CHAPTER 7

APPLICATIONS

1. Introduction

Many existing information management systems that try to capture relationships between real world entities are not able to express them completely due to limitations in their structure and information retrieval techniques. The hypermedia paradigm provides a new and improved approach to developing complex information management systems in order to increase their effectiveness and usage. In this chapter, we review some of the applications based on the concept of hypermedia.

2. Encyclopedias, Dictionaries, Manuals, Handbooks, and Online Documents

A hypertext form of a voluminous dictionary such as the Oxford English Dictionary (OED) will not only help find meanings for words but also help us manage our daily knowledge work better [Raymond & Tompa, 1988]. In addition to browsing, complex queries can be built and intelligent searches can be performed. That is, users typically refer to dictionaries as part of more extended tasks. Improved navigation and IR mechanisms will greatly assist the information gathering process. Since much of the OED is made of quotations, links can be directly established to the source of the quotation or to other texts.

The field of medicine requires immediate evaluation and treatment of most ailments. Many a times, physicians have to recall general approaches to diagnosis and treatment of a particular ailment based on their previous experience with other patients. They have to retrieve previous medical records of patients, literature on the subject published in a journal, notes from another colleague etc. Such associations of material from diverse sources can be made easily accessible by using hypertext based information systems. Washington University developed the Dynamic Medical Handbook to provide immediate and easy access to medical information to medical professionals [Frisse, 1988]. Chapters from the Manual of Medical Therapeutics were converted to hypertext format. The handbook combined traditional IR mechanisms with browsing techniques to improve information retrieval. Such dynamic medical books, also called "hyperbooks" are widely used in medical schools. These hyperbooks can be integrated with medical media such as X-rays, CT images, MRI images, Charts, and Graphs into a medical "hyperlibrary". Such a system can help collaborative work in medicine where physicians, radiologists, and surgeons can diagnose and suggest treatments over a distributed hypermedia network with telepointing, annotation etc.

Users tend not to read printed manuals since finding the relevant information is cumbersome. Hypertext systems are the obvious choice for providing online documentation since they enable easy and flexible ways of accessing only relevant information. Online documentation can be combined with online help, tutorials, and error recovery. For example, an error message can be linked to some help text which can elaborate on the problem - why it occurred and how it can be remedied. Nielsen calls such online assistance as integrated user assistance [Nielsen, 1990].

Incorporating hypermedia in documentation allows document designers and users to create an unlimited number of independent contexts or perspectives over the same hypertext network, each constructed for a different category of users [Maurer & Tomek, 1990]. Such tailorable tutorials or views can cater to novices as well as experts using the same corpus of material. This eliminates duplication of the material for different audiences.

3. Learning Systems, Museum Exhibits, and Interactive Kiosks

Hypertext paradigm is highly suitable for learning systems in order to encourage learning by exploration. Epics and classics can also be represented in hypertext form. The Shakespeare Project was started in order to exploit multimedia and hypertext technology providing educators a radically new way to teach not only Shakespeare and theater, but also disciplines such as psychology, sociology, and communications which depend on the observation of complex, visually dense, and hard-to-record events [Friedlander, 1988].

Various applications in the Intermedia environment have together been used to create educational material for courses in English and Cell Biology [Yankelovich et al., 1988]. These interactive courses also encouraged students to submit term papers using hypermedia tools by referring to each others' papers. These experiments illustrated some interesting aspects of group dynamics involved in a collaborative class environment.

Museum goers gather information by exploration and hypertext systems can be used to describe the various exhibits. Hypertext-based museum information systems can provide visitors with a greater degree of involvement [Shneiderman & Kearsley, 1989]. The HyperTies system has been used at several museums, including the Smithsonian Institution, to describe museum exhibits on the Holocaust and "King Herod's Dream". Interactive kiosks can be used as tourist guides since tourists would like to read only parts of the information available about a city or country. Glasgow Online is another popular hypertext tourist guide that provides a subject-oriented overview such as city profile, accommodation, maps, places of interest, shopping centers etc. Selecting one of these topics will take the user through a trail of items related to the topic. The tourist can be looking at the city profile and be interested in a hotel in a certain price range. He or she can then search for accommodation fitting the requirement which would yield a list of hotels. The hotel of interest can then be located in a map of the region.

