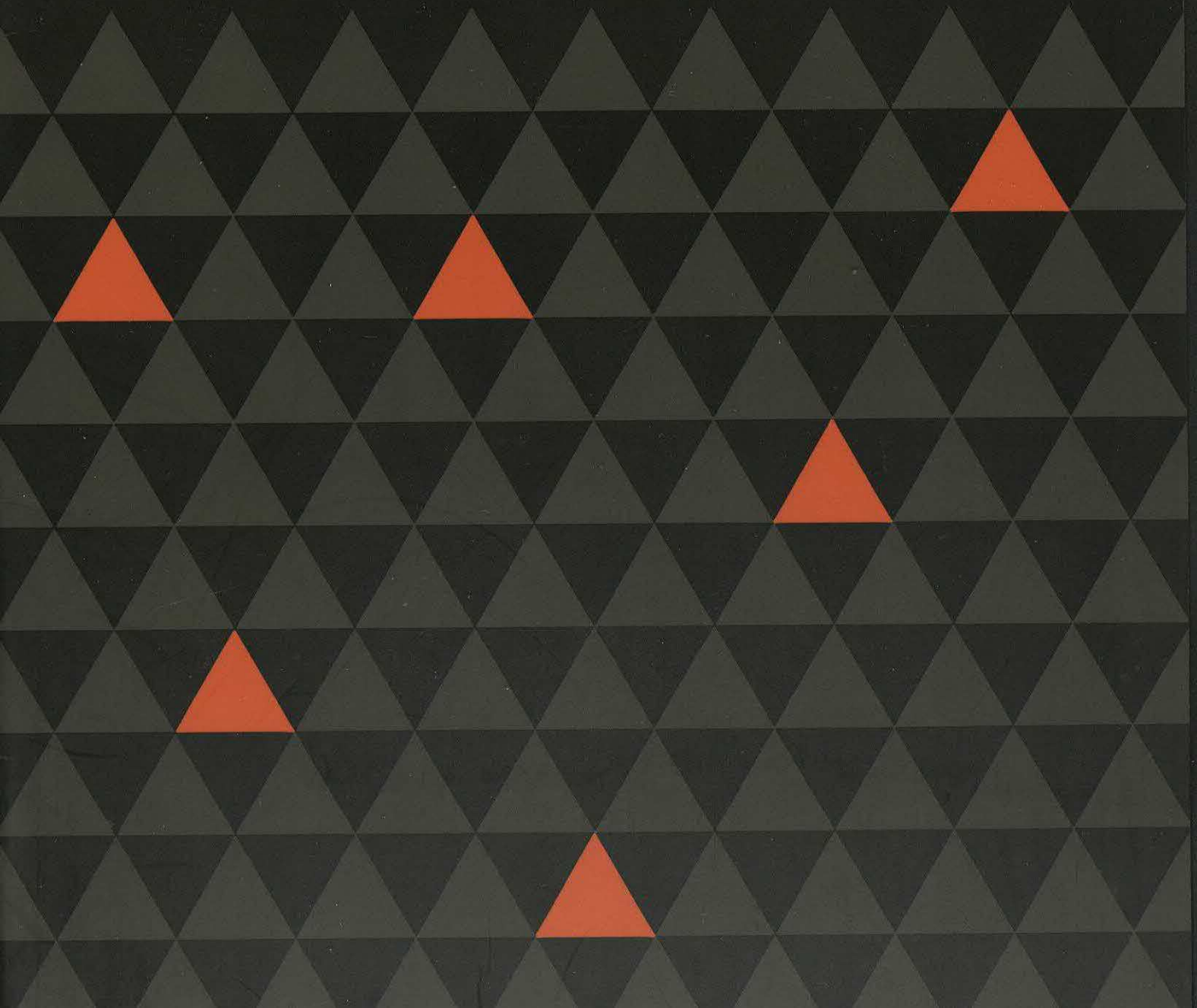
Hypertext

BUTLER COX FOUNDATION

A Paper by David Flint
August 1988



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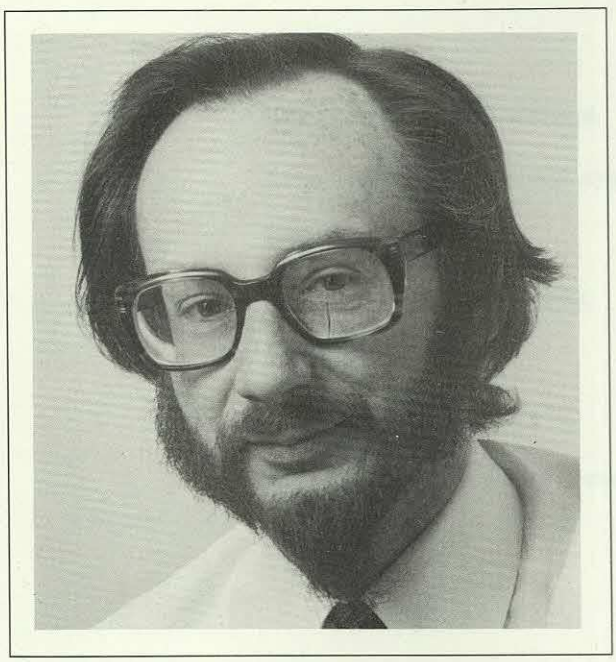

David Flint is a Principal Consultant with Butler Cox, specialising in telecommunications and office systems.

One of his roles in Butler Cox is to track new developments in information technology and its application and to identify the 'rising stars'. He believes hypertext is one such development.

Hypertext was described briefly in Foundation Report 63, The Future of the Personal Workstation, to which David made a substantial contribution. The purpose of this paper is to describe what hypertext is in more detail, to illustrate its potential applications, and to explain its significance.

Although hypertext cannot be defined precisely, hypertext systems (of which Apple's HyperCard is an example) share certain characteristics. They are usually document oriented, rather than data oriented, containing 'chunks' of information (typically a few paragraphs) connected by 'links.' Each chunk can be linked to several other chunks. Users select the next chunk to be displayed by choosing the appropriate link from the currently displayed chunk.

Hypertext systems are already being used for online help systems and interactive publications, the latter often involving the use of videodiscs or CD-ROMS. In the future, they will be used as personal knowledge organisers, somewhat like an electronic equivalent of a Filofax. They will also be used for workgroup collaboration, allowing groups of specialists to access and add to each other's knowledge. Ultimately, they could lead to the 'hyperverse', the all-embracing system for organising knowledge.

The long-term significance of hypertext is that it allows information to be stored and used in a way that is better matched to the workings of the human mind. Moreover, the information stored need not be restricted to text. Hypertext systems can just as easily include graphics and pictures, or indeed any information that can be stored in digital form.

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There is growing awareness of hypertext, amongst both user organisations and computer journalists. As with any significant IT development, there is a lot of 'hype' in the comment about hypertext. It is also difficult to judge its true significance as hypertext is difficult to define. The purpose of this paper is to explain what hypertext is, what it can be used for, and why I believe that it is important.

The current interest in hypertext is more than a media event. During 1987, for instance, Hewlett-Packard surveyed 50 large customers to ascertain their future requirements. Just over half of them said they required hypertext facilities. And a recent lecture on hypertext at the University of California, Los Angeles, was packed out — not just with computer experts, but with business people who wanted to know what hypertext could do for them.

The most significant event to have stimulated the current interest in hypertext was probably the launch in 1987 of Apple's HyperCard product. At the end of 1987, Infoworld, a leading US computer magazine, asked its readership to name the most significant products launched during that year. HyperCard was voted number one in three separate categories. A further indication of the huge interest in hypertext is given by the sales of the first book about HyperCard (the *Complete HyperCard Handbook* by Danny Goodman). It is a large book (over 600 pages), but 100,000 copies have already been sold. (This publication is listed in the bibliography at the end of this paper together with other relevant publications.)

Figure 1 contains a list of some of the hypertext systems already in use. The applications range from academic institutions, that are experimenting with hypertext as a teaching aid, to commercial applications such as the hypertext-based online help facility being developed by Atlantic Bell.

