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Download Time and Intent to Use a Web Page

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Richard F. Lucy and Craig VanLengen

INTRODUCTION

The World-Wide Web (WWW) has grown, and continues to grow, at an epic rate. In 1993, there were only a handful of hosts serving web documents. After the introduction of the Mosaic browser in the summer of 1993, there were over 500 web servers. By June of 1994, there were 1,500. By the end of 1995, tens of thousands of web servers hosted hundreds of thousands of web sites (Schwartz, 1999). Today, millions of web sites attract the attention of tens of millions of users. Neilsen's *NetReporter©*, which gathers Internet usage information from over 20,000 households, indicated for the week of January 27, 2000, the number of active Internet users was 56 million, out of a potential Internet universe of 123 million who had access but did not necessarily go online. For the week ended August 27, 1999, Neilsen estimated the number of Internet users at 46 million with a universe of 108 million (Hsu, 2000a). The change in user count from August 1999 to January 2000 represented a 22 percent increase in the number of active Internet users and a 14 percent increase in the Internet universe in a period of only five months.

Active users in January 2000 averaged about three hours per week on the web; however, the duration, or time spent viewing a page, was only 53 seconds (Hsu, 2000a). This usage record compares to 2 hours and 45 minutes of usage per week and 1:22 minutes duration of a page viewed for the week of August 27, 1999. Over the same period, the number of pages viewed per session increased from 20 to 35. On November 28, 2000, Neilsen reported that usage per week had increased by 10 minutes from January, pages viewed per session increased by two, and the duration per page had decreased by one second. Neilsen also estimated that the Internet universe had increased to 154 million with an active base of 69 million (Hsu, 2000b).

The primary goal of Internet merchants is for users to behave in useful and profitable ways with an interactive, virtual universe (Zona Research, 1999). Unlike other media, such as television in particular, significant numbers of users are not found on the web at the same place at the same time. Web users also are prone to move frequently from page to page (Schwartz, 1999). In most cases, a web site has only one chance to make a favorable first impression. If a web page takes more than a few seconds to present this first impression, the user may decide to abandon or "bail out" from the current site and move to another site.

As the number of web users increases daily, the communications infrastructure has difficulty maintaining the pace. The rate at which a page loads on an individual computer is constrained by the hardware and software used, as well as by the available bandwidth of the communications pipeline. Web page load times subject to extreme variation because they are affected by the size of individual pages, the number and size of graphic images per page, the construction and configuration of enabling hardware, and Internet traffic at any given time of day.

In GVU's 1998 WWW User Surveys, speed was indicated as the biggest problem facing the web. The result of failure to deliver information to the user in a "reasonable" amount of time to a commercial web site is the loss of business--possibly forever. StatMarket™ Loyalty Index, which measures how many times a user returns to a site, indicates that approximately half of the visitors to web sites are first-time users and only 25 percent return to a site an additional one to three times. Similar findings were noted in a study of browser history mechanisms, which stated that there is a 58 percent probability that the "next" page visited had been visited previously and that users visit the same web page frequently. Consequently, many web pages are visited only once (60 percent) or twice (19 percent) (Tauscher and Greenberg, 1997).

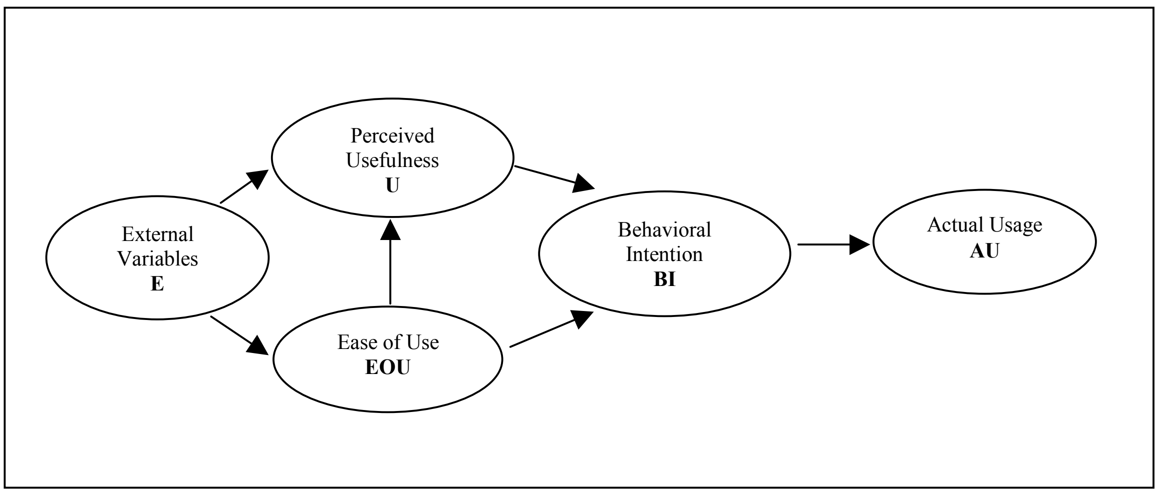
Zona Research has indicated that as much as $362 million in e-commerce sales in the U.S. may be lost each month (from the estimated 20 percent of Internet users that actually purchase online) due to unacceptable download speeds, regardless of the source of the problem--actual load time, $74 million; web page load failure, $58 million; or ISP connect failure, $230 million (Zona Research, 1999). Zona reports that, when frustrated with an online search, 34 percent of users give up trying to buy an item. Another 44 percent tend to turn away from the computer and buy from traditional retail sources, and 14 percent purchase from another web site. It is clear that users tend to blame the web site for slow download times, rather than the source of the problem, which often is not the site itself (Zona, 2000; Schwartz, 1999; GVU User Surveys, 1998).

