

Design of Hypermedia Publications: Issues and Solutions

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This paper originally appeared in the *Proceedings of the International Conference on Electronic Publishing, Document Manipulation, and Typography (EP90)* edited by Richard Furuta, Cambridge University Press, 1990, pp. 107-124.

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Overview

For a hypermedia collection to function properly, an author must successfully combine the verbal language of the document content with an equally persuasive visual language of hypermedia design. This visual language should help define a sense of hierarchy in the presentation of information, create a sense of order, structure and clarity, and allow the user to focus on what is alike and what is different. This paper discusses some of the issues that face the designer of hypermedia documents being considered by a joint research team of software engineers, software designers, content specialists and graphic designers. We discuss specific implementation issues that informed the creation of *Exploring the Moon* and *The Dickens Web*, the first two hypermedia publications created with IRIS Intermedia version 3.0. In analyzing these two works as well as ideas for future hypermedia publications, we have identified a new set of issues which we list at the end of the paper.

Hypermedia Document Design Issues

Hypermedia is the term used to describe software systems which support navigational linking between documents of several types (i.e. text, graphics, animation, etc.). Intermedia, the research hypermedia system developed at Brown University's Institute for Research in Information and Scholarship (IRIS), supports the editing, display, and linking of text, structured graphics, bitmap graphics, animations, and video documents in a single integrated system [Yankelovich 1988]. This software offers the designer a number of features with which to work. Some, like the shape and position of the link marker, are relatively inflexible artifacts of the system design. Others, like the formatting of text and graphics within a document frame, are more open-ended features that must be shaped to serve a particular purpose.

Presentation on the Screen

The hypermedia system presents information solely on the computer screen. This is an important difference between hypermedia and most software designed to edit and format text and graphic data. Word processing, page layout, or two-dimensional graphics software use the computer screen as an intermediate step. The "soft copy" presented on the computer screen is a convenient and malleable surrogate for the final "hard copy" to be delivered on paper or film. As a result, how information is presented on the screen is not as important as how it will appear on the printed page. This is not true in the case of hypermedia documents. For hypermedia, the luminescent surface of the computer screen is the page.

The Perception of Order

In *Entropy and Art: An Essay on Disorder and Order*, Rudolf Arnheim points out the importance of order and hierarchy to human perception.

Order is a necessary condition for anything the human mind is to understand. Arrangement such as the layout of a city or building, a set of tools, a display of merchandise, the verbal expression of facts or ideas, or a painting or a piece of music are called orderly when an observer or listener can grasp their overall structure and ramification of the structure in some detail. Order makes it possible to focus on what is alike and what is different, what belongs together and what is segregated. When nothing superfluous is included and nothing

indispensable is left out, one can understand the interrelation of the whole to its parts, as well as the hierarchic scale of importance and power by which some structural features are dominant, others subordinate. [Arnheim 1971]

Hypermedia offers a new challenge to our sense of order and hierarchy. On the highest level, our design efforts must address this challenge. The use we made of typography, negative space, consistency in formatting, and other design strategies described below are subordinate to this larger principal. Hypermedia design must establish a sense of order on the surface of the computer screen.

Experiences with Real Systems and Real Materials

A great deal of thought and effort has gone into the design of the Intermedia user interface. Starting with the visual language of the Macintosh Toolbox, IRIS researchers have developed a group of editors and a set of general system functions. We have followed principles of visual consistency and simplicity throughout the development cycle. The result is a system which is innovative and powerful yet simple to learn and to use.

Intermedia has been used to support courses in an experimental classroom at Brown from January 1986 up to the present. During the first three years, materials were created with a series of development versions of the software. There was no opportunity to employ consistent rules of graphic design in a rigorous fashion to the materials as they were being developed. The software features, the hardware platform, and even the monitor size changed drastically during this period. In April 1989, a version of Intermedia, called IRIS Intermedia version 3.0, was released as a generally available software product. As part of the software release, we created our first hypermedia publication, a collection of linked documents that would stand as an example of educational materials for others to emulate and learn from.

This first collection, titled *Exploring the Moon*, is a set of materials on the Apollo lunar missions that had been developed by Katie Livingston, Jane Aubele, and Professor James Head for use in a Brown University course on Planetary Geology [Livingston 1989]. This material was chosen for publication for several reasons. Most of the material already existed in electronic form, having been prepared for a HyperCard stack. After adding and rescanning some materials, the collection was still relatively small (a little over 100 individual documents, about 1.2 megabytes of data) but at the same time provided deep coverage of its subject domain. It contained a rich mixture of text and graphic materials. Copyright of the graphic materials was not a problem, since the entire collection was either extracted from or based upon NASA and other U.S. Government publications.