4. Idea Processing

Hypertext systems can be used for idea processing and brainstorming since both are made of a large number of disparate chunks of information put together by associations. Conferencing systems support idea processing and are suitable for hypertext features. Hypertext systems can also be used in journalism since it involves putting together various news items and stories. In fact, research or literature review such as this paper, will greatly benefit through hypertext authoring tools instead of word processors. We should be able to scan in the original documents (copyright laws permitting) used as references. When a reference is made to a document, a reference item should be created and the user should have the option to look at the original document on the screen.

NoteCards supports such collaborative idea processing where users in a group can create nodes, add links to nodes created by others, and add annotations to other nodes. It provides a rich and extensible set of tools to capture, represent, link, manage, and communicate ideas [Halasz, 1988]. Users can transform informal and unstructured ideas into formal analyses and structural representations. In addition to end-user tools, NoteCards provides a set of well-defined methods and protocols for programmatically manipulating the hypertext network. Examples of applications in which NoteCards has been used are researching and writing complex legal briefs, analyzing arguments presented in scientific and public policy articles and managing general personal and project information for small group research projects. It has also been used for a number of interactive, non-linear, multimedia reference manuals.

SEPIA (Structured Elicitation and Processing of Ideas for Authoring), is an active, knowledge-based authoring and idea processing tool for creating and managing hypertext documents [Streitz et al., 1989]. The main principle behind this system is the idea of cognitive compatibility - the system provides an environment to the author consisting of properties inherent to different cognitive activities and structures of writing. The system is task-oriented and through different representations supports the easy mapping of internal structures to external structures and vice versa. The system provides a variety of "activity spaces" which differ both in structure and functionality. The "content space" provides facilities to collect information, generate, and structure ideas for the content domain. The "planning space" provides support to the author in setting up an agenda, coordinating and directing all sub-activities, and monitoring and revising plans and goals. The "argumentation space" serves as the medium for generating, ordering, and relating arguments for specific issues, addressing one issue at a time. The "rhetorical space" allows structuring the outline of the final document, the rhetorical organization of positions and arguments for each sub-issue and the development of a coherent document.

The writing process is not straightforward but a criss-cross of interactions between these activity spaces. Information flows from the planning space to the other three phases: Issues specified in the planning space set topics for the content space, direct the structuring of positions and arguments for the argumentation space which are then transformed into an outline in the rhetorical space. On the other hand, information also flows directly from these spaces back to the planning space. This helps in refining the planning space also called "opportunistic planning".

5. Collaborative Work and Computer Mediated Communications

Hypermedia is highly appropriate for collaborative work. In addition to being used as a tool for idea processing, NoteCards has been used for collaborative writing. Since this activity can be highly coupled and unstructured, hypermedia is the most appropriate technology to represent both the work and the discussion about the work (meta-discussion) and about sharing the medium [Irish & Trigg, 1990]. Also, the rationale for decisions made during the writing activity can be preserved for historical purposes. NoteCards provided the environment for people to capture, structure, compare, and manage large amounts of loosely structured textual, graphical, and numerical information. In order to support the social interactions inherent in collaborative work and shared access to networks of information, NoteCards required multi-user access and concurrency control mechanisms, and version control. Irish and Trigg state that hypermedia is a good medium for supporting meta-discussions for the following reasons:

Meta-discussion often needs to directly refer to portions of the actual discussion.

A record of the meta-discussion preserved in context can be valuable for historical and chronological access.

