Hypertext Functionality

Michael Bieber

New Jersey Institute of Technology
Hypermedia Research Laboratory
Computer and Information Science Department
University Heights, Newark, New Jersey 07102 U.S.A.
Email:bieber@njit.edu
Web: http://www-ec.njit.edu/~bieber

Harri Oinas-Kukkonen

University of Oulu
Department of Information Processing Science
FIN-90570 Oulu, Finland
Web: http://www.tol.oulu.fi/~hok
Email: Harri.Oinas-Kukkonen@oulu.fi,

V. Balasubramanian

Contexture, Inc.
Email: bala@contexture.com

Abstract: The Hypertext Functionality field studies techniques for and the impact of supplementing everyday computer applications with hypertext (or hypermedia) functionality (HTF). The HTF approach encourages system developers to think actively about an application's interrelationships, and whether users should access and navigate along these relationships directly. It views hypertext as value-added support functionality. The HTF approach fosters three major areas of research: using HTF to improve personal and organizational effectiveness, HTF and application design,and integrating HTF into applications.

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Hypertext Functionality

The Hypertext Functionality field [HTF 1999] studies techniques for and the impact of supplementing everyday computer applications with hypertext functionality (HTF). We view hypertext as value-added support functionality [Oinas-Kukkonen 1995]. Hypertext structuring, annotation and navigational functionality can enrich business, scientific, engineering and personal applications, thereby making them more effective. People use these applications

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primarily for their underlying analytical functionality, i.e., not for their ability to produce hypertext documents or displays. People will not abandon the applications they use everyday in favor of those that offer hypertext. Developers therefore must find it relatively easy to retrofit HTF to existing applications, as well as incorporate HTF into new ones. HTF should be integrated and deployed so seamlessly that users do not find its presence at all out-of-place. Augmenting applications with direct access and hypertext structuring, annotation and navigation functionality [Bieber 1997] should result in new ways to: view an application's knowledge and processes conceptually; navigate among items of interest and task stages; enhance an application's knowledge with comments and relationships; and target information displays to individual users and their tasks.

Hypertext structuring functionality includes local and global information overviews; alternate views and contexts; transclusions that preserve context by "including" the original content at all places that use it and maintaining links between all these uses; link propagation; node, link and anchor typing; as well as keywords and other attributes on all of these. Navigation encompasses access ranging from information retrieval to browsing. This includes content- and structure-based query; history-based navigation and sophisticated backtracking; bi-directional linking; dynamic and computed linking; and process enactment or execution through link traversal. Annotation includes bookmarks, landmarks, manual linking and commenting. Note that many of these features can be shared in collaborative environments. Many also can be personalized for different users and tasks. We consider the terms hypertext and hypermedia synonymous. Nominally hypertext refers to relating textual elements, while hypermedia encompasses relationships among elements of any media type. The concepts are identical, though hypertext is more difficult to implement in non-textual media.

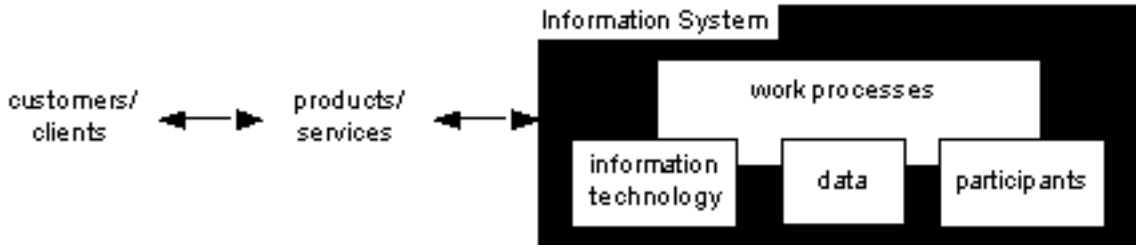

Figure 1: An Information System (after [Alter 1996])

The HTF field can be viewed as a subfield of information systems, which studies most aspects of applying information technology (IT) effectively. Alter [Alter 1996] defines an information system as a collaboration among IT, data and human participants that supports or implements various tasks or "work processes" in order to produce services or products that benefit a customer or client. See Figure1. (Computer applications comprise the computerized portion of the information system and can encompass computerized products and services.) During the design stage, hypertext design techniques can help participants plan more effective application design. For implementation, hypertext constructs and functionality can provide value-added features to the application, including enacting its work processes [Noll 1996], [Noll 1999]. When clients interact directly with the information system, HTF can enhance their access to the application's data, meta-information and processes.

HTF builds upon general hypertext research. Whereas most hypertext research concentrates on building hypertext-specific applications, the HTF approach supplements the design, implementation and services of other, everyday applications.