BEHAVIORAL MODELS OF USAGE

Individual reactions to information technology and their implications on technology usage are an important topic in current research. Many authors have studied the phenomenon and have posited a variety of theoretical models. These include Diffusion of Innovations (DOI) (Compeau and Meister, 1997; Moore and Benbasat, 1991), the Technology Acceptance Model (TAM) (e.g., Davis et al, 1989; Venkatesh and Davis, 1996), the Theory of Planned Behavior (TPB) (e.g., Mathieson, 1991; Taylor and Todd, 1995) and Social Cognitive Theory (SCT) (e.g., Compeau and Higgins, 1995a, 1995b; Hill, et al, 1986, 1987). Each of these theories posits that the use of information technology (IT) is based upon of a set of beliefs about IT that result in a set of behavioral responses. Research to date has focused user acceptance of application software. The purpose of this research is to identify components of these models that will describe and predict usage in a web context.

Founded upon the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980), the TAM, as shown in Figure 1, has been used in a vast number of studies to explain the behavioral antecedents to the usage of information technology by linking external variables to user acceptance and usage (Davis, 1989; Davis, et al, 1989). Several empirical studies have verified the robustness and validity of the basic model in predicting user intentions and subsequent usage across a wide variety of systems (Igbaria, et al, 1997; Chau, 1996; Davis and Venkatesh, 1996; Venkatesh and Davis, 1996; Taylor and Todd, 1995; Szajna, 1994; Mathieson, 1991). Similarly, Hendrickson, et al. (1994), demonstrated that the Davis (1989) instrument had a high degree of test-retest reliability. Davis and Venkatesh (1996) later showed that the high proportion of the variance in usage explained by ease of use and perceived usefulness in the TAM was not an "artifact of the measurement approach."

Figure 1. Technology Acceptance Model (TAM).



External variables included "objective design characteristics, training, computer self-efficacy, training, user involvement in design, and the nature of the implementation process, which were shown to influence the use a system, and ultimately actual usage, indirectly through their influence on perceived usefulness and perceived ease of use" (Davis, 1989). In a web context, external variables are encapsulated by the physical design of a web page, which includes its physical size (and hence download time) as well as aesthetics.

Davis (1989) defines perceived usefulness (PU) as "the degree to which a person believes using a particular system would enhance his or her job performance" (p.320). Both the TRA Model and TAM purport that usefulness affects usage (AU), via behavioral intentions (BI) to use a system (Davis, 1989; Davis et al, 1989; Igbaria, et al, 1997). In the web environment, PU would be applied directly to the acquisition of information--the degree to which a user believes use of the web will result in the acquisition of the sought-after information or the perception of successful outcomes.

Perceived ease of use (EOU) in the TAM "refers to the degree to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320). The affect of EOU on usage was suggested by Davis, et al (1989), as a causal antecedent to PU. The affect of PU on EOU has been documented in several studies (Szajna, 1996; Matheison, 1991; Goodwin, 1987). Other research also has indicated the significant and direct effects of both EOU and PU on usage (Rogers, 1995; Straub, et al, 1995; Adams, et al, 1992; Mathieson, 1991; Thompson, et al, 1991). In a web context, perceived EOU has the same meaning.

