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# An empirical study of Web browsing behaviour: Towards an effective Website design

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**Abstract**

Prior studies have suggested that a good Website design which facilitates a user's Web browsing behaviour would generally lead to better user performance. In this research, we examine user Website behaviour as a way to understand Website design using a "think aloud" protocol analysis. Main theoretical contributions of this research are the illustration of the flow of cognitive processes during the Website browsing and the establishment of Website design dimensions – the meaning and content implied by Website content, its outward form, and the structure and navigation – in relation to user performance.


*Keywords:* Website design; User performance; Cognitive mapping; Wayfinding

## 1. Introduction

Badly designed Websites frustrate users and cause them to leave as they cannot find what they need. For e-tailers who rely on the Internet to conduct the sales, this is a serious implication as it means a potential loss of online sales [1]. The reasons cited for the users' negative experience included information not current, difficult to use and mostly, not finding what they wanted [2]. To encourage users to return, Websites should be designed to facilitate users in finding what they need and increase satisfaction while accomplishing their tasks [3].

Wayfinding[1] has been widely studied in a variety of environments ranging from city planning [4], airports [5], libraries, hospitals [6], virtual environment [7] and Websites [8]. In fact, wayfinding in the Website is more important than in the real environment. Website features such as hyperlinks, navigation bars, sitemaps etc. give a user more flexibility by allowing him/her to browse in a non-linear fashion and the ability to "jump" to different parts of the Websites without backtracking. This is a double-edged sword, for it also makes it more difficult for the user to a user to learn and remember his/her movements in the Website. Furthermore, Webpages change frequently, such that a repeat visitor will have to re-learn his/her way about the Website. Moreover, as Websites expand in size and complexity, they have to be designed to reduce the user's browsing efforts in completing his/her task [9].

Therefore, the goal of this research is to discover factors of Website design that reduces cognitive overhead involved and facilitate wayfinding. The contribution of this research is the establishment of Website design dimensions, which influences browsing behaviour, as well as formation of guidelines to assist designers to better identify areas for improvement and create effective Website.

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[1] Wayfinding is defined as "the ability to find a way to a particular location in an expedient manner and to recognize the destination when reached", [19]. Wayfinding is based on a "consistent use and organization of definite sensory cues from the external environment" [4], with the ultimate goal of finding the way from one place to another.

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## 2. Literature review

Website design and usability has been widely studied academically. Palmer [10] identified five measurements of Website usability – *download delay* (i.e. access speed), *navigation/organization*, *interactivity* (i.e. customization), *responsiveness* (i.e. feedback and FAQ) and *information content*. Based on a questionnaire survey of 214 online shoppers, Ranganathan and Ganapathy [11] empirically derived four key dimensions of business-to-consumer (B2C) Websites – *information content, design, security*, and *privacy* – that have an impact on the online purchase intent of consumers. Liu and Arnett [12] found that learning capability, playfulness, system quality and system use are significant to well-designed B2C Websites.

In the immediate context of wayfinding for both a first-time visitor or repeat visitor to a Website, the dimensions[2] that have a direct impact are navigation and structure of the Website (for example, [13,14]), the Website's outward presentation (example [15–17]), and meaning conveyed by Website content (example [18]). Wayfinding theory postulates that in order to accomplish a wayfinding task (i.e. "to reach a final destination") a user would perform three processes – cognitive mapping, decision generation and decision execution [6].

### 2.1. Cognitive mapping

Cognitive mapping[3] is the processing and organizing of information from a user's past experience as well as from the current Website environment to produce a cognitive map [6]. Environmental information, i.e. all the necessary information needed, is categorized into sensory (Is), inferential (Ii) and memory (Im) information. The sensory information (Is) is directly related to the current environment that the user is in and is made up of architectural and spatial characteristics of a setting, signs, and people who provide cues to the user. Inferential information (Ii) refers to what he/she infers from the current environment, for example, the "Exit" sign above a door implies that it leads to the outside of a building. Lastly, memory information (Im) refers to his/her past knowledge or past cognitive map.[4]

Based on the environmental information and the wayfinding task, the output of cognitive mapping is a user's updated cognitive map, a mental representation of the real environment at a particular moment in time. It is made up of three components: landmark, route, and survey knowledge [21]. Landmark knowledge tells what something is and they can be points of identity, location, navigation aid, and orientation [22]. Route knowledge is a representation of the paths connecting the various landmarks, informing a user where something is [20]. Lastly, survey knowledge is the topology of the environment or good understanding of the surrounding area that allows a user to get to a destination efficiently.

Prior literature has assumed that there is a sequential order in the development of cognitive map, starting from landmark to route to survey, which may be incorrect [23]. A user may develop survey knowledge independently, without landmark or route knowledge, through the use of a map which is an external representation of the environment. Thus, there may not be a direct sequence in the formation of cognitive map.

