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**An Empirical Study on Web Usability:
Enhancing the World Wide Web as a Sociotechnical Capital**

An Interactive Qualifying Project Report

submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

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Date: May 5, 2009

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ABSTRACT

This project aims to better utilize the World Wide Web as a sociotechnical capital by improving web usability and user experience. Grounded in human-computer interaction literature, four hypotheses were formed and tested via two task-oriented studies: an online survey and an eye tracking study. Subjective assessments and objective measurements were taken. The results provided insight on designing websites that facilitate a more effective and pleasant user experience. Implications for improving the World Wide Web as social capital are discussed.

EXECUTIVE SUMMARY

In the age of information, the World Wide Web is an important communication channel serving our society. Despite the popularity of the Web, it has underlying accessibility and usability problems. Senior adults and people with disability heavily rely on the World Wide Web to access health information, communicate with others, and purchase services and goods. Because of the Web, people even in the most remote areas can have social presence and connection. The Web serves as an important sociotechnical capital in today's world. However, poor design can greatly diminish the value of the Web and stand as an obstacle to efficient communications. The objective of this project, therefore, is to address this issue by improving usability of the Web and enhancing user experience, and thus the World Wide Web as a sociotechnical capital can be better utilized.

To achieve this objective a finance-oriented web page was adapted and tested. The choice of genre was particularly relevant because such a web page provides abundant, valuable, and important information to its readers. Two alternative designs of this finance homepage were created. The distinction between the two designs was contained within one section of the page only. In that section, one design had human faces while the other had company logos to support the accompanying text. The differences in design were tested by asking users to complete tasks that required them read the area that was under investigation.

Grounded in human-computer interaction theories and previous research findings, it was hypothesized that the design containing human faces will be more appealing to users and that visual appeal of the page will affect users' trust. Additionally, it was hypothesized that the order of the provided information as well as inclusion of human faces on the page will influence user performance.

The results showed that a page with images of faces was indeed more appealing to users and that Visual Appeal and Trust were significantly correlated. Serving as an important visual cue and matching up with the key word of the tasks, the facial images of people helped participants to improve their performance on the given tasks. User performance was also influenced by the order of information that was positioned on the page. These results help professionals to design pages that are not only more appealing but also more effective; their implications offer abundant information toward a design that enables better user experience. Thus, the findings of this project provide insight for improving the Web as our sociotechnical capital.

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1. INTRODUCTION

The World Wide Web today is a prevalent platform that enables people to interact, communicate and share information. In addition, not only is the Web a popular element of our lives, it has also become a critical resource in many aspects. As noted by the World Wide Web Consortium (W3C), the Web is increasingly crucial for areas such as education, employment, government, commerce, and health care (Education and Outreach Working Group (EOWG), 2005). For example, the Internet has become a prevailing and sometimes an essential medium and community for some senior citizens and people with disabilities to communicate, retrieve information, and shop for services and goods (Loiacono, 2004). It is a great sociotechnical capital that deserves to be easily accessible by as many people as possible.

However, because of poor designs, the value of Web can be greatly diminished. Many times people cannot take advantage of this technology. For example, the poor usability of a web site could stand as an obstacle between two communicating parties. Usability can also be viewed as an efficiency issue: a design with low usability will decrease the efficiency of its users and thus reduce the value of the Web. Aesthetics, yet another aspect of web usability, can also pose a problem because not only negative emotions can be elicited due to poor designs, users' decision-making process could also be negatively influenced (Hirschman & Holbrook, 1982).

Therefore, making the Web accessible and usable is not only a technical but also a social and behavioral science issue. It is important that we can better utilize the Web as a social capital and improve its accessibility and usability so that this advancement in technology can create more values, increase human productivity and better serve our society.

One way to improve such a sociotechnical capital is by improving user experience. In order to do so this projects uses theories in the fields of human-computer interaction and web

usability to study user behavior and thus offer suggestions and guidelines for better utilization of the Web.

2. BACKGROUND

A major component of an Interactive Qualifying Projects (IQP) at WPI is to explore social impacts of technology. This IQP project examines factors that can enhance a user's ability to use the Web, which serves as an essential channel of communication and network in today's society and thus has become an important "sociotechnical capital" (Resnick, 2001). The objective of this section is to provide the necessary background for this IQP.

2.1 History of the Internet and the World Wide Web

The Internet was created originally out of a military initiative in the 1950s. Because of a successful launch of the rocket Sputnik by USSR in October of 1957, the United States created the Advanced Research Projects Agency (ARPA) as an immediate action to retain technological advantages (Griffiths, 2002). In a 1965 ARPA experiment, the telephone network succeeded to transfer data through a low speed dial-up telephone-line linking computers in UC Berkeley and MIT (Griffiths, 2002). Later on, ARPANET, a plan for computer network system, was proposed and constructed by a variety of teams who designed a protocol known as an interface message processor (IMP) to connect computers (Griffiths, 2002). By 1971, ARPANET linked 23 host computers among research centers and universities such as UCLA and Stanford, allowing them to send and receive messages and data through this network (Griffiths, 2002).

ARPANET transformed into Internet in the 1970s (Griffiths, 2002). A direct person-to-person communication, which we now call e-mail, was introduced in 1972 (Griffiths, 2002). In addition, ARPA and Stanford scientists developed the transmission control protocol/internet protocol (TCP/IP), which allowed communications between different networks (Griffiths, 2002).

A crucial concept of TCP/IP is “open architecture” networking, which specifies rules in gateway traffic, package, and routing (Griffiths, 2002). Many years later, with adaptations in microcomputer support and network compatibility, the TCP/IP was universally adopted in 1982 and became the standard of connected networks, replacing the backbone system ARPANET (Griffiths, 2002).

The acceptance of Internet grew dramatically; in 1984, the number of hosts reached 1,000 and traffic grew larger, mainly due to the popularity of e-mail; the growth started to overwhelm the entire system (Griffiths, 2002). Two developments came into help: one was the introduction of domain name servers (DNS), which assigned each host computer a name and address with a domain such as “.edu” and “.com” and could translate the easily-memorable addresses to IP addresses such as 130.215.XX.XX; another development was the promotion of Internet use in research and education (Griffiths, 2002). In 1985, the U.S. National Science Foundation created and funded NSFNet to serve American schools with a large capacity of traffic enabled by supercomputers (Griffiths, 2002).

The Internet continued to expand thanks to government and academic efforts; in 1989, a browser program named the World Wide Web (WWW) was developed by Tim Berners-Lee and scientists at CERN in hope to retrieve research documents (Griffiths, 2002). Two developments have enabled the popularity of the WWW and its ease of use: the Hypertext Markup Language (HTML), which allowed text to have links behind and made pages easily navigable, as well as a protocol named Hypertext Transfer Protocol (HTTP), which enabled the retrieval of document on the Internet through an address input (Griffiths, 2002).

The WWW became increasingly popular with exponential growth in its users and hosts. When asked about the difference between the WWW (the Web) and the Internet (the Net), the founder of the former gave the following answer:

The Web is an abstract (imaginary) space of information. On the Net, you find computers - on the Web, you find document, sounds, videos ... information. On the Net, the connections are cables between computers; on the Web, connections are hypertext links. The Web exists because of programs, which communicate between computers on the Net. The Web could not be without the Net. The Web made the Net useful because people are really interested in information (not to mention knowledge and wisdom!) and don't really want to have know about computers and cables. (Griffiths, 2002)

The Web enables communications unimaginable in the past, creating new values and enhancing productivity, and thus should be treated as not only a mere technological advance and achievement, but also a capital, as discussed in details in the following section.