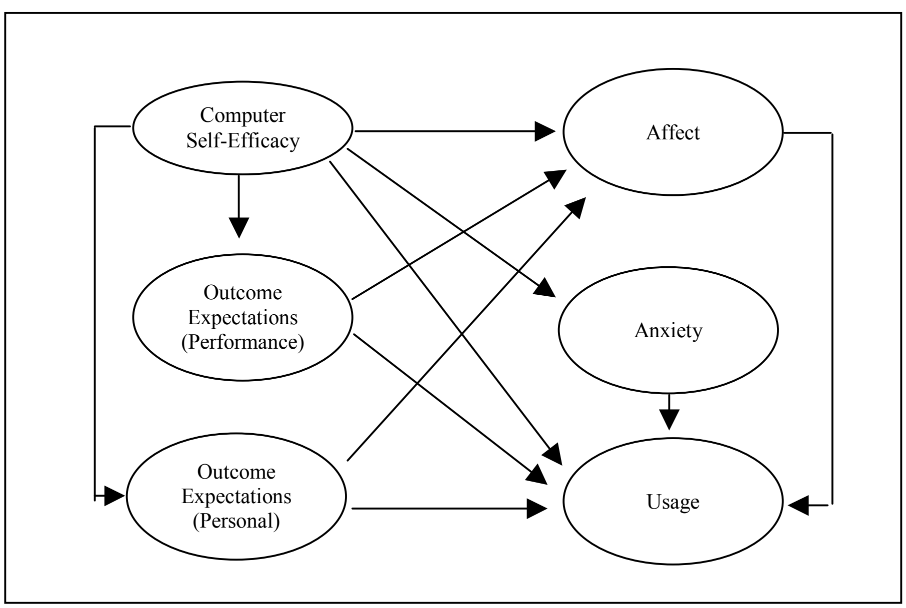
On the other hand, the TPB Model incorporates the idea of perceived behavioral control as an independent influence on behavior. TPB recognizes that there are circumstances in which a behavior ultimately will result in positive net benefits, but will not be undertaken due to a perceived lack of ability to control the execution of the behavior (Compeau, et al, 1999). This model supports the notion that web users may opt to break off a search strategy, even if the strategy would be highly successful if pursued to its ultimate conclusion. However, web users break off search strategies when they *perceive* that the strategy may be unsuccessful or they *perceive* that pursuing the strategy may consume more time than they are either willing or able to invest. The importance of user perceptions also is supported by expectancy theory, which asserts that the perceived relative attractiveness of options are related to individuals beliefs about the consequences of each option (Chau, 1996; Davis, 1989; Porter and Lawler, 1968; Vroom, 1964).

The SCT research model, as shown in Figure 2, used by Compeau, et al (1999), includes six constructs:

- Self-Efficacy - reflects an individual's beliefs about his/her capabilities to use IT
- Performance Expectations - the perceived performance-related consequences of using IT, such as improved efficiency and effectiveness
- Personal Expectations - relates to expectations of rewards
- Affect - relates to positive consequences of IT
- Anxiety - relates to the negative side of using IT, such as apprehension or anxiety.
- Usage - the degree of IT usage

Compeau, et al (1999), showed that self-efficacy exerted a significant influence on both performance and personal expectations, a significant influence on affect, a significant and negative influence on anxiety, and a significant positive effect on usage. They also demonstrated that performance expectations had an influence on both affect and usage; however, they noted no significant impact on personal expectations and affect. Further, they observed a significant negative relationship between personal expectations and usage, contrary to the hypothesized relation. Affect had a positive influence on usage, but anxiety did not. Based on these results and similar results of previous work (Compeau and Higgins, 1995b), it was shown that self-efficacy is a strong and significant predictor of affect, anxiety, and use. At the same time, the results indicate that personal expectations appear to have little or a small negative impact. The negative impact of anxiety on usage was partially supported by expectation research, which purports that users with unrealistic expectations of IT tend to be less satisfied and may ultimately use IT less based on prior experience (Ginzberg, 1981; Compeau, et al, 1999).

Figure 2. Social Cognitive Theory Model (SCT)



WEB PAGE USABILITY AND USAGE

Web users can be classified into two broad categories: surfers and information seekers (Spool, et al, 1999). GVU's 1998 User Surveys indicate that 69.7 percent of individuals search the web for specific information the majority of the time; 29.6 percent will sometimes search the Internet for specific information; and only 0.7 percent actually are just surfing. When looking for information, users are much more focused and tend to select the link that is most likely to be successful. However, unlike software usage, Spool found that, on the web, usage was not a reasonable proxy for measuring usability--some users chose the site with which they were most successful, and others did not (Spool, et al, 1999). This finding also is consistent with previous research that demonstrated a significant and positive interaction between usefulness and enjoyment (Davis, et al, 1989).

