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ABSTRACT

Effective navigation is becoming more and more critical to the success of electronic commerce (E-commerce). It remains a challenge for educational technologists and Web designers to develop Web systems that can help customers find products or services without experiencing disorientation problems and cognitive overload. Many E-commerce Web sites are beginning to employ a pull-down menu because it provides the most versatile navigation mechanism. Although the pull-down menu design has been used in other computer applications, it is relatively new on the Web. This study analyzed the navigation effect of the pull-down menu design with three hierarchical information structures (constant, increasing, and decreasing types). The navigation effect was measured by two information searching strategies (searching and browsing) and three users' attitudinal measures (appeal, perceived usability, and perceived disorientation). Three Cyber-shopping malls were developed with the pull-down menu design as well as three information structures. Participants were 58 undergraduate and graduate students at a Midwestern university. Findings provide useful information for designing a pull-down menu and information structure for effective navigation. Results show that there exist better combinations of pull-down menu design and information structure in terms of the efficacy of browsing, the overall appeal of the site, the perceived usability and the users' perceived disorientation. Overall results show that decreasing information structure produced more effective browsing speed, appeal, perceived usability, and disorientation than when information structure was increased. (Contains 33 references.) (Author/AEF)

An Empirical Comparison Of Navigation Effect Of Pull-Down Menu Style On The World Wide Web

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Abstract

As the popularity and accessibility of the World Wide Web (Web) increases for shopping, effective navigation is becoming more and more critical to the success of E-commerce. Even though many educational technologists and Web designers have spent their energy developing effective navigation tools, it remains difficult to develop Web systems that can help customers find products or services that thy wan to purchase without experiencing disorientation problems and cognitive overload. Many E-commerce Web sites are beginning to employ a pull-down menu since it provides the most versatile navigation mechanism. Although the pull-down menu design has been used in other computer applications it is relatively new on the Web. This study analyzed the navigation effect of the pull-down menu design with three hierarchical information structures (constant, increasing, and decreasing types). The navigation effect was measured by two information searching strategies (searching and browsing) and three users attitudinal measures (appeal, perceived usability, and perceived disorientation). Three Cyber-shopping malls were developed with the pull-down menu design and three information structures. Fifty-eight undergraduate and graduate at mid-western university participated voluntarily in this study.

The findings provide useful information for designing a pull-down menu design and information structure for effective navigation. The results of this study show that there exist better combinations of pull-down menu design and information structures in terms of the efficacy of browsing, the overall appeal of the site, the perceived usability and the users perceived disorientation. The overall results showed that decreasing information structure produced more effective browsing speed, appeal, perceived usability, and disorientation than increasing information structure. This study demonstrated that the information structure that has more links on the upper levels induced more effective browsing by providing more links. Finally it is recommended that Web designers or Web researchers should consider the information structure in order to analyze the navigation effect of menu design.

Introduction

The popularity and accessibility of the Web have been increasing dramatically and changing the fundamental way to purchase products and services (Yoo & Kim, 2000). As both the amount and availability of products and services on the Web increase, effective navigation is becoming more and more critical to the success of E-commerce. However, navigating a Web site is often not an easy task, especially for novices (Berg, 1997; Dieberger, 1997; King, 1996; Sand, 1996). The potentially complex linking system and information structure awaiting Web customers can cause disorientation, increase cognitive loads (Collis, 1991), and lead to users getting lost in cyberspace (Neilsen, 1990). Hammond and Allinson (1989) contend that users may encounter a number of common problems: "They may have difficulty gaining an overview, finding specific information, or using the interface tools; they may wander without an orienting goal or strategy, or may even get lost"(p. 69).

Web customers navigate through an enormous body of information by following a likely path from one page to another until finding the product they want to buy. As the amount of products and services have been increasing dramatically, the way to organize, present, and access the products has become a crucial issue in order to support customers' effective navigation because the complexity of navigation has increased correspondingly (Berg, 1997; Chen, Mathé, & Wolfe, 1998; Newfield, Sethi, & Ryall, 1998; Pitkow & Recker, 1994). Recent usability tests show similar evidences. Users still get lost very easily on the Web and it is still a dilemma in designing a Web site where users can find information fast and easily (Nielsen, 1997, 1999; Kim, 1995)

Such problems have prompted research on the manner in which users interact with the Web. Many researchers have studied the relationships between the user interface and information structure for effective navigation and information searching. Since the main purpose of the E-commerce Web site is to access products effectively, how the information is structured on the Web site and how the link mechanism is presented on the menu of the Web site can significantly influence the success of navigation effects (Berg, 1997; Bra, 1988; Halasz, 1988; Hardman, Bulterman, & Rossum, 1994; Shneiderman, 1998; Shneiderman & Kearsley, 1989).

