Exploring User Preference for the Dashboard Menu Design

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Abstract

User interfaces generally rely on a main menu for navigation and orientation. Therefore, the main (navigational) menu layout design is a determinant of user performance and satisfaction levels. Effective menu designs also help users avoid feeling lost and disoriented when seeking information or finding functionality. Research on menu design finds that an understanding of users' ability to recognize a menu layout through positional and semantic grouping of menu items helps explain design effectiveness and user preference. Our research compares an expandable index menu layout design to a frame-based (dashboard) design, and finds that the positional and semantic groupings of the frame-based (dashboard) design were preferred. Real clients using a live system participated in this study using the Think Aloud usability evaluation method. This research is significant in that it contributes to ongoing work in development of effective user interfaces, and in that it strengthens the findings of earlier researchers.

1. Introduction

Broadly speaking, Human-Computer Interaction addresses any human interaction with computers - whether as developers or as users, as individuals or as groups [31]. Specifically, the discipline of HCI is concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them [3]. Furthermore, HCI proposes techniques, methods, and guidelines for designing better and more "usable" artifacts [1].

The user interface is one of the main components of any interactive computing system. Indeed, the user interface is the part of the information system through which the end user interacts with the system either physically, perceptually, or conceptually [27], and so helps form most user perceptions of the system. There are several types of user interfaces - natural language interfaces, question-and-answer interfaces, menu interfaces, form-fill interfaces, command-language-interfaces, graphical user interfaces (GUIs), and the Web – each with their own strengths and weaknesses.

User interface design is vital to successful information system implementation. Information Technology projects invest a significant amount of resources in the design and construction of the user interfaces, in some cases 80-90% of the code of a system involves elements of the user interface. If a user interface is poorly designed, the user's effectiveness and efficiency will decrease, defeating productivity gains envisioned for the system. It is therefore important to understand the impact on the user on various user interface designs. This research examines the relative effectiveness of two different designs for the system's main navigational menu.

The information system's main menu is a key aspect of a user's experience, as it is the means of accessing the system's functionality [29], and a means for navigating the system. Like other user interfaces, a menu's presentation consists of several different elements which impact its usability. These elements can include menu layout design, organization, color schemes, labels, and content.

User efficiency and satisfaction levels are directly tied to the design of the main navigational menu [43]. Much research has therefore been conducted on considerations when designing a main navigational menu. A large portion of early menu design research explored hierarchical menus with tree structures of varying breadth (number of items offered per menu) and depth (number of levels in the hierarchy) [14] [19] [20]. This research has found that users generally perform information searches faster and are more satisfied when a menu's tree structure has higher breadth and lower depth.

More recent menu design research has focused on user performance and satisfaction with different types of menu designs. Designs explored include fish eye menus [4], expandable index menus [44], and cascade menus [5] [17] [42]. More detailed discussion can be found in later sections of this paper, but the basic differences are as follows:

- Fish eye menus present the user with a longer list of menu items in a smaller font with the currently selected menu item magnified.
- Expandable index menus present menu items which, when clicked, expand to reveal the submenu related to that menu item. The

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structure of menu items and their submenus is presented like an outline.

- Cascade menus are similar to expandable index menus except that the submenu for an item is revealed in a new window.

The latest type of main navigational menu is a referred to as a system dashboard, which allows the user to view all the functionality of the system and navigate directly to the desired capability. Dashboard menus are distinct from those previously discussed in that they show full system functionality on the main menu at all times, eliminating concerns with expansion, magnification, or cascading windows. This study compares user performance and user satisfaction ratings between an expandable index menu and a frame-based dashboard menu.

This comparison is explored through the examination of data collected through a usability evaluation conducted with the user interface of a critical client-facing application. The associated information system is very complex, with many interacting components and users fulfilling a variety of roles when using the system, and so has a relatively complex and potentially confusing user interface. Qualitative and quantitative data were collected using the "Think-Aloud" usability evaluation method, with the data then used to evaluate and compare the two main menu designs. Both designs are textually- rather than graphically-oriented, a constraint imposed by the real world environment of the information system.

