical representations of some of the

mathematical principles; otherwise the the collection remains incomplete.

Nuclear Arms Control and Disarmament (Richard Smoke, Nicole Yankelovich, Martha Nicolson, and Shoshana M. Landow). This heavily linked web (79 documents and 361 links) represents an anomaly in the Intermedia collections since it was originally developed for another kind of hypertext environment and then recreated on Intermedia. In 1984 Professor Richard Smoke of the Center for Foreign Policy Development created a body of materials for his course in Political Science that used an experimental computer component based on the Brown University Computer Science Department's BALSA authoring system. Nicole Yankelovich, later Project Coordinator at IRIS, used Smoke's materials to create a quasi-hypertextual component for his course, and in 1987, realizing the materials would make a fine Intermedia web, she and Martha Nicolson transferred them to the early IBM-based version of Intermedia; Shoshana M. Landow, a Princeton undergraduate working as an IRIS research assistant, transferred and re-linked the collection to Intermedia 3.0 in 1988. Although Smoke, who originally designed the materials seems never to have used them in their Intermedia version, students in English 32 and 34 have used this web to investigate the context of several assigned works, primarily Graham Swift's 1983 novel, *Waterland* (Landow, 1990a). The Nuclear web employs a timeline for the years 1938 to 1984 as an overview to organize four categories of information: issues, treaties, weapons systems, and contemporary history.

The Renaissance Cultural History Web (Shoshana M. Landow). This collection, which consists of 245 documents and 349 links, was developed as a component for a planned course in Renaissance cultural history that was never taught. In the summer of 1989, Ronald Weissman, then director of humanities computing and a member of the History Department, hired Landow as a summer research assistant to design and implement the web, drawing upon published works.

The resulting collection, which centers on Renaissance Florence, makes heavy use of images of architecture. After Weissman's departure for a position at NeXt Computing, the planned course was not taught, and the materials have been only used occasionally by students in English

Les Français (Allan Grundstrom). Professor Allan Grundstrom in the French Department at Bucknell University began to use Intermedia in the fall of 1990 in teaching a French language course. Unfortunately, technical difficulties severely limited his use of the system, though he did manage to create a large collection of materials, *Les Français,* which he expects to use at a later date. Although he and his students have three machines available, they are not networked together. The students are not yet actually doing their work in Intermedia.

During the 1990-91 academic year, Grundstrom added hypermedia *concepts* to his course in preparation for using the software at a later time. For example, rather than have his students write lengthy papers, he set assignments that emphasize the conceptual interconnectedness of smaller pieces of researched material. His students are required to write one or two page pieces of research with the expressed intention of having these small pieces later imported into Intermedia and linked together. Thus, he expects to create a body of materials that will make sense when looked at together, each piece providing necessary context for the other pieces. He hopes that these materials will be available in Intermedia to future groups of students. The only student contact with Intermedia in the fall of 1990 was reading texts, portions of a yet unpublished textbook written by Grundstrom. Due to frequent technical difficulties, these texts were subsequently made available to students in hard copy.

Social Thought (Robert Alun Jones). Professor Robert Alun Jones, in the Sociology Department at the University of Illinois in Urbana-Champaign, has used Intermedia in a course on the history of social thought for three semesters: Fall 1989, Spring 1990, and

Fall 1990. He describes the materials as "very similar to those brought together by George Landow and his graduate students, for example, biographies, contexts, commentaries, pictures, diagrams, etc." [correspondence from Jones, May 1990]. The materials were created by Jones and several graduate teaching assistants, and the teaching assistants provided support for the students using the Intermedia system. Our comments are based on an examination of a copy of the course materials made at the beginning of the Fall 1990 semester along with a sample of webs created by students in two courses during that semester.

Jones's web, entitled *Social Thought,* is large, containing 287 documents and 356 links. It is very heavily oriented towards source materials, containing all the texts in *Western Social Thought,* with a 400-page anthology of readings arranged chronologically from Plato to Alasdair MacIntyre that Jones prepared for the course. The students have a printed copy of this text as well as access to the Intermedia version in a laboratory classroom.