Renault, the French car manufacturer, is using hypertext techniques as its service manuals are transferred to CD-ROM (compact disc, read-only memory). The CD-ROMs will be distributed to 19,000 dealers and agents throughout the world between 1990 and 1992. Renault sees this as a competitive-edge application and expects a substantial return on its investment.

As a result of the Renault project, IBM France has adopted as an IBM product the hypertext system originally chosen by Renault, under the name Hyperdocument. (Renault, however, has since decided to use HyperCard on the Apple Macintosh because of its ease of use and powerful development facilities.)

Although no other part of IBM yet has a hypertext product, various parts of IBM are showing considerable interest. In April 1988, Pat Matola, Manager of the OS/2 EE (Extended Edition) Database Manager, announced that IBM was working on a "different approach to hypertext" that might eventually be incorporated into OS/2 EE.

THE CONCEPT OF HYPERTEXT

There is no standard definition of hypertext. Rather, it is a concept, or a set of related concepts. Thus, it is not possible to say that a particular product or piece of software is or is not a hypertext system, only that a particular system has the general characteristics of hypertext.

Hypertext systems are primarily document, rather than data, oriented. They often share the concerns

Figure 1 Some hypertext systems already in use

User organisation	Application
Atlantic Bell	Online HELP
Brown University	Teaching
Cornell University Medical College	Teaching
Ford	Service manual
High Productivity Software	Methodology manual
NASA	Apollo documentation
Renault	Service manual
Smithsonian Institute	Museum display
Télébourse (Switzerland)	Online trading
Turing Institute	Expert systems development
University of Maryland	Teaching

for the appearance of electronic documents that led Xerox to develop the award-winning Star workstation. Most, but not all, hypertext systems allow the inclusion of images in their documents.

But hypertext goes beyond document production by supporting the location and retrieval of parts of documents. This is achieved by exploiting the power of database technology to manage and locate sections of text. Hypertext systems are therefore both document and database systems — their novelty and value coming from this marriage of approaches. This hybrid origin also explains much of the confusion that surrounds hypertext technology.

Many of today's hypertext systems have been developed to meet a single specialised need, often in a research environment. Because of the variety of these original needs, and the preferences and resources of their developers, these systems vary greatly in their features and sophistication, especially in the relative importance accorded to word and image processing, and to database management.

However, almost all the systems seem to share three basic hypertext concepts:

- Information is held as 'chunks'.
- The chunks are linked.
- Links are activated via screen 'buttons'.

Information is held as chunks. Text (or other information) is not held in the form of large document files, possibly divided into chapters. Instead, it is subdivided into 'chunks'. The chunks can be of varying size, but a typical chunk is a few paragraphs of text. Some hypertext systems allow quite large chunks, however.

The chunks are linked together. For most information-retrieval purposes, a single chunk of information is rarely sufficient. The chunks are therefore linked together in a way that makes it easy to move from one chunk to another related chunk, however.

The links are activated via screen buttons. The 'buttons' are displayed on the screen, and may be single words in a document, or icons. The buttons are activated by pointing and clicking with a mouse, which causes the link to be traversed and the chunk at the other end of the link to be displayed.

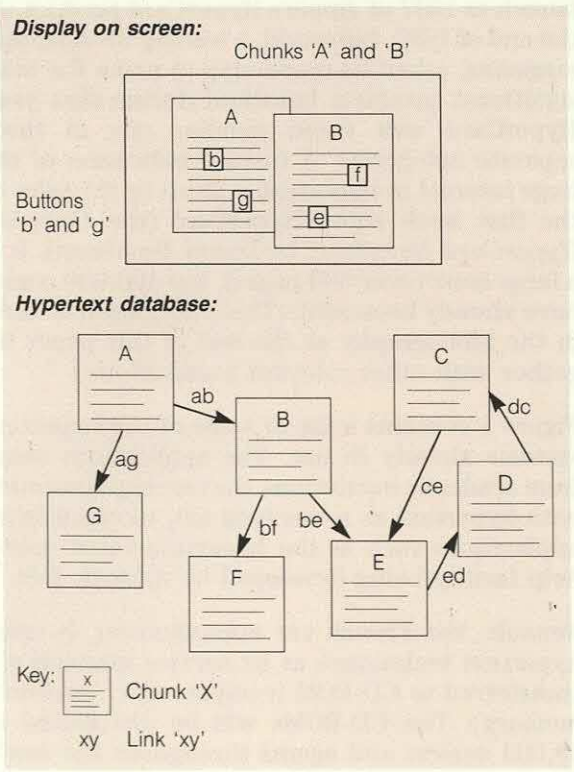
Figure 2 illustrates the concepts of chunks and links. In this illustration, the user began with chunk 'A' displayed on the screen. At the appropriate point in chunk 'A', the button, 'b', for link 'ab' was activated, causing chunk 'B' to be displayed on the screen as well. The representation of the hypertext database in the bottom half of the figure shows that there is a wide range of links that can be traversed. The user is entirely in control of the choice of links to be traversed and their order.

An essential feature of hypertext systems is the need for navigation aids. Hypertext is different from 'linear text' in that the information need not be presented in a fixed sequence. There are now applications with as many as 100,000 chunks interlinked in a sort of massive 'spider's web'. Users need to be provided with the means to find their way about the system so they do not get lost in the maze of available links.

TWO TYPES OF HYPERTEXT SYSTEM

Hypertext is a new and rapidly developing field. Most of the developments originated from the United States, where there are two strongly held points of view about the form that hypertext systems should take. Each point of view is presented with evangelical zeal by its proponents. One group (which I call the 'card sharps') believes that the basic unit of information (a chunk) should be no more than will fit on a display screen. They see the box of file cards as their basic metaphor. The best-researched of these systems is Xerox PARC's experimental NoteCards and the best known is Apple's HyperCard.

Figure 2 Hypertext chunks, links, and buttons



I call the other group the 'holy scrollers'. They believe that it is sometimes necessary to view more information than can be contained in a single screen image. For example, a chunk of text consisting of four or five paragraphs cannot all be displayed on the screen at one time. The 'holy scrollers' therefore advocate the use of straightforward scrolling techniques. The two types are discussed below.

CARD-BASED SYSTEMS

The NoteCards system was developed at Xerox's Palo Alto Research Center in California. Figure 3 shows a typical NoteCards screen display dealing with information about intermediate-level nuclear forces. Note that, although all of the cards in the example contain textual information, they could equally well contain graphical information.

NoteCards allows many cards to be displayed on the screen simultaneously and I have drawn arrows to show how a hierarchy of cards has been constructed. Clicking on a box (or button) in one card causes the card with the next level of detail to be displayed. This example demonstrates that NoteCards is, in concept, a hierarchical storage-and-retrieval system. In many respects it is akin to videotex, but with very sophisticated display facilities.

HyperCard, on the other hand, displays only one card at a time, but provides facilities for backtracking through previous cards, or for returning to the 'home' card. The home card, which is shown overleaf in Figure 4, is displayed when HyperCard is loaded. In this case all of the buttons are icons, rather than text contained in boxes. Clicking on an icon causes a new card to be displayed.