The following section discusses the research on menu layout design which helps to explain the differences in user performance and satisfaction between the frame-based layout and the expandable index menu designs. We then present the details of the "think-aloud" evaluation method we used to obtain our data, followed by an analysis of these findings. Finally we discuss the implications of our findings for future research.

2. Background

We begin by discussing the importance of menu layout design in improving user performance and satisfaction. Important design considerations are mentioned, and then illustrated through a discussion of different layout types. Additional design considerations relevant to the comparison of the expandable index and frame-based menus are then mentioned, including menu depth and breadth and the concept of semantic and positional grouping. We finish by discussing how these guidelines suggest that the frame-based menu should be preferred over the expandable index menu.

2.1 Importance of Menus

In most cases, the purpose of a menu's layout is to provide the user with a sense of the organization of the contents of the system and the available functionality. The main menu provides a starting point, an organizational structure to help the user avoid becoming lost or disoriented while navigating through the contents of a menu [9]. A menu's structure becomes clearer to a user when structural cues are provided [33]. For example, this may include providing a navigational overview similar to a website map, which helps a user to understand his or her position within the navigational structure [13].

2.2 Menu Layout Design Considerations

To understand how to compare menu layout designs, we present some generally applicable elements of effective menu layouts. Yu and Roh [42] present three key elements to be considered in the design of a menu's layout: 1) menu item presentation, 2) structural cues, and 3) menu path flexibility. A menu's approach to the implementation of each of these functionalities can enhance or detract from a user's ability to search for information.

Menu Item Presentation - The first element considers how menu items are presented. Different presentations can assist the user in finding the functionality they seek. For example, a menu presenting items in alphabetical order or in order of frequency of use is likely of greater use than one whose items are in seemingly random order.

Structural Cues - A menu provides structural cues by allowing a user to see where he or she is in the structure of a menu. This can be accomplished by providing bread crumbs or by allowing the user to see the parent menus of the current menu at the same time.

Menu Path Flexibility - A menu may allow a user to "jump" to a submenu without having to explore all the submenus in between, thus providing a more flexible means of navigating to the submenu.

These items work together to determine the basic functionality of the menu interface.

2.3 Menu Types

There are multiple menus layout formats to help guide a user in seeking information. A few are mentioned here in order to illustrate how Yu and Ro's [42] design elements can often explain why a certain type of menu will outperform another in guiding a user to information. The menu types discussed here include fisheye menus [4], cascade

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menus [42] and expandable index menus [44]. These menu types are described in **Table 1** below.

Fisheye menus offer enhanced menu item presentation by magnifying the item currently selected in the list, thereby allowing the menu to provide simultaneous visibility of more items. This added functionality allows users to find information in a list faster than in a menu design without the enhancement [4].

Table 1. Menu Type Descriptions

Menu Type	Description
Fish-Eye	Holds more menu item in a pull-down menu by: (1) making the font size of items smaller (2) magnifying the currently selected item
Cascade	Similar to pull down menus in Windows. Each submenu window cascades to a new menu
Expandable Index	When a user clicks on a menu item, it expands to reveal the item's submenu.

Cascade menus offer a user the ability to navigate directly to a lower-level menu item without having to traverse through each sub-menu, therefore providing greater menu path flexibility. Yu and Roh [42] show that cascade menus outperformed a standard sidebar menu. Specifically, they show that cascade menus help users find information more effectively because they provide menu layout design elements including flexible access to information (users can quickly peek at information in a submenu) and make the navigational structure more apparent to prevent users from feeling lost (the position of a submenu item is still part of a visible hierarchy).

Expandable index menus provide a more flexible navigation structure (users can "expand" a menu item by clicking on it to reveal its contents), as well as a more apparent navigational structure (a user can better see his or her position in the hierarchy). Expandable index menus provide users with additional structural cues by allowing them to see all levels of the hierarchy at the same time. The design also provides greater path flexibility in a manner similar to cascade menus. Since the design includes these design elements, users should perform better and be more satisfied with the expandable index menu. However, these enhancements do not always result in higher user satisfaction and information-seeking performance. Zaphiris et al. [44] found that users performed better and were equally satisfied with a standard sequential hierarchical menu which had less path flexibility and structural cues. Other design considerations are needed to explain the differences between the usability results of the Zaphiris et al. [44] study. The design considerations relevant to this study follow.

