Farkas, David K. “Hypertext and Hypermedia,” *Berkshire Encyclopedia of Human-Computer Interaction*, Berkshire Publishing 2004, pp. 332-336.

This version includes two figures that were deleted during the editing process.

Hypertext and Hypermedia

Hypertext and hypermedia refer to Web pages and other kinds of on-screen content that employ hyperlinks. Hyperlinks give us choices when we look for information, listen to music, purchase products, and engage in similar activities. They take the form of buttons, underlined words and phrases, and other “hot” areas on the screen.

Hypertext refers to the use of hyperlinks (or simply “links”) to present text and static graphics. Many websites are entirely or largely hypertexts. Hypermedia refers to the presentation of video, animation, and audio, which are often referred to as “dynamic” or “time based” content or as “multimedia.” Non-Web forms of hypertext and hypermedia include CD-ROM and DVD encyclopedias (such as Microsoft's Encarta), ebooks, and the online help systems we find in software products. It is common for people to use "hypertext" as a general term that includes hypermedia. For example, when researchers talk about “hypertext theory,” they refer to theoretical concepts that pertain to both static and multimedia content.

Starting in the 1940s, an important body of theory and research has evolved and many important hypertext and hypermedia systems have been built. The history of hypertext begins with two visionary thinkers: Vennevar Bush and Ted Nelson. Bush, writing in 1945, recognized the value of technologies that would enable knowledge workers to link documents and share them with others. Nelson, starting in the mid-1960s, spent decades trying to build a very ambitious global hypertext system (Xanadu) and as part of this effort produced a rich (though idiosyncratic) body of theory. Below you will

find the ideas that are most important for understanding hypertext and hypermedia. These ideas are also essential for designing websites or other kinds of hypertext/hypermedia projects.

Linear and Non-linear Media

A “linear” communication medium is one we typically experience straight through from beginning to end. There is little or no choosing as we go. Cinema is a linear medium. In the world of print, novels are linear, but newspapers, magazines, and encyclopedias are somewhat non-linear. They encourage a certain amount of jumping around. The Web and other hypertextual media are strongly non-linear. Indeed, the essence of hypertext and hypermedia is choice—the freedom to decide what we will experience next. You can build a website in which the hyperlinks take the user on a single path from beginning to end, but this would be a strange website, and one can question whether it is really hypertext.

Nodes, Links, and Navigation

Web designers and others who are interested in hypertext often use the term “node” to refer to chunks of content. Much of the time a “node” is simply a Web page. But there are times when we want to envision a cluster of closely related Web pages as a single unit. Also, there are times in which one physical Web page really behaves like two or more separate chunks of content. Furthermore, the “page” is not the fundamental unit of content in websites built with Flash (an animation technology from Macromedia) and in many non-Web hypertext systems. Therefore, we do well to use the term “node” as the fundamental unit of hypertext content. Links (or hyperlinks) are the pathways between nodes.

When we click links and thereby display a succession of Web pages (nodes), we are in a sense “navigating” the website. Navigation is only a metaphor; no one, of course, travels anywhere. Navigation, however, is a very natural and useful metaphor because exploring a website (or a non-Web hypertext) is much like finding our way through a complex physical environment such as a city. In both hypertext navigation and physical navigation, we choose the most promising route and keep track of where we go. If we get lost, we may backtrack to familiar territory or even return to our home base and start

over. In the best case, we gain a mental picture of the overall structure of the environment (a bird's eye or map-like view).

At the same time, the concepts of nodes, links, and navigation have limitations, and their relevance and usefulness are being called into question due to the growing sophistication of Web technologies. If clicking a link plays an audio sequence, is the audio sequence then a node? Does it matter whether the audio sequence is a single word or a 3-minute popular song? If clicking a link on a Web page begins a video sequence on a portion of that same page, how do we describe what has happened? Is the video sequence a kind of sub-node embedded within the node that is the page as a whole?

In early hypertext systems links were just simple electronic pathways with a fixed origin and destination. But now if you revisit an e-commerce website, you may find an automatically generated, personalized link inviting you to buy a new book by an author whose books you've previously purchased. Furthermore, this link may be gone the next time you visit the site. Do we need to distinguish between links that everyone sees and links that only appear under specific circumstances?

A limitation of the navigation paradigm is that it doesn't correspond to the full range of user behavior. At times users do not think spatially; they just click the most promising links they see. Designers, in fact, have begun employing a different metaphor for Web use—the metaphor of the "information scent." The idea is that users, like animals foraging or hunting for food, look for strong and distinct scents that point them toward their desired goals. Designers, therefore, should strive to create links that give off these strong and unambiguous scents.