### 2.2. Decision generation

After cognitive mapping, the next process is decision generation in which a user generates and structures a series of decisions that would complete his/her task. All these decisions have two aspects – planned behaviour and expected image. Planned behaviour is what a user has planned to execute, while expected image is what he/she perceives of the outcome of the execution. This would then lead to decision execution.

### 2.3. Decision execution

During decision execution, the decisions are transformed into actions by comparing predictions about the environmental features and the information obtained from the current environment, i.e. comparing the expected image of a decision and perceived image of the current environment, which is also Is.

If the expected image matches the perceived image, then a user would execute his/her decision which is a behavioural action. If they do not match, this implies that certain information is lacking from the environment in order to act out his/her decision. As such, the decision is not executed and becomes a new subtask. This prompts a loop-back to the cognitive mapping process and restarts the whole procedure.

In fact, the environment and task will dynamically change and the knowledge of the user will dynamically update as he/she moves through the environment. Similarly, the cognitive maps would be updated whenever information is added or forgotten. If the cognitive maps have changed, the plans would change as well.

## 3. Research methodology

This study focuses on the notion that an effective Website design permits a user to perform wayfinding easily and

[2] *Download delay* or access speed does have an impact on wayfinding. However, we decided not include this dimension as access speed is dependent on Internet traffic and not entirely under the control of the Website manager.

[3] Downs and Stea [20] defined cognitive mapping as "an abstraction concerning those cognitive or mental abilities that enable us to collect, organize, store, recall and manipulate information about the spatial environment".

[4] For a first-time visitor to a Website, although he/she will not have a cognitive map of the current Website, he/she still has a past cognitive map of "what Websites should look like" and general strategies of navigating at a Website.

accomplish his/her task effectively. To this end, we apply the "think aloud" protocol analysis to study cognitively how users wayfind through the Website. Given that the three processes of wayfinding are cognitive in nature, this method allows us to "open the blackbox and... understand the changes taking place in the decision process" [24]. The mere act of spontaneously verbalizing aloud does not change the sequence or contents of a subject's thoughts as he/she performs the task, although he/she would take a longer time to perform the task [25,26]. The concurrent neutral-probing verbalization as the subject browse the Website also has the advantage of being the most valid and reliable method for formal protocol collection [25,24].

### 3.1. Case background

The Website used was Dell's (http://www.dell.com, accessed: October 2002). Dell's Website made "*computer buying painless",* and thus, it is rated as one of the top 10 classic Websites this year by PC Magazine [27]. Other comments from their customers surveyed by BizRate.com on Dell were very positive, "*this was the best shopping and buying experience I've ever had!*", "*my second experience purchasing.....once again a pleasure*", "*very easy and user friendly to place the order*".

### 3.2. Subjects

Six subjects were recruited using an attractive high fixed payout. Their demographics were three males and three females, average age was 22 and they seemed to be quite comfortable and skilful with the Internet. This group of subjects also represented the major group of the Internet population who was also responsible for a large portion of the online sales last year [28]. As protocol analysis can yield very rich data, large sample sizes are not necessary [24].

### 3.3. Data collection

The assigned task was for the subject to purchase either a desktop or notebook computer of his/her choice from Dell's Website.

The first step was for the subjects to fill up a pre-interview survey and also draw an initial (i.e. pre-task) cognitive map of structure of Dell's Website. The experience of the subjects and their initial impressions of the investigated Website were obtained from the pre-interview surveys. They were next given a short warm-up exercise in verbalizing aloud before proceeding to do the assigned task. As the subjects perform the task, they would need to think aloud their thoughts and actions by stating what they see, their location, how they got there, whether they could recognize the steps taken etc. In addition, a special software program called Camtasia Studio, developed by TechSmith, was used to record all actions on the monitor screen as well as voices of the subjects and interviewer. The interviewer prompted the subject to verbalize only when he/she lapsed into silence, but care was taken to prompt non-directively.

After completing the assigned task, the subjects filled up a post-interview survey regarding their experience at the Website. They also drew another (i.e. post-task) cognitive map of the structure of Dell's Website. Lastly, a short open-ended interview was conducted, summarizing their thoughts on the interview session which was taped using a video camera.

### 3.4. Data analysis and measurements

The three processes of wayfinding are difficult to measure directly as they are internal to the user, hence only indirect measurements were used. For cognitive mapping, much literature had dealt with measuring it through drawings of the real environment [29,4]. It tests the ability of the user in organizing and processing the information. Decision generation was measured through a diagram of hierarchy of decisions as they are self-generated by a user on the subconscious level which may go unnoticed by him. Decision and sequence diagrams were attained by transcribing the coding of the observations. In coding the observations, the wayfinding protocol, developed by Passini [6] was adopted. Lastly, for decision execution, it was measured through the action taken as the result of it would signify whether the task was accomplished, which was then sent as a feedback to the user, as well as the satisfaction gained in accomplishing it.