2.4 Depth vs. Breadth

Menus commonly contain a hierarchical structure as a means of presenting menu items. When menus contain multiple levels or hierarchies, the arrangement of these hierarchies into a structure with more breadth or depth can have an impact on user information search performance, perceived complexity, and user satisfaction [14]. The depth vs. breadth inquiry began with Miller's study [20]. [20] Miller found that response time increased with increasing depth, and several studies later replicated these results [6] [14] [19] [43]. Kiger [19] found that both user satisfaction and better performance were associated with greater menu breadth rather than depth. Norman and Chin [30] found similar results, and attributed them to the increased familiarity with menu screens that users experienced when viewing fewer menu screens. This line of research recommends that menus should be designed so that menu items are presented in menu structures with greater breadth and less depth. This arrangement better facilitates the user becoming familiar with the menu's structure.

2.5 Positional and Semantic Chunking

Another way for users to increase familiarity with a menu's structure is through positional and semantic chunking. Positional chunking refers to spatially grouping items, and semantic chunking refers to grouping items by similar meaning [28]. The idea of "chunking" or organizing menu items in a way that has meaning to the user has been found to be a benefit to menu design [37]. The arrangement of menu options often involves inferences made by the user about logical and/or categorical relationships among items [2]. "Chunking" the menu items in fixed positions facilitates the ability of the user to recognize this information [28]. Niemela and Saariluoma [28] found that both semantic and positional chunking improved a user's ability to recognize the structure of information. Frame-based menus also provide visible navigational structure and flexibility, but do it in a way that preserves both the semantic and positional grouping of the items in frames. When these groupings are preserved, user recognition of the menu structure is preserved, leading to better information seeking performance [28]. These groupings act as effective structural cues

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which prevent the user from becoming disoriented [42]. They do this in a way which allows the user to become more familiar with the menu's structure as well.

3. Comparing Expandable Index Menus to Frame-Based Menus

Our study compares an expandable index menu to a frame-based dashboard menu. We predict that the frame-based menus will be preferred by the users. We expect users will have more satisfaction and better performance using the frame-based menu because they will more easily recognize and learn the menu layout and identify the capabilities and features of the system. The frame-based menu allows all sub-menus to be presented on screen simultaneously, speeding access relative to expandable index menus where semantic grouping must be remembered, as menu items are sometimes hidden. The frame-based menu also holds menu items in fixed positions, whereas items in an expandable index do not remain positionally constant. This fixed position characteristic contributes to higher user satisfaction and performance using frame-based menus.

3.1 Method

Research in the HCI field has asserted for a long time that the study of usability factors is a key to the successful design and implementation of user interfaces [35] [36] [15] [24] [25] [26]. Broadly defined, usability is " the capability [of the system] in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios" [34]. Specifically, according to ISO 9241-11, usability is defined as "The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments." Other researchers are even more specific, defining usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [18]. Applied to the field of information technology, usability addresses the system's functionality and the effect of the interface on the user, and identifies specific problems of the design. Usability is evaluated through a form of testing that is applied to the design of computer software, in particular the interface with which users interact [8].

Nielsen [25] measures the usability of a computer system in terms of five attributes: learnability, efficiency, memorability, errors, and satisfaction. Learnability, efficiency, and memorability are measured by choosing users with different levels of expertise to evaluate certain attributes of the system. Novices are used to evaluate learnability whereas experienced users are used to evaluate efficiency. Memorability is judged on how easily the casual user can return to the system after not using it for a time and still remember how the system works. The error rate for the system reflects the amount of errors made by the user over time period. Finally, user satisfaction is also measured subjectively.

Usability testing determines whether a system meets a pre-determined, quantifiable level of usability for specific types of users carrying out specific tasks. A complete evaluation of human-computer interaction must consider the user, the tasks, the computer, the organization, and the relationships among them [32]. Various methods can be employed to measure usability factors and to quantify the results.

Often, the methods of usability evaluation are classified according to how the system's user and computer components are represented in the evaluation process [41]. The two components of the system can be either "Real" or "Representational," and the resulting evaluation methods are thereby classified into four categories. Based on all of the classifications, the evaluation methods are organized into four categories.