The icons are designed to be as self-explanatory as possible. Thus, clicking on the 'Address' icon will cause the first card of a name and address 'stack' to be displayed. (A stack is a set of cards, with each card containing the same type of information.) Clicking on the 'HyperCalc' button brings up a card which has the image of a pocket calculator on it. The mouse can then be used to 'press' the buttons on the calculator. And clicking on the 'Phone' icon brings up the card stack containing telephone numbers. Once the card with the required number has been located, pressing a

Figure 3 A typical NoteCards display

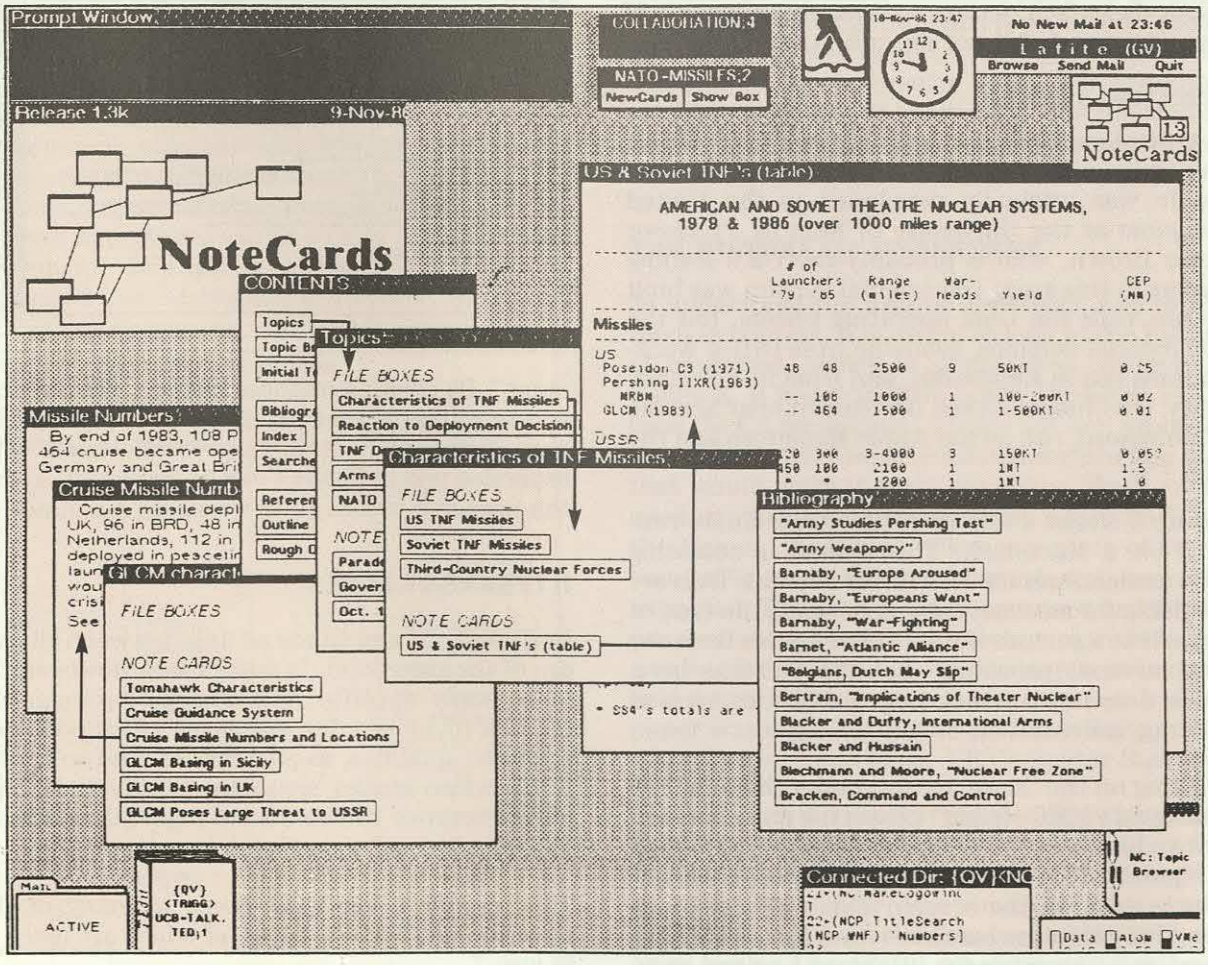
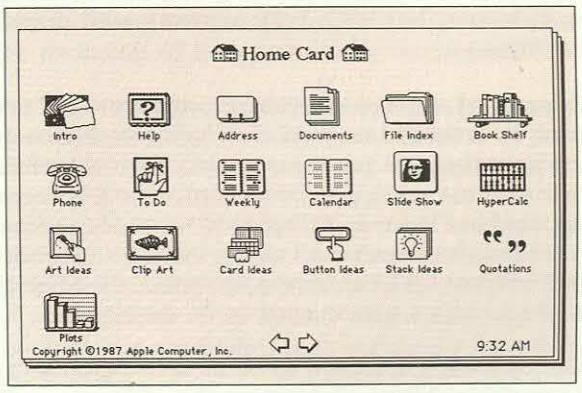


Figure 4 Home Card in hypertext system



button on the card will cause the telephone number to be dialled (provided that the appropriate telephone line is connected).

HyperCard is, in fact, a great deal more powerful than this brief description suggests. The embedded programming language, HyperTalk, allows the actions associated with buttons to be of almost unlimited complexity. They may, for instance, include the invocation of other applications and network communications with other computers. Though essential to a full understanding of HyperCard, these facilities are not essential elements of hypertext so I will not describe them further.

SCROLLING SYSTEMS

A typical example of scrolling-based hypertext is the Guide system, now adopted by IBM France. Guide was originally developed in the United Kingdom at the University of Kent by Professor Peter Brown, who is probably the UK's leading expert in this area. The original version was built to run with the Unix operating system, but the commercial versions, available from Office Workstations Ltd in Edinburgh, and from its US subsidiary, Owl International Inc. (based near Seattle, Washington), run on the Apple Macintosh and the IBM PC.

Figure 5 shows a screen display from Guide running on a Macintosh. This system is accessing information from the Wall Street Journal. Tools are available for automatically generating the type of hypertext structure shown in the figures from the original text, providing that the text has been marked-up or contains recognisable cues, such as spacing, indentation, or font changes.

Clicking on the 'More' button under the headline ''Malaysia's MMC Metals'' causes the more detailed text to be inserted under the headline, as shown in Figure 6. This serves to amplify the original text, which stays on the screen. The additional text provides two more buttons — one for ''Malaysian Reaction'', the other for ''Bank of England statement''. By clicking on these buttons, the user can access different viewpoints about the particular news item. Also, it is easy to backtrack. The expanded text in Figure 6 can be 'collapsed' so that the user can return to the original headlines.

Figure 5 A screen of information from the Wall Street Journal displayed on the Guide System

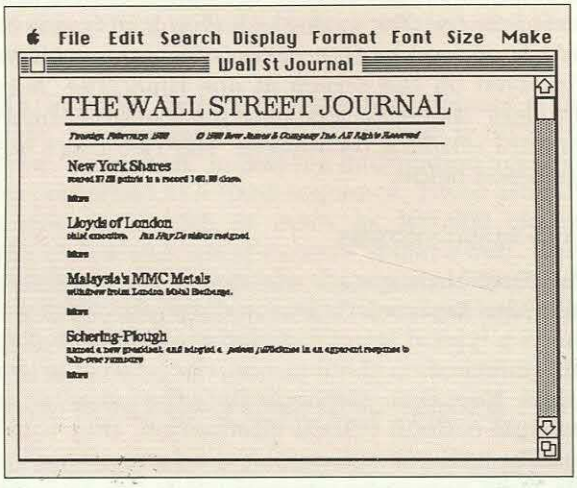
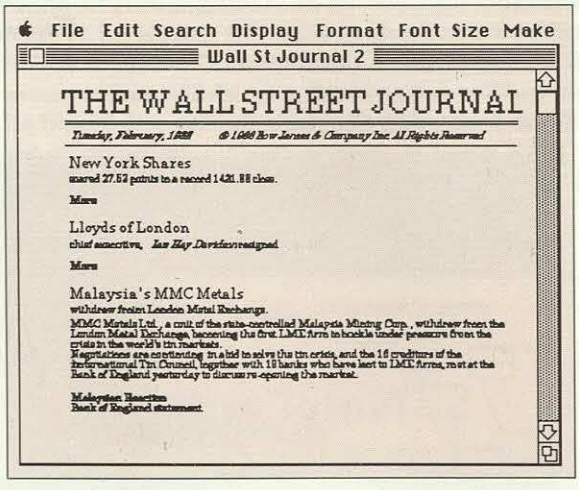


Figure 6 More detailed information from the Wall Street Journal on the Guide System



HYPERTEXT LINKS

In HyperCard and Guide all links between chunks are of the same kind. In many cases, however, the links imply specific relationships between the chunks (evidence for, summary of, supersedes, refers to, qualifies, implication of, and so forth). It therefore makes sense to classify links into different types, rather than to regard them simply as being like animated 'go to' statements.