In the fall of the same year, we began the more ambitious project of creating the second Intermedia publication by extracting materials about Charles Dickens from *Context32*, the Intermedia materials used to support Professor George Landow's survey course on British Literature [Landow 1989]. The larger collection is a continual "work in progress" containing materials on dozens of authors and related social and historical topics, which is added to each semester by Professor Landow and his students. We sought to create a coherent example of the work, suitable for distribution, titled *The Dickens Web* [Landow 1990]. Dickens was chosen as the subject because the materials about him and *Great Expectations* (the novel taught in the course) are of the highest quality

and exemplify the kind of intricate connections between literary, historical, and social forces the collection is intended to support. The collection consists of approximately 250 documents including original essays, brief quotations from secondary sources, concept diagrams, and timelines plus scanned reproductions of out-of-copyright book illustrations and portraits.

It was clear from the beginning that a critical element was lacking in both these collections: graphic design. The authors, content specialists in their respective fields, had selected images and texts that fit their pedagogical purpose, but, as is often the case with textbook authors, they did not have an overall image of how to graphically present this material to their readers. The Intermedia system was intended to provide a flexible environment for authors to create their own materials, rather than provide design templates or a set of design constraints. To address this problem, IRIS requested assistance from members of the graphic design department of the Rhode Island School of Design (RISD). An editorial and design team consisting of the present authors identified several areas that needed attention.

Hypermedia and Print Media

The team sought to define what it means to design hypermedia document collections. The first problem is to determine what is not unique. That is, what aspects of hypermedia documents require the same application of graphic design principles as printed documents. The remaining problems arise when hypermedia is used to convey information in new ways.

We have identified three graphic design principles used in print media (newspapers, posters, magazines, books) that are appropriate for the design of hypermedia collections:

The Rules of Type: The relationship of type, leading, and line length to legibility are as important on the computer screen as they are on the printed page. The output device for Intermedia is the Apple Macintosh screen, which supports a resolution of 72 dots per inch. This compares unfavorably with the 1250 lines per inch of output devices used to create the image of type on a printed page. To maintain legibility of type, adjustments must be made to account for the low resolution of the output device.

Consistent Formatting: The importance of consistent formatting rules for individual documents and collections of documents are largely unchanged. When designing a single publication or series of publications, the repetition of consistent formatting rules is an important factor for supporting reader orientation. The same is true for hypermedia, though, as noted below, hypermedia presents additional orientation problems.

Clear Information Graphics: Most characteristics that determine whether a black and white information graphic is clear or confusing do not change simply because that graphic is on soft rather than hard copy. Some adjustments must be made for the relatively low resolution of the computer screen, the focal distance from which the reader approaches the image on the screen, and the effects that reflected light from a print media versus transmitted light from hypermedia have on contrast and shading.

The Intermedia Publication and the Book

The presentation of information on the computer screen has some similarities to one of the book's earliest forms, the scroll. In Mediterranean antiquity, before the technology of binding leaves of papyrus or parchment between boards was developed, the method for creating portable collections of written material was to roll and tie continuous pieces of papyrus into a scroll [Roberts 1983]. The way in which a scroll stores and presents information to the reader is interesting in the context of our present work on the computer screen. In a scroll, information is stored on either side or above and below the area being read. This is similar to the operation of the scrolling bars of the document window on the computer, and the present practice of revealed information only within the document window. In either case, the reader does not know what information is just out of view. Unlike the pages of a book, which are of a fixed size, the viewing area of a scroll can be broadened or narrowed. As a result, the demarcation between visible and hidden information on the surface of a scroll is not as clear as the edges of a book page.

Even in the case of the scroll, the reader is oriented to the magnitude of the collection by being able to hold the entire collection in her hands. In contrast, a visual examination of the surface of the computer screen does not give the reader the same kind of access to the hypermedia publication as a whole. The hypermedia documents are 'hidden' within the memory of the computer and the visual appearance of the icons that represent each document does not express the same information as spines of bound volumes on a shelf or stacks of papers on a desk.

There are other interesting comparisons to be made between hypermedia and the printed book. Yankelovich, Meyrowitz, and van Dam [Yankelovich 1985] point out a fundamental difference between the two: that information in a book is static. Once committed to ink on paper, the information cannot be changed without reprinting the book. Their table of comparison emphasized the greater potential for reader interaction found in electronic media. While print media offers advantages in areas such as portability, established standards of typography and graphic design, and general aesthetic appeal, the reader of a book cannot alter the content or customize the arrangement of a printed page to suit individual needs. Intermedia, designed in large part by Yankelovich and Meyrowitz, challenges this relationship between the author and the reader. The Intermedia reader must actively create the sequence in which information is presented. Within the limit of permissions established by the author, the reader is also invited to add to and alter the information being presented.

While this area of comparison is entirely valid, there are other issues of orientation and meta-information that should not be overlooked. These include a consideration of the non-verbal information found in the book as a physical object, the differing relationship between verbal and visual language in the two mediums, and a comparison of the sensory channels through which the book and the computer screen present information to the reader.