Analytical Methods -- In this category, both the computer and the user are representational. A cognitive walkthrough of the system is one type of method employed. In a cognitive walkthrough, reviewers evaluate a proposed interface in a context of one or more specific user tasks using a mock-up of the interface or a working prototype [40].

Specialist Reports -- This category involves one or more people who are not real users assessing a version of the real computer. It could be HCI specialists who are evaluating the design of a prototype version using relevant handbooks, guidelines, or their own experiences. Typical methods include checklists, guidelines, walkthroughs, or heuristic evaluations by specialists.

User Reports -- This category involves real users and their mental representations of computers. Methods typically involve the use of questionnaires, interviews, or ranking methods. The methods are used to obtain data or opinions from the users on some aspect of the system.

Observational Methods -- This category involves the real system and real users interacting with a real

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computer. The set of such methods is very large, ranging from informal observation of a single user to full-scale experimentation with appropriate numbers of subjects and control variables. The observation can be conducted in the real working environment [21] or in usability laboratories [24]. Other examples of observational methods are "thinking aloud" logging measuring actual user usage, and scenario-based usability evaluations.

3.2 The Think Aloud Method

The Think Aloud method was selected based on the availability of a real version of the system as well as real users. Using the Think Aloud method, the user attempts to perform tasks with the system and is encouraged to "think-aloud" –to describe what he or she believes is happening, why certain actions were taken, and what is trying to be accomplished [10]. While this is happening, the usability evaluator records the information, thereby providing immediate qualitative feedback about user's problems with the system and where it occurred. Think Aloud tests can focus on quantitative [7] or qualitative [12] data collection or both. An advantage of Think Aloud evaluations is that they generate rich data sets from a small number of interviews. The Think Aloud method is also classified as a discount method [22], as it provides most of the benefit of more robust evaluation techniques without having to pay a much higher price in effort and resources. This is perhaps one of the reasons why the Think Aloud evaluation method is amongst the most popular involving users [40]. In addition to providing immediate feedback about a user's efficiency and accuracy when performing tasks with the user interface, the Think Aloud method also provides immediate feedback to system designers about the user's understanding of the system. For example, users often make comments which explain their level of understanding of the system. These comments can be particularly helpful when they differ from the designer's understanding of the system or when they reflect difficulty using the system.

In addition to the Think Aloud method, a usability evaluation questionnaire was also employed to collect quantitative data. The questionnaires were completed immediately after completion of the Think Aloud sessions – a constraint we realize is not ideal from a research design perspective, but one that was necessary due to limited user availability and the compressed timeline of this project. The questionnaire contained questions linked to the user's ability to navigate the menu, questions associated to the ease of finding information, as well as other usability-related questions. Quantitative data can be used in conjunction with qualitative data to triangulate findings [16]. The quantitative data of the usability questionnaire and the quantitative data collected with the Think Aloud interviews provide measurable results, while the qualitative data is used to explain the reasons for these results.

The system selected for this study was a critical system at a military facility which we will refer to as the Report Generation System (RGS). Revisions for the system were planned including an overhaul of the system's main menu. The RGS interface is used by approximately two hundred users to track data and generate reports. One of the central tasks assigned to the evaluation team was to evaluate the usability of the layout and organization of the main menu for RGS. There were two main menu design being considered, the expandable-index based menu (see **Figure 1**) and the frame-based menu (see **Figure 2**).

The frame-based menu was not intentionally designed with spatial and semantic grouping as defined by Niemela and Saariluoma [28]. However, spatial and semantic grouping were identified—similar functionalities were found within the same frame. The new design did consider such principles as enforcing recognition over recall, using borders to group tasks, color theme, and maximizing user consistency as recommended by Weiss et al., [39] .

3.3 Participants

The participants were day-to-day RGS users; eight users volunteered to participate. The small testing sample was considered adequate due to availability of the distributed users, the demands on the users' time, and the time constraints set placed upon the team. Also, as pointed out by Eveland and Dunwoody [11] a smaller number of participants may be more appropriate for the Think Aloud method since more data is collected per individual. It should be noted that the participants in the evaluation were not the same users who contributed recommendations for the design of the frame-based menu design for RGS.