2.2 Web as a Capital

At the end of 2008, the Internet has become accessible for over 1.5 billion people, which is 23.6% of the world's population (World Internet Users and Population Stats). In North America, its penetration rate is as high as 73.1% and it is still growing (World Internet Users and Population Stats). The Internet and its various services such as the World Wide Web are not simply emergences in technology application. Resnick has argued that the Web qualifies to be identified as a "sociotechnical capital" which brings about values and creates productivity (Resnick, 2001).

It is not surprising that capitals include physical capital (e.g. buildings, tools), financial capital, and human capital (e.g. education). These capitals were identified long ago and are resources which can be accumulated and can help people generate values (Resnick, 2001).

Apart from the previously mentioned, because a network of people who are working together is more productive than them working individually, even granted the same physical, financial, and human capitals, the concept of social capital is introduced. Based on shared communication paths, knowledge, values, sense of collective identity, obligations, norms, and trust, a social capital facilitates exchange of information and other resources at lower transaction costs; it also enables easier emotional support and coordination of actions (Resnick, 2001). Human network is a capital because it can be used as an investment which develops resources and creates values as well (Resnick, 2001).

Later on, with the introduction of information and communication technologies, which enabled greater productivity by opening new opportunities of interaction, a concept of “sociotechnical capital” is presented by Resnick to refer to productive combinations of social relations and technology (Resnick, 2001). Sociotechnical capital is a special but important subset of social capital since many of the advancements were unexamined from the traditional social capital perspective (Resnick, 2001). For example, previously distant communication was difficult in a social capital. Without the help of web sites, it was difficult to reach a large size of audience. It would also be impossible to inform the same audience as efficiently without the help of today’s technology (Resnick, 2001). Therefore, it is critical for our society to make use of this capital and utilize it to increase the productivity and create additional values.

One way to increase productivity through this sociotechnical capital is by making users' interactions more effective. Enhancing user interactions, which is a major focus of research in Human-Computer Interaction (HCI), is discussed in the following sections.

2.3 Usability and Human-Computer Interaction

As computers and software become more popular, the diverse and non-technical groups of end users ought to have their preferences and needs addressed (Rosson & Carroll, 2002). A system needs to be easy to learn, easy to use, and satisfactory to its user (Rosson & Carroll, 2002). In fact, users today would expect a product's interface to be easy to use (Fuccella & Pizzolato, 1998). Therefore, usability is a quality attribute that assesses user interfaces and methods for improving the ease-of-use (Nielsen, 2003). An ISO publication defines 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” (International Organization for Standardization, 1998, p. 6).

One important perspective of usability is human-computer interaction, which emerged as a shared interest between computer science and cognitive science (Rosson & Carroll, 2002). Provided by the Association for Computing Machinery (ACM), HCI is defined as “a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them” (SIGCHI, 2008). Concerns of HCI consist of the analysis of mental activities that guide behavior, the study of learning challenges of interactive systems, the activity of design itself (Rosson & Carroll, 2002).

Recent studies show that visual aesthetics is an important part of web usability (Lavie & Tractinsky, 2004). Consequently, a great number of studies have focused on aesthetic aspects of

websites (Lavie & Tractinsky, 2004; Tractinsky, Katz, & Ikar, 2000). Next section provides a brief review of this literature.

2.4 Aesthetics

The importance of aesthetics has been recognized and addressed since ancient times; its application has been demonstrated in every aspect of life, such as architecture, product development, and marketing strategies (Lavie & Tractinsky, 2004). Aesthetics should therefore become an important concern for web design also.

Aesthetics is the study of beauty. The word "beauty" is commonly applied to things that are pleasing, either to the senses, to the imagination, or to our understanding, and it has been studied from two different perspectives: the philosophical approach and the empirical approach (Lavie & Tractinsky, 2004).

In the philosophical approach, scholars debate on the intentionality of aesthetic attitudes. For example, the basis of aesthetics study relies on the question of whether an aesthetic attitude is developed and guided by a purpose or a set of properties in the mind of the viewer (Lavie & Tractinsky, 2004). Some argue that a thing is beautiful if it is constructed to its function, or "form follows function", while others claim that the attitude is formed without such purposes; however, in today's world a design is judged by both "instrumental and aesthetic merits" (Lavie & Tractinsky, 2004).

The issue of whether aesthetics should be viewed objectively or subjectively is also a topic of debate within the philosophical approach. While some maintain the objective view that objective properties such as order and symmetry define the essence of beauty, others take the subjective approach and argue that the beauty and emotion are connected and the former should be viewed within the subject, not the object (Lavie & Tractinsky, 2004). Again, most current

studies take a middle position and believe aesthetics lies in both the subject and the object (Lavie & Tractinsky, 2004).

The other approach in the study of aesthetics is the empirical approach, which can again be divided into two branches: one being the experimental approach that identifies aesthetic qualities by testing isolated elements of a form, and another being the exploratory approach characterized by higher-order exploration of subjective perceptions of aesthetics. The latter is concerned more with human judgments and adopts factor analysis techniques (Lavie & Tractinsky, 2004).

Recently researches have drawn a relation between aesthetics and the traditional areas of study of human computer interaction, such as time to learn, error rate and time to complete a task (Lavie & Tractinsky, 2004; Butler, 1996). In fact, as argued by Fogarty et al., “the need to consider aesthetics ... in the design of interactive systems will increase” as computers have become ubiquitous tools for broad aspects of life (2001, p. 150). In addition, it is claimed that “more interesting interfaces increase users’ arousal and sustain their interest and effectiveness” (Lavie & Tractinsky, 2004; Gait, 1985). Aesthetics has become a popular research topic and is found to be an influential factor for web users (Lavie & Tractinsky, 2004; Karvonen, 2000; Tractinsky, Katz, & Ikar, 2000).

2.5 Web and Web Usability

The Web has numerous applications in the society. On the individual side, it enables people to share experiences, to expose tacit knowledge, to make recommendations, and to discuss a wide range of topics; it also enables people to socialize and seek affiliation, companionship, and support (Girgensohn & Lee, 2002). On the business side, the Web enables

the conduction of economic transactions and relationships to be built among businesses and customers (Girgensohn & Lee, 2002).

Despite the popularity of the Web, it has underlying accessibility and usability problems. While a survey found that 70% of senior adults use the World Wide Web to access health information online (SeniorNet, 2002), providing such information on the Web, as argued by Becker, does not mean that it can be accessed by its targeted audience because of existing usability barriers such as font, graphics, navigation, and other interface problems (Becker, 2004). Web usability, in this case, exists as an obstacle for the retrieval and processing of critically important information and has undermined the abundant resources it carries; the effectiveness of the usability principle is thus diminished.

In another scenario, web usability could be an efficiency issue. When the web is implemented in a corporate environment, it was found that employees' productivity can be sabotaged when they operate on poorly-designed intranet web pages (Nielsen, 2003). In enterprises user efficiency is a major problem that can diminish the value and acceptability of IT investments (Verton, 2002), and thus the user satisfaction could degrade as well.