The steps in the protocol analysis were in line with those suggested by Todd and Benbasat [24]. We used a variety of data collection – recording of the performance of the tasks, questionnaires before and after the task, and a short open-ended interview. Care was taken to ensure that probing was kept to a minimum and non-directive during the task. We closely followed the coding scheme developed by Passini [6] to develop the sequence diagrams and structure diagrams, to ensure that the results were not data-driven.

## 4. Research findings

### 4.1. Cognitive mapping

It was observed that the subjects were constantly extracting environmental information and it could be similarly broadly classified as sensory, inferential, and memory information. Most of the time, it was noticed that the subjects were taking in sensory information, for example in Dell's Website, "*I see three types of Dimension desktop*", "*Select country option...*". Thus from our observation of the subjects, the sensory information was mainly comprised of spatial characteristics analogous to the frames, window screen, tables; and signing of the Websites, such as hyperlinks, navigation bar, sitemap etc. The third type of sensory information would translate to the online assistant, FAQ, and alternate hyperlink description. However, this third type was not widely observed during subjects' exploration,

only one subject turned to the FAQ in the hope of finding "*the warranty of (that) computer*".

The second most documented was inferential information, while the least was memory information. Inferential information was comments by subjects based on the current Website environment, like on Dell's Website, "*this is a simple and nice homepage design*", "*this Dimension desktop model is cheaper than Dimension* 8200". As for memory information, the subjects seldom recalled information from their memory. When they did recall, it was regarding how similar Dell's homepage looked like "*other commercial Websites*", and desktop "*looks familiar*".

As in the real environment, the subjects were observed to possess previous knowledge or cognitive map of similar Websites, and after their exploration, they had developed a new or updated ones. This was observed from the pre-task and post-task cognitive maps of Dell's Website structure drawn by the subjects. The drawings were noted for features or items that could translate to mental representations in the subjects' cognitive map.

With regards to the mental representations of the features or items, Farris et al. [30], and Kim and Hirtle [31] argued that Webpages could be seen as landmarks and hyperlinks as routes, while survey knowledge was analogous to the layout of landmarks (Webpages) and paths (hyperlinks). Having landmarks as Webpages was actually similar to a point in the whole Website structure, however based on [22], suggestions, landmarks could also be points or features within a Webpage, translating to the title header, navigation bar, company logo, and main text body. As for survey knowledge, the layout of landmarks could be on the Website level, a sitemap, and on the Webpage level, placement of features. Hence the accuracy of the drawings was measured on these levels, i.e. the identification of the exact main features and its placements, as well as an approximate of the depth and breadth of the Website structure.

The analysis of the drawings showed that the subjects' pre-task cognitive maps of Dell's Website matched closely with the actual one. Majority of the subjects had visited Websites that sold computer hardware, all of them had heard of Dell and only one had actually visited Dell's Website before. The subjects visualized correctly majority of the landmarks and their placements for Dell's homepage, like the company logo, navigation bar, product catalogue, and content area. They could also visualize that Dell's Website has a deep structure. The high similarity in the drawings of both pre-task cognitive map and actual Website suggests that the user adopts mental images of the Website based on past experiences.

### 4.2. Decision generation

The subjects were found to be performing decision generation based on the observation of the sequence diagrams. At certain points, the subjects would pause to think before making the decision, especially in the case of comparing products in Dell's Website, comments were like "*let me see...*", "*how do I do this...*", "*where is the catalogue now...*". During these pauses, subjects were actually looking at the Websites, attempting to organize the information that they had and generating the possible decisions to accomplish a task. Hence, the subject would generate all the possible decisions using his/her cognitive map, like in the real environment.

Furthermore, from the structure diagrams, the actual decision generation could be observed. Faced with the assigned task of purchasing a computer online, the subjects broke it down to two subtasks – browsing for a suitable product to purchase and looking at the ordering information. These subtasks were then further decomposed to browsing the current promotions, looking at the product catalogue, comparing prices and specifications of the products etc. (see Fig. 1).

### 4.3. Decision execution

This last process is also similar in both real and virtual Website environments in terms of the decisions that are executed and unexecuted. From the sequence diagrams, it could be observed that the confirmation of a decision being executed was the revealing of another Webpage based on the hyperlinks clicked and selections made, or changes in price of system according to changes in configuration of system etc. (see Fig. 2). As for unexecuted decisions, they became new subtasks, looping back to cognitive mapping and restarting the whole procedure, illustrated from the example of the subjects figuring out how to compare different computer models in Dell's Website (see Fig. 3).

### 4.4. User performance

#### 4.4.1. Perceived effectiveness and efficiency

Since this is a protocol analysis of a single Website case study with few subjects, it is not meaningful to make quantitative measurements of effectiveness and efficiency. The subjects were surveyed post-task for their perception of

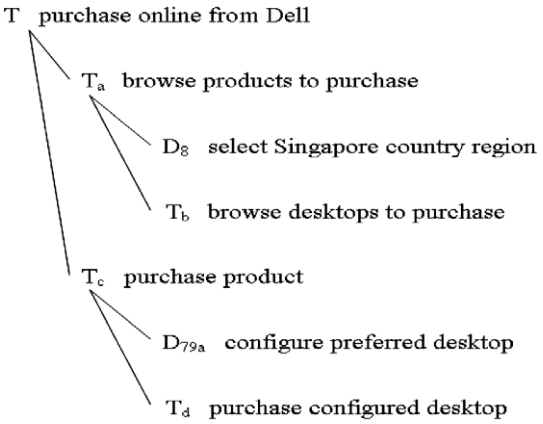


Fig. 1. Subject B's decision hierarchy in Dell's Website.