E-commerce Web sites have been applied many menu designs for better navigation. Numerous Web sites began to employ a pull-down menu since it provides the most versatile path mechanism for fast navigation. The navigation effect of a pull-down menu, however, can be different depending on how information structure is organized. The information structure is invisible to users when they enter the Web site. It is the menu design that provides users with the linking mechanism. They come to understand the structure of the Web site only after interacting with menu. What users perceive from menu design may also differ depending on how information is organized. Therefore, studies investigating the effect of a menu design on the Web should be

analyzed with information structure. In other words, the ideal study should be conducted in a situation which employs the menu design and information structure together to allow an analysis of how these two factors have an influence on navigation or information searching performance.

It must be emphasized that the research on navigation or information searching should consider those two factors in the same situation. This study concentrates on a pull-down menu design and information structure in the same line in order to analyze how the pull-down menu design affects information searching performance depending on different information structures.

The Navigational Structure of the Web

Navigation can be defined simply as accessing information on the Web (Gay, 1991). Navigation, however, means more than a process of simply accessing information. Cunliffe, Taylor, and Tudhope (1997) defined navigation as "...high interactivity in a structured environment with the destination seldom pre-determined. Navigation is often a compromise between user and system responsibility; an incremental process with the user making choices from directions and feedback provided by the system..." (p. 99).

A Web site is the networked body of chunks of information with links (Horney, 1993; Jonassen, 1996). The basic technique for navigating a Web site is selecting the paths provided by links (Rosenfeld & Morville, 1998). Navigation in the Web demands users engage in relatively easy activities (typing a URL, using search engines, and moving mouse and clicking links) for navigation. Information structure is how the information is organized on the Web and it provides the primary ways users can navigate through links (Rosenfeld & Morville, 1998). Since users can only create paths based on the links provided, the logical navigation underlying design of those links influences the paths that users can take. Therefore, the structuring of the information plays a fundamental role in navigation (Hardman et al., 1994).

When users enter the Web site, it is not easy to understand the entire information structure of it. Users come to understand its structure as they navigate through the paths provided by the menu design. The fundamental function of the menu is to display links on the screen so that a user can navigate through a Web site (Schwartz & Norman, 1986). A series of interactions among a user, information structure, and menu allow a user to construct a cognitive structure for navigation.

Users exchange the information and control with a given system based on two main components: menu design, which controls the communication with users through linking mechanisms, and the information structure, which relates to how to incorporate the original structure of the content into the structure of a Web site (Chang, 1995; Jul & Furnas, 1997; Marchionini, 1995; Oliveira, Goncalves, & Medeiros, 1999). Although the information structure is invisible to users, they come to understand it when they interact with menus that reflect the information structures. Clearly there are a number of ways menus and information structures vary. For instance, the same information can be structured using a different structure style. There also can be different ways to design the menu to present the same information structure. In that point, it is possible that the information searching performance can be different in situations where users interact with the same menu style that presents a different information structure.

In the research on menu design, a simple and constant information structure has been employed to analyze the effect of menu design. Most studies have investigated only constant, symmetric hierarchies in which the menus at all levels have the same number of items. However, most real-world menus are not constant but vary in the number of alternatives at each level due to the nature of the database (Norman & Chin, 1988). For these reasons, this research employed three information structures in order to examine the navigation effect of a pull-down menu.