For organizations, it is critical that web usability is assured. In fact, business organizations utilize the World Wide Web more than ever. The business uses of the Web exceeded non-commercial uses for the first time in 1993 (Anderson, 1993). As indicated by a 2002 research on American surfers' top activities, 63% of respondents use the web to "research products/services" (Greenspan, 2002), which implies that the Web should be of specific importance to businesses. Therefore, it has been argued that "usability is a necessary condition for survival" for e-businesses (Nielsen, 2003). When an organization has a presence online and wishes to reach and retain its audience, web usability is a major concern. Research finds that

40% of customers will not return if they have had a negative experience on the first visit (Manning, McCarthy, & Souza, 1998). Moreover, as noticed by Nielsen, Web users simply leave the website if it is difficult to use, read, or navigate (Nielsen, 2003).

Fortunately, there are cures to these issues. Guidelines and theories, such as social presence and Gestalt theory, exist in the field of psychology and are nowadays heavily used and referred to in the field of human-computer interaction. With the help of such research results Web builders can design more user-friendly pages. Such improvements are of great interest to companies. A recent survey has found that the return on investment (ROI) for investment usability design is as high as 83% (Nielsen, 2008). Considering the high risks of IT investments (Violino, 1997), the usability design is essential to ensure that such investments are implemented and deployed properly. The following section provides a brief review of three design theories that are relevant to this project.

2.6 Social Presence Theory

Web-based communications can often be enhanced by theories and guidelines that deal with designs and presentation modes (Leflore, 2000). One way to enhance the usability of a website is through embedding social presence. The social presence theory was first proposed by Short, Williams, and Christie in their book *The Social Psychology of Telecommunications* in 1976. The theory describes the mediation of communication over a certain media and how the communicator has awareness of the presence of another person (Short, Williams, & Christie, 1976). Originally applied to and studied upon traditional media, the theory now applies to computer-mediated communication as well (Tanis & Postmes, 2003). Social cues such as a picture can increase positive impressions (Tanis & Postmes, 2003). Because e-commerce is more impersonal, anonymous and automated than traditional person-to-person commerce, it may be

viewed as lacking human warmth (Head, Yuan, & Archer, 2001; Hassanein & Head, 2006). Therefore, a common practice for websites to attract and retain viewers is to embed pictures of human beings in their pages. By having traces of human presence embedded in the design, users can perceive a higher social presence, are likely to have warm feelings elicited, trust the website more, and become more aesthetically attracted to it (Short, Williams, & Christie, 1976; Gefen & Straub, 2003). Such perceptions in turn are shown to be correlated with usability of a Web (Lavie & Tractinsky, 2004).

2.7 Gestalt Theory

Another theory that is often used to improve the usability of a website is the Gestalt theory. “Gestalt” is a German word meaning form or shape. In short, the theory could be summarized as “the whole is greater than the sum of the parts”. When we perceive a picture, we interpret the entire composition of individual perceptual stimuli rather than just aggregating the perception of each (Flieder & Mödritscher, 2006). It states that our mind groups elements together based on their similarity, proximity, and symmetry; we also continue to perceive a pattern even after a pattern stops or has something missing (Flieder & Mödritscher, 2006).

A web page, as argued by previous researchers, has Gestalt properties (Hsiao & Chou, 2006). Based on the principle of simplicity from Gestalt theory, visuals used in the Web should be unambiguous and easily interpretable because users unconsciously simplify their perception – they have to understand what is simple first before they can understand anything complex (Leflore, 2000). Therefore, it is important to consider how individuals make meaning of information and respond to the presentation of material and thus supply better designs that can facilitate user perception (Leflore, 2000). Organizing the visual pattern based on Gestalt

grouping principles can lead to efficient and simpler perceptions as well as better user understanding (Hsiao & Chou, 2006).

2.8 Affective Quality

The third area of theories that pertains to the study of human-computer interaction relates to psychological emotions and behavior. Russell defined a theoretical framework that incorporated several affective concepts such as core affect and affective quality (Russell, 2003). Core affect is a “neurophysiological state that is consciously accessible as a simple, nonreflective feeling that is an integral blend of hedonic and arousal values” (Russell, 2003, p. 147); core affect exists within a person (Zhang, Li, & Sun, 2006). The core affect could be changed by an affective quality (Russell, 2003), which exists in the stimulus (Zhang, Li, & Sun, 2006). The perception of affective quality (PAQ), one’s perception of the ability of a stimulus (such as a web page) to change the core affect, will eventually influence subsequent reactions to the stimulus (Russell, 2003). It was identified that perceived aesthetics and perceived visual attractiveness are concerned with the perception of affective quality of websites (Zhang, Li, & Sun, 2006; Tractinsky, Katz, & Ikar, 2000; Heijden, 2003). In other words, the affect of a website can influence one’s emotions.

3. PROJECT DESCRIPTION

Grounded in the abovementioned theories, in this project two studies were conducted. These two studies examined two alternative designs of a finance-oriented website through an online surveys and an eye tracking experiment. Four hypotheses were formed based on findings and theories of previous researches.

The two studies were both task-oriented studies based upon the same research material. Different subjective and objective measurements were tracked and then analyzed. This section begins with an explanation of the commonly used prototypes, including the tasks and hypotheses, followed by the specific design of each study and its results. Last, some additional exploratory analysis was provided.

3.1 Research Material

For the purpose of this study, two homepages of a finance-centered website were created with exact same layout but different in the images in the Expert Insights section, which is located below the fold of the web page (see Figure 1 and Figure 2). In one condition, images of the logo of GE and a picture of cash going into Uncle Sam's hat were used, versus in the other one, pictures of professionals centering on their facial area were used. These two conditions are henceforth referred to as the Logo prototype and the Faces prototype.

3.2 Tasks

The studies were both designed to be task-oriented in order to test whether the presence of logos versus the faces could influence user's behavior as well as perception of the web page. Participants were required to complete several tasks, two of which were critical tasks designed for testing the Experts Insights section of the pages where the research prototypes differed. One of these critical tasks asked users to find an opinion on what is next for GE. This task required users to access the left side of the Expert Insight section. The other critical task asked users to

find an opinion about what the worst mistake on their taxes is. This task required users to access the right side of the Expert Insight section of the page. In this paper, henceforth, these two tasks will be referred to as Task 1 (“Find an opinion on what's next for GE”) and Task 2 (“Find an opinion about your worst mistake on your taxes”).