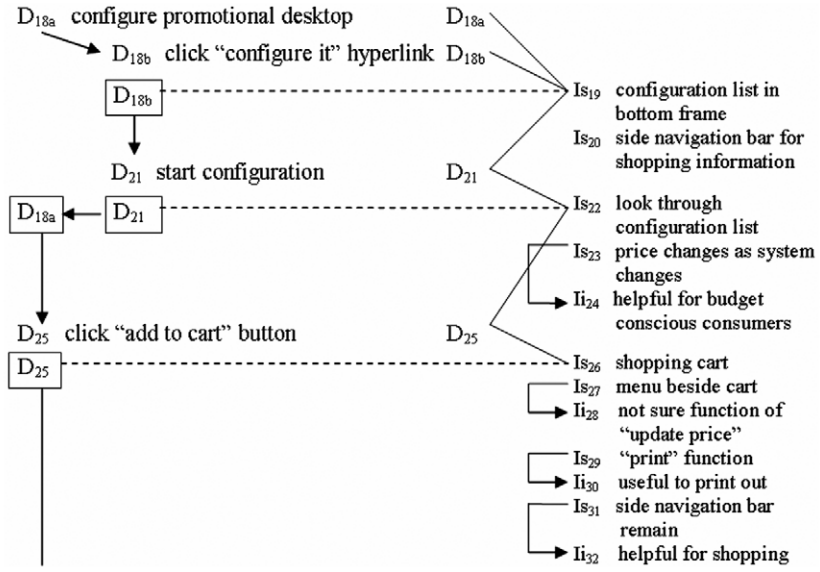


Fig. 2. Price changed while Subject F configured Dell's product.

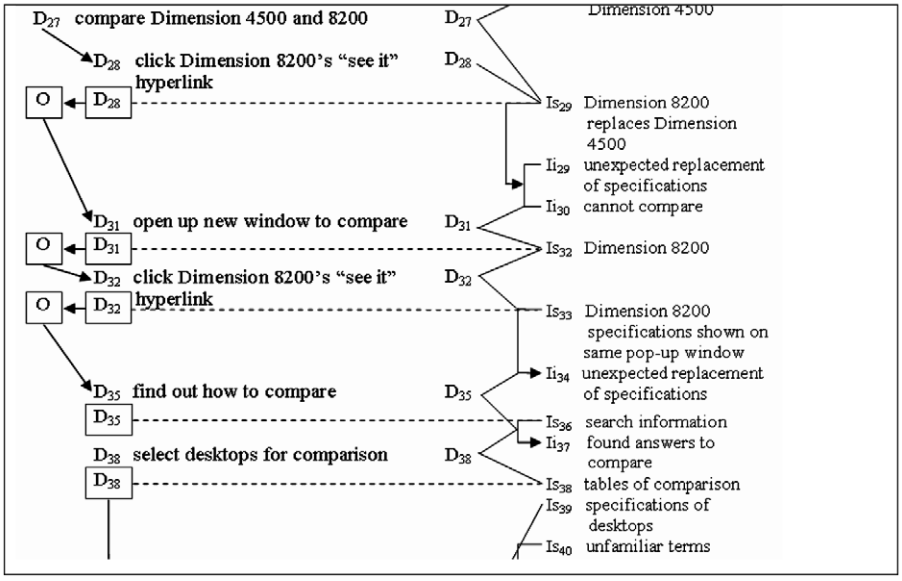


Fig. 3. Subject C used different windows to compare Dell's Dimension products.

effectiveness and efficiency. In terms of effectiveness, all subjects had managed to select a computer system that they preferred and "purchased" it. On the whole, the Website was given a rating of 6 out of 7 by the subjects for being able to assist them in accomplishing any tasks effectively. They also gave a rating of 6 out of 7 for being able to assist them in accomplishing any tasks efficiently. The high degree of the design dimensions found in the Website helped to notify the subjects where the information was. Hence, subjects felt that they could find what they needed within a few minutes or clicks.

#### 4.4.2. Perceived satisfaction

In measuring the subjects' satisfaction, there were a few "lostness" registered. "Lostness" was felt as the subjects experienced difficulty getting to the "*mainpage*", as well as "*how do I compare these models here?*", "*I can't seem to find the (computer) warranty*". Fortunately, it was considered to be minimal and of little effect on the overall satisfaction as the subjects managed to find what they needed after a few trials and errors. Thus, they gave a high rating on satisfaction to the Website, and on average rating of 5 out of 7, they felt that the visit was interesting and enjoyable.