3.4 Procedures

Users were first asked to complete three to five tasks using the main RGS menu as a starting point. These tasks were specific to the function that person would normally perform within his or her particular role when using the RGS. Since participants were users with different roles, the study design assured that the user was assigned to complete the tasks associated with his or her day-to-day role. This resulted in two sets of tasks, referred to in this paper as Task Group

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A and Task Group B. Users were asked to complete the tasks corresponding to their user role with both the frame-based menu design and the expandable index menu design. To control for learning effects which would possibly increase user performance using whichever menu was tested second by a particular user, the order of the menu designs was swapped so that half of the users performed tasks on

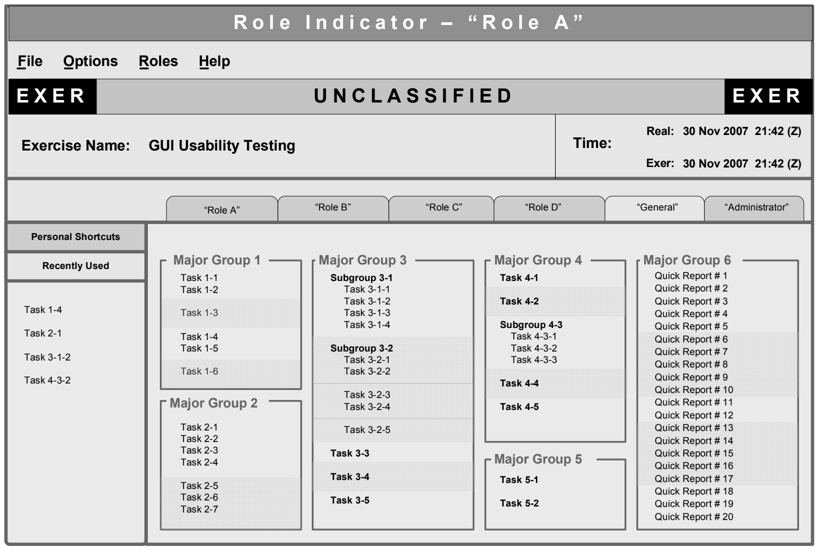

Figure 1. Expandable-Index Menu

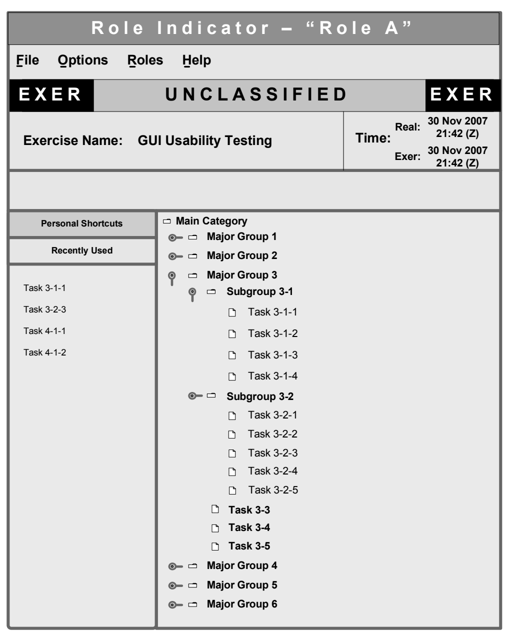

Figure 2. Frame-Based Menu

the frame-based menu first and half performed tasks on the expandable index-based GUI first. Test administrators observed the user performing the tasks and recorded their impressions and observations, the time for completion of the task, any navigation or other errors, and also the thoughts verbalized by the subject during the conduct of the test.

Users were also asked to answer questions regarding menu usability and overall satisfaction. Twenty questions specific to each GUI were asked

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after the tasks for each menu-design were completed, and three additional "overall satisfaction" questions were asked at the conclusion of the test. Each of these questions was based on a 7-point Likert scale, with higher scores representing higher satisfaction. Finally, users were asked to provide specific comments on overall likes, dislikes, perceptions, and comparisons between the two GUIs. Refer to **Figure 3** below for a summary of this process.