The top level folder contains the web and four folders, "Commentary," "Contexts," "Introductory," and "Thinkers." In the "Introductory" folder the user finds a graphics document called "Begin Here," which is the title page of the collection, and which leads to two basic explanatory documents ("About Hypermedia," which explains the concept of hypermedia, and "About Social Thought," which explains the course), and to the main overview for the collection, "Social Thought OV." The "Social Thought OV" is the central document in the collection, and from there the user can follow links that lead to most of the materials contained in the collection. This overview, unlike Landow's graphical concept diagrams, is an online, linked copy of the course syllabus, leading to further information and to the text of each of the authors studied in the course.

Thus the segment for Week 11 of the course lists two authors, Weber and Simmel, and representative works by each. The link markers above the author names each lead the user to lower-level author overviews, which are sometimes called "author OV" and sometimes "author outline." From these overviews the user can then

follow links to author biographies, pictures, social and historical contexts, lists of major works, bibliographies, and so on. The link markers above the representative works of each author lead to the full text of the work by that author that is read for the course. For instance, the link to Weber's *The Protestant Ethic and the Spirit of Capitalism* brings up a 14-page extract from the book. These extracts or chapters are not extensively linked, either to supporting material or to the works of other authors. In most cases each is linked only to the "Social Thought OV" and to the appropriate author overview.

In some cases (for instance, Augustine's *City of God)* an author's work is also provided with an overview, presumably because there is a significant amount of background material about that particular work in the collection.

The "Contexts" folder contains 16 folders with names such as "American," "Ancient Greece," "Victorian Eng.," etc., providing historical context for the authors and works studied. These folders contain maps, illustrations, timelines, and brief text documents. The timelines were not created using InterVal, Intermedia's timeline editor. Both Jones and Ess (see below) found InterVal's inability to deal with B.C. dates problematic enough to abandon its use in favor of timelines created with either InterWord or InterDraw. Many of these contextual documents remain unlinked and in varying states of completion. In fact a folder called "General" seems to have been created for the purpose of storing context documents that as yet do not have a more obvious home.

The folder called "Thinkers" contains 42 folders, most of which bear an author's name. The few exceptions have names like "Marxism," "Pre-Socratics," and "Greek Hist," and contain documents about groups of related authors. These folders hold the author overviews and also the biographies, pictures, and other materials that are reached by following links from the author overviews.

The "Commentary" folder contains 29 text documents, most about particular thinkers ("Kant," "Kierkegaard," etc.) or groups ("Cambridge Platonists," etc.). These documents are not stored in the in-

dividual folders for each of these authors or groups in the "Thinkers" folder because each document represents critical remarks on several thinkers (see Figure 4).

In general, the *Social Thought* materials represent a very large structure that was only partially completed. The scope of the primary materials was defined by the curriculum of the course, and although all the primary materials were added to the system, only
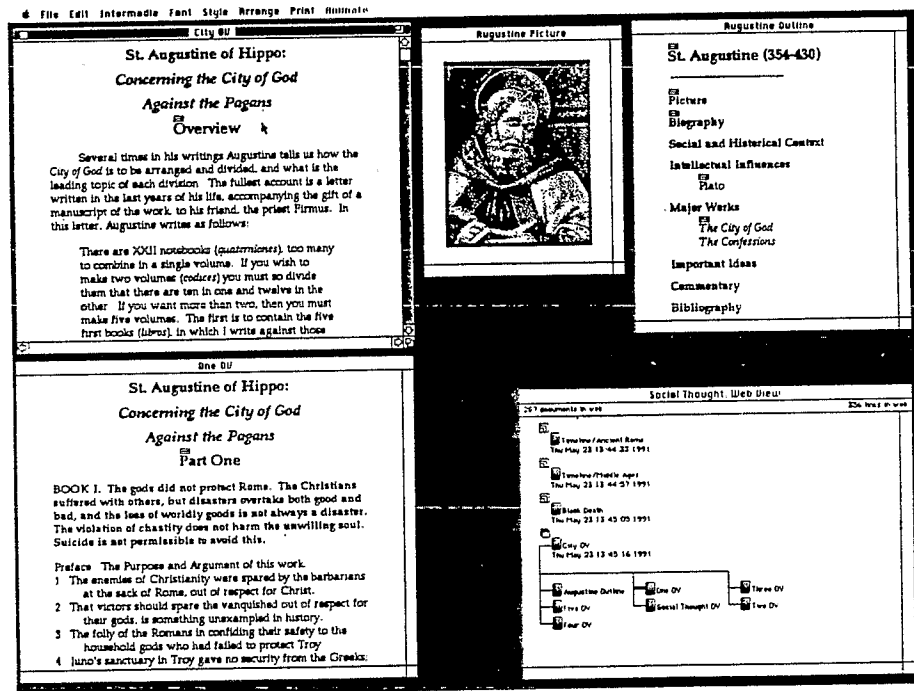