Information Structures

Designers of websites and other hypertexts must work hard to decide which nodes will be linked to which other nodes. Only with thoughtful linking will users be able to navigate successfully. Fortunately there are well-known arrangements of nodes and links—often called "information structures"—that guide designers as they work. By far the most important of these structures is the hierarchy. Also important are the web-like and the multipath structures. These information structures are shown in Figure 1.

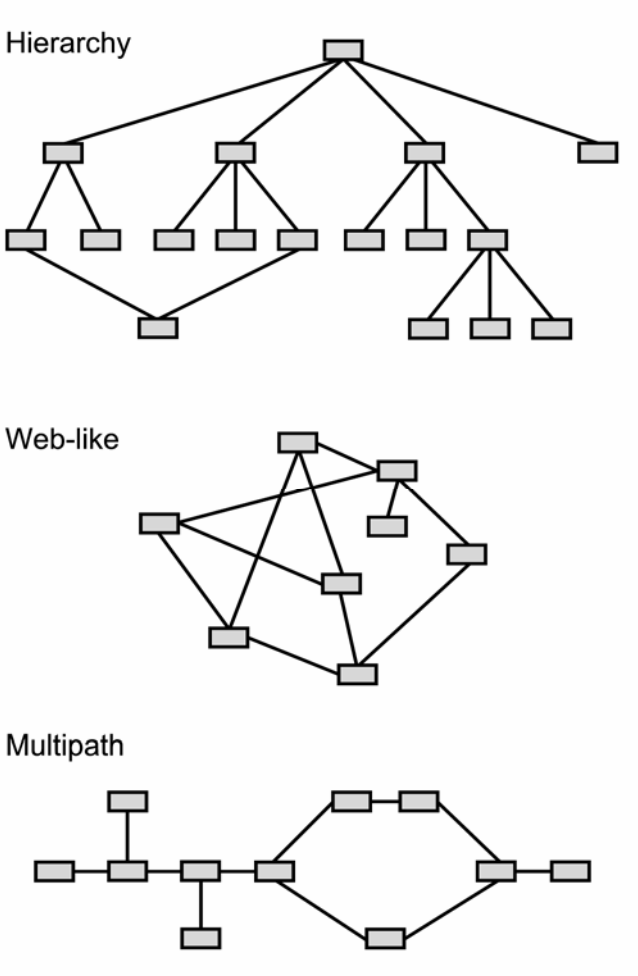

Figure 1. The hierarchical, web-like and multipath, information structures.

The Hierarchical Structure

The hierarchy is by far the most important structure because it is the basis of almost all websites and most other hypertexts as well. Why is this so? Because hierarchies are orderly (so users can grasp them) and yet they provide ample navigational freedom. The node-link diagram in Figure 1 shows the orderly nature of hierarchies. Users start at the home page, descend the branch that most interests them, and make further choices as the branch divides. At each level, the information on the nodes becomes more specific. Notice that branches may also converge.

The flexibility of the hierarchical structure is apparent in the more richly linked hierarchy shown in Figure 2. Here the basic hierarchical structure (the primary links, shown as solid lines) is supplemented by secondary links (shown as dotted lines). The

secondary links function mainly as shortcuts; they let users jump around more freely. For example, users can move laterally along the sibling nodes of a single branch and can jump from one branch to another, without having to first move up to a higher-level node. Although not shown in the diagram, there is almost always a link from every node back to the home page (the top of the hierarchy) and other kinds of upward links.

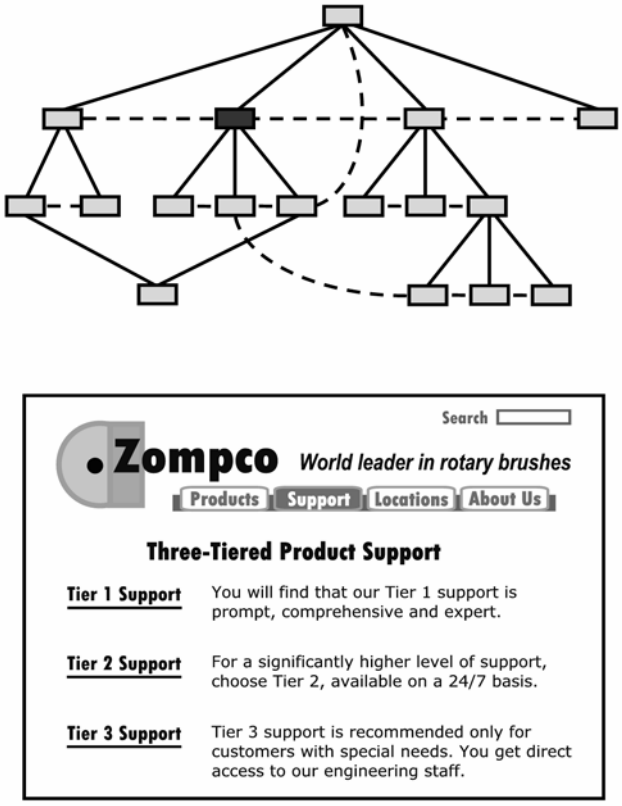

Figure 2. A node-link diagram of a website and a mock-up of one of the pages in this website.