Repetitive usage of a particular web site was based upon content and relevance to the user rather than its usefulness in providing information. When users disliked a site, it usually related to some difficulty in using the site, indicating a usability problem; however, there was not a converse correlation. Hence, positive user satisfaction was not a reliable antecedent to site usability (Spool, et al, 1999).

Elements placed on web pages to attract surfing, such as animations, music, etc., were a distraction to information seekers unless the user perceived that the graphic would provide useful information (Spool, et al, 1999). Therefore, users tend to scan pages for useful information and often do not allow the entire page to load once they have identified a useful link or the actual information is found (Britton, et al, 1998). Similarly, advertisements that contained movement were masked by information seekers, even if the ad site had the information that was sought. However, as noted by Spool, animated advertisements tended to have higher click-through rates. This observation further supports the contention that surfing, which relies on click-throughs, is different than information retrieval processes. With this concept in mind, Spool contends that designing a site for one category of user may hurt the other. This viewpoint is echoed by Miller (1999), who states that "the first step in design is figuring out who you are designing for."

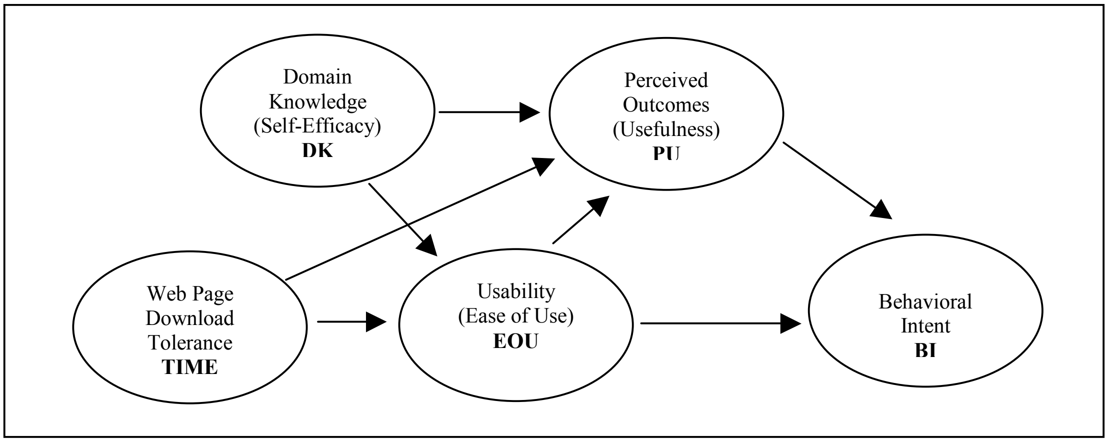
WEB PAGE DOWNLOAD TIME

Web page download time tolerance has an inverse relationship to the perceived chance of success. If the perceived chance of success is high, web site visitors will endure longer download times (Spool, et al, 1999). Similar research has been conducted validating the importance of "wait" cursors. Bickford conducted an experiment with expert typists to test how long users would wait before taking some action if the system did not provide a status indicator. After hard-coding a two-minute wait loop into a data entry application, he showed that the time the typists were willing to wait before rebooting or taking some other action was about 8.5 seconds. Switching to a watch cursor extended the wait to 20 seconds, an animated watch cursor extended the wait to over a minute, and a progress bar kept them waiting until "the second coming" (Bickford 1999). Bickford's findings are consistent with previous software response time research, which indicates that 10 seconds is about the limit for keeping a user's attention focused on dialog. Much longer than this and users will want to perform other tasks (Miller 1968; Card, et al, 1991). Similar findings also were noted in on-hold telephone behavior, which indicated that, of the 84 percent of callers who hang up, the average caller will hang up after thirty seconds, and, if music is playing, the caller will stay on twice as long (Allen, 1999).

RESEARCH MODEL

GVU's Web Surveys indicate that the vast majority of web users are information seekers rather than surfers (GVU User Survey's 1998). The behavioral characteristics, motivations, and tolerances for each user type are different. The same individual can be an information seeker and a surfer at different points in time. However, no direct economic impact occurs until the surfer changes roles and becomes an information seeker and possibly a consumer of goods or services delivered via the web. Thus, this research model, presented in Figure 3, focuses on information seekers, primarily to provide guidance to commercial sites.