Figure 4: Social Thought. This screen image from Intermedia version 3.0 shows how the software was used to structure philosophy texts at the University of Illinois. The Outline document on St. Augustine (upper right) is linked to a picture, biography, outlines for related authors, and works by that author. Here the work being studied, The City of Hope, is summarized (upper left) and this summary is linked to major portions of the text itself.

parts of the secondary materials were created and only some of the primary materials were reorganized for use in Intermedia.

Student Work: During the Spring 1990 semester, students were encouraged to browse through the materials and to add new materials, either by scanning printed documents or by writing original work on the system and adding links to existing materials. During the Fall 1990 semester, the students were given the assignment to create a web of their own in lieu of a term paper. Their work on this assignment represented about 25% of their grade. They were free to create links among the materials already in Intermedia or between these and any materials they chose to add to the collection. These students were encouraged to think about the relationships among the various materials discussed in class and represent these relationships in the form of links in Intermedia.

This assignment took advantage of several features of Intermedia. The fine-grained linking allowed students to link specific passages in the various primary texts. The separation of link and document data allowed them to examine and link the primary texts without the distraction of the professor's or other students' links. The multi-user features allowed all the students to work on the same collection of text simultaneously and students could link to materials added by other students if it was relevant to their own work.

The results were quite mixed in style, thoroughness, and technique. Some students made use of fine-grained linking and anchor explainers between primary texts whereas others linked entire documents to simple text outlines. Several students focused on a small grouping of two or three thinkers and created webs to express their connections to earlier writers. Although most students recognized the value of some kind of central overview or organizational document, others created a web in their personal folder containing links in the primary texts alone. In such cases the only way to examine the links in the web was to browse through the folder system and happen upon a primary document in which a link had been made. Several students added materials by authors covered in the course by locating their works in the library, scanning portions of them, and then

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integrating them with existing materials by linking them to an outline or prose summary.

To evaluate this student work, Jones and his assistants followed the links and judged the thoughtfulness involved in identifying relationships among the thinkers, with some credit given for students who added new or original work. About 30% of the students improved their course grade through their work on this assignment and about 10% performed poorly.

In general the students in all three semesters felt that the system had a great deal of potential but that more work was needed to better integrate the Intermedia experience with the traditional course materials and work. Jones expressed the feeling that this integration would be the natural outcome of working with the system in the course over a number of years. However, largely due to software support issues that arose when Apple modified A/UX. Jones ended the use of Intermedia for *An Introduction to Western Social Thought* after these three semesters.

Religious History and Pre-Socratic Philosophy (Charles Ess). Two collections, one on Religious History and one on Pre-Socratic Philosophy, have been created by Professor Charles Ess of Drury College for use in his Honors course, *Religion, Philosophy, and the Emergence of the Natural Sciences.* The Pre-Socratic web has also been used for a course entitled *History of Ancient and Medieval Philosophy.*

The copy of the *Religious History Web* we examined is an early version and the smallest of the collections discussed, containing 15 documents and 14 links. The smallness of the web does not imply narrowness however. The documents in the collection are hypertextual by design. In other words, there is an emphasis on conceptual connections. Ess very purposefully creates and organizes documents in such a way that a student will quickly learn how to approach the collection. The main overview for the collection entitled "START," which appears in the top-level folder, provides a graphic overview

of the subject matter and indicates how various subtopics connect via vertically and horizontally arranged text labels.

From here, the user can reach most of the other documents in the collection, though the collection is not yet fully linked. Only one of the documents in our version of the collection was contributed by a student, though in Ess's installation student contributions are a more visible part of the collection. Virtually all of the text documents contain commentary of some sort with questions. The few scanned bitmap images contain no text and are not extensively linked. In intention and design, therefore, this collection is very similar to *Context32*, meant mostly as a study guide for students, both in their preparation for class discussion and in reading and preparing for papers and exams.