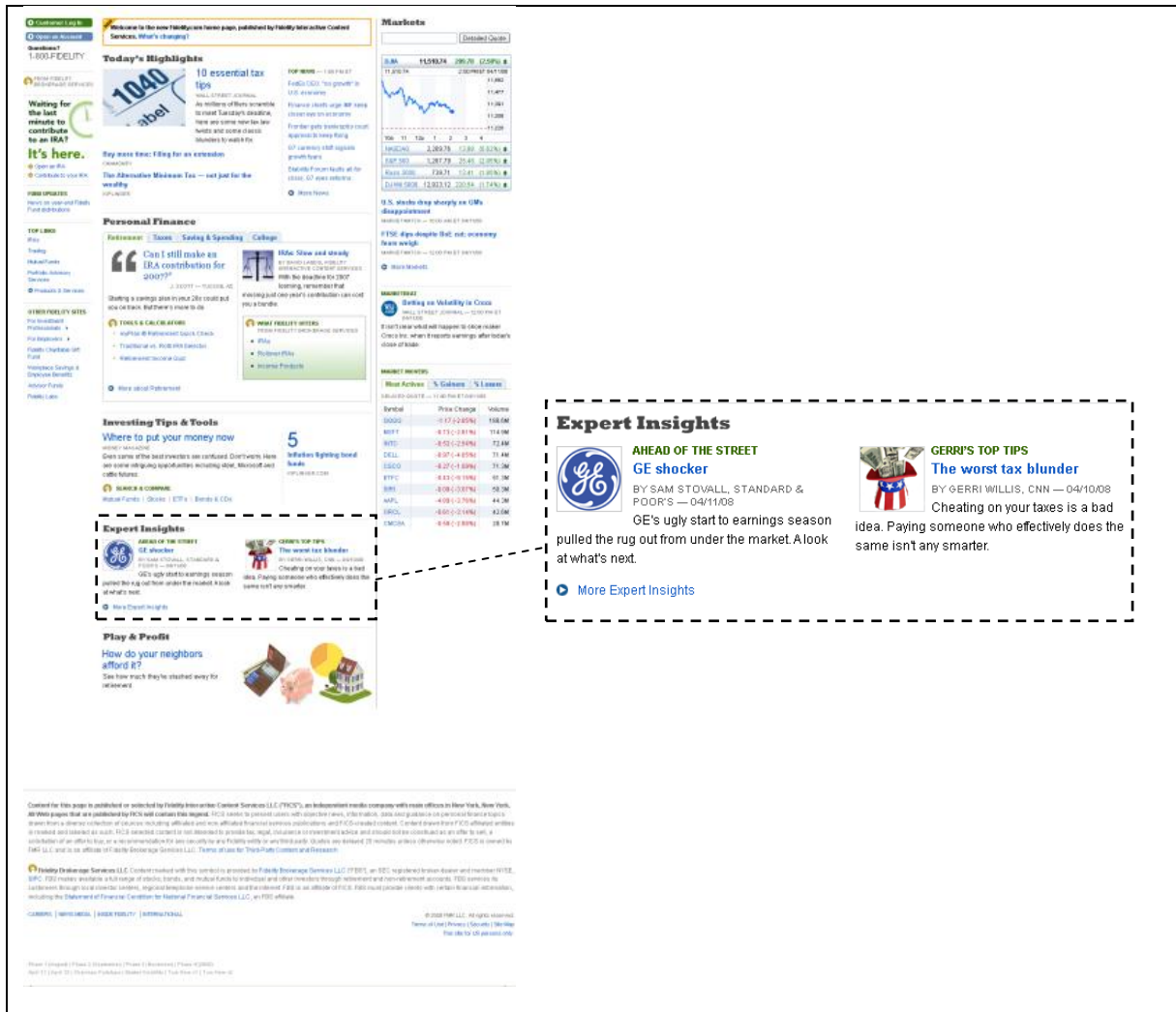


Figure 1. Logos Prototype.

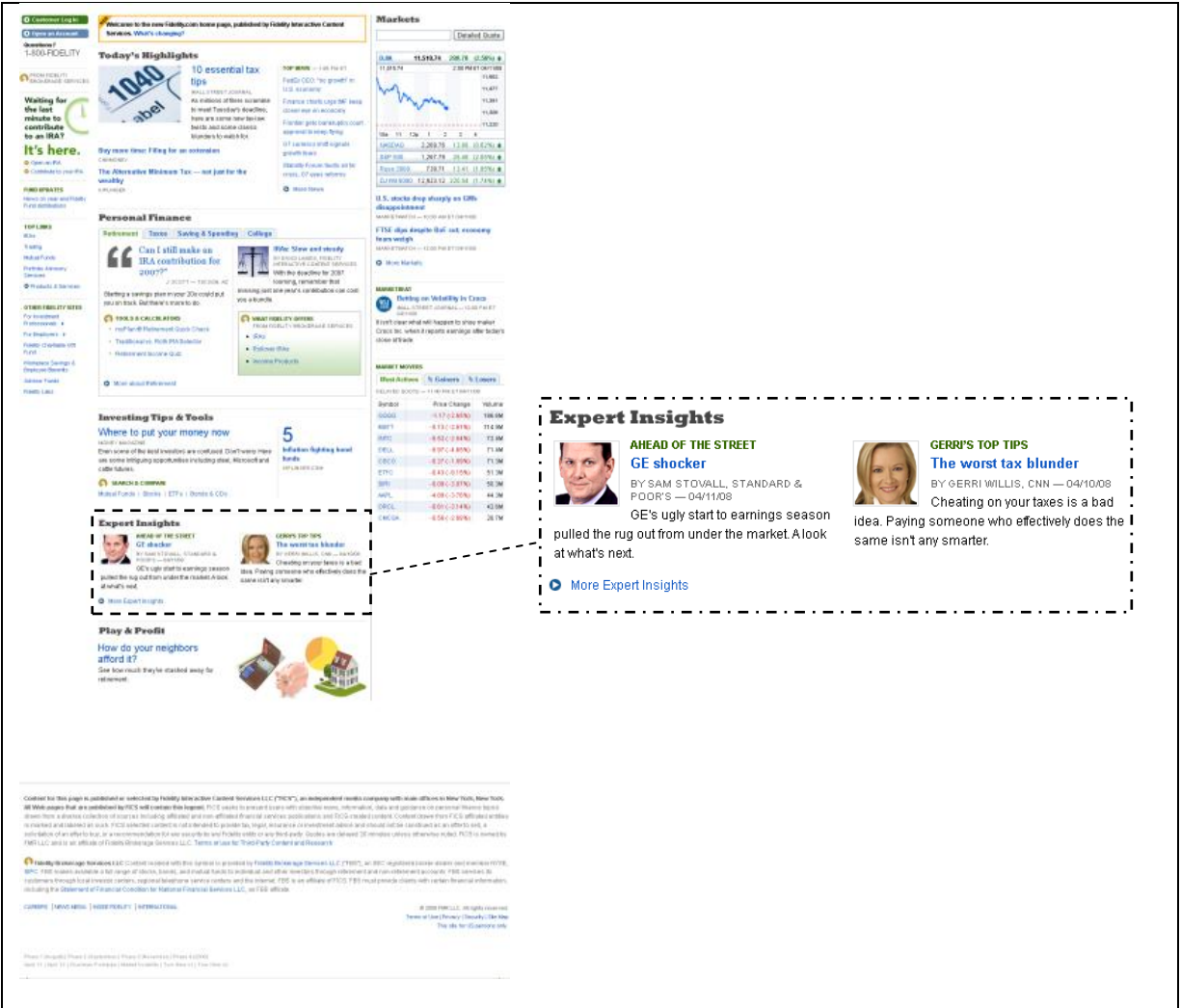


Figure 2. Faces Prototype.

3.3 Hypotheses

In this section, several hypotheses are proposed based on previous findings. The hypotheses guided the collection and analysis of the experimental results.