Materials and Methods

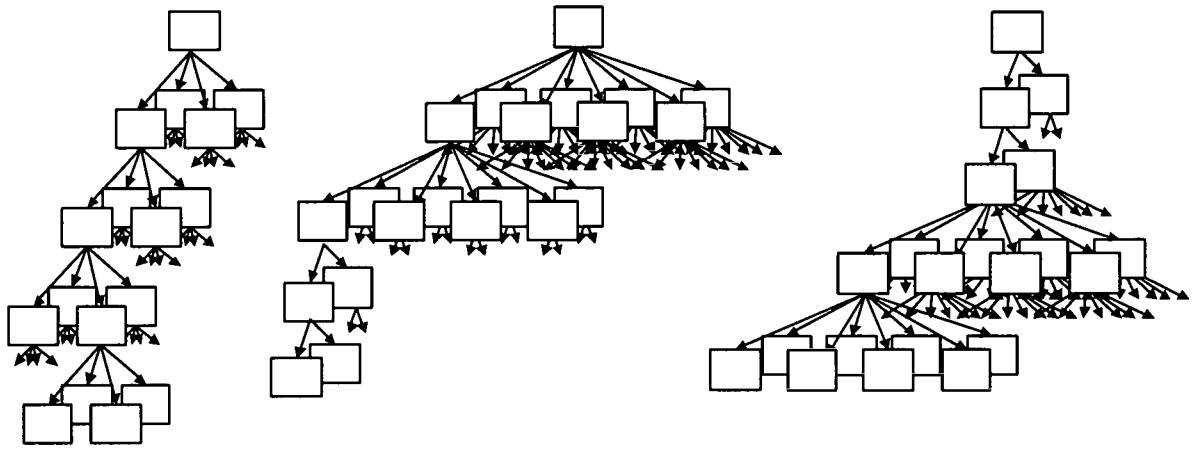
Pull-down Menu

The pull-down menu design is relatively new on the Web even though it has been used in many other computer applications. Pull-down menus appear over objects in the interface instead of in a static menu area, and they allow users to access directly the Web page they want. The advantage of this menu style is that it provides the most versatile path mechanism for navigation. Users can jump to any page by moving the mouse and clicking without through passing intermediate pages. Many Web sites for E-commerce have been adapting this menu design since users can find information fast.

Figure 4. Pull-down Menu

Information Structure

Literature in hypertext and the Web shows that the hierarchical information structure is the most popular and appropriate structure (Morris & Hinrichs; Rosenfeld & Morville, 1998). In this study, the hierarchical information structure on the Web site was organized in three ways: constant, increasing, and decreasing structure. Figure 2 shows three structures for presenting 256 items of cyber-shopping merchandise items with a depth of four levels.



Constant Structure Decreasing Structure Increasing Structure

Figure 5. Three Information Structures

Constant Hierarchical Structure

The constant structure serves as a baseline of comparison since it has been used most frequently in past research. There are four links at each level in constant hierarchical structure (4 x 4 x 4 x 4).

Decreasing Hierarchical Structure

The decreasing hierarchical structure gives a large number of choices at the top of the menu and narrows the range of choice at the bottom. In this structure, there are eight links at first and second level and two links at third and forth level (8 x 8 x 2 x 2).

Increasing Hierarchical Structure

The increasing structure gives a small number of links to the user at the top level of pages and increases the number of links at the bottom. There are two links at first and second levels and eight links at third and fourth levels (2 x 2 x 8 x 8).

Table 1 shows a summary of three Web site variants comparing the number of pages and links for each experiment. Each information structure was organized with a total of 256 pieces of information in a depth of four levels. However, the number of Web pages at each level in each information structure is different. For example, the experimental Web sites where constant information structure (4 x 4 x 4 x4) was organized with a pull-down menu designs have a total 85 numbers of Web pages. In the experimental Web sites 2, each Web site was consisted with a total number of 201 pages while experimental Web site 3 has only 39 pages in total.

Table 1. Comparison of Number of Pages and Links in Experimental Web sites

Websites	Information Structure	Number of Pages					Number of Links			
		Level					Level			
		1	2	3	4	Total	1	2	3	4
1	4×4×4×4=256	1	4	16	64	85	84	84	84	84
2	8×8×2×2=256	1	8	64	128	201	290	290	290	290
3	2×2×8×8=256	1	2	4	32	39	38	38	38	38

The most important fact in experimental systems is that the number of links is different from each other since it is determined by the shapes of information structure. For instance, the number of links at each page is 84 with constant structure, 290 with decreasing one, and 38 with increasing one when users open the all pull-down menus. The main focus of this study is how these differences caused by combination of different information structures and a pull-down menu affect users' information searching and other perception on appeal, usability, and disorientation.