Ess's other collection, *Pre-Socratic Philosophy*, is larger and more complete than *Religious History*. The collection we have seen is not entirely finished, but even at this point provides a sense of the breadth of the topic. The 34 documents and 47 links in the documents we examined are not yet organized systematically into folders, but the main overview, INTRO-OV, provides access to much of the collection. This overview contains directions on how to find materials not contained within the web, links to sample student assignments and student work, and, most important, links to second-level overviews that serve to organize and lead to all of the sub-topics of the collection. These second level overviews are very different from any other Intermedia overviews we have seen. Ess uses a combination of a textual-outline format with various indents, lines, and arrows to express the relationships among the text labels in his overviews.

Student contributions are integral to Ess's use of Intermedia. In both collections, students collaborate in a number of ways. As a group, they add comment documents, which are responses to specific questions, or group reviews of a particular philosopher, which are read by all class members. Students have the option of doing their writing assignments in Intermedia and may put their major research projects in Intermedia as well. Last, students have the option of keeping a personal journal in their personal folders in Intermedia. The journals

are not public access, unless the students choose to make them available to classmates. Any materials created in the public space for the course are considered public documents.

Besides these two major collections, Ess has also created what he calls a "child web" containing medieval materials (see Figure 5). This web can be viewed independently of the other webs. It contains a "START" overview, and an "Instructions" document. Using these two documents, students can examine the textual and graphic materials in the collection, and they can follow either a suggested
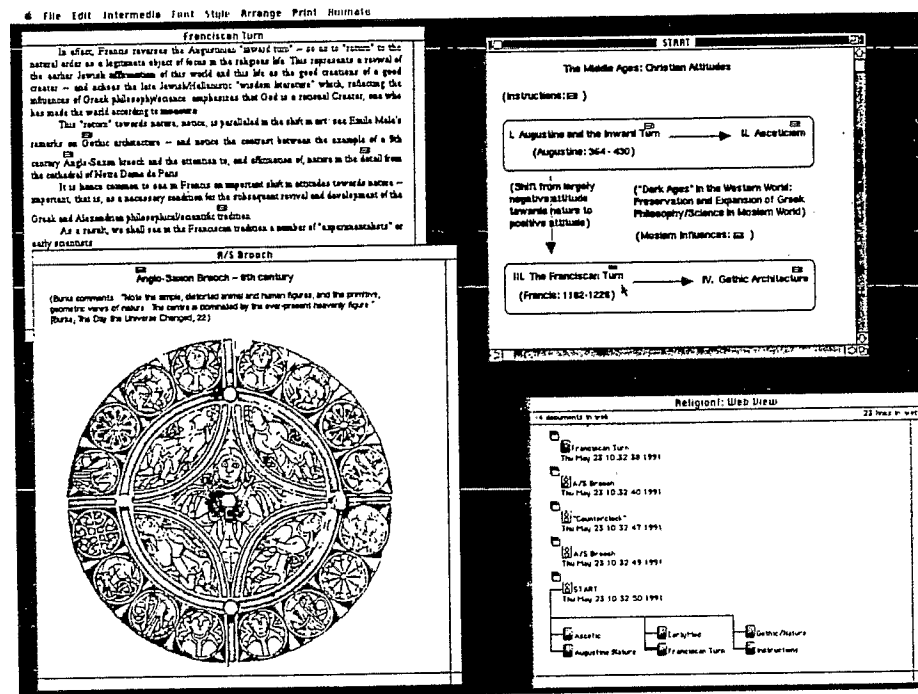
Figure 5: Religious History. This screen image from Intermedia version 3.0 shows how the software was used to support the teaching of religion at Drury College. The starting document (upper right) is a diagram illustrating opposing Christian attitudes in the Middle Ages. This is linked to essays (upper left) which in turn are linked to illustrations and commentary (lower left).

sequence through the materials, taking note of a progression of ideas, or they can simply examine those materials that initially seem most compelling. The documents in this collection, which are well inter-connected, contain references to materials in the other two collections described above, including instructions on how to locate and access the other webs.