Figure 3 - Research Model



Web page usability is predicated upon the user's previous experience in achieving successful outcomes or the perception of successful outcomes in the search strategy at hand. History mechanisms in web browser software enhance the user's ability to revisit pages they prefer or with which they have had previous success. As domain knowledge increases, the user's perception of the probability of success increases. Hence, increased domain knowledge offsets or mitigates the effect of usability on behavioral intent. The amount of time a user is willing to wait for a web page to download is one component of the web site's usability. Unlike the TAM and other models used to identify user behaviors and attitudes toward applications software, and which indicate a strong influence of usability on usage, on the web this linkage fails as the level of domain knowledge increases. Usage of a web site is dependent upon behavioral intent, which in turn is based upon user preferences, which (inconclusively) may be affected by the site's usability (Spool, et al, 1999).

Conventional applications software, like those analyzed with previous models, provide a fixed and stable navigation schema. On the other hand, the dynamic nature of the web requires an adaptive search methodology. The technology that enables the web also allows designers to make frequent design changes to respond to rapidly changing market conditions and consumer demands. Thus, a user may anticipate positive outcomes from a particular site; however, the web site may subsequently be altered or removed, negating previous positive user attitudes. Similarly, hyperlinks that historically have been successful may be removed or broken, nullifying the usefulness of the page. The advantage of efficiently locating, or relocating, information lies with those who possess a higher domain knowledge or skill level. Although users tend to view pages previously visited or those with a known or high probability of a successful outcome, web users also tend to be fickle and continually incorporate new pages into their portfolio at a regular rate, while at the same time further developing their domain knowledge (Trauscher and Greenberg, 1997). Again, domain knowledge has a tendency to mitigate the effect of EOU on perceived outcomes. Restated, as domain knowledge of the web increases, the user becomes more confident of achieving a desired outcome.

This research addresses web page download time as an antecedent to both usability and perceived outcomes. Web page size tolerance is operationalized as the amount of time it takes to download a particular web page from the time a hyperlink is clicked or a URL is entered to the point at which the selected page is displayed on the user's personal computer, irrespective of the source of any delay. This assumption contends that the user holds the web page owner to be wholly or primarily culpable for the speed at which their page downloads. It is recommended that web page physical construction and other aspects of usability, as well as content delivery, which is a component of usage, be subjects of future study.

As noted by Compeau, et al (1999), and other research, self-efficacy has a significant influence on perceived outcomes, whether positive or negative. Similarly, self-efficacy, or domain knowledge in this context, is operationalized in this research as an individual's beliefs about his/her capabilities to use of the web. Due to the marginal or insignificant effects of personal outcomes noted by Compeau, et al (1999), this model posits that, from a web search perspective, there is no segregation of perceived outcomes between personal and performance outcomes. This research also uses a single perceived-outcomes construct more akin to the TAM's construct of usefulness.

Since the focus of this research is upon the utilitarian behaviors of information seekers, perceived outcomes are operationalized as the user's perception that a particular search strategy will result in a positive outcome--the acquisition of the correct information. Similar to previous work, a negative correlation is posited between self-efficacy and web page size tolerance. Restated, as a user becomes more adept at using the web and becomes more aware of alternate sources or methods of acquiring information, he/she is less likely to tolerate slower-loading pages.

RESEARCH METHODOLOGY

Procedures

A survey was administered in April and May of 2000. Subjects consisted of high school upperclassmen, university undergraduate, and MBA students. As indicated by Narrowline Media Research Group, an advertising transaction and information services company, individuals with these education levels represent approximately 95 percent of all Internet users (*InternetWorld* 1998). High school students were selected from English classes in local high schools. Undergraduate students were selected from a variety of computer information systems courses at all levels. All MBA students were surveyed. Unlike other studies using students, the Narrowline surveys indicate that this general age group represents approximately 42percent of web users and composes a larger portion of web consumers.

Measures

A domain knowledge assessment was administered based upon GVU 's WWW User Survey's criteria, as shown in Appendix A. The survey used is shown in Appendix B. Based upon their responses, respondents were classified into four categories: novice, intermediate, experienced, or expert. Additional questions were added indicating the number of search engines that a user utilizes to conduct a search and whether or not the user has filed a tax return or renewed a vehicle registration over the web. Although the GVU Survey editors suggested weighting the questions, to date they have not proposed a schema to do so. Hence, this research did not weight the domain knowledge responses.