This approach has been taken in many of the experimental systems, three of which are listed in Figure 7.

The Textnet system (used for literary criticism) has 80 types of link, including 'refutation', 'support', 'irrelevant point', and so on. Thus one chunk may be linked to another by the critic as a support point, as a refutation of the point, and so forth. The CREF system, which is used for research analysis, has four types of link ('refers to', 'summarises', 'supersedes', and 'precedes'). In each case the types of link reflect the purposes for which the systems are used.

In the case of CREF, it is possible to collect together all of the chunks that are precedents to a particular chunk. With the Textnet system, you can automatically collect all the points alleged to be refutations of a particular argument (chunk). The links, and the operations that can be performed with them, thus provide powerful facilities for manipulating the information held in a hypertext system. However, there is no established practice (or theory) for deciding on how many types of links a system should have, how they should be allocated, or whether users should be able to define and generate link types for themselves.

Systems using the types of links shown in Figure 7 are designed to be used by groups of people working on common problems. (Not all hypertext systems are designed in this way. HyperCard, for example, is designed to be used by an individual.) These systems in effect allow the user to examine a document together with several individuals' comments about the document. Hypertext allows the user to organise the material and manipulate it. Thus, hypertext does not seek to replace human judgement. Instead, it allows opinions to be expressed and interlinked. (Of course, the usefulness of the links depends completely on the skills of the people who allocate them.)

Figure 7 Types of hypertext links

Hypertext system	Purpose	No. of types of link	Examples of types of link
Textnet	Literary criticism	80	Support Refutation support Point irrelevant Data inadequate Style rambling
IBIS	Problem exploration	9	Responds to Objects to Questions Specialises Generalises Refers to Replaces Supports Is suggested by
CREF	Research analysis	4	Refers to Summarises Supersedes Precedes

An interesting aspect of hypertext is that the process of allocating links helps to stimulate thinking about the subject area being encapsulated in a hypertext system and can often lead to new insights being gained.

In most hypertext systems the links can be traversed in both directions so that, having jumped from one chunk to another, it is possible to return to the original chunk. In HyperCard this may be triggered by a menu selection, an icon on the current card, or by a special card that shows the last 40 cards examined and allows the user to jump immediately to any one of these.

These facilities work well whilst the user follows the hierarchical structure of a hypertext system. However, if the user continually jumps sideways from one topic to another, it is all too easy to get lost in the hypertext structure. Methods of controlling such jumps, and helping the user to navigate and remember where he or she has been, are still essentially at the research stage.

Because of the importance of the links, hypertext systems are normally used for static or growing information bases. Although it is possible to delete information from a hypertext system, this is rarely useful because it breaks down the structure established by the links. Instead, the inaccurate information will be kept as a historical record and linked to a chunk giving the correction.

THE HISTORY OF HYPERTEXT

To understand the uses of hypertext, and to put them in context, it is useful to look at the history of hypertext, which is summarised overleaf in Figure 8. It began in 1945 when Vannevar Bush, then the US presidential science advisor, proposed a project to organise scientific literature in a way that would make it available online. Bush envisaged an animated electronic desk, which he called the Memex, that would allow any piece of literature to be examined and particular pieces to be extracted. This project did not progress beyond the proposal stage because the technology of the day was not adequate, but the concepts were published in a paper called *As we may think*. (This paper was republished at least twice during 1987 — by Microsoft and in the UK Computer Bulletin.)

The next milestone occurred in 1963, when Doug Englebart proposed a super-integrated office automation system called H-LAM/T. (Englebart is probably best known for inventing the mouse, which resulted from the same work.) By 1968, the NLS system, based on Englebart's work, was

Figure 8 The history of hypertext

1945	Vannevar Bush's proposal for Memex
1963	Doug Englebart's proposal for 'Human using Language, Artifacts, and Methodology in which he is Trained' (H-LAM/T)
1968	Initial implementation of H-LAM/T as the NLS system
	Hypertext Editor working at Brown University (Ted Nelson *et al*)
1972	ZOG working at Carnegie-Mellon University
1980	Ted Nelson's proposal for Project Xanadu
	ZOG used on USS Carl Vinson
1981	KMS released
1983	First PhD thesis on hypertext (University of Maryland)
1984	Think Tank released
1987	Apple released HyperCard
	IBM France adopted Guide
	Other hypertext products: For Comment Houdini Hyperties

working, as was the Hypertext Editor, which was built by Ted Nelson for NASA. Thus, real hypertext systems have existed for 20 years.

In 1980, Ted Nelson published a book called *Literary Machines* in which he put forward his ideas for Project Xanadu. In effect, Project Xanadu was 'Memex revisited', but with electronic data processing as the underlying technology. Instead of publishing information on paper, it would be added to the 'hyperverse', where everything can be cross referenced to anything else. Since then, Ted Nelson has been trying to build a system to implement his ideas and trying to persuade people to fund this work.

During the 1980s there has been a trickle of hypertext-like products. The breakthrough came in 1987, however, when the stream became a flood, with Apple's HyperCard leading the way. Figure 9 lists some of the proprietary hypertext packages now available. All of these products are much more limited than the grand designs of Bush, Englebart, and Nelson. Apple's HyperCard, for example, is a single-user system; For Comment allows users to share text on a network. The original concepts were aimed at building a grand unified solution to all problems. This has proved impossible to achieve (at least with present-day technology), so the problem scope has been reduced gradually until it matches the capability of the technology. (Professor Negroponte, who heads the Media Laboratory at MIT, and who has spoken at several Butler Cox Foundation conferences, has described this process as the 'tyranny of subgoals'.)

USES OF HYPERTEXT

Trying to define the uses of hypertext is a bit like trying to define the uses of a computer. Either may

Figure 9 Some commercially available hypertext packages

Package	Supplier	Workstation
Ask Sam	Seaside Software	PC
Black Magic	Ntergaid	PC
Cross/Paint	Cross Information Co.	PC
For Comment	Broederbund	PC
Guide	Office Workstations Ltd.	Macintosh PC Unix
HyperCard	Apple	Macintosh
Hyperties	Cognetics	PC Sun
Infosift	Seaside Software	PC
Knowledge Management System (KMS)	Knowledge Systems Inc.	Apollo Sun
Knowledge Pro	Knowledge Garden	PC
Neptune	Tektronix	Tektronix
Search Express	Executive Technologies	PC
Textpro	Knowledge Garden	PC
Window Book	Box Co.	PC

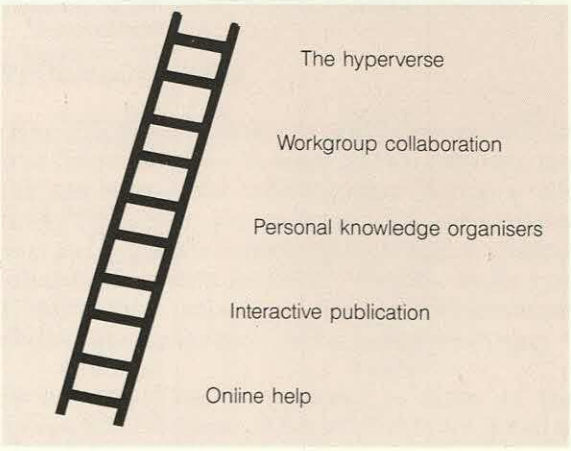
be used for a very wide range of applications — a range limited only by the imagination of those involved.

I find it helpful to picture the difference between the ultimate aim of the hypertext pioneers and what is practical today as a ladder of applications, as depicted in Figure 10. At the top is the hyperverse; at the bottom are the practical, but limited, hypertext applications that can be achieved today. Higher up the ladder are applications that will be achievable in the foreseeable future. I am now going to help you climb that ladder.