Student Work: In addition, Ess has provided us with copies of two student-created webs, one focusing on "Time" and the other on "Women in Science." These collections, like those created by Jones's students, were created as final projects for the course. Ess has commented, "This set of materials I find especially noteworthy as a comment on what is otherwise, to my knowledge, an "undocumented" feature of using Intermedia. That is, it reflects the way in which Intermedia evoked an astonishing level of research activity, as students seemed to delight in the ease with which they could compile and present the results of their research using the program." [correspondence from Ess, January, 1991] These webs, unlike those created by Jones's students, are comprised entirely of materials either written by the students, or scanned and imported by them, and then linked.

Chinese Literature (Paul Kahn). The Chinese Literature collection began as a research collection about Chinese poetry in English translation compiled by Paul Kahn and has since been used in a course in comparative literature at Brown University. The purpose of the collection was to model how an information collection that scholars would normally assemble could be implemented instead as an Intermedia web, using materials taken from published sources, both serials and monographs, rather than from documents specifically written for hypermedia presentation. Although the design was intended to be quite general, the content is limited to selections of work by three Tang dynasty poets: Tu Fu, Li Po, and Han Shan.

The Chinese Literature Web contains a very high ratio of links (1400) to documents (170). The collection is organized by folders, each containing the work of a translator, a major anthology, or a

reference work. Documents in each folder generally represent selections from a single serial or monograph, though anthologies and reference books are divided into one document for each section, with each section linked to a TOC (Table of Contents) document. An overview folder contains graphic overview documents for the three poets. These link to each document that contains translations of or discussions about that poet in the collection. An alternate overview diagram for one of the poets, a diagram for the Chinese texts included in the collection, a graphical index to a popular poem, and an overview of the work by one of the translators is also included. An organizational focus of the collection is an index of English translations of the works of these three poets, adapted from 25 *T'ang Poets: An Index to English Translations* by Fung and Lai. The index document contains the first line and bibliographic reference for each translation in the collection, organized by poem translated. The largest of these documents contains several hundred links that connect the index to all the translations, notes, and Chinese text of each poem in the collection.

The collection also contains the full text of two published essays by Kahn on Chinese poetry in translation, written before the hypermedia collection was created. The online versions of these essays are linked to all the cited or quoted sources.

During spring 1991, this collection was used to support a team-taught comparative literature course, *Exile and the Condition of Writing,* which covers the poetry of Tu Fu along with poetry in Classical Latin (Ovid) and European writers of the nineteenth and twentieth centuries. To adapt the collection for use in this course, some unpublished translations and commentaries by David Lattimore, one of the professors teaching the course, was added to the collection. To simplify browsing for the students, additional overviews were created for four of the poems discussed in the lectures. The collection was used by some of the students as a supplement to their lecture and section discussions.

CONCLUSIONS

WE HAVE ORGANIZED our conclusions in three parts. First, we offer some general remarks on how Intermedia authors have used the tools provided by the software. Second, we summarize the estimations of effectiveness of the software we have received from the authors themselves. Third, we offer our own estimation of the impact Intermedia has had on those who have chosen to use it

HOW INTERMEDIA HAS BEEN USED

Intermedia has been used educationally for two purposes. First, it has been used to present information, selected and prepared by a teacher, to students. Second, it has been used to engage students in a process of collaborative learning, in which one or more students create new information in collaboration with their peers and their instructor.

The actual use by individual instructors has generally combined both methods to some degree. Even a collection such as Heywood's Biology 106, which remained largely static over three years of teaching use, has had student contributions added to the original collection prepared by the professor and his assistants. The amount of student contribution has differed largely as the result of the structure and expectations provided by the supervising faculty member. Landow was able to direct students to generate the bulk of the materials for several projects, based on the examples he established in *Context32*. Both Jones and Ess have provided specific means for student collaboration within Intermedia and both have resulted in a kind of student contribution to and engagement with the material being studied that would not be possible in simple written assignments. The relative lack of success in this area enjoyed by Malone, Banchoff, and Grundstrom appears largely due to factors of technical support and timing. When adequate technical and pedagogical support has been provided, useful student contributions have resulted.

The basic features of the software itself have proven to be easy to master for faculty and students alike. The use and application of what might be termed advanced features have varied from site to site, however. By *advanced* we mean some of the features that the present authors took into consideration when creating Intermedia publications such as *Exploring the Moon* and *The Dickens Web:* use of folder hierarchy and planning multiple destinations, anchor explainers, and document position.