The physical presence of a book, i.e. its weight, size, method of binding, its cover (hard or soft), can tell the reader something about the publication before it is read. Flipping quickly through the pages will tell the reader about the type of publication, the amount of copy, the size of type, the number of illustrations

(if any). Our visual sense is the primary channel through which we receive information from a book. However, a person reading a book uses more than just the sense of sight. A book can be picked up and oriented to the viewer's requirements. The "hard" nature of the book brings in such sensory information as the physical feel of the pages, the weight of the book, the smell of the ink, evidence of past ownership, and so forth.

By convention, books have bound pages that are expected to be read with a directional orientation. While this directionality varies from culture to culture (Greek and Latin reading horizontally left to right, Hebrew and Arabic reading horizontally from right to left, Classical Chinese reading vertically right to left), the page of a book in the European tradition is, by convention, read from top left to bottom right. The contents of pages within a book are most commonly organized in a linear, sequential fashion.

Combining Verbal and Visual Language Systems

Intermedia already contains parts of the visual language of hypermedia. In addition to the visual elements inherited from the Macintosh toolbox, such as pull-down menus, document icons, etc., these include unique features such as the link marker, the highlighting of the anchor extent, and the web view.

However, Intermedia, like most computer software, has been designed largely from the perspective of a verbal language system. Each document is surrounded by a frame. Within that frame the conventions of the book page and the linear order of our verbal language are maintained. Intermedia also supports webs of navigational links, connections between selections in multiple documents. These connections are non-sequential and bi-directional. The hypermedia author has the tools to create a collection of information both vast and complex. The same author has the potential to create complete visual and intellectual chaos and confusion.

This power to connect elements in separate documents and go beyond the conventions of our verbal language system begets the need to create a clear and persuasive visual language of hypermedia presentation. For a hypermedia collection to function properly, an author must successfully combine the verbal language of the document content (what Landow has elsewhere called "the rhetoric of hypertext" [Landow 1989]) with an equally persuasive visual language of hypermedia design. This visual language should help define a sense of hierarchy in the presentation of information, create a sense of order, structure and clarity, and allow the user to focus on what is alike and what is different.

Strictly from the point of view of visual language, the computer screen offers a limited palette. The simplicity of the means of representation on the computer screen does not accommodate all the solutions open for investigation in two- and three-dimensional modes of operation. A comparison of Intermedia with the two-dimensional and three-dimensional design reveals the relative narrowness of this new medium [see Table 1]. However, by investigating and applying theory from two-dimensional work on paper and three-dimensional design to the challenges presented by Intermedia, it is possible to look at new aspects of graphic representation and find new solutions.

Table 1
*Comparison of the
 three modes of operation*

	Three-Dimensional	Two-dimensional	Intermedia
Sight	Length, breadth, depth absorbed light reflected light transmitted light visual elements constructional elements relational elements animation	Length, breadth absorbed light reflected light — visual elements — relational elements —	Length, breadth transmitted light — — visual elements — relational elements animation
Sound	X	X	—
Touch	visual elements constructional elements	— X	— —
Smell	X	X	—
Illusionary Elements	conceptual elements relational elements	conceptual elements relational elements	conceptual elements relational elements

Creating Intermedia Publications

Document Organization

Creating handout materials for a particular class requires less forethought and design than creating a general-purpose textbook. Until April 1989, Intermedia had been used solely to develop materials for courses, and not to produce a formal publication. To create a complete publication, we had to take a new look at how information was presented.

In Intermedia, users create documents, folders, anchors, links, and webs. Documents are an abstract representation of individual files in the Unix file system, and may be collected into a hierarchy of folders. Anchors are selections within documents, and they may be joined to form bi-directional links. Webs are special documents that represent collections of anchors in documents and the links between these anchors. While the links and anchors in a web are stored in a database, not in the documents themselves, they appear as an overlay on the documents when the web is opened.

Intermedia does not have a separate facility for managing a group of folders or documents as a single “hypermedia document.” The system allows links to be made between any selection in any document anywhere in the file system.

To establish a clear, logical, and visual relationship between the folder hierarchy and an Intermedia web, the convention was established that all documents in a hypermedia publication would be in one “parent” folder. Further, we used the hierarchical file system to organize documents into logical groups within that folder according to subject. The documents in *Exploring the Moon* were sub-divided into folders according to six Apollo missions. The documents in *The Dickens Web* were sub-divided into folders for topics such as history and literary relations. Documents that correspond to the front matter and index of a book publication were placed in the “parent” folder so that they would be immediately apparent to the reader.

Graphic Formats for Document Types

Intermedia supports many windows open on the screen at a time. Following a

link adds information to the screen display, rather than dismissing the current display and replacing it with another one. The entire system encourages users to maintain simultaneous visual contact with several different documents.

The opening of multiple documents creates a structure of overlapping windows within the overall frame of the computer screen that has no fixed and predictable order. This order is not random, however. The author can determine the initial size and position of each window, but cannot determine the sequence in which windows will appear or the number of windows open at any particular time. The reader's choice can be visually confusing, as many windows pile on top of each other and the reader is confronted with a diversity of intersecting rectangles and visual styles. We sought methods to create an underlying structure that would bring order to this diversity by maximizing visual familiarity and minimizing visual distraction.

