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RESEARCH ARTICLE

ENHANCING THE DESIGN OF WEB NAVIGATION SYSTEMS: THE INFLUENCE OF USER DISORIENTATION ON ENGAGEMENT AND PERFORMANCE[1]

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Abstract

This paper draws on research from a wide literature base to develop a model relating Web navigation systems, disorientation, engagement, user performance, and intentions. The model is tested in an experimental study examining the effects of one simple and two global navigation systems. Although well-accepted design guidelines were followed for the first global navigation system, it was not superior to the simple system. However, the second global navigation system resulted in lower disorientation than the simple system. Based on the study's results, two design guidelines to govern the development of future Web-based systems are suggested.

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> *Readers need a sense of context, of their place within an organization of information. In paper documents this sense of "where you are" is a mixture of graphic and editorial organizational cues supplied by the graphic design of the book, the organization of the text, and the physical sensation of the book as an object. Electronic documents provide none of the physical cues we take for granted in assessing information. When we see a Web hypertext link on the page we have few cues to where we will be led, how much information is at the other end of the link, and exactly how the linked information relates to the current page. Even the view of individual Web pages is restricted for many users.* (Lynch and Horton 2002)

> *On IBM's website, the most popular feature was the search function, because the site was difficult to navigate. The second most popular feature was the "help" button, because the search technology was so ineffective. IBM's solution was a 10-week effort to redesign the site....In the first week after the redesign, use of the "help" button decreased 84 percent, while sales increased 400 percent.* (UsabilityNet 2003)

Introduction

A common problem users face on the Web is disorientation (Danielson 2003; Head et al. 2000; Wen 2003; Yu and Roh 2002) or the tendency to lose one's sense of location in a Web site. This can result in frustration, loss of interest, and a measurable decline in user efficiency (McDonald and Stevenson 1998). Despite its promise to produce complex, richly interconnected, and cross-referenced bodies of multimedia information, the Web can also produce disorganized tangles of haphazardly connected documents that make locating information difficult (Utting and Yankelovich 1989). In addition, the organization of a site is an important influence on Website effectiveness (Palmer 2002) and user attitudes (Chen and Wells 1999). Thus, researchers suggest that well-designed navigation systems can help to reduce disorientation (Head et al. 2000).

Navigation systems, or systems that support users' determination of paths through Web sites, may include features such as links to other pages, search facilities, directories, or site maps. According to Nielsen, users have difficulty finding information and need support in the form of a strong sense of structure and place; these can be provided by a navigation system. Nevertheless, lack of navigation support was cited as one of the 10 most-common mistakes in Web design in both 1996 and 1999 (Nielsen 1996a, 1999b). Surveys indicate that over 60 percent of Web users are either "searching" or "browsing" (Pitkow et al. 1998), reinforcing the importance of presenting information in an easily searchable and locatable manner. Consequently, designers have proposed that any useable hypertext system should include an effective mechanism for navigation (Lightfoot 1997).

Staying oriented is frequently a problem in virtual environments (Darken and Sibert 1993). Thus, the basic rationale for navigation support is to remind users where and at what level they currently are in Web sites (Spiller and Lohse 1998). In 1994, about 90 percent of commercial Web sites had poor usability: they either did not have the information users needed, or the information was not easily locatable (Nielsen and Sano 1994). By 2002, Nielsen reported that only 49 percent of sites followed usability guidelines (such as providing search engines). Even the highest-scoring site only followed 66 percent of the guidelines (Netsavvy Communications 2002). According to a Zona Research Inc. (1998) survey, 28 percent of Internet-savvy users reported that it was either somewhat or extremely difficult to locate specific products, and 62 percent gave up looking for products on-line. Finally, a protocol analysis concerning the usability of a popular greeting card Web site demonstrated many navigation issues, including problems with finding desired links and information, getting lost, and determining the correct buttons for navigation (Benbunan-Fich 2001). In this study, we investigate navigation support by examining the effects of simple and global navigation systems on disorientation and performance.

Reducing disorientation not only has performance benefits but also allows users to be more engaged in their Web interactions. Engagement, or the feeling that a system has caught, captured, and captivated user interest (Jacques et al. 1995), is an important goal for system design (Mayes 1992) and may even encourage users to revisit Web sites (Kim and Moon 1998).

Although these represent important issues faced by Web designers, little empirical research has addressed user perceptions of disorientation (Olnick Kutzschan and Webster 2006), improved navigation support (Park and Kim 2000), or increased user engagement (Mallon and Webb 2000). Thus, our study proceeds as follows. We begin by describing perceived disorientation, navigation, and engagement, distinguishing between related but distinct constructs. We then present a model linking these constructs to performance and intentions by drawing on research from a variety of areas, including human factors, cognitive psychology, marketing, and information systems. We present an experiment that tests this model. We conclude by presenting implications for practice and research.

Theoretical Model

Our model has three main constructs: disorientation, navigation systems, and engagement. We develop hypotheses connecting these constructs to user performance and future intentions to use a system. For this study, we conceptualize performance as both search correctness and search time and conceptualize future intentions similar to the marketing construct of "intention to revisit" (Luna et al. 2002).

Perceived Disorientation

Disorientation represents "perhaps the oldest (and arguably the most devastating) problem of Web navigation" (Danielson 2003, p. 154). Disorientation has been defined as the tendency to lose one's sense of location and direction in a nonlinear document (Ahuja and Webster 2001; Conklin 1987; Head et al. 2000). It has been called the "getting lost" phenomenon that occurs when "the user does not have a clear conception of relationships within the system, does not know his present location in the system relative to the display structure, and finds it difficult to decide where to look next within the system" (Woods 1984, pp. 229-230), and the "lost in hyperspace" phenomenon that occurs when users experience "cognitive problems of finding their way in the information space" (Smith 1996, p. 365).

Disorientation has led Web users to make such remarks as "I had specific places I wanted to go and couldn't understand how to find them" (Jarvenpaa and Todd 1997, p. 74). Disoriented users might reopen the same page (a single hypertext document in the Web site) repeatedly. Disorientation might also take different forms, such as those demonstrated in Web user surveys describing difficulties in finding pages known to exist, finding a page already visited, and visualizing paths taken and paths that could be taken (Pitkow and Kehoe 1996).