Most of the Intermedia authors used the folder hierarchy to categorize their materials. The reader of *Biology 106, Social Thought,* or *Emblem* finds a folder by that name containing a web and a group of subfolders, each with a name indicating a topic or category of information. Once the web is open, opening a document from the folder will generally show the reader a document on the topic named by the parent folder linked to one or more other documents in the web. In an unfinished collection such as *Social Thought,* the reader may find many unlinked but clearly categorized documents in this manner. Two of the collections students created, *Wood,* and *Flatland,* did not make use of this feature. These were organized only by links, with this organization not reflected in the folder names and hierarchy. *Wood* is organized with a series of overview documents linked to a series of documents and to each other, but the location of these overviews and related documents is not reflected in the folder structure. The links in *Flatland* are built around the text of the novel, which divides into a series of linked documents that are in turn linked to all the supporting overviews, essays, and illustrations scattered in various folders. In both of these cases, the authors seem to have put all their attention into the way documents were linked in the web and little or no attention into where documents were located in the folder hierarchy. Such an approach suggests that the authors expect their readers to proceed chiefly by following links rather than searching folders.

Few authors made use of anchor explainers, and those who did made inconsistent use of them. Intermedia makes it easy to create links without seeing or naming anchors, and anchor explainers are

useful only when multiple destinations are to be presented. The heavy use of links with multiple destinations seems to be limited to the non-teaching collections and portions of Landow's *Context32, Context34, In Memoriam Web,* and *Literary Theory Web.* It is possible that the cognitive overhead required to plan and execute anchor explainers is too high for the benefits supported by the current software.

None of the teaching collections make consistent use of document position. Instead, documents seem to have been saved in whatever position they were in when created or edited. Student contributions often have editing palettes still showing. The concept of saving a document's content and formatting is familiar to most computer users. However, the additional concept that the document's frame, the state of its editing palettes, and its screen position can all be saved as part of the document is not familiar and not easily learned.

ESTIMATIONS OF EFFECTIVENESS

The 1987 study by Beeman et al. (1989) is the only formal evaluation that has been done of the use of Intermedia integrated into a course. This study of the pre-3.0 version of Intermedia originally used by Landow and Heywood discussed the effectiveness of the Intermedia software in supporting what the authors termed "non-lineal thinking" among students. Randy Knuth of Indiana University's School of Education has collected data for a new study of students in Landow's Fall 1990 section of English 32. The results of this study will likely be the subject of a doctoral thesis by Knuth sometime in the near future.

General faculty satisfaction with the software is evident from the fact that both of the original faculty participants, Landow and Heywood, continued to use the software for several years. In recent years, when other software with hypertext features such as Guide, HyperCard, and similar programs have been generally available, additional faculty users have been attracted to Intermedia by the software's collaborative potential. Faculty using Intermedia have been enthusiastic about the different type of student participation the system

seems to encourage. Because the students become accustomed to making connections by following links in Intermedia, they go on to make their own connections, both within Intermedia by creating their own links and webs and in more traditional modes of study such as library research and classroom discussions.

Ess has expressed similar conclusions to those expressed earlier by Landow and Heywood on these student benefits from using Intermedia. For instance, he remarks on the fact students "arrived in class already familiar with several basic issues and arguments, and with some of the views of their classmates . . . . Markedly less lecture time was required for clarifying material and conceptual relationships, and more class time was spent on discussion and clarification of views, including the arguments or reasons for holding particular viewpoints." Likewise, he writes "Unprompted comments from one student confirm Intermedia's demonstrated effect of reinforcing and expanding students' understanding of the importance of traditional cross-references . . . . Following hypermedia links seems to bring home to students in a powerful way the importance of following such connections in traditional print media as well." (Ess, 1990b)

However, to this we might add the comment from Jones's students that how well the use of Intermedia lives up to its potential depends on how well the hypermedia materials are integrated into the student's course work as a whole. In cases where there was little or no faculty-directed interaction, Intermedia itself produced little engagement on the part of the students.