To accomplish this we established a basic visual style and screen placement for each document type. By document type here, we mean the conceptual type of the document within a particular collection. By using the same typography, margins, screen placement, and other visual cues for each document type, we made it easier for the reader to recognize the kind of document that had been opened and see the differences between types of documents.

Intermedia 3.0 supports two typefaces: Times and Helvetica. For *Exploring the Moon* we mixed the two, using Times 12/14 for body text and Helvetica 14/16 for titles and picture captions. For *The Dickens Web*, which contains a great deal more text, we abandoned Times altogether. Helvetica 12/14 was chosen as the base type because of its legibility on the screen. Being a sans serif design, its simplicity and open forms adapts well to low screen resolution. The relatively large point size and leading for body text (9/10 to 10/12 is commonly used in books) proved absolutely necessary to support screen legibility. We reduced to 4.5 inches the usual 6 inch text column used for standard 8.5 by 11 inch cut-sheet pages. The narrower column for text on the screen was used for much the same reason as it is in newspaper layouts: to increase legibility of multiple blocks of text.

The white space within a document frame was treated as an important design element in both text and graphics documents. In particular, the left edge of text documents can affect basic legibility by supporting or detracting from the reader's ability to pick up the next line in a column. This left edge white space is all the more important when stacks of several document windows interact on the same screen layout. With this in mind, we became increasingly generous with the left margin in text, broadening it to a full inch when designing documents to appear on the 22-inch Apple monitor for *The Dickens Web*. We maintained balanced white space around all graphic images. In the case of many photographic images in *Exploring the Moon* that depended on a black background, this value was reversed. In these cases, the black edge was needed to support the illusion of a black background and a white image in the foreground.

Screen Position for Document Types

Printed page design traditionally uses an underlying grid to maintain visual balance between elements in a layout. The layout divides the page into one or more columns separated by "gutters" of white space. Text and graphics elements are generally constrained within this grid, which acts much like a frame

for a picture. Balanced use of white space helps the reader detect edges and repeating the position of elements on sequential pages helps the reader to maintain the continuity of a text.

We experimented with an underlying grid for both publications. *Exploring the Moon* is visually simpler than *The Dickens Web*. This first publication consisted of four basic document types: prose summaries, maps, photographs with captions, and prose transcripts associated with photographs. A single visual style was established for each type and then a general zone on the 12-inch Apple monitor was assigned to each, corresponding roughly to a page layout grid. Thus, photographs were designed to always open on the upper left of the screen, with the associated prose transcript opening on the lower left. The document window for these transcripts was made rather narrow, since we assumed the reader would rather scroll through the prose of the transcript while maintaining visual contact with the associated photograph than obscure the image with a larger window. Examples of this are shown in Figures 1-3.

The Dickens Web presented more complex problems. The information represented in *Exploring the Moon* is of a concrete nature. The overviews, which serve as indices and navigational tools for the collection, are photographic maps with links from text labels on these maps to information about places and things. The more abstract information in *The Dickens Web* relies on abstract overviews to show the reader what kinds of information are included and the inter-relationship among the various elements. These overviews take the form of information diagrams.

The original diagrams, developed by Professor George Landow over several years of using Intermedia for teaching, were re-interpreted. An underlying grid was used within the document frame to balance the white space between elements and to organize lines used to show relationships. A visual language of rectangles, rounded rectangles, and lines was developed, making use of four line weights and two colors (black and gray). Only horizontal and vertical lines were used, since any degree of skew caused distracting jagged effects. To reduce visual interference, no lines were allowed to cross (see Figures 4 and 5).

Figure 1
The first of three figures showing a sequence of documents being opened in *Exploring the Moon*, illustrating the placements of document types. This figure shows the lunar map overview with the web view in the foreground