The Website had earned high satisfaction rating and positive comments as the subjects considered that it had an "*attractive homepage, like the personalization touch*" with the selection of country region, and was "*very professional looking*". An average of 3 counts of positive comments per subject was noted from the subjects' coding.

As a result of the effective Website design and good user performance, the subjects expressed their "*trust*" in Dell and intentions to purchase or recommend to others were also high.

The results of the study showed that an effective Website is an environment that facilitates wayfinding and generates high user performance.

## 5. Discussion

Overall, the subjects ranked Dell's Website highly on informed purchase decision, consistency with the general Web conventions, presentation style, and navigation style. They commented that it had "*relevant and updated information*", was "*neat, clear, clean, consistent and easy to read*", and had "*proper menus to guide (them)*". From the results, we uncover three dimensions that facilitate the three wayfinding processes.

### 5.1. The meaning conveyed or implied by the Website content

As most users are surfing on the Internet to gain specific information, it is imperative to understand the key characteristics of information quality from the user's perspective [32]. Katerattanakul and Siau [18] defined the quality of information to comprise the following four categories – intrinsic information quality, contextual information quality, representational information quality and accessibility information quality. The content of the Website was perceived to fulfil all four categories of information quality. It was perceived to have intrinsic (accuracy and reliability) information quality as the subjects did not need to analyse whether the information is accurate, updated etc. but thought that the Website displayed "*relevant and updated information*" and "*I trust Dell to put up the latest products and information*".

They also perceived the information to have contextual (information is relevant to the task at hand, and provided in a timely manner) and representational (concise representation, interpretable, easy to understand) information quality. One subject noted that "*information was given in a very user friendly manner*". Dell's Website had mid degree as multiple computer jargons were used in the description of their products. Fortunately, the subjects with their years of experience using the Internet did not run into much problem, but a visitor new to computer technology might be taken aback by all those technical terms. Hence, Dell's Website had short description and footnotes accompanying the terms such that the subjects could understand the product specifications easier and place them in their cognitive maps so as to compare them mentally, as a subject commented, "*I like the description, very clear and I can understand them quite well*".

Last, the subjects perceived Dell's Website content to be accessible – "*I think I can find the product warranty in this table*", "*the product I want should be in here*".

Together, these information qualities facilitate the wayfinding processes. First, the good quality of information reduces the cognitive overhead in forming cognitive maps. The comprehensive content enabled the subjects to construct a good description regarding the different Webpage landmarks, making each Webpage unique. As such, subjects could form the landmarks in their cognitive maps quickly and generate decisions quickly to identify which landmark to focus on and know exactly where to find it (see Fig. 4). Johnson-Laird [33] noted that providing relevant information is important as it assists in building a user's cognitive map by mapping it onto existing or new one.

Furthermore, the contents found in this Website helped the subjects to form well-informed decisions during decision generation in selecting a product to purchase, and helped them to assess their decisions for execution. For example, the presentation of the comparison feature made it easy for the subjects to gather and compare the specifications of the various computer models. It made the subjects feel confident that they were looking at the information exactly or close to what they need. Finally, the contextual-

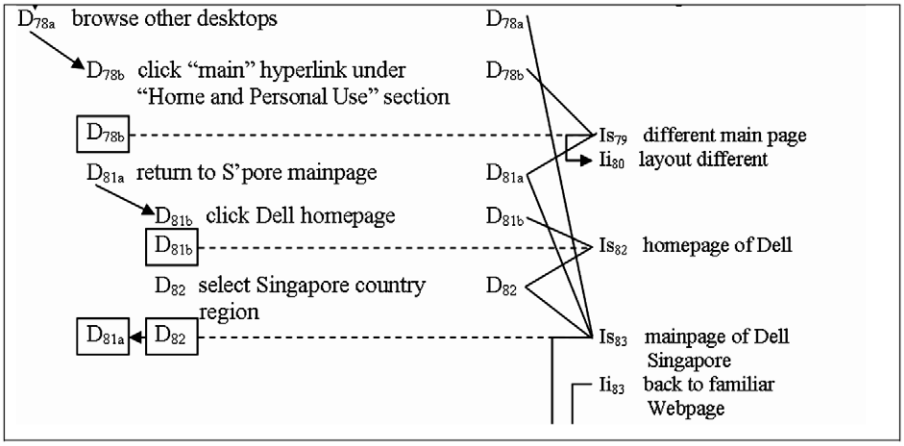


Fig. 4. Subject C assessing Dell homepage and Dell-Singapore mainpage.

ization of information helped to narrow down the information that they had to go through, making it more convenient for them to accomplish their tasks. For example, Dell's Website pointed to subsites representing different countries. Such customization not only created home-like environments for the subjects, but also localize the information such as the computer models available, prices and shipping time, further reducing the subjects' overhead in decision generation and evaluation.