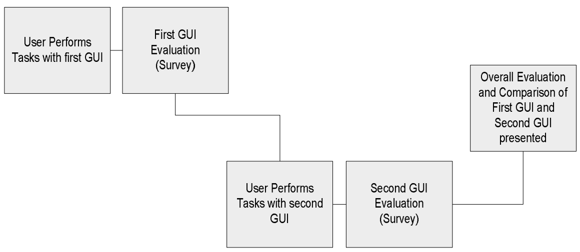

Figure 3. Evaluation Test Process

4. Data Analysis and Results

This section discusses the analysis of the data collected through the Think Aloud approach which is relevant to the comparison of menu layout designs. Other data were collected which are relevant to usability issues other than menu layout design. The analysis section is divided into two sub-sections: the first part of the analysis focuses on the quantitative data obtained from the usability evaluation questionnaire. The second part of the analysis focuses on the qualitative and quantitative data obtained from the Think Aloud sessions.

4.1 Usability Evaluation Questionnaire Data Analysis

To compare user satisfaction with the two different menu designs, the quantitative responses to the 20 questions on the usability survey were analyzed. Initial data analysis consisted of averaging the responses of all eight users to each of the quantitative questions. The frame-based menu design prevailed in essentially all measures. Specifically, the average score for the expandable-index menu design on the 20 questions was 4.9, while for the frame-based design it was 5.7 - an improvement of 16%. A second analysis was also conducted by excluding those questions which applied equally to both menu designs. For example, the color schemes for both menu designs were identical, so the question asking about acceptability of the color scheme should not have been specific to either menu design. Five such questions were eliminated, bringing the averages on the remaining 15 questions to 4.7 for the frame-based design and 5.7 for the expandable index design. This yielded an improvement of 21%.

Additionally, the final overall comparison questions asked the user specifically which menu design was preferred. In this case, the frame-based menu design prevailed over the expandable index design by a 6.4 to 2.2 margin.

The five questions for expandable index design having the lowest averages are listed below in **Table 2**. These items are likely to reflect aspects of the user interface that, if improved, would most increase user satisfaction. Note that on these lowest scoring items, there was the high agreement among subjects, as indicated by the low standard deviation.

Table 2. Lowest Average Satisfaction

Evaluation Criteria	Average	Standard Deviation
I was able to navigate easily while using the system.	**3.75**	**1.39**
The labels that describe the functions were meaningful.	**3.75**	**1.39**
The system was easy to use.	**3.87**	**1.46**
I was able to find functionality where I expected.	**4**	**1.31**
I was able to find information where I expected.	**4**	**1.61**

4.2 Analysis of Statistical Significance

Further analysis of the quantitative data was conducted using the Wilcoxon Signed-Ranked Test methodology on each individual question. This test examines groups of responses, in this case pairs of responses, to determine if there is a statistically significant difference between them. The Wilcoxon Signed-Rank Test is a well-accepted statistical technique for analysis of dependent samples, and was chosen for this reason. Analysis shows that differences for five of the 20 questions were significant at the 95% level, with an additional two showing differences significant at the 90% level. The small sample size directly contributed the lack of statistical significance of most of the differences. The results of the statistically significant differences are reported in **Table 3** below.

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Table 3. Differences in Satisfaction

Evaluation Criteria	Mean Scores		Sig?
	Expand able Index	Frame	
The system was easy to use.	3.87	6.13	Yes
I was able to navigate easily while using the system.	3.75	5.75	Yes*
The labels that describe the functions were meaningful.	3.75	5.63	Yes
I was able to find information where I expected.	4.00	5.75	Yes
The organization of functions made sense to me.	4.25	5.38	Yes*
I was able to find functionality where I expected.	4.00	5.75	Yes
I could become productive quickly using the main menu.	4.88	6.25	Yes
*= Significant at 90% Confidence Interval, otherwise significant at 95%			

4.2 Think Aloud Data Analysis

Observations of user behavior and comments about the system were noted by the research team which helped to understand the usability of the two systems as well as provide insights. The following data are examples of data relevant to the comparison of the two layout designs.

4.2.1 User Comments. Several users were not satisfied with the labels used to describe submenus while using the index-based menu. (Note that the labels were identical between the two sample user interfaces.) One user stated that the labels were generic enough that system functions could fall under multiple labels. Using the index-based menu had to remember the various names of the labels when deciding which one to select, whereas on the frame-based menu all labels were visible and they could easily compare and select faster. The frame-based menu appears to have supported semantic chunking as explained by Niemala and Saariluoma [28].