Disorientation is related to, but conceptually distinct from, ease of use, or the "effort one experiences in the process of carrying out tasks using a given system" (Davis et al. 1992, pp. 1114-1115). Disorientation represents a feeling or state of the user (e.g., "I didn't know how to get to my desired location" [Ahuja and Webster 2001, p. 18]), while ease of use refers to the user's perception of a system (e.g., "Learning to operate [software name] would be easy for me" [Davis 1989, p. 340]). For instance, users may perceive that they learned to use a Web site easily, but can still feel disoriented. That is, they may find it easy to become skillful at using the Web site, but they still may become lost and not know how to get to their desired locations in the site. Empirical research further suggests that disorientation and ease of use are related but distinct constructs. In one study, differing menu layouts related to disorientation but not to ease of use (Bernard and Hamblin 2003). In another study, disorientation and ease of use loaded on separate factors in an exploratory factor analysis; in a second study reported in the same article, two competing a priori models were compared using confirmatory factor analysis,[2] and a χ^2 difference test demonstrated that the "distinct yet correlated" model fit the data better (Ahuja and Webster 2001).

Our model incorporates perceived disorientation, rather than objective measures of users' actions. Disoriented actions are typically measured through the number of pages opened and the number opened more than once (McDonald and Stevenson 1998). However, many pages may be opened for other reasons, such as exploring a Web site; thus, employing users' actions as a proxy for disorientation can be problematic (Smith 1996). In this regard, some research has found weak relations between perceived disorientation and users' actions (Ahuja and Webster 2001). Other research has demonstrated that perceived disorientation relates to accuracy of mental models and task time, while actions do not (Otter and Johnson 2000). Thus, perceived disorientation represents a more appropriate indicator. This assertion is consistent with those made by researchers in the behavioral sciences, who recommend that questionnaire measures represent more suitable methods of measurement for understanding users' internal feelings (Sandelands and Buckner 1989).

Navigation Systems

Navigation has been defined as "a process of tracking one's position in a physical environment to arrive at a desired destination" (Cutmore et al. 2000, p. 224). Navigation, although originally denoting a physical process, has been extended to include the process of determining a path to be traveled by any object through any environment (Darken and Sibert 1993). It "has emerged as a useful metaphor for information access" (Isakowitz and Bieber 1995, p. 6).

Computer-based navigation has been defined as "the decisions and actions that contribute to a person's ability to find and examine data organized in the computer medium" (Watts-Perotti and Woods 1999, p. 270). More generally, it has been conceived as "the creation and interpretation of an internal mental model" (Spence 1999, p. 921). A mental model, in turn, has been described as the organization of knowledge about how a system works or operates (Norman 1988). Mental models may be more or less correct and may have been formed spontaneously via experience or systematically via training (Santhanam and Sein 1994). Correct mental models help users complete tasks effectively. Incorrect mental models can lead to performance breakdowns. Marchionini and Shneiderman (1988) propose that effective hypertext usage depends on the quality of the mental models users develop for systems.

Drawing on these definitions of navigation, we describe a Web navigation system as a system that is designed to aid users in the creation and interpretation of an internal mental model that helps them find and examine data on a Web site.[3] Next, we compare simple with global navigation systems.

[2]The first model tested the hypothesis that disorientation was distinct yet negatively correlated with ease of use; the second that disorientation and ease of use were one construct.

[3]A Web navigation system may be as straightforward as providing navigation bars (that is, specific areas on each page with links to other pages). Web navigation systems are browser-independent; that is, they exist in addition to any navigation buttons, such as "Back" or "Home," on common browsers such as Netscape™ or Explorer™.

Simple navigation systems present local links to other pages in the site (such as "previous" and "next"). Global navigation systems provide overviews of the entire site (such as site maps) on each page (Park and Kim 2000). Consider a site with three main sections: About Us, Catalog, and Contact Us. If the site is small, a simple navigation system could be implemented by putting a link on every page back to the front page. On the main page for each of those sections, or "second-level pages," a navigation bar could link to the site's front page (first level) and the other two sections' front pages (second levels). In contrast, a global navigation system might include navigation bars with links to About Us, Catalog, and Contact Us on all pages, a detailed site map, a table of contents, and a local search engine (i.e., one that searches only the contents of that particular Web site).[4]

Global navigation systems are not yet the norm. Liu et al. (1997) found that only 40 percent of company sites surveyed provided search facilities. Moreover, only 30 percent provided an index or directory. Further, Spiller and Lohse (1998) reported that only 6 percent offered product search, and only 4 percent of sites had a site index. We further investigated these statistics by examining popular Web sites.[5] We found that

- 34 percent had a site map
- 81 percent had a search facility
- 93 percent had some type of navigation (70 percent had a "bar" and 23 percent had a "tree" type of navigation)
- most had navigation links at the top of the screen (89 percent had navigation at the top of the screen, 51 percent had partial navigation links at the bottom of the screen, 34 percent had some navigation at the left of the screen – these numbers do not add up to 100 percent because many had navigation links in more than one part of the screen)
- none had stationary navigation links when scrolling through a screen
- 77 percent had navigation links on all pages
- 70 percent had consistent displays

These popular sites may have been created by professional design firms, but those created in-house may have even lower statistics. For example, a study of 184 nonprofit organizations revealed that only 30 percent had a site map, only 33 percent had good or excellent search facilities, 32 percent did not provide information concerning the user's location in the site, and 40 percent did not include clear navigation links (Cukier and Middleton 2003). Thus, many Web sites do not include all of the functionality of global navigation systems.

Although not yet a general practice, designers have proposed that a visual representation of the entire system will aid in navigation (Nielsen 1999a), and researchers are beginning to explore this area. Researchers have examined the effects of hyperlink annotations that represent Internet connection speeds ("traffic lights" [Campbell and Maglio 1999]), the impacts of a history mechanism (Head et al. 2000), the effects of "add-on" links (such as horizontal links to neighboring pages [Kim and Yoo 2000]), and the consequences of add-on links in conjunction with a history mechanism (Park and Kim 2000). However, these studies do not examine the effects of other global navigation system characteristics, such as detailed site maps or search functions.

Engagement

Users are engaged in a system when it "holds their attention and they are attracted to it for intrinsic rewards" (Jacques et al. 1995, p. 58). Users describe their experiences when interacting with engaging systems as feelings that the system has caught, captured, and captivated their interest (Jacques et al. 1995).[6] Engagement is similar to flow, a state representing the extent of pleasure and involvement in an activity (Csikszentmihalyi 1975). More specifically, flow has been described as a multidimensional construct encompassing perceptions of user control, attention focus, arousal of curio-

[4]Nielsen (2000) points out that users often examine Web content while ignoring global navigation elements. In spite of this, he cautions that navigation elements should not be removed from Web pages, proposing instead that users will notice these elements when they need them. Rather, he suggests that global navigation should be limited to five or six useful elements, including features such as search functions, overviews of the current region, and links to levels above the current location.