From a Computer Mediated Communications (CMC) point of view, hypertext can be "viewed as a mechanism to enable an individual to impose a cognitive viewpoint on a collaborative database, and to facilitate group agreement on a shared understanding of the resulting semantics." [Turoff et al., 1991]. In a group project, each member of the team is working towards a sub-goal which forms part of a larger objective for the organization. Such an environment requires tracking, linking, and reorganization of information related to various sub-goals and the main goal itself. It can be argued that every CMC system capable of mail, conferences, comments, replies, and notifications can be viewed as a variation of the hypertext concept. For example, in EIES2, the facilities to reply to a mail item or add an attachment which form branches to the original piece of material can be considered a hypertext feature. The ability to cross-reference through keywords, and associated comments can be considered another hypertext feature.

Turoff et al., extend the general framework for hypertext functionality (covered in Chapter 6), to include a general morphology of terms for node and link types. Such a general approach allows users of a system to freely assign their own semantics to objects and relationships. The semantic model for hypertext-based collaborative systems should support the full range of human intellectual abilities. That is, such a system should allow any group member to define and describe objects (nodes) and relationships (links) between objects incorporating the full range of possible meanings for those nodes and links. Collaborative hypertext should also provide information about the composition or evolution process, the way the network is dynamically changing. This can be achieved by creating a "group memory" where nodes and links created during the collaborative process can be accumulated. Collaborative hypertext systems should support "collaborative intelligence where the group can obtain a far more intelligent result than the most intelligent member would have acting alone." [Turoff et al., 1991].

An application called InterNote has been implemented in the Intermedia framework to support annotative collaboration [Catlin et al., 1989]. The annotative collaboration process involves commenting, questioning and critiquing others' work. In addition, these notes or annotations can be assimilated back into the original document to create a new and improved version of the document. The facility to incorporate annotations into the original document, resulting in data transfer across the annotation link, is called ***warm linking***. The system also supports annotation management, simultaneous multi-user annotation, and contention management.

The Virtual Notebook System (VNS) is a collaborative environment for scientific groups engaged in basic and clinical research in an academic medical center [Shipman III et al., 1989]. This system supports information acquisition, information linking and sharing, and information management in a group environment. It is capable of maintaining information about hypotheses, notes, and other relevant information which can be shared with other researchers located at remote sites. The system has facilities to import information from external sources such as electronic mail, USENET bulletin boards, bibliographic services, genetic sequencing information, and clinical databases.

Researchers who developed ABC, a hypermedia system for Artifact-Based Collaboration, consider the output of a group problem-solving process as an artifact [Smith & Smith, 1991]. For example, in the software development process, the artifact consists of concept papers, architecture, requirements, design specifications, programs, diagrams, references, and user manuals. The system can manage source code trees (as hypertext graphs), decomposition diagrams, call-flow diagrams, and uses-hierarchy diagrams. ABC contains six key components - a graph server, a set of graph browsers, a set of application programs, a shared window conferencing facility for synchronous and asynchronous communications, real-time audio and video, and a set of protocol tools to study group behavior and strategies.

6. Decision Support Systems and Issue Based Information Systems

Incorporating hypermedia with Decision Support Systems can greatly enhance the decision making process. This can be achieved by adding computation and dynamism to hypermedia. A knowledge-based Decision Support System called Max has been developed which incorporates hypermedia facilities to navigate among DSS application models, data, and reports [Bieber, 1993]. It supports browsing by analysts as well as executives. Analysts can execute decision models under various scenarios. Reports are dynamically created and they can incorporated with other models, data, and reports to produce summaries containing embedded generalized hypertext links. On the other hand, executives can browse through these final reports and follow hypertext links, if necessary, to look at information supporting an analyst's recommendations and findings [Bieber & Kimbrough, 1991].

Max contains the interface subsystem and the application manager subsystem. The interface subsystem contains the hypermedia engine and it is responsible for the dynamic creation and display of interactive hypermedia documents and menus based on application requests. The application manager subsystem provides the interface between the hypermedia engine and the underlying DSS applications such as finance, engineering, manufacturing, etc. These applications contain domain specific decision models (mathematical models) and data. This subsystem also provides the commands to execute the models, provide explanations, and generate reports. Elements in the application's knowledge base are mapped to components in the hypermedia engine through translation routines called bridge laws (See Chapter 6).