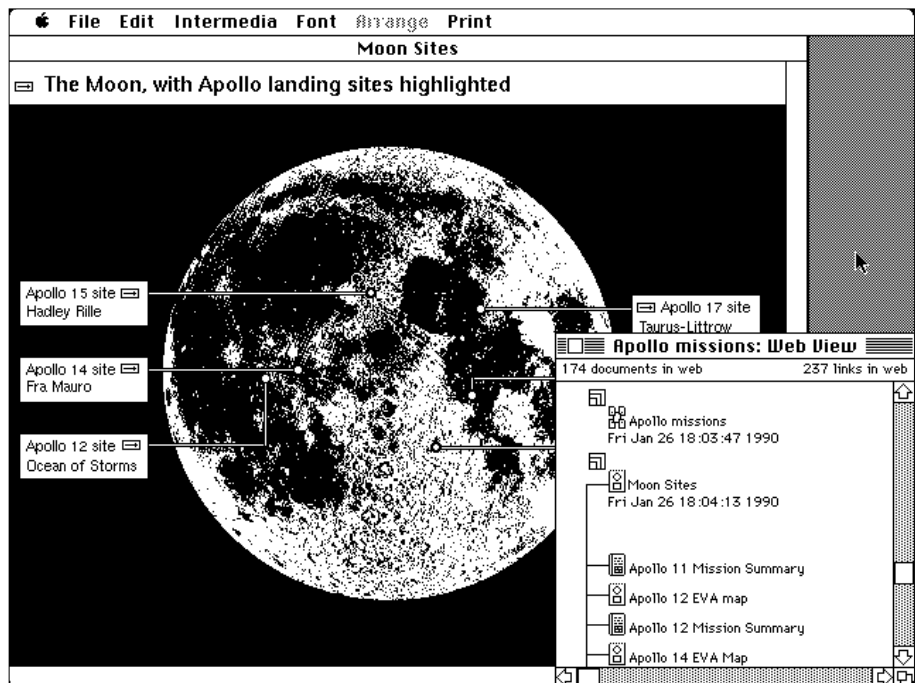


Figure 2

Following a link from the site of the Apollo 17 landing in Figure 2 brings the mission summary essay to the foreground on the upper right. Scrolling through this essay and following a link from the mention of Nansen Crater places a photo of the site on the upper right

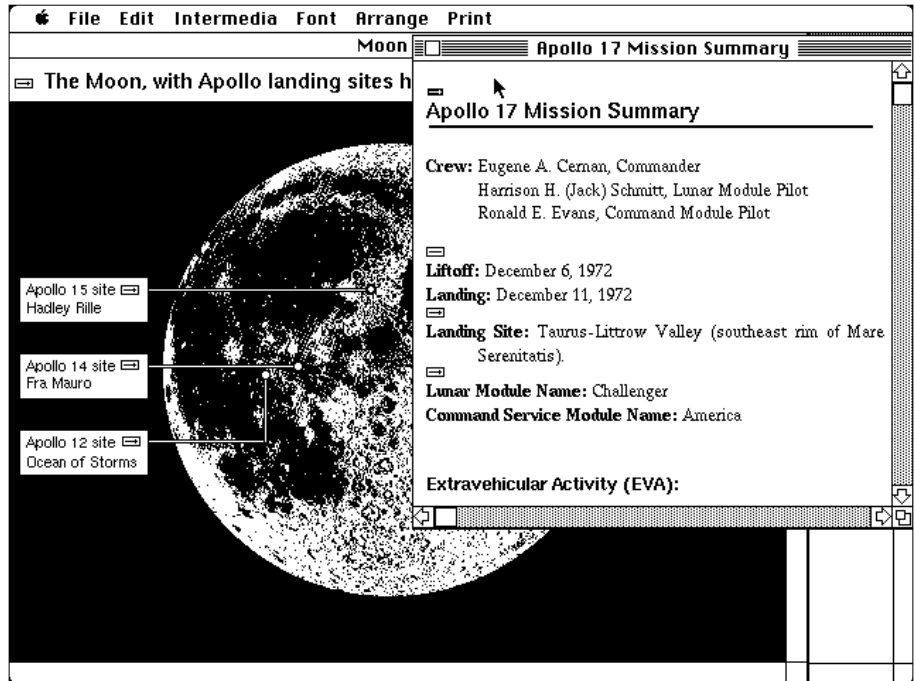


Figure 3

Following another link from this photo brings a caption document to the foreground, covering the lower part of the photo

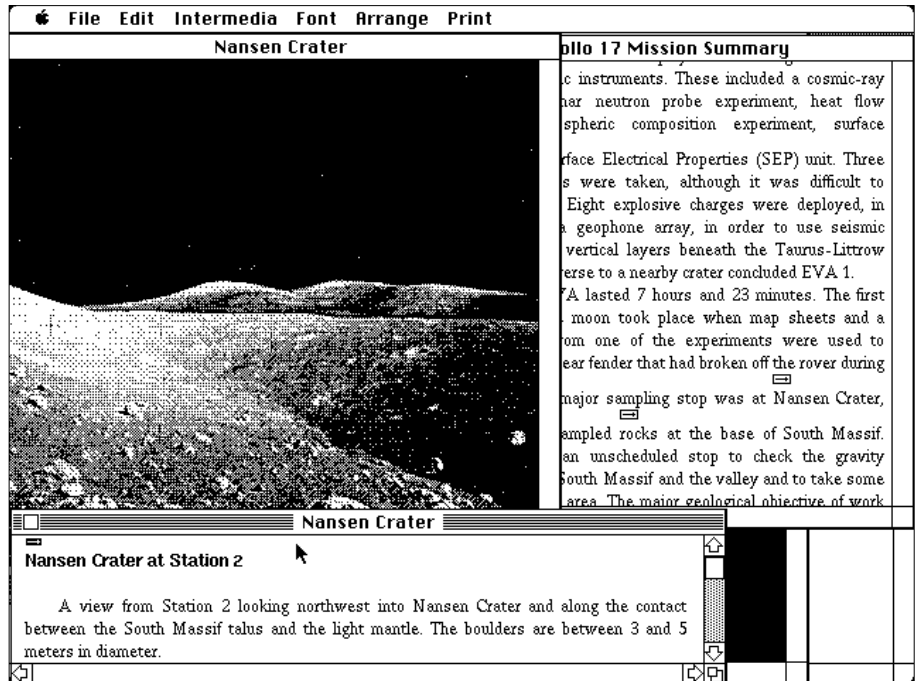


Figure 4

This shows a comparison of an author overview used in the Intermedia classroom collection and the same overview redesigned for The Dickens Web. A stronger visual image was selected and the rectangles were organized according to a 10-pixel grid.