RUNG 1: ONLINE HELP

It is no exaggeration to say that the computer industry has been overwhelmed with manuals. In

Figure 10 The hypertext ladder of applications



my view, any paper-based manual for a computer system is, in effect, a confession of failure. The need for online manuals has been recognised for ome time, but their implementation has left a lot to be desired.

It turns out that hypertext is a good way of providing online help systems. Thus, if the user encounters a problem at a particular point in an application, he or she can ask the hypertext system to provide relevant help. The system will route the user directly to the relevant chunk of help information. It could be that the explanation uses an unfamiliar term. In this case, the hypertext system can be used to route the user to the chunk explaining that term.

The best way of understanding how such a help system works is to try it in practice. (In fact, this is true for all hypertext applications.) The help facility built into Apple's HyperCard is a good example and Figure 11 shows a card from the HyperCard help facility. To get this display I selected 'Menus' from the menu bar at the bottom of the screen then 'File' from the resulting display and finally 'Import Paint' as shown.

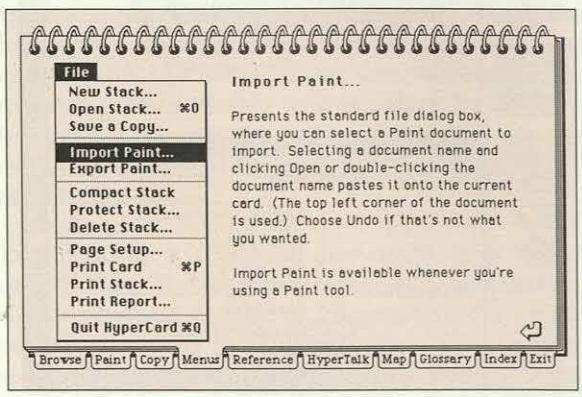
The right-hand side of the card contains the description of what 'Import Paint' is and when it can be used. If I had clicked on 'Export Paint', the narrative would have changed to describe that feature. Hypertext online help systems also make if possible to run the application in a controlled environment. Thus, the system will not only describe the features, but can also show the user what it looks like in action.

Hypertext-based help systems are already well-established on Symbolics and Tektronix workstations. Such a system is also an integral part of Hewlett-Packard's New Wave operating environment for MS-DOS and OS/2 PCs.

Online help systems are not only relevant to suppliers and PC users. They are, or should be, of interest to every organisation that builds or uses IT systems. Good online help facilities can make systems easier to use and reduce the need for printed manuals. Unlike printed manuals, online help provides assistance where it is needed, at the workstation, and when it is needed, which is when the user calls for it.

Atlantic Bell has already accepted the logic of this position. This company is, in effect, saying that all future users of IBM 3270 telecommunications networks will have to use a hypertext help system rather than a printed manual. The interesting part about this hypertext application is that it is being implemented in the standard IBM computing environment rather than on esoteric, high-priced, engineering workstations.

Figure 11 A card from the HyperCard help facility



RUNG 2: INTERACTIVE PUBLICATION

Hypertext's ability to present information is not restricted to information about computer systems. This wider use may be termed 'interactive publication' and has been mainly restricted to commercial databases in the past.

New opportunities are arising in this area, not just because of hypertext, but due to the emergence of CD-ROMs and the general growth in the installed base of online terminals and workstations.

A CD-ROM can store up to about 550 billion bytes on a single platter — nearly 700 times more than the 800k bytes available with the standard Macintosh disc. This huge storage capacity means that various types of information — data, text, pictures, even music — can be held on the same disc. Hypertext provides a means of exploiting the vast amount of storage available with CD-ROMs.

By 1992, we expect the majority of managers and professionals to be using intelligent workstations, as will a reasonable proportion of senior executives and clerical staff. Although there may not be one workstation per desk, most staff will have access to an intelligent workstation. I believe that this will mean there will be increasing pressure to provide information in an electronic form. At present, we are at the stage where information is searched for electronically, but is then converted to hard copy before it is used. I believe this will be an interim phase.

However, there is considerable debate about how best to access and display information on a screen-based system. Experience shows that if you try to replicate a printed publication on a screen, you end up with an inferior version of the original. Some years ago, Isaac Asimov wrote an essay in which he described the ideal medium for communicating information. According to Asimov, the information should be optimally ordered, the

medium should have a low energy requirement, and it should be portable. He concluded that the ideal medium would be '*b*ound, *o*ptimally *o*rdered *k*nowledge' (or '*book*').

There is considerable merit in this line of argument, but there are some problems as well. Books, after all, present information in a fixed sequence, so the author has to decide on the optimum order. However, the optimum order for one reader may well be ill-suited to another reader. The problem can be illustrated by a quotation from a technical system developer in a large manufacturer: ''Presently, the technical information for our sonar systems has about 50,000 pages and requires the customer to send people to a 10-day training course to learn how to use the technical information we supply.'' Surely, there must be something wrong when it takes 10 days just to learn how to read a set of books.

I believe that hypertext, combined with CD-ROM, provides part of the solution to this type of problem. CD-ROM provides the means of storing large amounts of information in a compact form. Hypertext allows the information to be organised so it can be accessed in different ways for different purposes by different users. Hypertext is able to do this because it separates the information (chunks) from the structure (links), allowing several different structures to be provided for a single set of information. It also allows different users to access the information from different points of view. For example, information about American history is now available on CD-ROM in a form where the user can choose a viewpoint. Thus, the information can be accessed from the point of view of a sociologist, a miner, or a general. Although the basic historical facts are the same, the publisher has constructed the links to allow the facts to be seen in different ways.

Figure 12 shows a display screen from the Intermedia System developed at Brown University in the United States. This illustration is part of an undergraduate biology lesson and it shows information about a micro-organism called Micromonas. Brown University has been using this type of system for nearly 20 years to teach specialist courses on science and literature. It now has more experience of building and using hypertext systems than anyone else in the world.

Hypertext publications are not restricted to the academic world, however. Figure 13 contains a selected list of publications now available —