Download time tolerance was assessed based upon whether or not the user had abandoned a Web site while waiting for it to load by performing any of the subsequently listed actions and how soon afterward the web page was abandoned during loading:

- Clicking on the back button
- Clicking on an available link as soon as it became available
- Entering a new URL (address) in the location or address area
- Some other means of abandoning the Web site
- Exiting the Web and completely abandoning the search

PU and EOU were determined using the measurements used by Davis (1989) and Compeau, et al (1999), modified for Internet usage. Several empirical studies have verified the robustness and validity of the basic model in predicting user intentions and subsequent usage across a wide variety of systems (Igbaria, et al, 1997; Chau, 1996; Davis and Venkatesh, 1996; Venkatesh and Davis, 1996; Taylor and Todd, 1995; Szajna, 1994; Mathieson, 1991).

As recommended by Fishbein and Ajzen (1975), reliability can be increased by utilizing multiple-act indicators or different acts indicating the same behavior. Thus, behavioral intent was measured by multiple behaviors similar to those used by Straub, et al (1997), modified for web usage. Similar intent and usage indicators were used by the GVU User Surveys. Although self-reported usage may not be an exact measure of actual usage, Blair and Burton (1987) suggest it is an "appropriate relative measure." The indicators used in this study are as follows:

- The average amount of time spent on the Internet per session
- Estimated number of web pages visited per Internet session
- Number of days per week the Internet is accessed
- The amount of time spent on the Internet per week

Demographics

Of the 768 respondents, 54 percent were male and 46 percent were female. The mean age of the group was 19-24. On average, the respondents logged on 5 days per week for an average session of two hours, excluding email, and viewed approximately 20 different web pages per session. When asked who was primarily responsible for slow-loading web pages, the respondents tended to hold their Internet service provider (62percent) primarily responsible for the slow download time of web pages, as shown in Table 1.

Table 1 - Responsibility Assignment for Slow-Loading Web Pages

Responsibility	Frequency	Percent
User	72	9.51
Telephone Company	70	9.25
ISP	469	61.96
Web Page Designer	47	6.21
Other Users	98	12.95
No Response	1	0.13

When asked what they would spend a modest amount of money on today, 67 percent of users indicated they would buy hardware (monitor, printer, CPU, etc.) or a new storage device (DVD, CD, hard disk, etc.), as shown in Table 2. Of those respondents indicating that they were personally responsible for slow-loading web pages, 60 percent indicated they would upgrade their hardware or storage devices, and only 21 percent said that they were willing to upgrade their communications capabilities. These responses would indicate that, even if a respondent recognizes that they have some personal responsibility for the speed at which web pages load, they are not overly willing to upgrade their own communications capabilities to improve the situation. This conclusion was further supported by the observation that there was no significant difference between the web page download time tolerance of respondents among the various upgrade alternatives presented.

Table 2 - System Upgrades

Purchase	Frequency	Percent
Hardware	325	42.71
Communications	104	13.67
Software	106	13.93
Input Device	38	4.99
Storage Device	187	24.57
No Response	1	0.13

To the contrary, web designers have a tendency to design web pages that showcase their creativity and technical abilities, which often increases the page size and, hence, the download time. In a recent survey, approximately two-thirds of 2,551 web designers indicated that they blame the users for not being able to adequately download their pages (Flanders, 1999). This designer attitude contradicts the traditional design heuristic of designing interfaces to work on platforms with the least capabilities. Given the fact that users predominately blame others for the speeds at which pages download, the typical web designer attitude creates a dilemma that must be addressed by site owners. Site owners must recognize that failure to address the behavior and needs of customers can result in lost business. This study indicates that the visual appearance of a web page is more important ($p< 0.01$) to surfers than to information seekers. Thus, a site whose primary purpose is to sell products to consumers should have a utilitarian design approach and be designed differently than one whose primary purpose is to attract users for entertainment purposes.

Other design issues explored indicated that the mean advertisement click-through rate for all respondents was two click-throughs per month. Surfers were approximately 25 percent more likely to click-through on an advertisement than information seekers ($p = 0.01$). However, no significant difference was found between surfers and seekers when it comes to scrolling on a web page. Unlike findings noted by Spool, et al (1999), both groups uniformly disliked scrolling.

In general, most respondents (79 percent) indicated that they use the Internet with a specific objective (information seekers) half or more of the time. Similar findings were noted when analyzing the GWU 1998 User Surveys. However, age does play a significant role in determining whether or not a user is predominantly an information seeker or a surfer, as shown in Table 3. Pairwise comparisons indicate a significant difference in information-seeking behavior and surfing between those above 30 and those below 30 ($p = 0.03$). Respondents 30 and over tended to be very objective-oriented when using the Internet, while those under 30 had a higher proclivity to use the Internet for entertainment purposes. Further investigation noted that age ($p = 0.04$) and domain knowledge ($p < 0.01$) were significant in determining whether a user was more likely to be a surfer or a seeker. As age and domain knowledge increase, the less likely a user was to surf the Internet without a particular objective. No significant differences were noted between the genders in surfing versus information-seeking behavior.