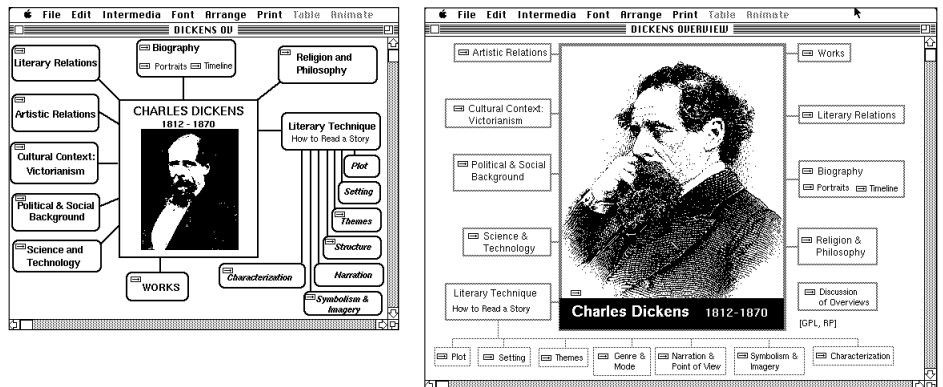
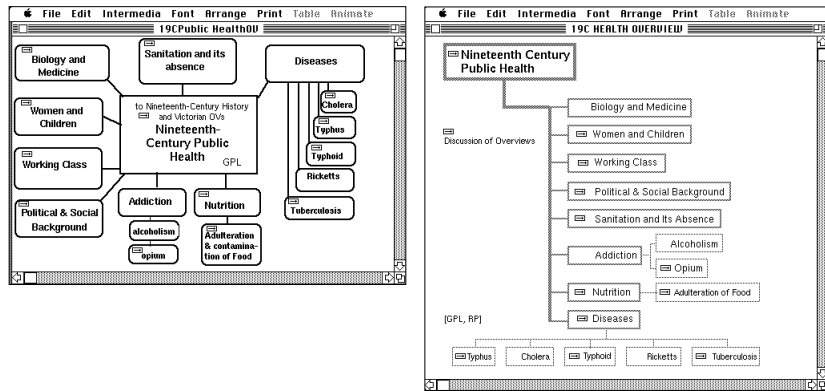


Figure 5

This shows a similar comparison for the more abstract overview of public health issues. Three levels of hierarchy are clearly expressed with minimum variation in type size by using variations in line weight and black/gray color.



Wherever possible, strong visual images (scans of photographs, engravings, or line drawings) were used as the central focus for these diagrams. This use of illustration worked particularly well in the case of author and novel overviews.

Just as the overviews in *The Dickens Web* were more complex than the overviews in *Exploring the Moon*, designing a screen grid for *The Dickens Web* and determining its document types were likewise a more difficult task. There are three major types of text documents: student essays, two- or three-paragraph quotations from literary or historical critics, and original essays of a page or more written by a number of contributing authors. Also included in the collection are numerous timelines, and book illustrations, several types of overviews of varying size and complexity, and bibliographies. Some of the timelines are intended to be viewed side-by-side, and therefore should not overlap on the screen when opened, and many of the illustrations are quite large (see Figures 6-8). Because of this complexity, the overall grid design for this collection had to be less rigid than the one developed for *Exploring the Moon*, while still providing enough order to lessen the confusion once a number of documents had been opened on the screen.

Figure 6

A screen with seven documents open from the intermedia classroom collection. Notice the variations in type size among similar document types and the minimal use of white space within the frame of both text and graphic documents.