[5]To conduct the coding, we hired an HCI graduate student to code the most popular U.S. Web sites from home and work listed in the JupiterResearch report, "Top 50 U.S. Web and Digital Media Properties of September 2002" (http://www.jupiterresearch.com/bin/item.pl/home). Of the 50 sites listed, three requested personal information such as SIN number; thus, 47 of the 50 sites were coded. This student had not been involved with our study, nor was she aware of the purpose of the coding. We asked her to code a variety of design issues, ranging from "site map" (present or absent) to "location of navigation" to "consistency of displays"; we coded two sites as examples for her, and she coded the remainder independently.

[6]Like engagement, involvement may also exhibit focused attention; however, involvement may occur because of task demands or deadlines and thus may not be enjoyable (Sandelands and Buckner 1989). In contrast, engagement includes intrinsic interest.

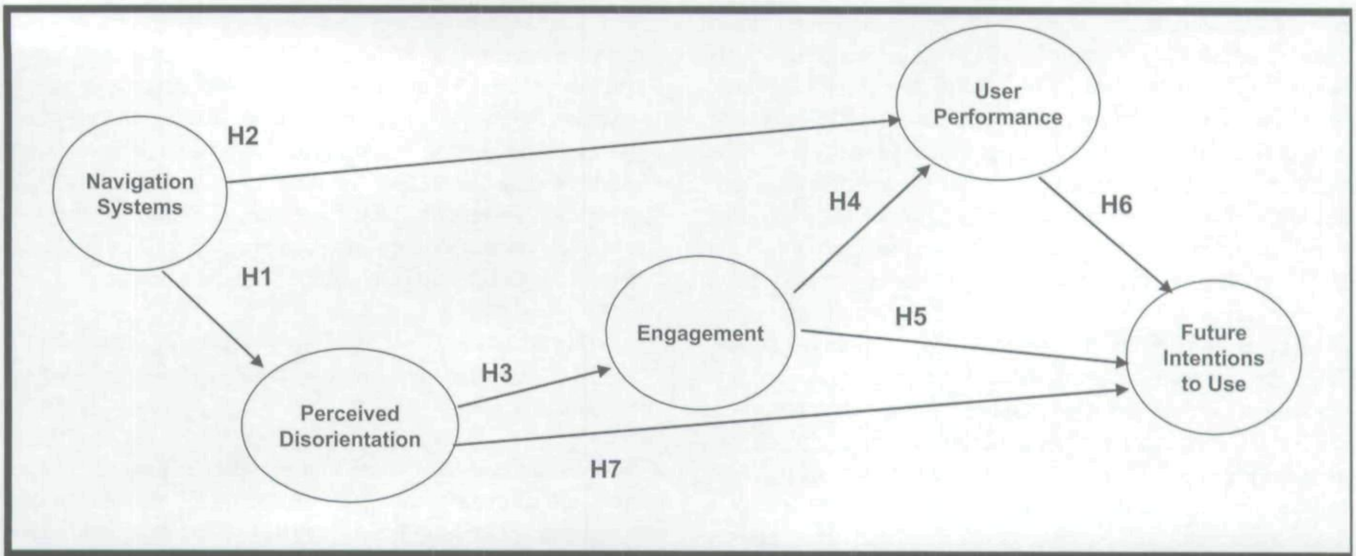

Figure 1. Model of Navigation Systems' Effects on Disorientation and Outcomes of Searching Web Sites

sity, and intrinsic interest in a computer interaction (Webster et al. 1993).

Engagement has been characterized as flow without user control, or perceptions of attention focus, curiosity, and intrinsic interest (Chapman et al. 1999). Engagement is a subset of flow and represents a more passive state. For instance, one may be highly engaged in observing (but not controlling what is happening in) a movie. Similarly, exploration-based training incorporates more user control than instruction-based training because the user sets the pace of the training. Thus, the former will more likely result in flow than the latter (Chapman et al. 1999). Analogously, one would expect that users exploring a Web site would experience more control (than those performing directed Web searches) because these users would be setting the pace and direction of their exploration. Thus, engagement appears to represent a more appropriate construct than flow when the user experiences less control, such as might occur in directed information searches.[7]

Development of Hypotheses

Figure 1 shows the model to be tested. We first propose that global navigation systems will result in less disorientation than simple navigation systems. As described earlier, a common cause of disorientation is determining where a link leads or being able to return to a document already visited (Utting and Yankelovich 1989; Wen 2003; Woods et al. 1990). This has led designers to propose that Web browsing can be improved by maintaining the context around the hypertext being viewed through the use of well-designed navigation systems (Newfield et al. 1998).

Global navigation systems provide a visual representation of the entire system. We suggest that these visual representations should reduce users' cognitive overload resulting from the additional effort and concentration needed to maintain several tasks or trails at one time (Conklin 1987). We propose that users of global navigation systems will rely more on recognition than recall by identifying a piece of information and referencing it to information already stored in long-term memory (Wickens 1992). For example, as we move through a Web site with a global navigation system, we may recognize the props that are present, such as buttons, icons, and maps, and use them with relative ease. This process is passive, and we rely on recognition memory to tell us what we are experiencing. The use of anchors, or invariant features of the Web site, helps reduce the load on users' cognitive resources (Tognazzine 1998; Woods 1984). Therefore, global navigation systems should help users recognize their positions, thereby decreasing cognitive overload and disorientation.

In contrast, when users travel to deeper levels of a Web site using a simple navigation system, the previous links disappear

[7]We incorporated engagement, rather than flow, in this model because the users in our study were directed to find specific information and were given a short period of time to do so. The users were not expected to have much opportunity to experience the control aspect of flow.

and are replaced by new links. To travel back, the user must click on a "Back" or "Home" link (Yu and Roh 2002). This results in "volatile" interaction with the Web site, because users encounter differing navigation links over a short time period (Danielson 2003). Navigational volatility, or "the number of hyperlinks appearing on the destination page that did not appear in the same screen location as on the source page" correlates with perceived disorientation (Danielson 2003, p. 141). Further, because simple navigation systems provide fewer site representations, they result in higher reliance on recall than recognition. Recall involves active, deliberate retrieval of information from long-term to short-term memory (Trumbo 1998). Short-term memory, however, has limited capacity (Head et al. 2000) Cognitive resources used for planning where to go and keeping track of position can become overloaded (Morris and Hinrichs 1996). As a result, the cognitive resources available for comprehension and understanding Web site material will be reduced (Thuring et al. 1995; Yu and Roh 2002). This will result in higher cognitive loads for simple navigation systems.