### 5.2. The appearance or outward forms of the Website

Graphical presentation, like icons, colours, images and animations, are used to present the Website more vividly and to increase satisfaction [16]. A well-presented Website would also improve Website navigation [15]. In essence, any Webpage should convey coherence, possessing a consistent presentation style that is used for all Webpages within the Website. Although practitioners know the importance of consistent Website design, there are still numerous Websites that have inconsistent design. This poses an enormous cognitive burden on a user to toggle and learn different methods of interacting within the Website [34].

In our study, the appearance of Website is instrumental in facilitating browsing to form better landmark and route knowledge, reduce cognitive load on subjects, and improve perception of information in order for subjects to perform better cognitive mapping and assessment of decisions for execution.

First, the consistency of design and compliance with the general Web conventions helped to ease the subjects' learning process in navigating the Website. the consistency placement of Dell's logo, navigation bar etc, allowed the subjects to form distinct landmarks such that they could easily form a cognitive map of how the next Webpage should look like and immediately focus onto a particular area, "*I'm focusing on this area because I know that the description is in here*". Dell's compliance with the general Web conventions facilitated the cognitive mapping of the Website. The subjects, having been exposed to many Websites, were accustomed to some Web conventions, "*Dell definitely follows the normal Web conventions*", "*everything looks pretty much the same as in any commercial Websites*". For example, Nielsen and Tahir [35] found that most Websites placed the navigation bar on top and the company logo in the top left corner, which was the exact positions found in Dell's Website. Thus, there was less cognitive load on the subjects as they could easily learn the design of the Website based on past experiences. A few subjects had noted that they "*know where to go*" without wasting their "*time trying to figure (their) way around the Website*" as the presentation of the information in the Dell's Website was "*more predictable*".

Second, the good graphical design also facilitated browsing by making it easier for the subjects to view. The appropriate inclusion of graphics would capture the subjects' attention and increases the comprehensibility of the information better than a plain text Website. As the saying goes, "a picture is worth a thousand words", well-represented graphics of landmarks could replace any text description of the landmarks [36]. Hence, the subjects could form better landmarks by using the graphics displayed on Dell's Website.

Third, the high legibility of the Website helped the subjects to extract even more information to form a proper cognitive map as well as to assess decisions to execute. Dell's Website followed Nielsen's and Tahir's [35] recommendation to have black text over white background, giving maximum colour contrast and made it easier for the subjects to read, "*this is quite easy to read*", "*I'm glad I don't have to highlight the text to read it*". Lastly, for Web-

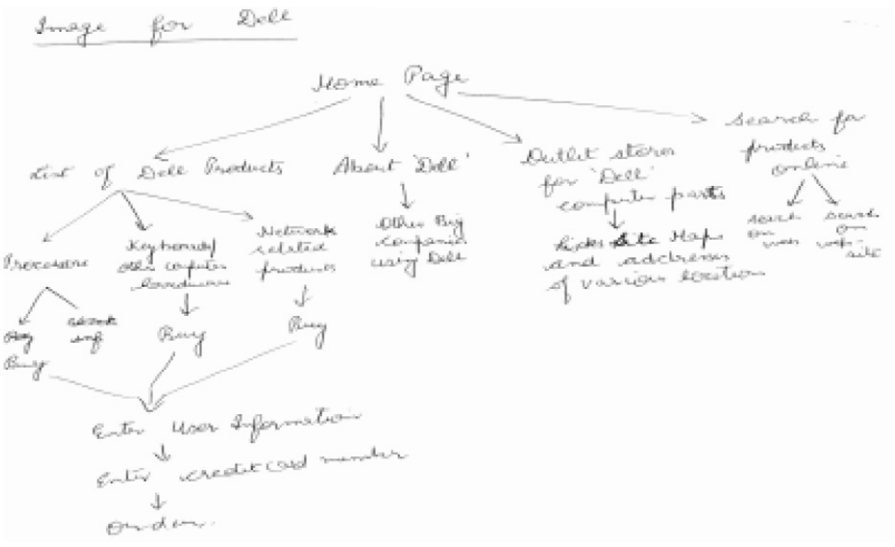


Fig. 5. Subject E's drawing of Dell's Website structure.

page layout, the subjects did not need to do much scrolling in order to view the information, and thus, they were able to perceive all the information on the Webpage at one go and concentrate on it.

### 5.3. The structure and navigation of a Website

Bevan [37] noted that a "structure which makes sense to the user will often differ from the structure used internally by the data provider." Since the user is the target user, the Web pages and its information should be structured in a way that is meaningful to the user. Lynch and Horton [38] highlighted that a hierarchy of Webpages should be built "that feels natural and well-structured to the user, and doesn't interfere with their use of the Website or mislead them". Larson and Czerwinski [14] showed that user performance is optimal when breadth and depth of Website is kept to a moderate level of $16 \times 32$. A user should have a good overview of the Website to reduce the cognitive overhead in establishing his/her cognitive map. He/she would then be able to orientate and recognize his/her current Website location, and navigate easily [14].