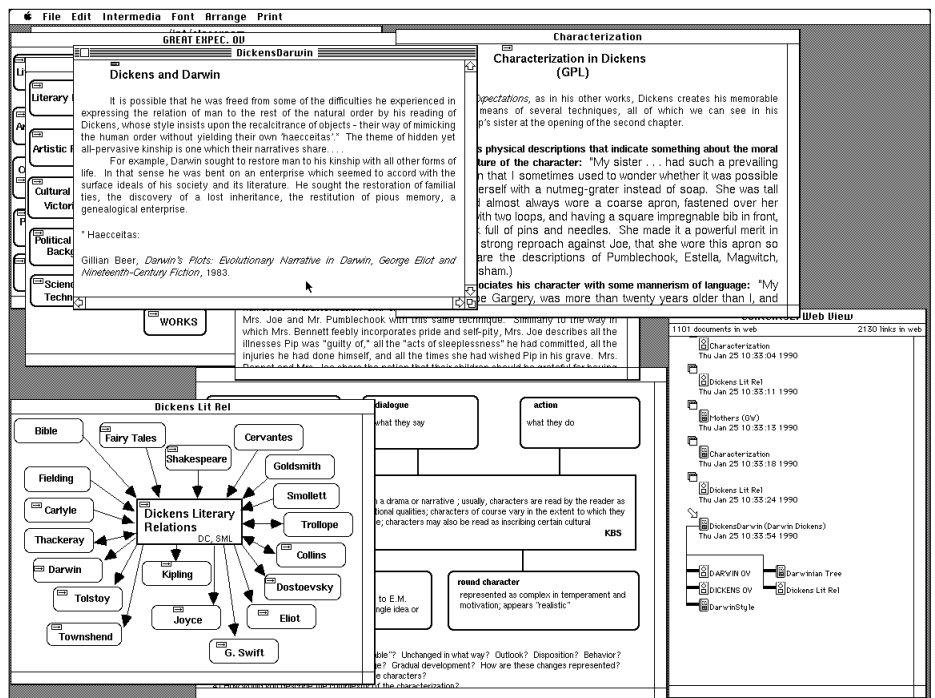


Figure 7 and 8 Shows a similar arrangement of redesigned documents open in The Dickens Web. The wider margins, narrower columns of text, and window alignment with the edges of the screen help establish an underlying sense of visual order.

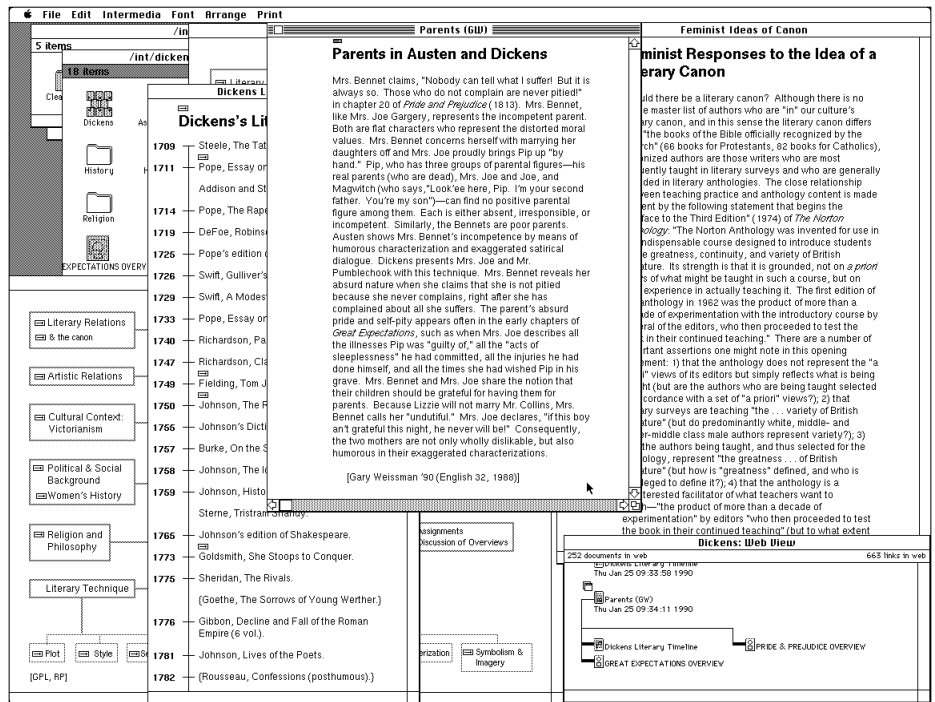
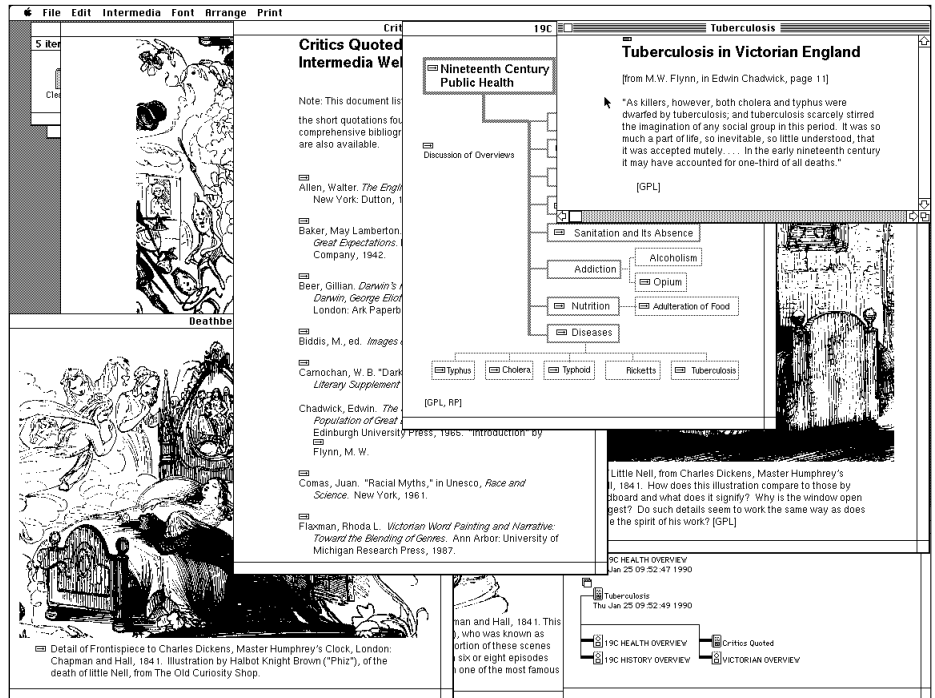