We propose that global navigation systems help create more-accurate mental models by giving users a feel for the structure of Web sites as they move through them. This is analogous to becoming increasingly familiar with a geographical environment, such as a city where we newly reside (Thorndyke 1981). Through accurate mental models, users should be able to determine their locations and what alternatives they have to progress to desired pages. In short, a well-designed conceptual model should reduce users' memory loads (Otter and Johnson 2000) because it provides a blueprint for the Web site (Yu and Roh 2002).

A global navigation system could also add to the user's cognitive load because it contributes to the amount of information presented to users (Yu and Roh 2002). On balance, however, we propose that cognitive load and disorientation decrease with well-designed global navigation systems. Therefore, we propose

> Hypothesis 1: *Global Web navigation systems result in lower perceived disorientation than simple navigation systems.*

Compared to global navigation systems, simple navigation systems can result in reduced performance because they reduce the speed of completing a given task or increase the time to find information (Conklin 1987; Fleming 1998; Nielsen 1996a, 1999a). These outcomes occur because simple navigation systems do not have a flexible path mechanism: users must pass through intermediate pages to locate information (Yu and Roh 2002). In contrast, global navigation systems help orient users and increase their efficiency. Users can travel to and find desired information more quickly (Darken and Sibert 1993; Yu and Roh 2002). Users become impatient with inefficient Web sites and are inclined to go elsewhere (Nielsen and Wagner 1996). Research has also shown that users browse more quickly with a global than a simple navigation system (Yu and Roh 2002). Moreover, they are less likely to abandon information-seeking tasks when a site map is present (Danielson 2002). Thus, we propose

> Hypothesis 2: *Global Web navigation systems result in higher user performance than simple navigation systems.*

Disorientation should relate to users' perceptions of engagement and ultimately their performance and intentions to use a Web site. Although little empirical research has addressed engagement in computer interactions, we can draw on related research to propose how engagement relates to other constructs in our model. As described above, engagement is made up of three dimensions: attention focus, arousal of curiosity, and intrinsic interest. Research examining these dimensions should help to explain how engagement might relate to other constructs in the model.

Users who feel lost will experience less attention focus while searching the Web. Practitioners propose that engagement with a Web site will be linked to how successfully the user can move across the pages and through the space (Fleming 1998). Further, they suggest that disoriented users who are unable to find the information they want cannot become engrossed in what they are doing (e.g., Spool et al. 1999). Thus, higher disorientation should lead to lower perceptions of engagement.

> Hypothesis 3: *Higher perceived disorientation results in lower engagement with a Web site.*

We propose that engagement will relate positively to performance because the increased focus of attention should lead to more effective Web searches. Research on flow and related constructs supports this assertion. For example, researchers have proposed that Web flow should be a central construct in explaining users' Web shopping experiences (Oinas-Kukkonen 2000). Research has shown that higher flow relates to outcomes like extent of use and expected use of the Web, quantity of communication, and training outcomes (e.g., Novak et al. 2000; Trevino and Webster 1992; Webster and Martocchio 1995). Research has also found positive relationships between (1) Web enjoyment and frequency of Web use for entertainment (Atkinson and Kydd 1997) and (2) intrinsic motivation and quality of output (Davis et al. 1992). Thus, we propose

> Hypothesis 4: *Higher engagement in a Web site results in higher performance.*

Engagement should also positively affect intentions to use a Web site in future because of users' intrinsic interest. Engaged users enjoy the activity or product, which may make them want to prolong the activity (Sandelands 1988) or use the product again (Jordan 1998). As with flow, the positive subjective experience becomes an important reason for performing the activity (Csikszentmihalyi 1975) and intending to revisit a site (Koufaris 2002; Luna et al. 2002). Thus, higher engagement should result in a more positive view of the computer interaction and higher motivation to interact with the software in the future (Webster et al. 1993).

Related empirical research helps to explain the expected positive relationship between engagement and intentions. Users visit Web sites that facilitate higher flow more regularly and for longer periods of time (Nel et al. 1999) and report higher intentions to revisit the sites (Luna et al. 2002). Further, higher flow relates to higher voluntary use (Webster et al. 1993). Trainees who experience higher flow report higher transfer of training to the workplace (Webster and Martocchio 1995). Similarly, users who enjoy a computer activity report higher intentions to use it in the future (Davis et al. 1992), those with more positive attitudes toward a Web site are more likely to use it (Lederer et al. 1998), and those with higher intrinsic enjoyment exhibit higher intentions to return to the Web site (Koufaris 2002). Thus, we propose

> Hypothesis 5: *Higher engagement in a Web site leads to higher intentions to use the Web site in the future.*

Users who perform better while searching a Web site should be more likely to want to revisit the Web site in the future. Thus, we propose

> Hypothesis 6: *Higher performance in using a Web site leads to higher intentions to use that Web site in the future.*

Finally, users will lose interest in Web sites when they experience disorientation (McDonald and Stevenson 1998) because they become frustrated and cannot accomplish their goals (Bessière et al. 2003). Given that frustration results in outcomes such as withdrawal, we suggest that more disoriented users will be less likely to want to use the Web site in the future. Thus, we propose

> Hypothesis 7: *Higher perceived disorientation results in lower intentions to use the Web site in the future.*

Methodology

The hypotheses were tested in an experiment that compared three versions of the same on-line learning Web site that differed in the navigation system used but were consistent in content. Participants were assigned randomly to one of three experimental conditions using a pretest-posttest control group design. This design allowed us to control for other unwanted influences. Before conducting the main experiment, the experimental manipulations and measures were refined after two pilot experiments. In the main experiment, participants searched for specific information on the Web sites. The three systems were placed on a local server, reducing variance in Web page retrieval times. Each session lasted almost 1 hour. Two graduate research assistants conducted all experimental sessions. A script was used by the research assistants to give instructions to the participants regarding the purpose of the study and the details of the task. Data were collected by (1) interaction logs recorded by server software, (2) performance on a formal search, and (3) preexperimental and postexperimental questionnaires. (Appendix B outlines the measures and their correlations.)