The first area of interest in this project was the visual appeal of the web pages under study and how the two prototypes of the web pages would differ in terms of this property. The Web is a social medium where human relationships and interactions are mediated (Biocca, Harms, & Burgoon, 2003). The social presence theory states that, because human beings are

social, there is a “sense of being with another”, which is essentially shaped and affected by interfaces (Biocca, Harms, & Burgoon, 2003). According to Sallanäs et al., “users are more or less aware of the degree of social presence of a medium and choose to use a medium that they perceive to be appropriate for a given task or purpose (Sallnäs, Rasmus-Gröhn, & Sjöström, 2000, p. 463).” Media having a high degree of Social Presence are judged as being warm, personal, sensitive and sociable (Short, Williams, & Christie, 1976). Especially, it has been argued that, in a Web environment, a sense of human warmth and sociability can be instilled by the use of pictures of humans (Hassanein & Head, 2006). Therefore, the first hypothesis is:

H1) Users will rate the web page with faces as more visually appealing than page with logos.

On the other hand, it had been argued that the quality user experiences in an interactive design should be a comprehensive attempt involving a variety of facets simultaneously; two of the criteria require that the product “serve users in sufficient and practical ways” while being “aesthetically pleasing” (Alben, 1996). Therefore, the second interest to this project was to investigate the issue of user efficiency.

Since aesthetics is an affective quality of a web page that can influence emotions of a user (Zhang & Li, 2005; Zhang, Li, & Sun, 2006), a more visually appealing design should elicit more positive feelings for its users. On the other hand, positive feeling was shown to facilitate a more effective use of information systems. For example, studies showed that information system users were able to process information better and faster (Djamasbi, 2007; Djamasbi, Tulu, Loiacono, & Whitefleet-Smith, 2008) when in a positive mood. Therefore, all things equal, a visually appealing design should draw better user performance. Since the Faces prototype was hypothesized to have better visual appeal, the second hypothesis asserts that:

H2) Users will perform better in the faces condition.

The task used in this study required the user to investigate the left part of the Expert Insights section in order to discover the answer for the task regarding GE, whereas the answer for task regarding taxes lay under the right part. According to Gestalt theory, the user will group elements in close proximity together (Faraday, 2000). Moreover, English readers tend to have a left-to-right reading order (Faraday, 2000). These two principles suggest that users are likely to notice the left portion of the Insight Expert section. In other words, a faster completion time shall be expected for the task that refers to the left portion of the Insight Expert section:

H3) Overall, users will complete Task 1 faster than Task 2.

Studies show that the beauty of a web site design greatly affect the level of trust in e-commerce (Fogg, Soohoo, Danielson, Marabel, Stanford, & Tauber, 2002; Karvonen, 2000). In one study, over two thousand Internet users were surveyed with regard to web credibility, and it was found that 46.1% of average consumers assessed web credibility “based in part on the appeal of the overall visual design” (Fogg, Soohoo, Danielson, Marabel, Stanford, & Tauber, 2002, p. 6). In addition, another study found that Internet users based e-commerce trust on visual pleasantness; users appreciated clean designs and were willing to trust one more easily if it was pleasing to them (Karvonen, 2000). Therefore, it is likely that visual appeal will be a predictor of trust in this experiment:

H4) Trust rating will be significantly influenced by visual appeal rating.

3.4 Study I: Online Survey Study

Study I examines user behavior through self report as well as objective measures of behavior. Every participant was randomly assigned to one of the two different prototypes and was asked to report his or her perceptions of the web page. The person's performance was also measured through task completion time.

3.4.1 Design

This study was conducted online. The project recruited participants by sending out emails to employees of a leading financial institution; each email contained a link to the prototypes described in previous sections. The participants ranged in age from their 20s to their 60s. In total, 290 people were randomly assigned to test the Logo prototype and 260 people to test the Faces prototype.

During the experiment, the participants were randomly assigned five tasks, and either one or two of the two tasks was/were critical task(s) (see Tasks section of this project). A user was guided and instructed through the tasks and asked to answer the questions in a survey window above the browser (see Figure 3).

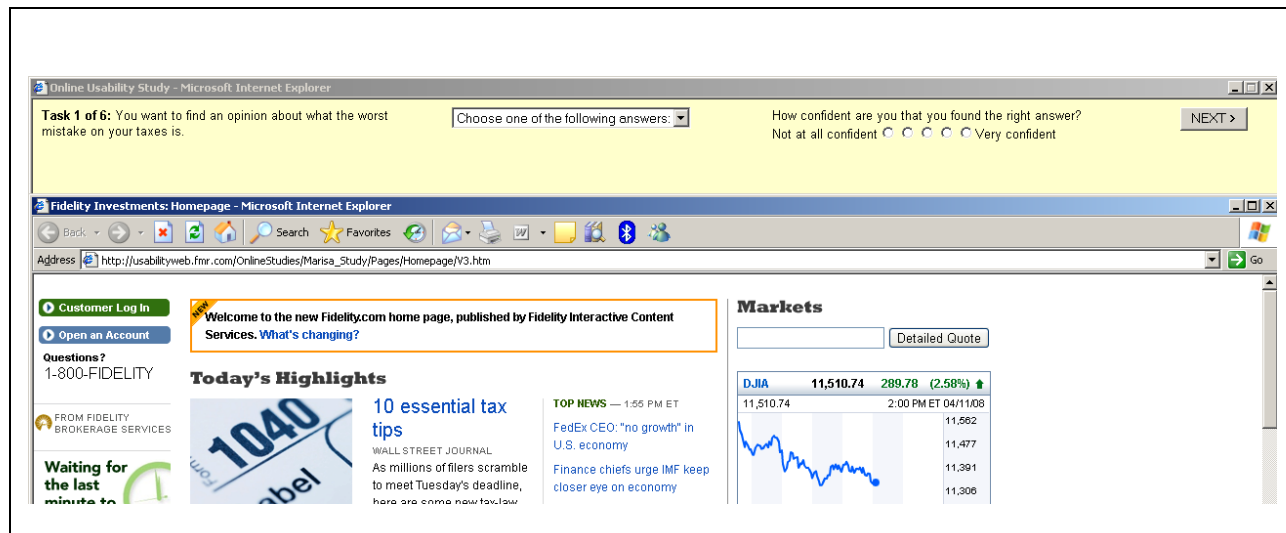


Figure 3. The Survey Window.

3.4.2 Measurements

The survey window was programmed to capture the task completion time of every user on every critical task he or she is assigned to. In addition to this objective measure, two subjective measures were recorded. After completing the tasks users were asked to rate visual appeal of the web pages they were assigned; they also were asked to indicate their level of trust in the accuracy of the information on the page (see Appendix D: Survey Questions). Visual Appeal and Trust were both self-reported ratings on a seven-point Likert scale. These two measurements were used in a number of previous studies (Fogg, et al., 2001; Lavie & Tractinsky, 2004). User performance was operationalized as task completion time, thus the mean task time represented user performance in this study.

3.4.3 Study I Results

H1 predicted that the Faces prototype would be considered more visually appealing than Logo. A one-tailed t-test was conducted to test H1 (see Table 1). This test showed a significant difference; Faces received a higher visual appeal rating (4.78 vs. 4.54, $p=.034$). H1 was therefore supported.

Table 1. Results of the t-test for visual appeal.