Issue Based Information Systems (IBIS) help members of a project team discuss issues related to a problem and come to a consensus on a solution. The graphical Issue Based Information System (gIBIS) from MCC is one such system which was built to capture the design rationale for software projects. Software design is a collaborative process in which various team members contribute their expertise and viewpoints to discuss the design. In gIBIS, participants in the online discussion argue about design issues by taking positions and making arguments for and against those positions. These position arguments are represented in a hypertext structure with three types of nodes: issues, positions, and arguments. Users can display overview diagrams to glance at the design rationale and look at the underlying text if required.

7. Software Engineering

Software design and development is accomplished through the cooperative efforts of team members who have to maintain an active information base in order to improve communication and coordination. Such an active information base can be achieved by applying hypertext to the Software Development Life Cycle (SDLC) [Balzer et al. 1989]. A number of documents are produced during different phases of the life cycle. These can be integrated together to form a highly cross-referenced body of information. For example, a design module in the design statement can be tied to its appropriate requirements specification and also to the relevant fragment of source code. Fragments of code can be linked to technical manuals. Similarly, several tools and concepts of software engineering can be applied to the development, use, and maintenance of hypertext systems.

DynamicDesign was developed at Tektronix as a CASE tool based on hypertext [Bigelow & Riley, 1987]. It is used to store and link C source code, requirements specifications, and other documents. A utility called graphBuild converts C source code into a hypertext graph based on the program's call tree. A data dictionary is built for the program containing its local and global variables. It also contains sourceBrowse, a browser that allows the developer to traverse, view, and edit a source code tree.

The Documents Integration Facility (DIF) was developed at the System Factory, University of Southern California integrating a hypertext system with software engineering tools [Garg & Scacchi, 1987]. This "software hypertext system" was implemented to exploit the facilities of software engineering tools for automated software development and the unique storage and retrieval mechanisms of hypertext. Based on the experiences with DIF, it was realized that there was a need for developing a hypertext system that could utilize its knowledge about its users and their software tasks and products. Such a system would actively participate in the software development process rather than being just a passive storage facility. The researchers later developed the Intelligent Software Hypertext System (I-SHYS). The knowledge about the environment was partly embedded in the design of I-SHYS while the remaining was defined during the use of I-SHYS.

8. Other Applications

8.1 Simulation and Modeling

The hypertext paradigm has been applied to a biological research problem to study the energetics model of Cassin's Sparrows [Schnase & Leggett, 1989]. This model tracked the daily energy expenditure of individual, adult sparrows. The computations and book-keeping activities associated with the simulation of the model and the analysis of field data were performed in an integrated hypertext environment using KMS on Sun workstations. Apart from hypertext related activities such as browsing, authoring, and annotating, researchers could write and run simulation programs. The resulting tables and figures could be integrated into the hypertext. This research proved that computational hypertext is appropriate for scientific applications, management of personal and group information, and community scholarship.

8.2 Law

Attorneys need a powerful information processing facility to gather information about cases, cross-reference them appropriately, retrieve them at great speed during trials and represent their ideas efficiently. They also need tools to make notes in a courtroom which can be shared with other attorneys to work on cases more effectively. In one law firm, it was found that all these activities could not be managed and linked even though there were a plethora of systems for word processing, electronic mail, billing, file management, and relational databases. Hypertext was used in this law firm to efficiently manage information about intellectual property. A system called HyperLex was developed using KMS to assimilate intellectual property information from various sources such as patents, trademarks, copyrights, trade secrets [Yoder & Wettach, 1989]. Information collected in this manner was properly organized, and cross-referenced to produce legal contracts, patent applications, court briefs and motions, and legal advice to clients. The system also provided links to group bulletin boards, calendars, employment agreements, and information on other previously published works. This system was used to catalog documents for a trial in which more than 10,000 documents had to be managed.