Experimental Manipulations

The Web site used for the experiment was adapted from an ongoing Technical Writing course offered on the Web by a North American university. This course, designed to teach principles of technical writing to nontechnical students, included complete books on various aspects of technical writing. For the experiment, the amount of content was reduced, resulting in three hierarchical levels; nevertheless, this had no impact on the look and feel of the site.[8] In the course, users were presented with an opening graphical view of their virtual office and various options such as Communication, Assignments, Bookshelf, Information, and Calendar.

We compared a simple navigation system and two global navigation systems (see Figure 2, which diagrams the navigation systems found at a second level for "Communication," and Table 1, which compares the features in these navigation systems). All systems used the course's original mixed topology structure and some type of navigation system. The first navigation system consisted of the existing navigation system of the Web course. It contained simple links; that is, links to the following page and to lower-level sections. Both global navigation systems allowed participants to move

[8]A study of on-line stores revealed that most had three or fewer levels (Spiller and Lohse 1998).

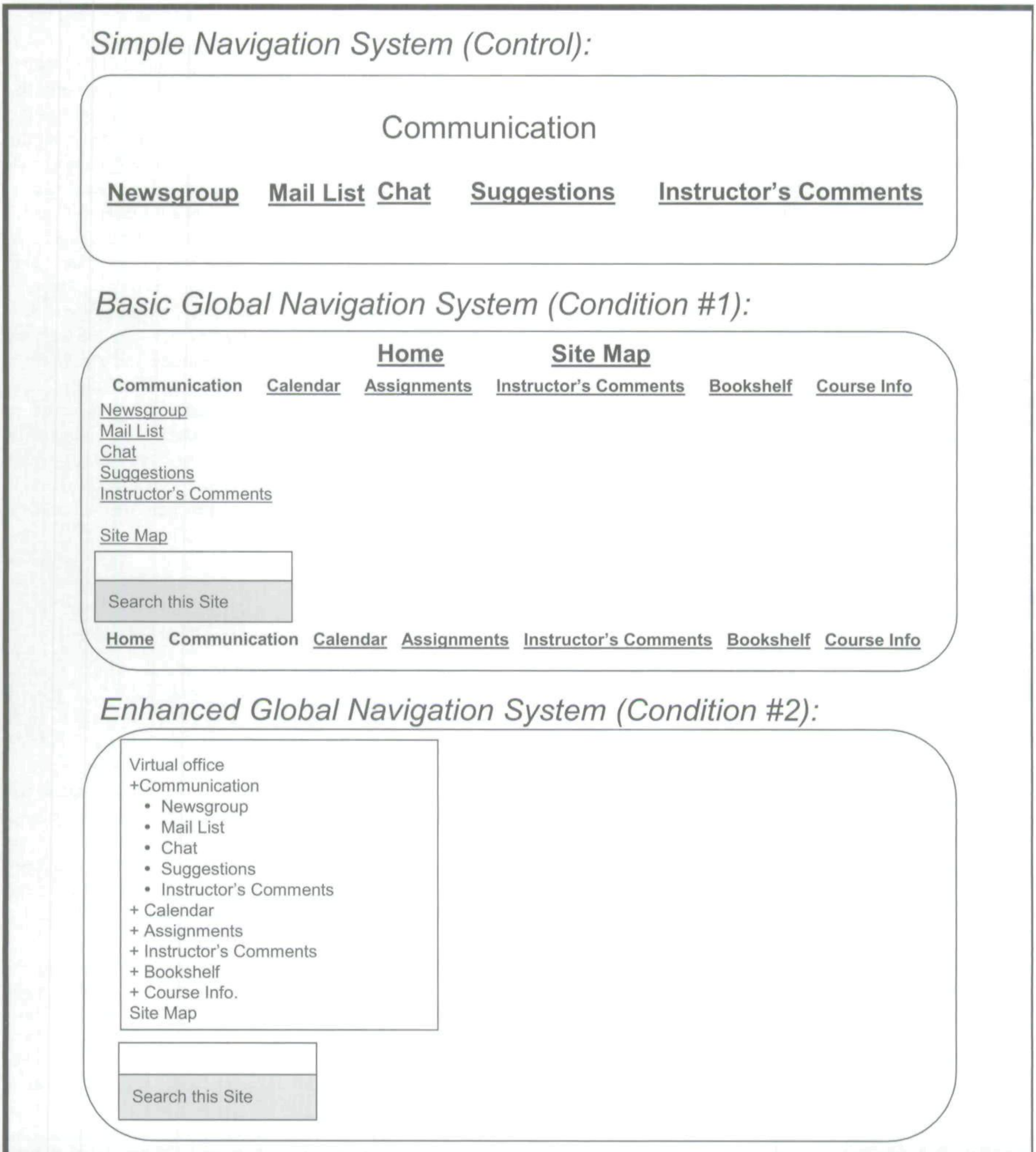

Figure 2. Second-Level Screen Layouts of Navigation Systems

Table 1. Comparison of Navigation Conditions

Simple Navigation System (Control)	Basic Global Navigation System (Condition #1)	Enhanced Global Navigation System (Condition #2)
• Hyperlinks only	• Navigation bars (top = current and parent level, left = child level, and bottom = top level) • Site-map (in top & left) • Search form (on left)	• Navigation tree (Explorer™ view in left frame) • Site-map (in left frame) • Search form (in left frame)
Navigation disappears when scrolling (i.e., hyperlinks for previous page disappear)	• Navigation can (partially) disappear when scrolling (site-map, search form and navigation bars on left and top; bottom bars appear when scrolling to bottom)	• Navigation always viewable when scrolling (site-map, search form and navigation tree always in left frame)

through documents by clicking on links and navigating in a hierarchy. Both were text-based and were available on all pages.[9] Additionally, both systems included backtrack facilities on all pages, cross-linking in certain locations, and search forms and site maps.[10]

Both global navigation systems were evaluated by the university's local Association for Computing Machinery CHI (Computer-Human Interaction) Group for consistency with usability guidelines. More specifically, the CHI Group compared the sites with commonly accepted guidelines developed by the HCI community (e.g., Fleming 1998; Furnas 1999; Nielsen 1999b; Tognazzine 1998; Woods 1984). These guidelines included (1) providing a visual representation of the system; (2) having a broad rather than a deep network of menus; (3) providing invariant features; (4) having facilities to backtrack and return to the parent level; (5) providing self-explanatory labels on the navigation system; (6) indicating the user's position in the Web site; (7) making transitions to pages "graceful"; and (8) using a consistent display representation. Any changes recommended by the CHI Group were implemented before conducting the pilot experiments described below.