Figure 8



Closure and Open-Ended Design

It is our intention that an Intermedia publication express a lack of closure on the subjects it covers. As previously stated, a feature of Intermedia is the lack of distinction between the author and the reader, and the ease with which information can be added and modified. In both publications we wanted the reader to see that the information being presented could be extended.

For *Exploring the Moon*, we added a folder of documents on the history of lunar astronomy. Anyone examining these documents would see that they are clearly related to each other. However, these essays and illustrations were not

linked to each other or to documents on the Apollo missions. It was our intention to draw the reader into the process of extending the web by adding links to these documents in any way they saw fit. By example, we hoped that this would suggest the many kinds of information that could be added to the existing web.

The Dickens Web is a more obviously incomplete collection. We began by selecting only those parts of *Context32* that were linked to the documents about Dickens, but the relationships were not so simple. We chose to leave some “unlinked” topics in the overview diagrams, as well as to include a very sparsely linked overview of Jane Austen’s *Pride and Prejudice*. Despite the fact that its relationship to Dickens was not crucial, we included a collection of about forty documents on the various religious traditions in England. It is our hope that the reader will see by these examples that the collection represents part of a much larger whole, and that the directions in which the collection could be expanded are many and various.

Future Work

This initial work has led us to propose several more topics of future research in this area.

Integration of motion

The research version of Intermedia supports video and animated graphic documents. In future publications which use these new document types, the graphic design of static text and graphics documents must account for their visual relationship to these dynamic elements in the collection. We are exploring various strategies for displaying link markers in dynamic media that will not interfere with the playback of an animation or video sequence.

Wayfinding

Hypermedia collections must convey to the user how things are interconnected. It must also be clear to the user how to navigate among the different parts of a collection. This is as much a design problem as it is a computational one. The Intermedia Web View helps the user answer important orientation questions such as “where have I been” and “where can I go” [Utting 1989]; however, the problems of seeing relationships that go beyond nearest-neighbor graphs and individual history lists remains. Much is to be learned from navigation aids in traditional book design: sidebar notes, page tabs, running line numbers, header/footer text, etc.

Document Types

Intermedia, like many other hypermedia systems, supports different representational document types such as text, graphics, and timelines. However, the software itself does not have any facility for identifying different conceptual document types such as overview diagram, photograph, map, or transcript [Halasz 1989]. To support these conceptual document types, we made use of graphic design cues and screen position. It is clear that a great deal more support could be built into the hypermedia system itself. Differences in document icons, document frames, and collection of text and graphic styles would all be interesting areas for experimentation.

Color and Transparency

The research version of Intermedia supports the use of color and transparency. These two new features open up important areas for further graphic design work. In addition to its obvious use in diagrams, color and related lighting effects could be used to distinguish stacks of windows. The use of transparent overlapping documents to support group annotation is already being explored. The general use of transparent stacks of related documents is also a promising area of study.

Redesign the Visual Desktop

We have worked thus far within the visual language provided by the Macintosh toolbox. All Intermedia documents are presented within the system-wide frame of the Apple menu bar, pull-down menus, dialog boxes, window controls, and representations of document names. A recent paper from Fitch RichardsonSmith [Evenson 1989] correctly suggests that we should develop a more appropriate visual language for hypermedia cues. We believe that a coordinated redesign of both the exterior frame of the operating environment and the symbols used within the document frame to support hypermedia movement are needed to better support an appropriate sense of order for complex hypermedia.

Acknowledgements

This work would not have been possible without the significant effort of the “content specialists” who created the materials we set out to redesign: Katie Livingston and Jane Aubele from Geology, and the team of faculty and graduate and undergraduate student contributors to *Context32* lead by George Landow. Thanks are also due to the IRIS technical staff, led by Norman Meyrowitz, who created our software tools. The authors would like to extend a special thanks to Karen Smith Catlin, Marty Michel, Barbara Kahn, and Nicole Yankelovich who offered us their useful comments and suggestions.

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