The HTF approach fosters three major areas of research:

1. using HTF to improve personal and organizational effectiveness

2. HTF and application design

3. integrating HTF into applications

Using HTF to Improve Personal and Organizational Effectiveness

HTF, when well designed, can improve users' comprehension [Thüring 1995]. Presenting information as a web of interrelated items enables readers to access information in the order most appropriate to their purposes. Hypertext links and structural features provide a rich context of related information and meta-information around information elements. Freedom of access within a web enhanced with contextual information provides a richer environment for understanding the information people find. Some applications can generate links and meta-information automatically; in others, authors and developers can add these manually. Following hypertext links can help users build a more complete mental model of a domain, thereby reducing ambiguity [Daft 1986], [Isakowitz 1993].

Hypertext also can improve individual and organizational memory [Kuutti 1998]. Annotation functionality allows any user to add comments and additional links within applications, which can be private or shared among a work group. Hypertext structuring can help organize discussions around any element of interest (e.g., using argumentation tools [Conklin 1989], [Selvin 1999]).

Comprehension and memory enhancement are relatively intangible benefits. HTF's impact, therefore, on individuals and especially on organizations is difficult to measure. Even though some evaluations of HTF exist, for example 24, it remains an important and under-researched topic.

HTF and Application Design

This encompasses two separate topics. HTF can improve the design process, and designers can incorporate HTF into their application designs. For example, [Balasubramanian 1998b] models the early, creative idea generation phase of the user interface design process as a hypertext network of design tasks linked to each other in a specific manner. Traversing this network enables the designer to complete these design tasks in any order, generating a set of intermediate design outputs, which together form the user interface design document. This document can later be used for prototyping. Similarly, [Noll 1996] describes how software processes can be represented as hypertext graphs that can be enacted to produce software artifacts. [Bieber 1999a] provides a relationship-based analysis technique for determining the relationship structure of any information domain. This analysis, in turn, helps designers understand their domain more deeply, and produce richer designs. Many hypertext design methodologies help the designer determine and specify an application's content and navigational structure [Garzotto 1993], [Isakowitz 1995], [Lange 1996], [Schwabe 1996]. Using them produces links and navigational features within the design. The hypertext design methodologies produce new hypertext applications. Little research addresses retrofitting existing applications with HTF [Oinas-Kukkonen 1999]. Another important aspect of design is evaluating the resulting application. Some techniques exist for evaluating hypertext links and applications. No techniques exist yet for evaluating hypertext support of non-hypertext systems.

Integrating HTF into Applications

Several techniques exist for providing information systems with hypertext support [Oinas-Kukkonen 1995]. With HTF, the emphasis is on providing hypertext support for non-hypertext systems. The HTF approach especially serves analytical or "computational" applications, which dynamically generate their content as a result of user interaction (e.g., a database management system) [Bieber 1995], [Schnase 1989]. Links and other HTF must be mapped to documents and views being generated dynamically in real time, as opposed to being added manually. Often links cannot simply be mapped based on a keyword, rather they must be associated with an underlying object with no fixed display text (such as the current price of a particular stock.) Here hypertext links and other HTF must be coordinated in real time as applications are generating documents and views for display. This raises interesting issues regarding when links and other hypertext features can be pre-computed and when they must be generated as they are about to be displayed [Ashman 1997]. Of course, users still should be able to augment these computational applications with hand-crafted links as well as annotation and structural HTF.

We distinguish between intra-application HTF and inter-application HTF. While this emphasis is a design issue regarding the intended scope of relationship management and other HTF support for an application, it also impacts the implementation approach. With intra-application HTF support, developers implement all HTF in the application itself or in a proprietary way that serves a suite of associated applications (say, if Microsoft were to provide full HTF support for its MS Office suite). Developers could use toolkit approaches to implement intra-application HTF [Anderson 1996], [Puttress 1990], [Sherman 1990].

Inter-application HTF support requires an external engine [Bieber 1998b], [Garrido 1996] or Open Hypertext Systems-style link services or hyperbases [Davis 1994], [Whitehead 1997]. These execute independently of the application, which must communicate with them in some way to gain HTF. Developers also can construct intra-application HTF with these tools. Research in the area of Open Hypermedia Systems [Nürnberg 1998], 25 primarily focuses on building middleware components or engines, which provide hypermedia functionality to tools orthogonal to their storage and display functionality [Wiil 1999]. Using the services of an OHS, existing tools in the computing environment can be "hypermedia-enabled", without altering the information itself.

HTF: The Promise

Why is HTF not more prevalent [Bieber 1997a] ? In part, it has not occurred to many designers and developers to incorporate HTF. Most of them do not have a hypertext mindset; they and their users have seen few examples and do not demand this functionality yet. In part, people rarely have the time to reengineer applications beyond their current capabilities. And, in part developers have few tools and techniques to incorporate HTF easily. Few system developers actively think about an application's interrelationships, and whether users should access and navigate along these relationships directly. HTF research seeks to remedy all these problems. When well implemented, HTF support should make the applications that people use every day richer and more effective. This is the promise of the HTF approach, and we expect, the future of application development.

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