The two global navigation systems, which we label basic and enhanced, differed mainly with respect to the position and design of the global navigation system. The basic global navigation system (condition #1) included navigation bars. It provided navigation features on the top, left, and bottom of all pages. Thus, the navigation system was present on every page. Nonetheless, the system might not always be totally visible to a user (e.g., when scrolling down to the middle of a long page). For the enhanced global system (condition #2), the navigation system was available on every page (on the left, using frames) in the form of a collapsible tree structure (similar to the Explorer™ view in Windows™), rather than navigation bars. Because frames were used, the enhanced global navigation system was always visible when scrolling down a long page. As described below, the design of these global systems was based on the results of two pilot experiments, which found that the basic global navigation system could have negative effects compared with a simple navigation system.

Pilot Experiments

Two pilot experiments were conducted. The first incorporated two conditions: the Web site with a simple navigation system (the control group) and the same Web site with a basic global navigation system (condition #1). Participants were 21 graduate students from one department. Although we (and our local CHI Group) believed that we had designed the navigation system to be consistent with

[9]Graphics were incorporated in the systems, but not for the navigation systems. Text was selected over graphics for the navigation systems, because text is recommended for persons with disabilities and provides faster loading times (Lazar et al. 2003). A graphical navigation system may look attractive, but an appropriate one can only be created by a competent graphic designer. As noted by Nielsen (1999a), bloated graphic design is the worst offender in terms of response times, and graphics should not be used if not needed.

[10]We chose to use site maps because some research comparing map displays with site maps (also called route lists) shows that site maps result in less confusion. Display maps generally are graphical representations of a space (like a map of a university campus), while site maps generally are hierarchical representations of a space (like an organization chart). Although Thorndyke and Hayes-Roth (1982) expected that the map display would be superior to a site map, they found the opposite: following a route helped reorient users when lost, whereas using a map display caused more confusion.

usability guidelines, we found a drop in performance and an increase in disorientation with the global navigation system (condition #1).[11]

During interviews, some condition #1 pilot participants observed that the global navigation system was complicated and difficult to use. For example, they felt that having to scroll to the top or the bottom of a page to navigate was undesirable. They suggested that this resulted in forgetting current positions and the various options available. Our global navigation system apparently introduced more navigation volatility into the users' interactions (Danielson 2003). To address these problems, another condition was designed with a navigation tree (rather than a navigation bar) that was always stationary on the left of the screen (condition #2).

In the second pilot experiment, six graduate students from the same department pretested the experiment again with condition #2. Results for this experiment indicated that participants using the enhanced global navigation system found the site less disorienting. They achieved higher performance than those using either the simple or the basic global navigation systems.

Based on these pilot results, we decided to include all three navigation systems in the main experiment. This allowed us to explore whether some global navigation systems (such as condition #2) might positively affect outcomes, while others (such as condition #1) might undermine performance more than even simple navigation systems.

Participants

Graduate and undergraduate students from various departments at a North American university acted as participants. The only prerequisite for participation was that the students be knowledgeable about using computers and familiar with the World Wide Web. Participants were recruited by making brief presentations in courses with more than 100 students. Of the approximately 1,200 students approached in classrooms, 275 signed up, and 207 participated in the experiment. Participants were paid $10 each. We chose to pay participants rather than offer incentives based on performance. We felt that offering performance incentives would be inconsistent with students learning from a Web-based system or customers looking for merchandise on a Web site. None of the students had seen the Web site prior to the experiment.

Approximately 56 percent of the participants were in the age group of 17 to 20, and approximately 90 percent were 24 or younger. Most were female (60 percent), undergraduate students (80 percent), from the Arts school (36 percent), with others from Applied Health Sciences, Engineering, Math, and Sciences. Most (88 percent) had spent at least 1 year using the Internet, which is normal for their age group (Pitkow et al. 1998). Over 80 percent had more than 9 years of education in the English language. Approximately 57 percent ranked themselves as novices with respect to their knowledge of Web design.

Results

Hypotheses were tested with structural equation modeling (SEM) using AMOS (Arbuckle and Wothke 1999). The navigation dummy variables, C1 and C2 (described in Appendix A), were allowed to relate because, by design, dummy variables are partly redundant (Cohen and Cohen 1983, pp. 189-190).

The AMOS analysis for the hypothesized model resulted in a good model fit (Hair et al. 1995): a χ^2 to degrees of freedom ratio of 1.94, a goodness of fit index of .97, an adjusted goodness of fit index of .92, and a root mean square residual of .07). Figure 3 presents the path coefficients for the model. The hypotheses were tested by examining the significance of the standardized path coefficients shown in Figure 3.

H1, which predicted that users of a global navigation system would report lower disorientation than those interacting with a simple navigation system, was supported. As shown in Table 2, those interacting with the enhanced global navigation system reported the lowest disorientation. Interestingly, the path coefficients in Figure 3 show that participants interacting with the basic global navigation system did not report lower disorientation than those interacting with the simple system. C1 did not relate to disorientation ($\beta = -.06$) while C2 did ($\beta = -.29$).

H2 predicted that global navigation systems would outperform simple navigation systems. The enhanced global navigation system demonstrated the highest performance (the highest score on the quiz and the lowest time), while the basic global navigation system demonstrated the lowest performance (Table 2). Path coefficients presented in Figure 3 support this conclusion: C1 related negatively to performance ($\beta = -.33$), while C2 did not ($\beta = .16$).

[11]This finding is not uncommon. Woods (1984) also noted previous research that has found an unexpected increase in disorientation with systems designed to follow usability guidelines.