Selection of Searching Task

In order to measure the influence of three different information structures on the Web site, this study included two types of tasks: searching and browsing (Canter, Rivers, & Storrs, 1985). Each five searching and browsing tasks were included in this study. The examples of each task were as follows:

- Searching task: You want to buy Epson Color 200 printer in this Web shopping mall. Please find the price of this printer in this site.
- Browsing task: Your father likes music very much and you want to buy a birthday gift for your father. Please select the music item that will make your father happy.

Participants

Total 60 undergraduate and graduate students participated at mid-western university in this study voluntarily. We excluded two subjects from final analysis because one subject had a serious sight problem due to her age and another subject missed or misunderstood several tasks due to language problem. The age of the former subject was 54years old, and the latter subject was an international student who was taking an intensive English program first level. Therefore, the actual number of subjects for the final analysis was 58. Subjects ranged in age from 20 to 49 years. They were diverse in terms of their computer and Internet related abilities.

Procedures

This experiment consisted of three sessions. During the first session, a participant was asked to fill out the background information form. It took approximately five minutes to fill out this form. After completing the questionnaire, a participant was assigned to one of three treatments randomly and was asked to find the answers of 10 tasks. Each task was given to the subject one at a time.

The subject was told to tell the researcher "start" before he/she started each searching task and to tell the researcher "the price of the item" after he/she found the answer. During information seeking tasks, the researcher measured the time for each task. This procedure continued until the subject finished all 10 tasks. It took approximately 10 to 15 minutes for a subject to finish all tasks. After completing the test session, the participant was asked to complete an attitude questionnaire. This took about 5 minutes.

Results

Information seeking performance, as mentioned earlier, was divided into two task types: searching task and browsing. ANOVA statistics showed the result of effect of searching task on time to spend finding answers among three structure designs (see Table 2). There was no significant difference among three structure designs, $F(2, 55) = .35$, $p > .05$.

Table 2. An ANOVA Summary Table With Group Means and Standard Deviations for Searching Task by Structure Design

Structure	N	M	SD
4×4×4×4	19	47.22	20.08
8×8×2×2	20	43.75	22.85
2×2×8×8	19	50.74	32.86

Source	df	SS	MS	F
Structure	2	476.93	238.47	.35
Error	55	37171.69	675.85	
Total	57	37648.62		

Tables 3 showed that there was significant difference among three structure designs in terms of browsing task, F (2, 55) = 3.86, $p < .05$. Tukey's HSD post-hoc comparisons were used to determine significant differences between means at $p < .05$. Post hoc comparisons results revealed that there was a significant difference between increasing information structure (2 × 2 × 8 × 8) and decreasing information structure (8 × 8 × 2 × 2). The amount of browsing time of increasing information structure (M = 56.55, SD = 15.49) was longer than that of decreasing structure (M = 42.05, SD = 8.95), $p < .05$.

Table 3. An ANOVA Summary Table With Group Means and Standard Deviations for Browsing Task by Structure Design

Structure	N	M	SD
4×4×4×4	19	47.32	22.04
8×8×2×2	20	42.05	8.95
2×2×8×8	19	56.55	15.49

Source	df	SS	MS	F
Structure	2	2087.76	1043.88	3.86*
Error	55	14878.72	270.52	
Total	57	16966.47		

* $p < .05$.

The following results, on the other hand, showed that there was significant difference among three structure designs with respect to three participants' perceptions: the degree of perceived appeal, usability, and disorientation.

As shown in Table 4, there was statistically significant difference in the degree of users' perceived appeal in terms of three structure designs, F (2, 55) = 4.60, $p < .05$.

Table 4. An ANOVA Summary Table With Group Means and Standard Deviations for Users' Perceived Appeal by Structure Design

Structure	N	M	SD
4×4×4×4	19	17.21	4.66
8×8×2×2	20	20.65	4.09
2×2×8×8	19	15.63	6.80

Source	df	SS	MS	F
Structure	2	258.03	129.01	4.60*
Error	55	1544.13	28.08	
Total	57	1802.16		

* $p < .05$.

Tukey's HSD post-hoc analyses also were conducted to examine differences in users' perceived appeal among three structure designs. There was significant differences between decreasing information structure (8 × 8 × 2 × 2) and increasing information structure (2 × 2 × 8 × 8). That is, the degree of users' perceived appeal for decreasing information structure (M = 20.65, SD = 4.09) was higher than that of increasing information structure (M = 15.63, SD = 6.80), $p < .05$.

Table 5 showed that there was statistically significant difference in the degree of usability in terms of three structure designs, F (2, 55) = 5.61, $p < .05$.