Figure 12 A display screen from the Intermedia project at Brown University

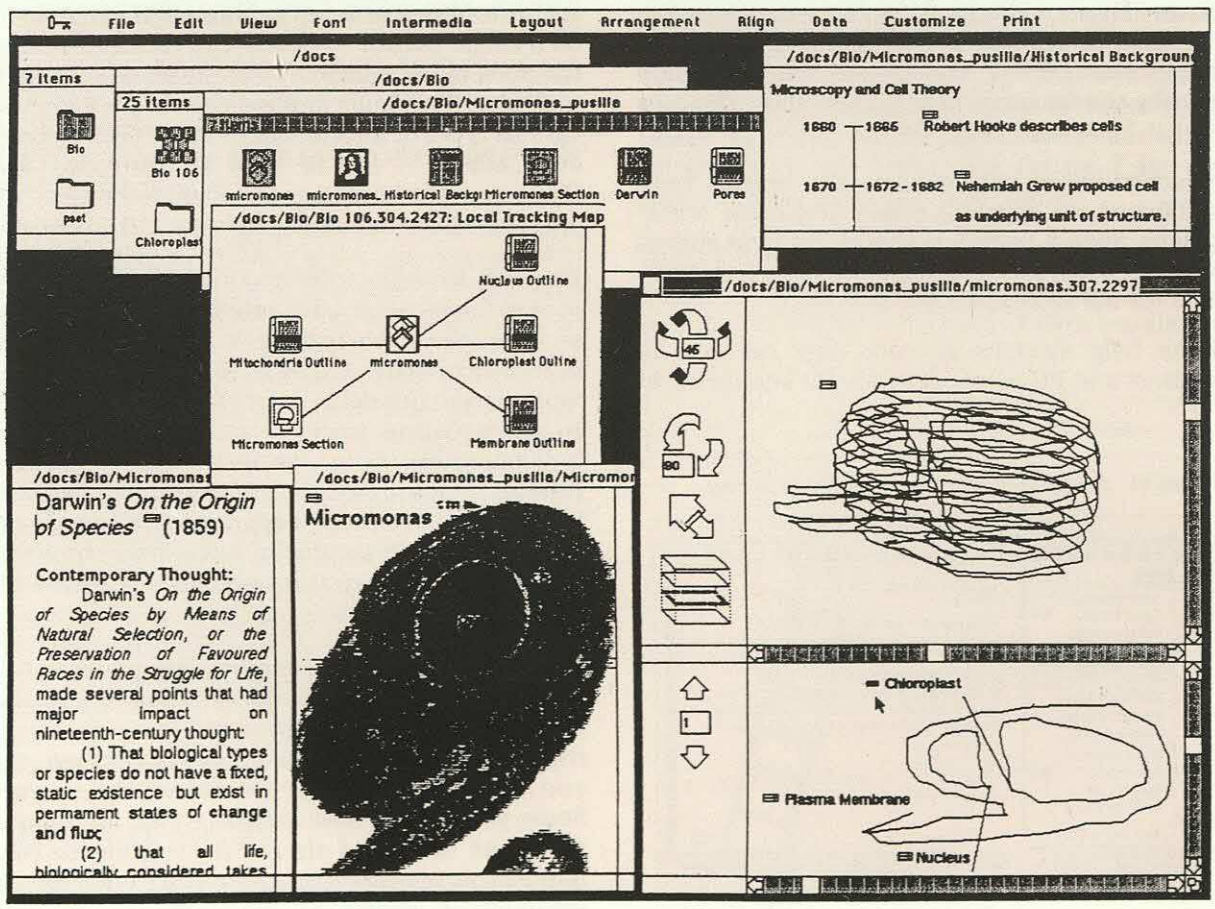


Figure 13 Some publications now available in hypertext

Publisher	Document	Subject	Hypertext system
Published on magnetic disc			
Glasgow Council	Glasgow Online	Glasgow	HyperCard
Odesia	Helix Helper 2.0	Double Helix Multiuser Helix	GUIDE (Macintosh)
Saving Zone	Product Guide	Macintosh products	GUIDE (Macintosh)
Sophisticated	Macs-a-million demonstration	Demonstration	GUIDE (Macintosh)
Training Resources Unlimited	Hypernews	HyperCard news	HyperCard
Published on CD-ROM			
Grolier	Electronic Encyclopaedia	Everything	—
Environmental Resource Management	—	Environmental rules	—
US Geological Survey	—	Water resources	Marcon
Loyola University	—	Robot engineering	Marcon
Microsoft	Bookshelf	Literature language	—
—	Medline	Medicine	Marcon
Published on interactive videodisc			
BBC	Domesday Project	United Kingdom	—

ranging from the Bible to information about water resources published by the US Geological Survey.

Some of the information in these publications is in the form of images and graphics, not just text. In this respect, the term 'hypertext' is somewhat a misnomer. The term 'hypermedia' might be more appropriate, but I suspect that the original term is now too well entrenched to challenge.

Hypertext provides a new metaphor for describing the medium created by the combination of online screens and CD-ROM. There are two particular problem areas with this new medium, however — the level and mix of skills required, and the problems of navigating through a hypertext information base.

Constructing a CD-ROM document is a major undertaking. The document may well contain tens of thousands of frames of information. To create an effective CD-ROM document, you require people who are good with words, people who are good with images, and people who can program. Moreover, it requires substantial management flair to get a mix of that type to work together.

The navigation problem is a result of the flexibility that hypertext provides to readers (and authors). In a system containing 50,000 chunks of information, the pattern of linkages can become very complex, making it difficult to navigate through the system. The scale of the problem is illustrated overleaf by Figure 14 which shows a sample from the Intermedia English literature course at Brown University. The document shown contains information about authors and publications and critical comment, all interlinked to form the complex spider's web shown in the figure.

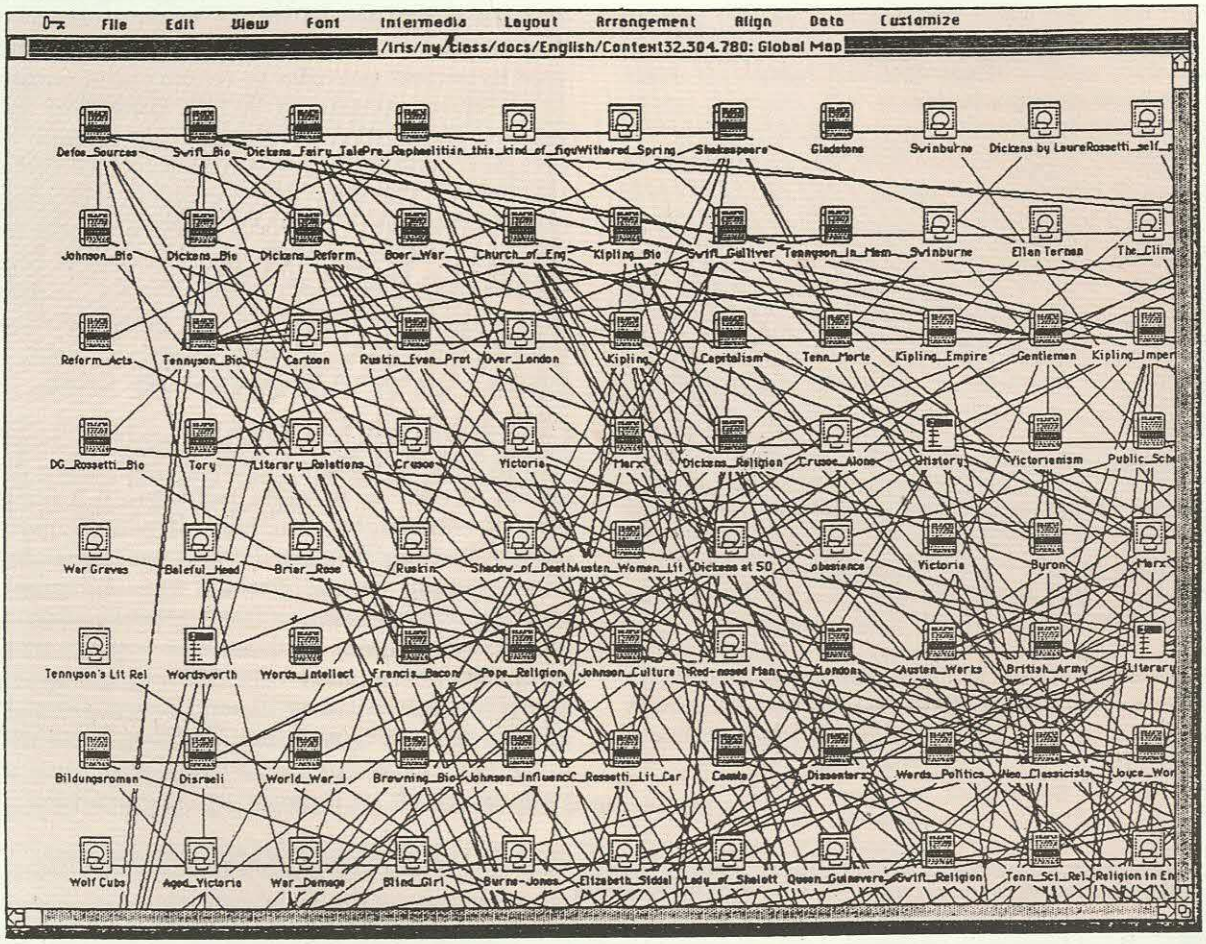
Considerable skill is required to construct the links in a hypertext system in a way that makes navigation as easy as possible and there is a notable lack of established principles of good hypertext design. Developers have devised a number of aids to navigation, several of which were discussed on page xx. One technique used by Intermedia can be seen in Figure 12. Near the top-left of the screen there is a panel ('Local Tracking Map') that shows the links between the chunk being displayed and its nearest neighbours. Other systems use a much more aggregated view of the structures, and various search techniques are also available.