4.2.2 User Errors. The poor labeling of menu items confused users. Several errors were associated with users clicking on the wrong sub-menu to locate functionality for a task. This happened regardless of which menu design they used.

4.2.3 Task Completion Times. The research team did keep track of the time it took to complete the tasks. However, the time was not accurate as some of the users requested to discuss a couple of issues, therefore the time was not completely accurate and consistent. Although the statistical differences between task completion times cannot be demonstrated, the participants completed all tasks in shorter amounts of time for the frame-based menu design. The results of both task times are summarized below in **Figure 4** and **Figure 5**.

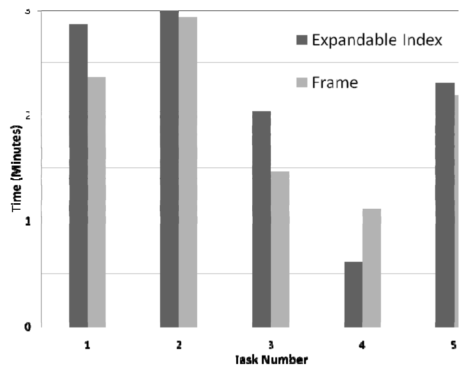

Figure 4. Completion Times Task Group A

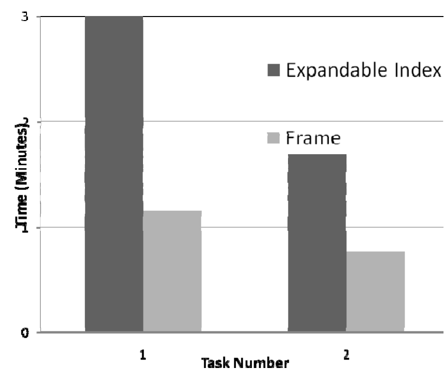

Figure 5. Completion Times Task Group B

5. Discussion and Conclusions

The frame-based menu design was found to be statistically better than the expandable index menu design on ease of use, ease of navigation, meaningfulness of labels, ability to easily find information and ability to easily locate desired functionality. The statistical results also indicated that users perceived they became more productive quickly using the frame-based menu design.

Increasing a user's ability to recognize the menu layout increases user satisfaction and performance. Zaphiris et al. [44] posit that the low performance of the expandable index in their study was due to the fact that as menus "expanded" they pushed menu items off the screen, making finding information more difficult, but this difficulty was not present in the current design. Expandable menus do not hold menu items positionally constant as compared to the frame-based menu. They also hide sub-menu items until the sub-menu is clicked, thereby inhibiting understanding of the semantic organization of the

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sub-menu items. The user is therefore less able to recognize the layout of the menu and requires more training and practice to become accustomed to it.

An interesting observation from our study is that correct labeling appears to become more important when users cannot see the group of items being labeled. Labels were consistent between menu designs. However, users felt that the same labels were less meaningful for the expandable index menu design where they could not see the contents of submenu relative to the frame-based menu design where they could. In addition, they reported that organization was less clear and finding information and functionality was more problematic with the expandable-index based menu which hid contents of submenus.

The visibility of the menu items in the expandable index menu may have caused the user to perceive that the menu had less breadth and more depth. Also, in the frame based dashboard menu where all menu items were constantly visible breadth and depth were non issues. As Norman and Chin [30] suggest, the benefit of this arrangement (greater breadth than depth) is that users need to become familiar with fewer menu levels. In the case of the frame based dashboard there were no menu levels. Thus, this also likely contributed to users' higher performance and preference for the frame-based dashboard menu.

In summary, we found the frame-based menu was a better design approach than the expandable index. This is insight will help practitioners design and build better main menus. It is also may be used to justify the additional effort it takes to code and design a dashboard type frame-based menu.

The study has two main limitations that should be noted. First, the sample size was small, although the qualitative data was rich. Secondly, statistical significance could not be determined for the task completion times, therefore conclusions based on these findings should be made cautiously.

Future research should consider the comparison of a text frame-based menu as used in this research to a more 3-D, graphical menu that incorporates various GUI visualization techniques such as GIS, video, graphs, etc. We also recommend verifying our results with a larger sample size.

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