8.3 World Wide Web

World Wide Web (W3) is a hypertext-based information retrieval mechanism providing information access across heterogeneous platforms mainly connected over Internet [Berners-Lee, 1992]. It is based on the philosophy that information should be freely available to anyone. We can say that it is a small step towards Nelson's vision of a docuverse. The W3 architecture has allowed many existing hypertext systems and information bases to be incorporated as part of the web by gateway servers. W3 was developed for High Energy Physicists at CERN to share information with their counterparts across the rest of the academic community. It has now been extended to cover over 80 topics from Aeronautics to Social Sciences. W3 is based on a client/server architecture and the information (subject files) can reside anywhere on the network. Browsers use the File Transfer Protocol (FTP) and they can be installed at local sites to access remote webs. Each browser can handle, at a minimum, plain text as well as simple SGML formats.

8.4 User Interface Design

Hypertext can be used to prototype the user interface for any interactive system since horizontal prototyping (look and feel) involves designing windows (treated as nodes) and linking them together through menus and buttons and presenting the entire interface as a set of navigation paths [Nielsen, 1990].

8.5 Organizational Hypermedia

Organizational hypermedia is hypermedia technology applied to the information processing needs of an organization where information is shared among individuals [Isakowitz, 1993]. Daft and Lengel had stated that uncertainty and equivocality are two problems faced by present-day organizations. Hence, they acquire more information in order to reduce uncertainty. However, this does not solve the problem of equivocality or ambiguity inherent in organizational tasks. Minimization of equivocality requires face-to-face discussions and rich exchange of views among decision makers. Both uncertainty and equivocality can be reduced by employing hypermedia functionality in organizational information systems. Since hypermedia provides the structural mechanisms to manage complex relationships between various pieces of information, it can support equivocality reduction (similar to CMC systems). However, experiments are required to support these theories. Similar to group memory in a collaborative system, an organization manages information in a repository called "organizational memory". Organizational memories contain entities such as facts, positions, and events which are highly suitable for hypertext representation. However, hypermedia systems should address some of the problems associated with organizational memory such as pollution, growth, waste, restructuring, interoperability, and flexibility.

The following are some of the research issues related to organizational hypermedia:

The task perspective: Identification of applications based on tasks which are best suited for hypermedia implementation.

The knowledge perspective: Since most organizations handle knowledge/information, hypermedia should be able to represent and manage knowledge structures.

The integration perspective: Organizations have invested a great deal of resources towards many existing information systems. Introduction of hypermedia functionality should be seamless across these systems and hypermedia systems.

9. Summary

The hypermedia paradigm can be extended to many traditional information management systems as well as emerging complex information systems. Some of the application areas that can be greatly improved by incorporating hypermedia technology include online documentation, electronic encyclopedias, interactive kiosks, learning systems, idea processing environments, decision support systems, collaborative systems, issue based information systems, software engineering, and medical information systems.

References

[Balzer et al., 1989]. Balzer, Robert, Begeman, Michael, Garg Pankaj K., Schwartz, Mayer, and Shneiderman, Ben. Panel Discussion on Hypertext and Software Engineering, Proceedings of Hypertext ’89, ACM Press, 1989.

[Berners-Lee, 1992]. Berners-Lee, Tim. An Architecture for Wide Area Hypertext, Hypertext ’91 Poster Abstract, SIGLINK Newsletter, December 1992.

[Bieber, 1993]. Bieber, Michael. Automating Hypermedia for Decision Support, Hypermedia, Volume 4, Number 2, 1993.

[Bieber & Kimbrough, 1991]. Bieber, Michael and Kimbrough, Steven O. On Generalizing the Concept of Hypertext, Management Information Systems Quarterly, 1991.

[Bigelow & Riley, 1987]. Bigelow, James and Riley, Victor. Manipulating Source Code in DynamicDesign, Proceedings of Hypertext ’87, ACM Press, 1987.