RUNG 3: PERSONAL KNOWLEDGE ORGANISERS

After interactive publications, the next rung on the hypertext applications ladder contains what I call 'personal knowledge organisers', which will be used to keep track of and integrate the many small files generated by the typical business PC user. Today, most office automation activity is based on various types of PC packages. Typically, a user will have a spreadsheet package, a word processing package, database package, a graphics package, and perhaps two or three others. However, the packages are used individually and there is little linkage between them. The only common feature is the need to store and retrieve files of information generated by the packages. What usually happens is that, after about 18 months or so, the user ends up with a large number of files, some with cryptic names, some with names in plain language. The user reaches the stage where he or she can no longer remember which files belong to which package, or even what their contents are. The effort of keeping track of the myriad of small files is beyond human capacity.

Hypertext could be used as a means of organising this material. Links could be established, for example, between a spreadsheet that contains the cost model for a particular client and the text file that contains the report in which the costs were presented to the client. Using hypertext in this

Figure 14 A map of part of the English literature course at Brown University



way means it is no longer necessary to keep track of the version of the model that was used for a particular client.

Apple has been positioning HyperCard as a personal knowledge organiser. It is certainly possible to use HyperCard in this way, provided you can dedicate a Macintosh with one megabyte of memory to HyperCard. Figure 15 shows how it would work. Starting with the 'Home Card', you would press the button that indicates the office automation functions. This brings up the first card of the Address stack. Note the other icons on this card. Pressing any of these would transfer the user to another stack — Reminders, for example, or Calendar. These standard stacks are provided with HyperCard, and the user is able to customise them with his or her own information.

If there are requirements not covered by the standard stacks, users can build their own stacks and insert information into the cards. For example, I could construct a stack that contains information about hypertext products. I could then cross-reference cards in this stack to a separate stack containing information about academic institutions. Thus the card containing information about the Turing Institute and its activities would be cross-referenced to the card describing HyperCard.

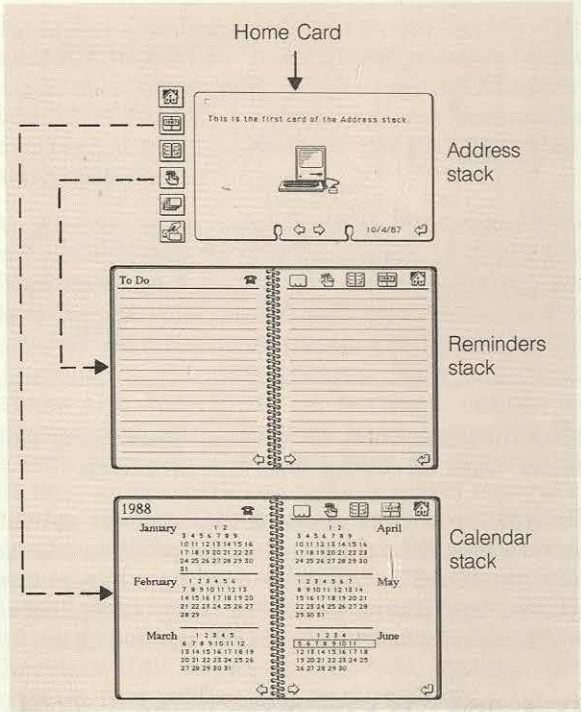
This all sounds very good in theory, but I must emphasise that considerable work is still required to determine the best types of links and structures for coordinating and organising all the separate information.

RUNG 4: WORKGROUP COLLABORATION

Although there is a considerable need for personal knowledge organisers, in most organisations people work in groups. So what is actually required is a set of tools that are personal in their application but that also support group working. This means that the tools need to support not only messaging, but the construction of 'knowledge structures' that allow members of the group to file and retrieve information.

Consider, for example, the documentation for a computer program. If the documentation is embedded in the program source code, it will swamp the code itself. Maintaining the documentation as

Figure 15 Using HyperCard as a personal organiser



a separate document also has drawbacks because it is quite likely that the latest version of the program will not match the documentation. Moreover, when the program is amended, the programmer often requires more than just a listing of the program and a description of what it should do. Usually, background information describing the history of the program, the studies and models that were done originally, the rationale for the data structures, and so on, are required as well. Much of this information is contained in correspondence between system developers, and between them and the client, and in file notes. Most readers will be familiar with the problem. The relevant correspondence cannot be found, and the client cannot remember the details of what was decided. The result is that the program is inadequately amended and the amendment causes all sorts of unforeseen problems.

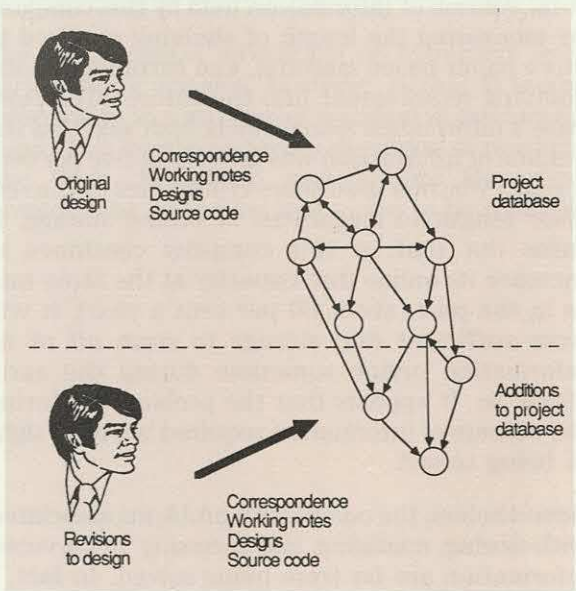
What is required is a procedure that captures the links between correspondence, working papers, modelling exercises, and so forth — all the information relating to why the program was designed and written in the particular way it was. Furthermore, this information should be organised so that it can be accessed easily by people not involved with the original development. Hypertext seems an ideal means of capturing these connections. MCC (Microelectronics and Computer Corporation) in Austin, Texas, the joint research operation funded by major US IT suppliers, is working on using hypertext in this way. There is also considerable research effort into ways of linking hypertext systems with computer-aided systems engineering tools.

Figure 16 illustrates the way that hypertext might be used for workgroup collaboration. Designers enter correspondence, working papers, designs, and source codes into a hypertext database. Some time later, when circumstances have altered, another designer may need to make some changes. This second designer can use the hypertext system to link new insights, new ideas, into the original model as shown in Figure 16. In this way, the designers will always be working with the most up-to-date information. Each person in a group can use the hypertext system, adding their own documents and making their own notes. An important advantage of hypertext is that the new material is automatically available to people consulting the original parts of the database.

The same type of problems occur in any major engineering project. The documentation problems of computer systems are trivial compared, for instance, with the documentation required to build a nuclear power station.

In 1980 a hypertext system called ZOG was used in the commissioning of a nuclear powered aircraft carrier, the *USS Carl Vinson*. ZOG was developed by staff from Carnegie Mellon University in close collaboration with naval officers. ZOG ran on a network of 28 PERQ workstations and supported online manuals, a task-management system, and an interface to an expert system. The KMS product, available from Knowledge Systems Inc., is derived from ZOG.

Figure 16 Using hypertext for a software project database

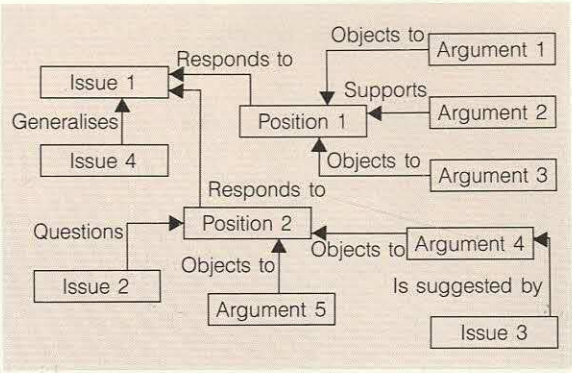


Hypertext systems can also be used for group collaboration outside the engineering field. The IBIS system was developed to help planners and analysts tackle 'wicked problems' — problems that lack a clear scope and definition.