Table 3 - How Often Internet is Used without a Specific Objective by Age Group

	Age Group Proportion				
Frequency	**% 18 and Under**	**% 19-24**	**% 25-29**	**% 30 and Over**	**% Total**
Never	13	12	18	27	14
Sometimes	49	49	41	51	49
About half the time	16	16	16	10	16
Frequently	14	18	18	8	16
Always	7	4	7	4	5
Undefined	1	1	-	-	-
Total	100	100	100	100	100

The average tolerable download time was approximately 15 to20 seconds, which is about 50 percent to100 percent as long as the previous heuristic of ten seconds (Spool, et al, 1999). Neither gender, user type (information seeker vs. surfer), nor Internet domain knowledge had any significant effect on web page download tolerance. Users aged 30 and over are more tolerant of slower-loading pages ($p < 0.01$) if the user is not aware of alternate sources of the same information. However, age did not make a significant difference regarding the average amount of time a user would be willing to wait for a page to download. Similarly, there was no significant difference between the age groups when asked if they would revisit a site with slow-loading pages. Most respondents indicated that there was a less than a 50-percent chance they would revisit a site with slow-loading pages. This response also is supported by StatMarket's Loyalty Index™, which indicates that 47 percent of users visit web pages for the first time and that only 25 percent visit two to four times (StatMarket, 1999).

Pairwise comparisons of means revealed a significant difference ($p < 0.01$) in the revisit rate to sites with slow-loading pages between those where the user had knowledge of alternate sources of information and those where the user did not. This response further indicates that, all other factors being equal, like PU, a user is willing to tolerate slower-loading pages until other sites are located--users will not revisit slower-loading pages if alternate sources of information are known. On a Likert scale of one to five from "not at all" to "very likely", when asked how likely users were to return to a page that had useful information but had slow-loading pages, the mean response was 2.73. This score indicates that users were slightly unlikely to return to these sites, or, one could posit that slow-loading pages encourage users to continue searching for information elsewhere. In economic terms, a user will continue looking for substitutes as long as they believe that there is a more "cost-" effective alternative.

Confirmatory Factory Analysis and Model Validation

Responses to the survey were subjected to a principal component analysis using ones as prior communality estimates. The principal axis method was used to extract the components, and the extraction was followed by a varimax (orthogonal) rotation. In interpreting the rotated factor pattern, an item was said to load on a given factor if the loading was 0.40 or greater for that factor, and was less than 0.40 on all other factors (Stevens, 1986). After removing survey items that appeared ambiguous, those that did not adequately load (.40), and those that significantly loaded on more than one factor, six factors were identified. Both the minimum eigenvalue criteria and a review of a scree analysis supported the inclusion of six factors. Combined, these six factors accounted for 60.63 percent of the total variance. Two deficiencies noted in this analysis are: (1) Factor 5 and Factor 6 only had two variables with significant loadings, and (2) the six identified factors accounted for less than 70 percent of the variance. However, increasing the number of factors confused the interpretability of the underlying constructs and confounded a simple structure of the rotated factor pattern.

Nunnaly (1978) suggests that, for scales used in research, coefficients above 0.70 generally are seen as adequate. The overall reliability coefficient as measured by the Cronbach (1951) coefficient alpha for the scales that included all survey items was 0.7773. A further review indicated that two questions demonstrated poor item-total correlations. An item-total correlation is the correlation between an individual item and the sum of the remaining items that constitute the scale. If an item-total is small, it suggests that the item is not measuring the same construct that is measured by the other items in the scale (Hatcher, 1994). Q56 was removed based on this review. In the next iteration, Q57, Q59, and Q61 were removed as exhibiting a low item-total correlation. After these adjustments, coefficient alpha reliability for the model improved to 0.8050. A factor analysis was then performed on the remaining variables. This analysis indicated retaining the originally hypothesized four factors: domain knowledge (DK), perceived usefulness (PU), EOU, and web page download time tolerance (TIME). The analysis also indicated that Q60 did not load distinctly on any of the remaining four factors.