Visual Appeal	Mean	Std. Dev.
Logo	4.54	1.58
Faces	4.78	1.43

$df= 546.92, t Stat= -1.831, p(one\ tailed)=0.034$

Based on H1, H2 essentially stated that users would complete tasks faster when given a better-looking prototype. A one-tailed t-test (see Table 2) on Mean Task Time was found significant between the two prototypes: Faces prototype had a lower mean (.82 vs. .96, $p=.007$) than Logo. The fact that Faces resulted in better user performance while at the same time being subjectively rated higher in terms of aesthetics supported H2.

Table 2. Results of the t-test for Mean Task Time.

Mean Task Time	Mean	Std. Dev.
Logo	0.96	0.73
Faces	0.82	0.55

df= 534.192, t Stat= 2.475, p(one tailed)=0.007

H3 asserted that, regardless of the prototype condition, the task that required access to the left side of the Expert Insight section (Task 1) would be finished faster than the task that required access to the right side of the same section (Task 2). To examine the validity of H3, a two-way ANOVA was conducted (see Figure 4). The completion time for Task 1 was significantly higher than the completion time for Task 2 for both prototypes (.92 vs. .80, $p=.013$) with a non-significant interaction term ($p=.185$), showing that both task and prototype had a main effect on the users' task completion time. Thus, H3 was supported. In addition, consistent with H1, the Faces prototype resulted in significantly smaller task completion times for both tasks compared to Logo prototype (.81 vs. .94, $p=.022$). These results are displayed in Figure 4, Table 3, and Table 4.

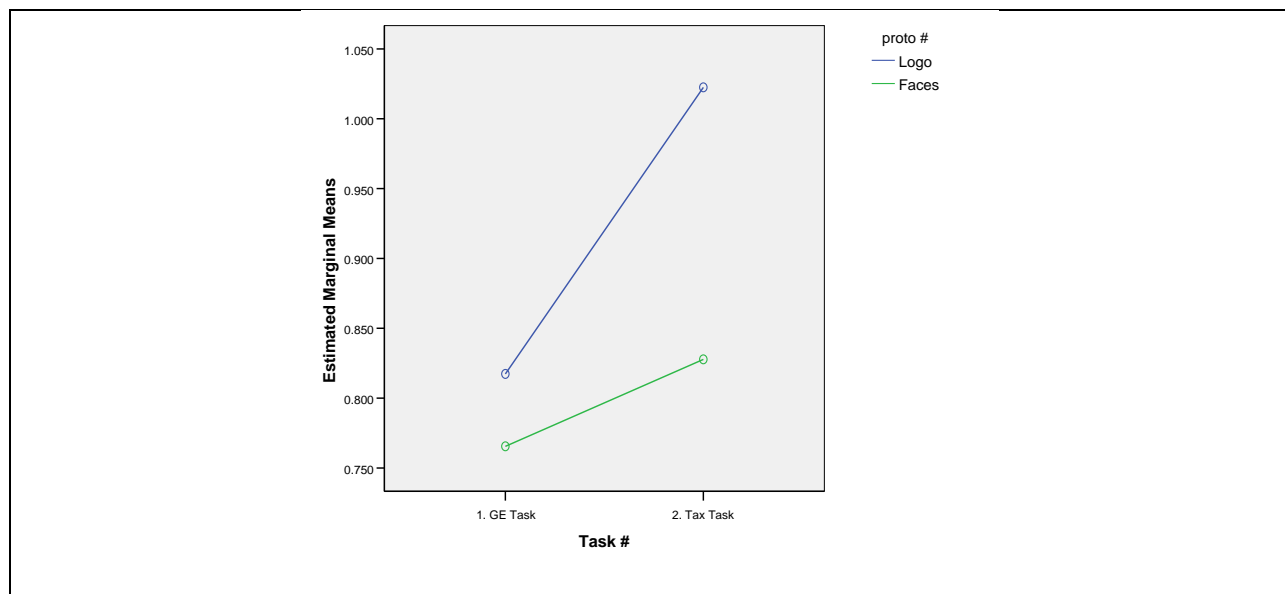


Figure 4. Task Time by Prototype and Task.

Table 3. Results from two-way ANOVA.

Task Time	Faces Prototype		Logo Prototype		Both Prototypes	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Task 1	0.77	0.51	0.82	0.62	0.80	0.57
Task 2	0.83	0.62	1.02	0.82	0.92	0.73
Both Tasks	0.81	0.58	0.94	0.75	0.88	0.68

Table 4. Between-subjects effects.

Source	df	Mean Square	F	Sig.
Prototype	1	2.375	5.232	.022
Task	1	2.795	6.156	.013
Prototype * Task	1	.798	1.758	.185

For H4, the assertion of visual appeal being a predictor for level of trust was tested through a regression analysis. The result showed that Visual Appeal ratings significantly predicted Trust ratings ($b = .288$, $p = .000$) and explained 15% of variance in Trust ($R^2 = .15$). Trust was positively correlated with Visual Appeal. In addition, visual appeal rating had a medium effect size ($f^2 = .18$) on trust rating (Cohen, 1988). These results supported H4 (see Table 5).

Table 5. Linear regression results.

Dependent Variable	Independent Variable	Parameter Estimate (B)	Standard Error	Standardized Coefficient	t-Value	P
Trust	Intercept	4.685	0.147		31.858	0.000
	Visual Appeal	0.288	0.030	0.383	9.590	0.000
Overall model $F = 91.972$; $p < 0.001$; $R^2 = 0.15$; Adjusted $R^2 = 0.15$						

3.5 Study II: Eye Tracking Study

Study I provided abundant information that has supported the four proposed hypotheses, but the obtained measurements and results were all statistical and numeric. Curious of how users would actually look at the Expert Insights section of the two prototypes, Study I was extended

and a second study was conducted. The objective of Study II was to refine the results by utilizing an eye-tracking tool and analyzing its result from a different group of participants.

3.5.1 Design

In order to retrieve unbiased results comparable with those from Study I, the same two prototyped web pages, survey window, and tasks were used in Study II. In addition, Study II was conducted in a laboratory environment where participants had their eye movements tracked using the Tobii 1750 eye trackers. The eye tracking system used was a non-intrusive eye tracker which enables the recording of accurate and robust result without restrictions on head movement; it is also suitable for participants with glasses and/or contact lenses.

According to the contents of the two critical tasks, two Areas of Interests (AOI) were defined on the web page of each prototype: GE and Tax, as seen in Figure 5. An AOI enables the study and analysis of aggregated experimental data for a specific region on the screen. In addition, to reflect a user's attention to a location on the page, consistent with prior research, a typical duration of 300ms for eye fixation was used (Rayner, Liversedge, White, & Vergilino-Perez, 2003).



Figure 5. Areas of Interest (AOI).

3.5.2 Participants

The participants were recruited from the same pool that was used in the first study (i.e., employees of the same company in Study I). Twenty male and female users participated in the second study. While all participants were employees of the same company in Study I, none was part of the first study. The age of participants in the second study ranged from 20 to 50. These participants were randomly assigned the Logo (12 participants) and the Faces prototype (8 participants).

3.5.3 Measurements

Based on the defined AOI's, the eye tracking system reported the elapsed time to first fixation, which measures the time for the first fixation within an AOI to form. It provides insight regarding which element attracts attention first (Tobii Technology).