THE IMPACT OF INTERMEDIA

Intermedia in its many incarnations; as a research prototype, a hypermedia framework, a software product, and a vehicle for presenting educational materials; has had an enormous impact on the field of hypermedia research in particular and educational software in general. As much as any hypertext/hypermedia system, Intermedia has defined what is possible to researcher and practitioner alike. The ambitiousness of the original design, with support for features such as multitasking, linking between different applications, bi-directional

anchor to anchor links, and support for multiple users, has set high expectations for what hypermedia can be.

Intermedia was intended as a research prototype. The delivery platform was chosen because it provided support for the features we wanted to offer. Beginning in 1985, we assumed a multi-user environment, a multi-tasking operating system, and high-speed connections between machines supporting a general network file system. Despite rapid growth in computing over the past five years most of the computers in use on college campuses still do not support these features.

We also assumed that the authors of educational materials would want to concentrate entirely on content and not want to be concerned with programming in any sense. This assumption led to the creation of a set of authoring tools that are easy to use for authors already familiar with a text editor, a graphics editor, and the copy-and-paste features of the Macintosh or Microsoft Windows operating environments. No other system has made student and faculty interaction so simple a task. However, the lack of a programmer's interface has precluded the kind of extensibility found in systems built with HyperCard or similar "software erector sets" that include their own programming language.

The ambitiousness of the system has been its most significant limitation. Since 1985, the impact of Intermedia on education has been self-limited by the kind of computing environment needed to support the software itself. We have made hard choices in order to create a system that demonstrated what could be done on tomorrow's systems while running on today's equipment.

The news has been both good and bad. The good news has been that this ambitious design has been accomplished without special hardware or operating system software. Pre-3.0 Intermedia required a version of the Unix operating system for the IBM RT PC that was not generally available. It had also been built on a layer of software and a database management system that presented formidable licensing constraints for distribution outside of Brown University. All of

these constraints had been overcome in Intermedia 3.0, and as a result over 200 licensed copies were distributed in 1989 and 1990.

However, the bad news has been that, despite its general availability since 1988, Apple's Unix has never been the operating system of choice for most Macintosh users. The cost of a Macintosh operating system is included in the price of the computer. A/UX must be purchased separately and has always required significantly more RAM (at a time when memory was very expensive) and more hard disk than the Macintosh operating system. In 1989-90, running A/UX added between $2,000-4,000 to the cost of a Macintosh II workstation. In addition, the kind of high-speed transparent network file access that makes the collaborative features of Intermedia possible require ethernet hardware. Up through the summer of 1990 Intermedia had been one of the few applications that runs under A/UX, and one of only a handful that made use of the Macintosh Toolbox to present a graphical user interface. In the summer of 1990, Apple Computer made changes to A/UX version 2.0 that made it incompatible with Intermedia. By that time, support for further development of Intermedia had ended. To run Intermedia, users have had to maintain or locate a version of A/UX that Apple no longer supports.

Despite this lack of incentives, the present survey demonstrates the kind of accomplishments that have been achieved by Intermedia users. Most importantly, Intermedia has affected the expectations of both faculty and students at a wide range of institutions in the United States and Europe. One of the most gratifying signs of this has been the general acceptance of Intermedia as part of the *standard computing environment* by undergraduate users at Brown. An anecdote shared by Landow best illustrates this point. One of his students took a year at another university after completing the English course supported by *Context32*. On his first meeting with the English professor at his new school the student asked where he would find the Intermedia-type workstation for the new course. He had to explain to the professor what he was talking about and the answer was that nothing like that existed yet. This student, however, knows what he

is looking for. We expect that within a few years he and others like him will find it.

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ABOUT THE AUTHORS

Julie Launhardt was assistant project manager at the Institute for Research in Information and Scholarship from 1989-1991. During that time she co-edited, with Paul Kahn, two Intermedia publications: *Exploring the Moon* and *The Dickens Web.* She also co-authored a paper on hypermedia templates that was presented at the Hypertext '91 conference. Currently, she is employed by the Boeing Commercial Airplane Group in Everett, Washington.

Paul Kahn, director of Brown University's Institute for Research in Information and Scholarship, has worked with a variety of text processing systems and full-text databases, including the development of Intermedia. His writings on information and computer technology have appeared in leading journals on the subject. Mr. Kahn's most recent book is *From Memex to Hypertext: Vannevar Bush and Mind's Machine,* published by Academic Press in 1991. Author's present address: IRIS, Box 1946, Brown University, Providence, RI 02912.