Fig. 5 shows one of the subjects' drawing of his pre-task cognitive map of Dell's Website. This subject has never been to Dell's Website before although he had visited other e-tailer Websites. The drawing shows the inverted tree structure of the organization of Webpages and linkage between them. As mentioned in Section 4.1, there is a high similarity between the pre-task and actual cognitive maps. This implied that the subjects did not have to make many changes to match their pre-task cognitive map as Dell has a "*predictable (Website) structure*".

A Website that supports navigation helps users find their way by showing them "where they are and where they can go" [38]. In navigating Dell's Website, the subjects did not find it difficult as there were several navigation aids

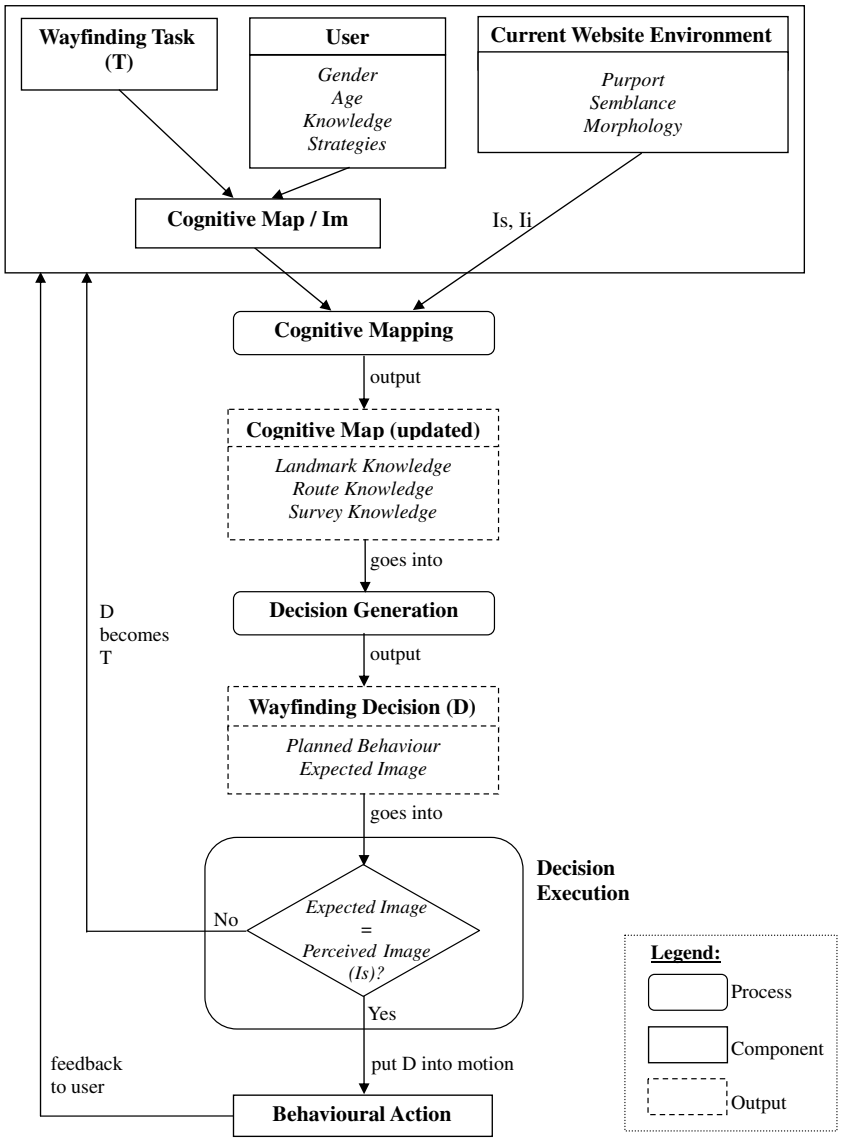


Fig. 6. New wayfinding diagram.

that allowed them to easily search for information. In fact, the subjects were using only the navigation bars and category hyperlinks, but not the search engine. Thus, those navigational aids formed navigational landmarks in the subjects' cognitive maps and they were used like marked trails to navigate the Website.

Bevan [37] advocated that hyperlinks should "tell users what to expect". Dell's Website had well-labelled hyperlinks that enabled subjects to orientate themselves and predict the content underlying it. Hence, they were confident that the "*(hyper) links link to the pages (they) expect*" and noted that even first-time visitors or "*novices will find it easy to navigate*" as they did not need to interpret the meaning of the cues. In the decision execution process, the subjects were assessing the words used in the label and attempting to match it with their cognitive maps. They could identify which hyperlink to click and the title header of a Webpage would assure them that they were on the right track. Thus, Dell's Website was quite "*predictable*".