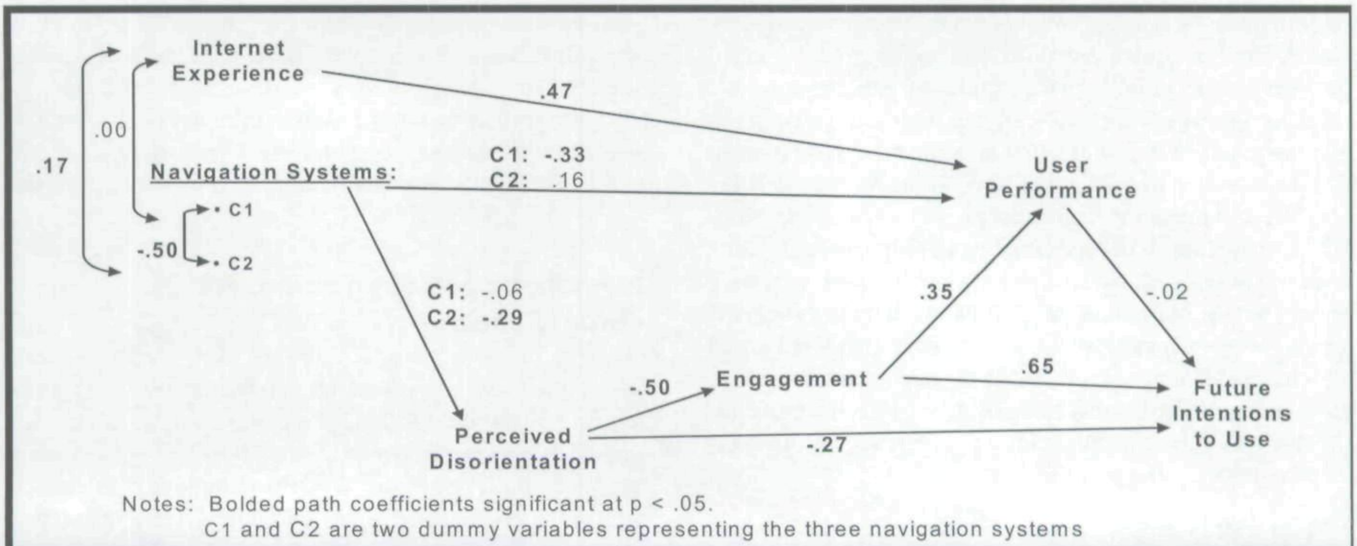

Figure 3. Navigation Systems' Effects on Disorientation and Outcomes of Web Site Searching

Table 2. Comparison of Means across Navigation Conditions

Means (Controlling for Internet Experience)	Simple Navigation System (Control)	Basic Global Navigation System (Condition #1)	Enhanced Global Navigation System (Condition #2)
Perceived Disorientation	3.39	3.24	2.65
User Performance: Number of Correct Answers	6.49	6.14	6.89
User Performance: Time in Seconds	1199.38	1359.53	1095.33

Four of the remaining five hypotheses were supported. **H3**, which predicted that lower disorientation would relate to higher user engagement, was supported ($\beta = -.50$). **H4**, which predicted that engagement would relate positively to performance, was supported ($\beta = .35$). **H5**, which predicted that engagement would relate positively to intentions to use the Web site in the future, was supported ($\beta = .65$). **H6**, which predicted that performance would relate positively to intentions to use the Web in the future, was not supported ($\beta = -.02$). Finally, **H7**, which predicted that higher disorientation would result in lower intentions was supported ($\beta = -.27$).

Discussion and Conclusions

This study responds to calls for more research aimed at understanding users' Web behaviors (e.g., Pereira 2000) and specifically the effects of Web system designs on disorientation (Otter and Johnson 2000; Park and Kim 2000). Our results indicate that the design of navigation systems can affect user performance and disorientation. Moreover, they indicate that strong relationships exist between disorientation, engagement, performance, and intentions to use a Web site.

Implications for Practice

Our study results demonstrate that simple navigation systems can be better than some global navigations systems. We were initially surprised to find in our pilot experiments that adhering to usability guidelines for a global Web navigation system does not necessarily result in less disorientation and higher performance than a simple navigation system. Similarly, in our main experiment, we found no difference in disorientation between the simple navigation system and the basic global navigation system. Moreover, we found better performance (task time) for the simple navigation system. Nonetheless, our enhanced global navigation system resulted in lower disorientation than the simple navigation system and the basic global system.[12] Recall, our basic and global navigation systems differed in two ways: the type of navigation feature (bars for the basic and trees for enhanced), and the placement of the navigation features. Additionally, the navigation features could disappear when scrolling through a long page in our basic global navigation system, while they were always visible in our enhanced global navigation system. It seems that navigational volatility was reduced in the enhanced system. Thus, it appears that using a navigation tree rather than navigation bars and keeping the navigation features continuously in view are important ways of reducing disorientation and increasing performance.

To keep the navigation features continuously in view, our enhanced global navigation system used frames. Nevertheless, there are some problems with frames, such as bookmarking, printing, and the accuracy of URLs[13] (Nielsen 1996b). In the short run, designers will need to weigh the reduced disorientation benefits of frames against problems that can arise with the use of frames. In addition, our research suggests that designers should be cautious when designing navigation systems: they should not implement more complex global navigation systems without first comparing users' disorientation and performance when using simpler systems. Doing so may inadvertently result in negative outcomes for users.

We recommend that designers measure perceived disorientation before and after modifying Web designs. Perceived disorientation instruments like Ahuja and Webster's (2001) can be completed in a few minutes and are simpler to collect and analyze than users' actions, verbal protocols, or videos. In spite of this, designers will still want to collect users' actions for certain time-critical tasks (event-driven, high-consequence domains, such as nuclear power plant operations, patient monitoring systems, and space mission operations [Woods and Watts 1997]).

This study emphasizes the design of navigation systems to enhance user searching efficiency. On the other hand, marketers may have goals other than user efficiency—they may want to create designs that encourage users to stay and explore pages, especially those with information about multiple related products. Further, we did not examine the effects of site content or graphics on facilitating user attraction. For sites designed to encourage users' exploratory behaviors, we suggest that designers measure users' perceptions of flow (which includes user control) rather than their engagement.

Limitations and Suggestions for Future Research

We studied university students interacting with an on-line learning Web site. Although we were able to control for Internet experience in our analyses, students may be younger and more skilled with the Web than employees interacting with intranets, job applicants submitting their resumes to organizations' Web sites, or customers ordering products or services via the Web. Nevertheless, we believe that our research results have implications not only for the design of educational and training sites but for job-applicant and customer sites.

We compared one simple with two global navigation systems. Because both of our global navigation systems consisted of search engines, site maps, and navigation bars or trees, we could not determine the relative importance of each feature. Future research should examine the relative importance of these navigation features to reduced disorientation and increased performance. Further, we did not study the organization of the navigation system's content. Researchers are beginning to examine users' personal ontologies for Web navigation (e.g., Chaffee and Gauch 2000) and this represents another promising direction for future research (Gruninger and Lee 2002).

We were intrigued by the fact that a global navigation system that adheres to usability guidelines might not be superior to a simple one. As indicated earlier, other research supports this finding (Woods 1984). This points to the need for further development of theory-based usability guidelines. Based on our study results, we suggest two guidelines for investigation. First, we propose that the entire hierarchy of a site be present on every page with expandable and collapsible sections or branches of the hierarchy (as with navigation trees). This will act as a conceptual model to allow users to travel forward or backward to any level and thereby help to increase the accuracy of their mental models. Second, we propose that navigation features be available in fixed positions on every page (as with frames). Doing so should reduce users' cognitive loads. These two guidelines are exploratory and emerge from our study results. Future research needs to study their efficacy for Web design.