Table 5. An ANOVA Summary Table With Group Means and Standard Deviations for Usability by Structure Design

Structure	N	M	SD
4×4×4×4	19	15.68	1.92
8×8×2×2	20	17.30	2.56
2×2×8×8	19	14.00	4.28

Source	df	SS	MS	F
Structure	2	106.11	53.05	5.61*
Error	55	520.31	9.46	
Total	57	626.42		

* $p < .05$.

Post-hoc analyses showed that there was significant differences between decreasing information structure ($8 \times 8 \times 2 \times 2$) and increasing information structure ($2 \times 2 \times 8 \times 8$). The degree of usability for decreasing information structure ($M = 17.30$, $SD = 2.56$) was higher than that of increasing information structure ($M = 14.00$, $SD = 4.28$), $p < .01$.

Finally, as shown in Table 6, there was also statistically significant difference in the degree of disorientation in terms of three structure designs, $F(2, 55) = 4.35$, $p < .05$.

Table 6. An ANOVA Summary Table With Group Means and Standard Deviations for Disorientation by Structure Design

Structure	N	M	SD
4×4×4×4	19	10.68	3.75
8×8×2×2	20	8.40	3.47
2×2×8×8	19	12.47	5.51

Source	df	SS	MS	F
Structure	2	162.84	81.42	4.35*
Error	55	1029.64	18.72	
Total	57	1192.48		

* $p < .05$.

Tukey's HSD post-hoc comparisons results revealed that there were significant differences between decreasing information structure ($8 \times 8 \times 2 \times 2$) and increasing information structure ($2 \times 2 \times 8 \times 8$). The degree of disorientation for decreasing information structure ($M = 8.40$, $SD = 3.47$) was lower than that of increasing information structure ($M = 12.47$, $SD = 5.51$), $p < .05$.

Discussions and Conclusions

The important outcome of the study was that the information structure had an influence on the navigation performance of the pull-down menu on the World Wide Web. Results showed that the combination of decreasing information structure and a pull-down menu resulted in faster browsing performance, high er appeal, higher usability, and lower disorientation, while performance and attitudinal assessments were worse when a pull-down menu was combined with increasing information structure.

As reviewed in the previous section, each information structure was organized with a total of 256 pieces of information in a depth of four levels. However, the number of Web pages and links at each level varies in each case. The decreasing information structure has more links than the increasing information because a decreasing information structure consists of more information on the upper level and less information on the lower level, while an increasing information structure is the reverse.

Customers who employ a browsing strategy to purchase a product or service need more information not only for narrowing down their purchasing ideas but also for navigating the E-commerce system. It is important for customers who browsing products to provide more links or selections because they can see more products without additional navigation activities. This may help customers decide the product to buy. The result of users' attitudes supports this explanation. Users perceived a Web site more appealing, more usable, and less disorientating under a decreasing information structure than an increasing information structure. Therefore, the differences in the number of links provided by information structure may have influenced the navigation effect of a pull-down menu.

This study failed to show significant differences on searching performance. There are three possible explanations for no significant differences on searching speed being found. First, the information structures may be not complex enough to detect the differences of the speed on searching performance. All three information structures were organized with 256 information in four level depths with different shapes. Even though each structure has a different number of links and of possibility of error selecting the right path, the differences among the three structures may not be complex enough to reveal the interaction with different menu designs on searching performance. Second, the level of task difficulty of directed browsing may have been too low to reveal differences among three information structures. The tasks for directed browsing were to find simple information in this

study. Lai's (1994) study showed that there was no difference on the participants' searching performance when the tasks were at a low level of difficulty, regardless of the experimental treatments. This study's results are consistent with her findings.

There are several limitations to the current study. First, this study employed only three information structures for the experiment. However, there are more diverse information structures in the real Web sites. Therefore, further studies should be conducted with more diverse information structures in order to investigate the information searching performance. Second, the information structure used in this study was the hierarchical structure with four pages at each four levels. The information structures in the real Web sites are not constant but varied. The research should expand to more different types of information structure (e.g. linear, matrix, network) and different shapes of hierarchical structures with different level of depths. These differences in information structure may result different in effects of menu design. Third, the population of participants was limited to undergraduate and graduate students in a mid-western university. Most of them had the basic skills in computer and Web. Further research should expand the population of participants.

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