The eye tracking system was also capable of generating standardized heatmaps with absolute values to visualize the amount of user fixation as well as its pattern. A heatmap has areas highlighted in red, yellow, and green, with red indicating highest fixations and green indicating the lightest.

3.5.4 Study II Results

Study I was an online study while study II was conducted in a controlled lab environment. In order to rule out the possibility of the laboratory setting on the participants' task completion time, a t-test (see Table 6) was conducted to compare the task completion time between Study I and II. The results, indicating no significant difference between the two task completion times, showed that the differences in the settings of the two experiments had no significant effect on task performance in the two studies.

Table 6. Results of the t-tests for across-study comparison.

Task Time	Faces Prototype		Logo Prototype		
	Mean	Std. Dev.	Mean	Std. Dev.	
Study I	0.82	0.55	0.96	0.73	
Study II	0.66	0.17	0.89	0.35	
		<i>df= 266, t Stat= 0.821, p=0.412</i>		<i>df= 15.339, t Stat= 0.586, p=0.567</i>	

The time to first fixation results obtained from the two AOI's were used to seek support for H3. A paired t-test between Task 1's and Task 2's time to first fixation values showed that such values were highly correlated ($p=.000$). In addition, although the t-test was not significant, the mean difference showed a trend that the overall first fixation for the GE AOI occurred 11.48 seconds earlier than that for the Tax AOI ($D=-11.48, p=.395$), which was consistent with the expectation discussed in H3.

Table 7. Results from paired t-test.

Time to First Fixation	Paired Differences	
	Mean	Std. Dev.
Task 1 – Task 2	-11.48	46.92
<i>df= 12, t Stat= -0.882, p=0.395</i>		

The heatmaps, as shown in Figure 6 and Figure 7, offered insights that were unavailable from Study I (heatmaps also available from Appendix B: Full Heatmaps). The heatmap for the Logo prototype, compared with the Faces prototype's, demonstrated a broader area of highlighted fixations. Regarding the density of fixation, the Logo prototype contained more yellow highlights than the Faces. However, neither showed a high fixation (red) in the Area of Interest; nor did they show a substantial fixation over the images. The heatmaps showed that participants who looked at the Logo prototype spent more time focusing on reading the text, especially the titles of the sections.



Figure 6. Heatmap of Logo prototype.



Figure 7. Heatmap of Faces prototype.

3.6 Exploratory Analysis

Despite the finding of H2 which showed that the Faces prototype demonstrated better user efficiency in terms of task completion time, the error rate, defined as the number of critical task(s) that was/were answered incorrectly divided by the number of critical task(s) given, was found to be non-significant ($p=.419$) between prototypes (see Table 8).

Table 8. Results of the t-test for error rate.

Error Rate	Mean	Std. Dev.
Faces Prototype	0.48	0.47
Logo Prototype	0.45	0.47

df= 548, t Stat= -0.809, p=0.419

When testing H3, a particularly more drastic jump from Task 1 (the GE task) to Task 2 (the tax task) was observable for the Logo prototype compared with the Faces prototype (observable from Figure 4). The between-prototype difference in Task Time was .052 minute for Task 1 (the Faces prototype took participants .052 minute less than the Logo prototype); for Task 2, however, the difference increased to .194 minute.

In this project, an assertion that visual appeal would predict trust (H4) was made. The results of regression analysis, as reported in the results section of study I, showed a significant positive correlation between Trust and Visual Appeal. To examine whether the two prototypes used in this study moderated this effect, two additional regression analyses (one for each prototype) were conducted (see Table 9 and Table 10). Next, the difference in slopes was examined. The results showing no significant differences between the two slopes ($p=.585$) indicated that the prototypes had no moderation effect on the relationship between Trust and Visual Appeal (Baron & Kenny, 1986).

Table 9. Linear regression results for Logo Prototype only.

Dependent Variable	Independent Variable	Parameter Estimate (B)	Standard Error	Standardized Coefficient	t-Value	P
Trust	Intercept	4.760	0.195		24.388	0.000
	Visual Appeal	0.286	0.041	0.388	7.054	0.000
Overall model $F = 49.765$; $p < 0.001$; $R^2 = 0.15$; Adjusted $R^2 = 0.147$						

Table 10. Linear regression results for Faces Prototype only.

Dependent Variable	Independent Variable	Parameter Estimate (B)	Standard Error	Standardized Coefficient	t-Value	P
Trust	Intercept	4.560	0.225		20.275	0.000
	Visual Appeal	0.299	0.045	0.385	6.632	0.000
Overall model $F = 43.977$; $p < 0.001$; $R^2 = 0.149$; Adjusted $R^2 = 0.145$						

Last, the metrics with respect to age were examined by dividing the participants into two age groups. Data including both prototypes were grouped together at different cut-off ages and a significant difference in Trust was found when people at the age of 30 were separated (see Table 11). People below 30 rated higher on Trust than people above 30 (6.23 vs. 5.96, $p=0.015$).

Table 11. Results of the t-test for trust grouped by age.

Trust	Mean	Std. Dev.
Below 30	6.23	1.00
Above 30	5.96	1.19

df= 498, t Stat= 2.447, p=0.015

4. DISCUSSION

Grounded in the Gestalt and social presence theory as well as theories of emotion, this project examined 1) whether including images of people (experts) had an influence on perceptions of visual appeal and trust, 2) whether the inclusion of such images had an impact on a user's performance on a task that involved those images, 3) whether a left-to-right order of information had an effect on performance, and 4) whether trust assessment was correlated with visual appeal rating. As predicted, the results showed that the page with images of professional-looking people was rated significantly more appealing than the page that did not include images of people. Moreover, Visual Appeal ratings were a significant predictor of Trust ratings (both were self reported) with a medium effect size. The results also showed that people completed their tasks significantly faster when using the page with images of people. Finally, the results showed that the order of information on the page had a significant effect on performance. Displayed in Table 12, these hypotheses and findings are consistent with Gestalt theory, social presence theory, as well as findings on emotions such as the affective quality.

Table 12. Summary of Hypotheses.

H1.	<i>Users will rate the web page with faces as more visually appealing than page with logos.</i>	Supported
H2.	<i>Users will perform better in the faces condition.</i>	Supported
H3	<i>Overall, users will complete Task 1 faster than Task 2.</i>	Supported
H4.	<i>Trust rating will be significantly influenced by visual appeal rating.</i>	Supported

In addition to the self-reported measures and user performance measures in Study I, the participants' eye movements were also examined. The analysis of user fixation pattern (heatmaps) showed that users fixated less on the Faces prototype. This finding is consistent with prior

research that showed weaker fixations on a condition with facial features compared with the condition without human presence (Cyr, Head, Larios, & Pan, 2006). This finding corresponds to the faster task completion time for the Faces prototype, which suggests that, with help of the pictures of professionals, the human faces in this task-oriented experiment design served as an important visual cue for the participants of the Faces prototype to interpret the information in the Expert Insights section faster and proceed with the hyperlinks.

The more efficient user behavior in the Faces prototype also agrees with the theory of visual rhetoric (Scott, 1994). According to Scott, “we would expect the ... graphics ... to be related in a specific way to the message itself” (1994, p. 255). The two critical tasks were both worded to ask the participants to find an opinion on or about a subject. Therefore, the key word of these tasks is essentially “opinion”, rather than its subject (i.e. “GE” or “tax mistake”). When participants were given a task and searching the web page for its answer, they would be looking for some visual cue on “opinion”, which would originate from a person. Consequently, it is natural for participants to relate business professionals to such a key word.