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[12] Participants' familiarity with an enhanced global navigation system through their university Web site is not an alternative explanation for the findings; the university did not have an enhanced system when the study was conducted.

[13] Our participants did not need to bookmark, print, or reference URLs, and therefore these were not issues in the current experiment.

A strength of this study's design was the consistent content, task, and structure of the Web sites. Nevertheless, we focused only on formal searching, a relatively intensive form of extracting information on a topic, because this best represents users' actions during focused searching on electronic commerce sites (Park and Kim 2000). However, informal searching is the most frequent search mode for employees using the Web in their jobs (Choo et al. 2000). For informal searching, we expect that the relation between users' actions and perceived disorientation will be even weaker than for formal searching. In support of this claim, Head et al. (2000) compared users' actions in general information retrieval (exploratory searches) with specific information retrieval. They found that users delved more deeply into Web sites and revisited pages more often in general information retrieval. Thus, perceived disorientation should represent a useful tool for assessing Web sites for both formal and informal searches. Further, because the task used in this study gave users little chance to exercise control, we assessed engagement rather than flow. On the other hand, we would expect users to exhibit many more exploratory behaviors and to have many more chances to exercise control during informal searching. In such cases, flow would represent a more appropriate construct. Thus, future studies should examine the relation between disorientation and flow during informal searching.

In summary, disorientation represents a common problem faced by Web users, and Web designs can have powerful effects on disorientation. With increasing user sophistication and advancing technologies, some argue that disorientation will lessen over time. Conversely, others propose that disorientation will remain a critical issue: it will become transformed from how to get to a location to how to return to a location (Wen 2003). To reduce disorientation and enhance performance, we have proposed two theoretically driven design guidelines, but many opportunities exist for extending this research. Future research should continue to develop and test design guidelines based on theory.

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Appendix A

Measures

Navigation Systems, the control condition (the simple navigation system), condition #1 (the basic global navigation system), and condition #2 (the enhanced global navigation system), were compared. They were coded into two dummy variables (C1 and C2) for analyses. That is, the control condition (the simple navigation system) was represented as 0 on both C1 and C2, condition #1 (the basic global navigation system) as 1 on C1 and 0 on C2, and condition #2 (the enhanced global navigation system) as 0 on C1 and 1 on C2. The use of dummy coding of experimental conditions for SEM analyses is recommended when investigating direct rather than moderating effects of experimental conditions (Jöreskog and Sörbom 1989; MacCallum and Austin 2000; Russell et al. 1998) and is consistent with others' use of dummy coding to represent experimental groups in SEM analyses (e.g., Webster and Martocchio 1995; Yoo and Alavi 2001).

Perceived Disorientation was captured with Ahuja and Webster's (2001) seven-item perceived disorientation measure on seven-point scales ranging from "never" to "always" (evidence of the measure's construct validity is reported in Ahuja and Webster). The items were

While I was browsing:

- I felt lost
- I felt like I was going around in circles
- It was difficult to find a page that I had previously viewed
- Navigating between pages was a problem
- I didn't know how to get to my desired location
- I felt disoriented
- After browsing for a while I had no idea where to go next

Engagement was captured with Webster and Ho's (1997) seven-item engagement measure on seven-point scales ranging from "strongly disagree" to "strongly agree." The items were

The Web site:

- Kept me totally absorbed in the browsing
- Held my attention
- Excited my curiosity
- Aroused my imagination
- Was fun
- Was intrinsically interesting
- Was engaging

User Performance was determined by two measures: the time taken to answer the questions (with a lower time representing higher performance) and the number of questions answered correctly during the formal search. The time taken to answer the questions was determined by the back-end program and was reverse-coded for analyses.

To determine the number of correct answers, participants were presented with a blue sheet during browsing which asked them to find the answers to eight questions. These questions were pretested in the pilot experiments, and answers to these questions were located in different sections and levels of the Web site. There were three types of questions.

Simple fact questions:

- When is Assignment #4 due?
- Who is the technical contact person?
- Which is the name of the first assignment that is due?

Judgment questions:

- From the software available for download, which one do you think is the best to capture screenshots?
- Which editor would be best to use for this course (to edit SGML documents)?
- What is the best way to print modules of the course?

Comparison of facts questions:

- If you wanted to know what the instructor has asked you to do, which is the best place to look: the Newsgroup or Instructor's comments?
- Which is the lowest Browser that is supported by this course: Netscape 3 or Netscape 4?

Future Intentions to Use. Six items from Jackson et al. (1997) captured intentions on seven-point scales ranging from "strongly disagree" to "strongly agree." The items were

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Using this web site would be a good idea
I would intend to use this web site
Using this web site would be a foolish idea
I would like the idea of using this web site
Using this web site would be unpleasant
I would intend to use this web site very frequently

Control Variables. In addition to the variables included in the model, we incorporated 10 control variables that past research suggests could relate to the outcomes of interest. More specifically, we examined the Web skill variables (Koufaris 2002) of Internet experience and Web design experience, attributions for performance (Kelly 1973), computer playfulness (Webster and Martocchio 1992), ease of use (Davis 1989), and demographic variables (Koufaris 2002) of age, gender, years of education in the English language, level of education, and subject of education. We compared these variables across the three conditions and only Internet experience (a one-item measure of "How long have you been using the Internet?" with three response choices, 1–6 months, 7–12 months, and more than 12 months) differed; hence it was the only control variable included in the analysis.

Appendix B

Correlations Between Measures[a]

	1		2	3	4		5	6
1. Navigation Systems:								
C1	(N/A)							
C2	-.50***	(N/A)						
2. Perceived Disorientation	.09	-.26***	(.90)					
3. Engagement	.03	.04	-.45***	(.92)				
4. User Performance:								
Time (reverse-coded)	-.27***	.24***	-.19**	.07	(N/A)			
Correct Answers	-.20**	.21**	-.27***	.21**	.26***	(N/A)		
5. Future Intentions to Use	-.05	.03	-.54***	.67***	.24***	.20**	(.90)	
6. Internet Experience	-.00	.17*	-.01	-.07	.17*	.31***	-.05	(N/A)

[a]Internal-consistency reliabilities on the diagonal.

*p < .05
**p < .01
***p < .001