Especially when designing larger hypertexts, designers must choose between making the hierarchy wider (putting more nodes on each level) or deeper (adding more levels). One well-established design principle is that users more easily navigate a wide hierarchy (in which nodes have as many as 32 links to their child nodes) than a deep hierarchy.

You may have recognized that a great many print documents are hierarchies in one significant respect: They are often divided into hierarchical divisions: parts, chapters,

sections, and subsections. These divisions create a logical hierarchy that the user encounters while reading linearly. Cross references in print invite the reader to jump from one part of the document to another and so are analogous to links in hypertext.

Web-like Structures

In the web-like structure any node can be linked to any other. There are no rules—although designers must take great care in deciding which links will be most helpful to users. Relatively few web-like websites and non-Web hypertexts are built. This is because many subject areas seem to break naturally into a hierarchical structure and because users are apt to have trouble navigating unsystematic structures. Many web-like hypertexts are short stories and other works of fiction, in which artistic considerations may override the desire for efficient navigation. Mark Bernstein, however, questions the belief that web-like structures are necessarily hard to navigate, and he has been a champion of web-like and other unorthodox hypertext structures for both fiction and non-fiction. See in particular his very engaging hypertext essay “Hypertext Gardens” (www.eastgate.com/garden).

Chains and Multipath Structures

As noted earlier, content linked as a linear sequence of nodes—a simple chain structure—probably doesn’t qualify as hypertext because the user’s choice is highly restricted. Linear sequences, however, are regularly included within a hierarchical websites, often taking the form of a tutorial, demo, or tour.

As shown in Figure 1, it is possible to build a sequence of nodes that is in large part linear but offers various alternative pathways. This is the multipath structure. Often we find multipath sections within hierarchical websites. For example, a corporate website might include a historical section with a page for each decade of the company’s existence. Each of these pages has optional digressions that allow the user to explore events and issues of that decade. Another example of the multipath structure is an instructional CD-ROM in which learners are offered different pathways through the subject matter, depending on their interests or mastery of the material.

Node-Link Diagrams, Sketches, and the Design Process

Because they show the overall structure of a website, Web developers often create node-link diagrams as part of the design process. Some Web authoring tools create these diagrams automatically. Using both node-link diagrams and mock-ups of Web pages, designers can effectively plan out how the site as a whole should be linked and how to design the linking of individual pages.

Figure 2 shows both a node-link diagram of a small website and a mock-up of a Web page of that same website. (The mocked-up page is represented by the darkened node in the node-link diagram.) On the mock-up, the four buttons on the navigation bar correspond to the four second-level nodes in the node-link diagram. The three links below the navigation bar correspond to this page's three child nodes. As the mockup shows, the designer intends to use highlighting ("Support") to indicate the currently displayed page.

When Web pages are well designed, the placement of the links on the page along with the phrasing of the links enables the user to grasp, at least in part, the overall site structure, the user's current location, and whether the user is moving down, across, or up in the hierarchy.

Many websites provide site maps for users. Although site maps differ greatly in appearance and usefulness, they resemble node-link diagrams in that they provide the user with a bird's eye view of the site structure.

Future Developments

Computing and the Web will continue to evolve in a great many ways. Monitors may give way to near-eye displays, at least for mobile computing. Virtual Reality may become more widespread and may be routinely incorporated into the Web. We may make greater use of voice commands and commands issued by hand gestures.

These and other advancements will surely change hypertext and hypermedia. For example, websites may provide much improved site maps consisting of a 3D view of the site structure, perhaps using the metaphor of galaxies and solar systems. The Web may well become more intelligent, more able to generate personalized links that really match

our interests. The Web may also become more social—we may routinely click links that open up live audio or video sessions with another person.

As a communications medium changes, theory must keep pace. Otherwise, it becomes increasingly difficult to understand the medium and design successfully for it. We will therefore need to extend the hypertext concepts of nodes, links, and navigation and augment them with new concepts as well.

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