In addition, it is worth noticing that, although the users were more efficient when completing the critical tasks using the page with images of people (Faces prototype), this efficiency was not due to favoring speed over accuracy. This conclusion was evident by the lack of significant difference between the user error rates of the two prototypes.

Another perspective to look at the findings is to compare the impact of tasks rather than that of prototypes. In this project, two critical tasks were given to the participants, and the fact that task completion time was larger for the Task 2 in both prototypes (see Table 3 and Table 4) suggests that the order of information does influence a user’s efficiency. Regardless of using pages with faces or logos, the object on the left, if aligned with another similar object on the right

in proximity, was likely to have an earlier fixation as evidenced by the trends of users' first fixation data in Study II.

An additional analysis showed that the disparity with regard to task completion time between the two prototypes was widened when comparing Task 1 to Task 2. This outcome can be explained with the Gestalt theory which requires that new information be introduced using simplified graphics (Leflore, 2000), suggesting that a designer should be extra-careful in the choice of picture when representing an unfamiliar idea. The GE was an obvious and most favorable choice for the representation of the company as it is unambiguous and widely known. However, it was a delicate choice to assign a logo to represent "tax". Although the logo selected depicts money going into Uncle Sam's hat, implying the meaning of tax and internal revenue to some extent, the picture itself is complex and requires interpretation. Therefore, this difference in task time is a reminder to web designers to ponder the image selection in order to secure more user efficiency.

In addition to performance and visual appeal, the issue of trust was studied in this project. In agreement with previous finding, the visual design of a web site could significantly influence a user's perceived level of trust (Fogg, Soohoo, Danielson, Marabel, Stanford, & Tauber, 2002). Through a regression test, Visual Appeal was a significant predictor on Trust. In Study I, an increase of 1 point in Visual Appeal rating resulted in a gain of 0.288 in Trust rating (see Table 5).

Another interesting finding concerning Trust was through an additional exploratory analysis which showed a difference in the level of trust between younger and older users. People below 30 assessed a higher trust level than participants above 30. Previous research (Fogg, et al.,

2001) suggests that age has an impact on perceptions of web credibility. The reasons behind this difference could be addressed by future studies.

5. CONTRIBUTIONS

This project has studied the issues of web usability and user experience from a viewpoint of sociotechnical capital that can increase productivity of the society through communication enabled by technology. So far, the results of this project have presented important and abundant implications for the field of HCI and web usability. In this section, contributions of this project with regard to its social implications are discussed.

First, results of this project show that including images of faces can provide a more appealing as well as efficient experience without sacrificing accuracy. Providing a smooth and pleasant user experience generates better user satisfaction and encourages more interaction between the Web and its user; in addition, efficiency was noted as an important leverage to improve the use of the Web as a sociotechnical capital (Resnick, 2001). Being able to create a user interface such that efficiency and visual appeal are both attained is an important component to a better utilization of the Web. In addition, since creating a design with human presence in turn creates warm user feelings, a web page design that incorporates such principle will elicit good mood and acceptance among users of the capital.

Second, the introduction of new ideas and the choice of images to represent such concepts should be a delicate process. Based on the visuals of a design, the clarity of communication could be either enhanced or diminished, thus affecting effectiveness of the social capital.

Third, a necessary condition for a social capital to output values at the optimum level is that trust is established over the channel of communication, since users on a platform such as the

World Wide Web are usually geographically separated. In this project, trust was found to be strongly correlated with ratings on visual appeal, which shows that the design of the website, particularly the aesthetic aspect of it, can be directly responsible for the degree of trust and can also influence the effectiveness of the sociotechnical capital.

Besides these discussions and implications, there existed certain limitations in this project. Such limitations together with future research suggestions are discussed in the following section.

6. LIMITATIONS AND FUTURE STUDIES

There are several limitations in the two studies conducted in this project. First, all participants in these two studies were employees in a leading financial corporation. The technology literacy possessed by the participants should be higher than that an average user. It may be the interest of some researches to include a more diversified sample that represents both experienced and novice users. However, with the large number of participants in Study I, the findings should not be accidental. In fact, having experienced users participate in these studies provided a more constructive and representative feedback and set directions for future studies.

In order to have a more complete picture of the issue on efficiency and visual appeal, two studies were conducted for this project. Study I was conducted in the form of online survey, which allowed participants to accomplish the task at their own choice of time and place; however, the tradeoffs for the natural setting were distraction and uncontrollable external factors. On the other hand, Study II was conducted in a controlled laboratory environment but granted the participants less freedom and therefore was less natural. The two studies complemented each other but the limitation of each should be noted.

The common nature of the two studies is that they are both task-oriented and finance-centered. While offering some specific insights, the studies are limited to its generalizability, an

issue common to most information systems studies (Hassanein & Head, 2006). Therefore, across-context designs can be examined in the future.

In addition to the examination of the hypotheses, there was some explanatory analysis that could be further inspected by future researches. For example, why was perceived trust lower for the older participants and how to improve this? In addition, as the Expert Insights section was placed below the fold for both prototypes, the user had to scroll down to be able to locate and answer the given question. In future studies, designs with key elements that are above the fold can be investigated. Other images can be tested as well in order to make a sound claim that the choice of the tax logo worsened efficiency.

7. CONCLUSION

In this project, two relevant studies were presented to investigate the issue of web usability and the area of human-computer interaction in order to better utilize the Web as a social capital. Two web page design prototypes, one with human faces and another with company logos, were tested using a task-oriented approach through two studies, one being an online survey study while another being an eye tracking study; the two studies complement and corroborate each other. Without sacrificing accuracy, the Faces prototype demonstrated better user efficiency and better visual appeal to the users. User performance was also influenced by the order of information that was positioned on the page. The two self-reported ratings, Visual Appeal and Trust, turned out to be correlated with a medium effect size. Last, the facial images of professional-looking people served as an important visual cue for completing the assigned task as they matched the key word of the tasks. The findings of the project, which agree with popular theories in the literature, provide insight for the design of web pages and the choice of visuals as representations of information. These understandings can help to improve web usability, enhance user experience, and contribute to a better utilization of the World Wide Web, the society's sociotechnical capital.

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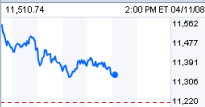
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10a	11	12p	1	2	3	4
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11,477
11,301
11,300
11,220

10a 11 12p 1 2 3 4

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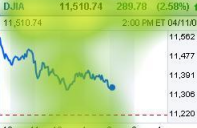
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APPENDIX C: TASKS

The exact messages of the critical tasks given to the participant are as follows:

Task 1: You want to find an opinion on what's next for GE.

Task 2: You want to find an opinion about what the worst mistake on your taxes is.

APPENDIX D: SURVEY QUESTIONS

During each study, every participant was asked to give the following two self-reported ratings:

- Rate your agreement with this statement: I find this page visually appealing.
- Rate your agreement with this statement: I trust the accuracy of the information on this page.

The participant responded to the questions on a seven-point Likert scale that went from “Strongly Disagree” to “Strongly Agree”.