IBIS provides a form of computer conference in which contributions are organised in terms of 'positions' on 'issues'. For example, if the issue is whether to close a foreign subsidiary, the marketing director might take the position that this should not be done because of the resulting loss of credibility in foreign markets. Other participants might take other positions or advance arguments for or against positions.

Figure 17 shows what an IBIS conference might look like. IBIS allows all of the arguments for and against a particular position to be assembled and examined. Although it is an experimental system, it is a good example of what can be achieved with hypertext.

Figure 17 Part of an IBIS conference



RUNG 5: THE HYPERVERSE

Beyond workgroup collaboration on my hypertext applications ladder is the 'hyperverse' — the all-embracing system for organising knowledge. The hyperverse can be thought of as a generalisation of workgroup collaboration — not just to a single workgroup, but to everyone who might want to comment on a topic, or access information about it. There are daunting problems to be overcome before the hyperverse can become a reality — not least being the sheer volume of published material.

However, the scope of the problem may not be as vast as it may at first sight appear. A couple of years ago, we did some consulting work for a major oil company to help them determine their future information-storage requirements. We assessed the total volume of information held by this company by measuring the length of shelving required to store paper-based material, and extrapolated the shelving requirement into the future. (The company's information management staff said that the volume of information was growing at five per cent a year.) We then used some crude rules to convert shelf length to megabytes of online storage. It turns out that, if this company continues to increase its online disc capacity at the same rate as in the past (about 60 per cent a year), it will have sufficient disc storage to store *all* of its information online sometime during the early 1990s. So, it appears that the problem of storing the volume of information required is within sight of being solved.

Nevertheless, the complexity problems associated with storing, managing, and accessing 'hyperverse' information are far from being solved. In fact, I suspect that the problems are not solvable in an absolute sense. Instead, we shall most likely find better ways of coping with the problems.

Even if the technical problems could be solved, there will still be a host of other problems. Huge funding would be required to set up a hyperverse system, and there would be very complicated problems concerning copyright and royalties.

HYPERTEXT IN CONTEXT

Because of its derivation from database and document-processing systems, hypertext exhibits similarities to a variety of other kinds of computer systems.

In some ways hypertext is similar to packages that help you to structure and prepare the outline of a document. However, hypertext goes further because it is concerned equally with reading the material. Indeed, some people claim that hypertext breaks down the distinction between writers and readers and that is certainly true for workgroup collaboration applications. Hypertext also has similarities to word processing systems, except that most word processors cannot help you to structure documents.

In other ways, hypertext is similar to videotex. The information-presentation facilities of videotex are fairly primitive, however, whereas hypertext systems emphasise high-quality presentation. Hypertext also provides better navigation facilities than videotex.

There are also similarities between hypertext and relational databases. However, relational databases have predefined structures, whereas the essence of hypertext is to allow the links to evolve. Significantly, the Brown University Intermedia system is based on the Ingres relational database system, and this is causing difficulties. Brown University has publicly stated: "we really wish we could find a better management system." Clearly, there is a need to match the state-of-the-art in

managing structured data with that for document management.

Hypertext also has considerable similarities with semantic networks (which are used in some artificial intelligence systems to represent knowledge). However, semantic networks can be interpreted automatically; in general, hypertext structures cannot.

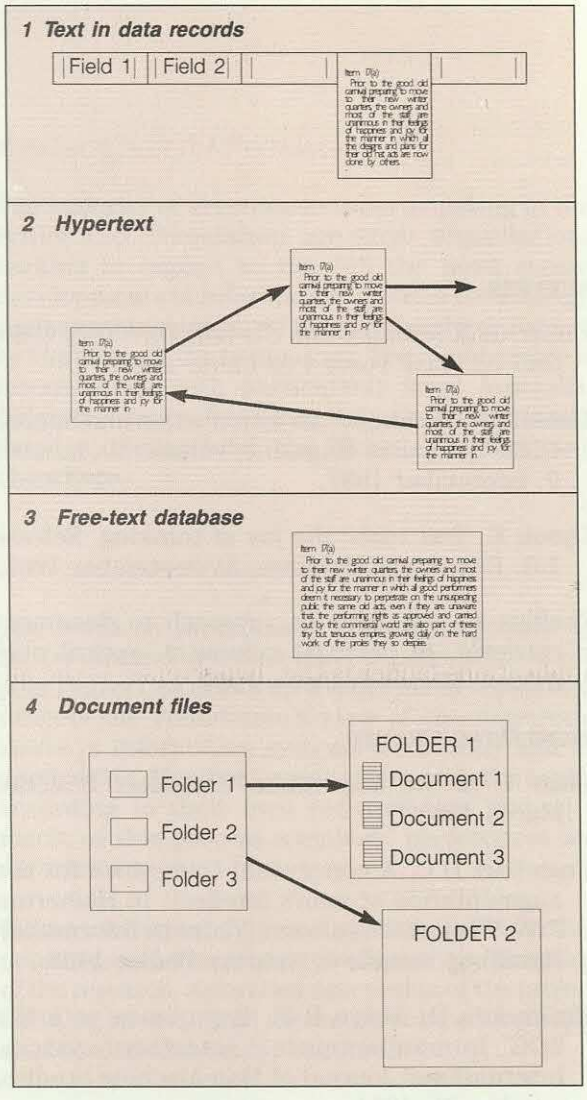
An alternative approach is to see hypertext as one form of text-data integration. Figure 18 shows four diferent ways of storing text. At the top, there are data records with embedded text fields. In this case, the structuring of the text is defined by the structure of the data records. With hypertext, where the structuring is between chunks of information, the links have to be set up by the author. Free-text databases have no structure at all but, given sufficient patience and computer power, useful information can be retrieved. Document-filing systems, like those available as part of the standard software on the Macintosh, do not provide any assistance in helping to decide which document should be retrieved. Hypertext therefore fits between free-text systems and systems that embed text in data fields.

THE SIGNIFICANCE OF HYPERTEXT

In summary, it is not yet possible to define precisely what hypertext is and is not. It is more an idea rather than a complete specification. Without doubt, though, hypertext is developing extremely rapidly, at both the research and commercial levels.

Hypertext is already a proven technology for on-line help and large online technical documents. It can now provide the basis for multimedia documents. In the discussion about personal knowledge organisers and workgroup collaboration, I implied that there was a need for a new basis for office systems. I believe that hypertext provides a key element of the new basis. Unfortunately, before hypertext can be exploited in this way it will be necessary for existing packages to be rewritten to use hypertext documents rather than standard files.

Figure 18 Hypertext in context: four different ways of storing text



The fundamental advantage of hypertext over earlier filing systems, however, is that it stores information in a way better matched to the human mind. This insight underlies the vision of pioneers like Bush, Englebart, and Nelson. Hypertext provides the means for that vision to be realised.

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BUTLER COX FOUNDATION

Butler Cox

Butler Cox is an independent management consultancy and research organisation, specialising in the application of information technology within commerce, government, and industry. The company offers a wide range of services both to suppliers and users of this technology. The Butler Cox Foundation is a service operated by Butler Cox on behalf of subscribing members.

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The Butler Cox Foundation sets out to study on behalf of subscribing members the opportunities and possible threats arising from developments in the field of information systems.

New developments in technology offer exciting opportunities — and also pose certain threats — for all organisations, whether in industry, commerce, or government. New types of systems, combining computers, telecommunications, and automated office equipment, are becoming not only possible, but also economically feasible.

As a result, any manager who is responsible for introducing new systems is confronted with the crucial question of how best to fit these elements together in ways that are effective, practical, and economic.

While the equipment is becoming cheaper, the reverse is true of people — and this applies both to the people who design systems and those who make use of them. At the same time, human considerations become even more important as people's attitudes towards their working environment change.

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The majority of organisations participating in the Butler Cox Foundation are large organisations seeking to exploit to the full the most recent developments in information systems technology. An important minority of the membership is formed by suppliers of the technology. The membership is international with participants from Australia, Belgium, France, Germany, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom, and elsewhere.

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