A sitemap provides an overview to "help users understand the scope of the site" [38]. Dell's Website was so easily navigable that none of the subjects needed to use it to navigate. Only one subject clicked it to see the organization of Dell's Website, "*I like to check out the sitemap and it will tell me the organization of the Website.*" The sitemap represents a high-level overview of the Website and it would help to form the survey knowledge in the users' cognitive maps. As the subjects were mostly relying on the navigation bars and category hyperlinks, i.e. landmark and route knowledge, they did not need to form the full survey knowledge of the Website to navigate.

### 5.4. The flow diagram of the browsing behaviour

This study focuses on how to enhance user performance through better Website design. Drawing from prior studies, we conducted an empirical study to examine Web browsing behaviour. From prior literature and results of this study, a new flow diagram of the browsing behaviour was formed (see Fig. 6). This new diagram illustrates the relationships between the processes and the components of Web browsing. As Web browsing is an iteration process, there are links leading from decision execution and behavioural action back to the top and restart the entire process. In the diagram, a big rectangular box, encompassing the browsing task, user, and the Website environment, is to signify that the three components dynamically changed or updated as the user progresses to complete his/her browsing task in the Website environment.

## 6. Conclusions

### 6.1. Implications to academics

Since Lynch [4] and later Passini [6] developed the wayfinding theory, it has been applied to many areas. However, the wayfinding process and analysis was given in textual description. Chen and Stanney [7] first developed a theoretical model of wayfinding, and we refined the model to show the flow of wayfinding at a Website.

This research shows the benefit of incorporating user behaviour into Website design in that it could lead to better human–computer interaction. This would require an extensive research ranging from the importance of user's memory on navigation to the visual effects of the Website features on the user's perception, revealing interesting results of user behaviour. With regards to the user's memory, it plays an important role in the user's familiarisation of the real environment as places and signs remain unchanged for a period of time. However, in the Website environment where Websites change frequently, a user is constantly faced with new designs of a Website that it may be pointless for a user to remember what information is located where within the Website. Hence, it would be interesting to know how important a user's memory is in navigating the Website.

Moreover, more research on the cognitive mapping process and its product would be beneficial. There is still a gap between what the user expects to see and what he/she actually sees in the Website. Currently, it is the user who closes the gap through learning to map the actual Website to his/her mental model and formulate his/her browsing strategy. By understanding cognitive mapping, an effective Website design can be formed which shortens the user's learning curve and supports multiple browsing strategies.

In addition, academics can also investigate whether the Website features would actually influence a user's perceived trust of the Website and his/her behavioural intention, as there were subjects' comments on Dell's Website such as "*I trust Dell*", "Dell is stable and professional". However, trust and behavioural intention are dependent on other factors like company policies, security etc. Hence this is a possible extension of the research as it would be of value to better understand the design of commercial Websites.

### 6.2. Implications to practitioners

Results of this research showed that practitioners should focus on the users' needs, which is to find their way around in the Websites easily, comfortably, and enjoy the process. Practitioners sometimes redesign their Websites for a variety of reasons – improving the Webpage layout and graphics, or giving a fresh look to attract repeat visitors. They should ensure that the new design should still enable repeat visitors to comfortably navigate around and locate what they need. Also, Website design should be clear in its purpose (for commercial, recreation, or personal), to the types of users who would possibly visit the Websites (first-time users versus experienced users), as these factors would affect how the users find their way around the Website. Hence, practitioners should re-prioritise Website features that facilitate wayfinding when designing Websites. For example, consistent presentational style and the presence of navigational aids and orientation cues are very important with regards to efficiency and satisfaction.

Practitioners can also draw from the browsing protocol and find out how effective their Websites are. It presents to them a systematic attempt to collect data on the direct experience of user and understand how certain Website features affect the user performance. With an effective Website that facilitates browsing, user would then be able to find what they want successfully. Thus, the usage of the browsing protocol would be appropriate for practitioners as well.

### 6.3. Future research

For future phases of the research, an investigation can be conducted on the importance of a user's memory in navigating through a Website. As mentioned earlier, a user's memory is very important in helping a user to recall the path to a destination in the real environment. However, the importance of a user's memory in navigating the virtual Website environment is questionable as the Websites change so frequently that little remains the same for a user to remember and recall. Hence, an exploration into the user's memory may reveal interesting results.

Experiments can also be conducted to investigate the main and interactivity effects of the Website features on user performance. From our study, it can be observed that these design dimensions could be (1) the meaning conveyed or implied by the Website content; (2) the appearance or outward forms of the Website; and (3) the structure and navigation of a Website. The subjects felt that they had taken certain Website features "*for granted*", like the navigation bar, consistent interface design, relevant and updated content. Hence, it was not clear whether individually high degree of each Website design dimension would actually have a positive impact on user performance and if any of the design dimensions had a stronger influence on the user performance than the others.

Furthermore, an investigation on the intervening variables, like cognitive map, strategies, and their effects on user performance can be conducted. The challenge lies in the measurement of the cognitive map as it is still in its early stages. Hence, this investigation would be of value to understand in-depth the user behaviour in the Website and the extent to which the influence of these intervening variables on browsing and user performance.

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