[Catlin et al., 1989]. Catlin, Timothy, Bush, Paulette, Yankelovich, Nicole. InterNote: Extending a Hypermedia Framework to Support Annotative Collaboration, Proceedings of Hypertext ’89, ACM Press, 1989.

[Friedlander, 1988]. Friedlander, Larry. The Shakespeare Project Interactive Multimedia, Editors Sueann Ambron and Kristina Hooper, Microsoft Press, 1988.

[Frisse, 1988]. Frisse, Mark E. Searching For Information in a Hypertext Medical Handbook, Communications of the ACM, July 1988.

[Garg & Scacchi, 1987]. Garg, Pankaj K., and Scacchi, Walt. On Designing Intelligent Hypertext Systems for Information Management in Software Engineering, Proceedings of Hypertext ’87, ACM Press, 1987.

[Halasz, 1988]. Halasz, Frank G. NoteCards: A Multimedia Idea Processing Environment, Interactive

Multimedia, Editors Sueann Ambron and Kristina Hooper, Microsoft Press, 1988.

[Irish & Trigg, 1990]. Irish, Peggy M., and Trigg, Randall H. Supporting Collaboration in Hypermedia: Issues and Experiences, The Society of Text, Edited By Edward Barrett, MIT Press, 1990.

[Isakowitz, 1993]. Isakowitz, Tomas. Hypermedia, Information Systems, and Organizations: A Research Agenda, Proceedings of the Twenty-Sixth Annual Hawaii International Conference on System Sciences, January 1993.

[Maurer & Tomek, 1990]. Maurer, Hermann, and Tomek, Ivan. Broadening the Scope of Hypermedia Principles, Hypermedia, Volume 2, Number 3, 1990.

[Nielsen, 1990]. Nielsen, Jakob. Hypertext and Hypermedia, Academic Press, 1990.

[Raymond & Tompa, 1988]. Raymond, Darrell, R., and Tompa, Frank Wm. Hypertext and The Oxford English Dictionary, Communications of the ACM, July 1988.

[Shipman III et al., 1989]. Shipman, Frank M., Chaney, R. Jesse, and Gorry, G. Anthony. Distributed Hypertext for Collaborative Research: The Virtual Notebook System, Proceedings of Hypertext ’89, ACM Press, 1989.

[Schnase & Leggett, 1989]. Schnase, John L., and Leggett, John J. Computational Hypertext in Biological Modelling, Proceedings of Hypertext ’89, ACM Press, 1989.

[Shneiderman & Kearsley, 1989]. Shneiderman, Ben and Kearsley, Greg. Hypertext Hands On! An Introduction to a New Way of Organizing and Accessing Information, Addison Wesley Publishing Company, 1989.

[Smith & Smith, 1991]. Smith, John B., and Smith, F. Donelson. ABC: A Hypermedia System for Artifact-Based Collaboration, Proceedings of Hypertext ’91, ACM Press, 1991.

[Streitz et al., 1989]. Streitz, Norbert A., Hannemann, Jorg, and Thuring, Manfred. From Ideas and Arguments to Hyperdocuments: Travelling through Activity Spaces, Proceedings of Hypertext ’89, ACM Press, 1989.

[Turoff et al., 1991]. Turoff, Murray, Rao, Usha, and Hiltz, Starr Roxanne. Collaborative Hypertext in Computer Mediated Communications, Proceedings of the Twenty-Fourth Annual Hawaii International Conference on System Sciences, January 1991.

[Yankelovich et al., 1988]. Yankelovich, Nicole, Smith Karen E., Garrett, L. Nancy and Meyrowitz, Norman. Issues in Designing a Hypermedia Document System, Interactive Multimedia, Editors Sueann Ambron and Kristina Hooper, Microsoft Press, 1988.

[Yoder & Wettach, 1989]. Yoder, Elise and Wettach, Thomas C. Using Hypertext in a Law Firm, Proceedings of Hypertext ’89, ACM Press, 1989.