After removing those items that did not load, both the minimum eigenvalue criteria and a scree analysis supported the four-factor model. Combined, the resultant four factors accounted for 61 percent of the total variance. Although the results were an improvement, the portion of the variance explained remained under 70 percent. Similarly, the overall reliability coefficient as measured by the Cronbach (1951) coefficient alpha for the scales that included all survey items improved to 0.7963. Scale reliability of the final model was assessed using the coefficient alpha. Reliability estimates ranged from 0.75 to 0.81. A subsequent maximum likelihood analysis provided further support for the four-factor model (Prob>Chi-squared < 0.0001 and Tucker-Lewis Reliability Coefficent = 0.9377).

The data subsequently were analyzed using the SAS System's CALIS procedure (SAS Institute, 1989). In a path analysis with latent variables, a measurement model describes the nature of the relationship between latent variables and the manifest indicator variables that measure those latent variables. The research model displayed goodness-of-fit index values of 0.90 or greater, including a non-normed fit index (NNFI) of 0.90 and a comparative fit index (CFI) of 0.92, which indicated an acceptable fit (Bentler and Bonett, 1980; Bentler 1989).

The SAS CALIS procedure provides approximate standard errors for coefficients that allow large sample t-tests of the null hypothesis that the coefficients are equal to zero in the population. As shown in Table 4, the t-scores obtained for the model coefficients indicated that all factor loadings were significant ($p < 0.001$), providing evidence supporting the convergent validity of the indicators (Anderson and Gerbing, 1988).

Table 4 - Properties of Revised Measurement Model

Construct and Indicators	Standardized Loading	t-value
Domain Knowledge		
(Q30) Average hours per week on the Internet	0.7803	24.4705
(Q31) Average days per week on the Internet	0.8788	29.2113
(Q32) Average Internet sessions per week	0.8778	29.1605
(Q33) Average hours per Internet session	0.4606	12.6534
(Q12-Q29) Sum of positive responses to modified GVU User Survey	0.6667	19.7183
Time		
(Q35) Likelihood of allowing a page to completely download given a useful hyperlink	0.6629	7.6818
(Q36) Download tolerance time	0.4109	6.7613
Perceived Usefulness		
(Q41) Using the web increases efficiency and/or effectiveness	0.7152	21.0975
(Q43) Web increases quality of work	0.7424	22.1981
(Q44) Web increases quantity of work	0.7255	21.5086
(Q45) Tendency to revisit pages that user has had previous success with	0.6720	19.4239
(Q46) The more the Internet is used, the more efficient the user becomes at finding information	0.6901	20.1127
(Q48) Tend to visit web pages based upon information that they provide	0.5205	14.1824
Ease of Use		
(Q52) On most web pages, user can find the information sought	0.5825	15.0984
(Q53) In general, most web pages are easy to interact with	0.8012	21.1050
(Q54) Most web pages are well designed for user	0.6629	17.3515

Path Analysis

The path analysis using a TAM-based research model indicates that the traditional applications software constructs of PU and EOU explain 8 percent of the variance in BI to use a web page when alternate sites are known (Figure 4) and 15 percent of the variance in BI when alternatives are not known (Figure 5). In most research, these low-variability measures would preclude this research model from being used as a predictive tool; however, the intent of this research is to illustrate and describe the effects of web page download time and not to propose a comprehensive model of web behavior. This research does purport that web user behavior is different than traditional application user behavior, indicating a need for further research into the antecedents of web behavioral intent that is unconstrained by traditional models.

Domain knowledge (DK) and web page download time (TIME) explained 36-40 percent of the variance in PU and 14-15 percent of the variance in EOU. DK, or general web expertise, had a significant effect on both PU ($p < 0.01$) and on EOU ($p < 0.01$). The effect of DK was approximately two-thirds greater on EOU than on PU. The larger effect of DK on EOU could be explained by a common navigation schema across web browsers. Subsequent testing indicated that, as DK increases, the effect of PU on BI increases, and the effect of EOU on BI, although still significant, declines. Hence, as a user becomes more adept at using the web, EOU becomes less and less of an issue. It was interesting to note that DK had no significant direct effect on BI. The significant effects of DK are indirectly passed through PU and EOU.

TIME has direct and significant effects on both PU and EOU, regardless of whether alternate sources of information are known. The effect of TIME on PU, however, is twice as great when the user does not have knowledge of alternatives. In other words, users are twice as likely to perceive the page as useful if they do not know what else is available. Similarly, if users do not have knowledge of other sources of information, they are willing to wait three times as long for the page to load. Hence, once alternate sources of information become known, users are three times more likely to bail out and thus will not allow a slow-loading page to fully download. This finding is supported by the StatMarket indicies that show most users are first-time visitors, and many of those fail to revisit the same page.

Similarly, the effect of TIME on EOU in both cases is significant and approxiamtely equal. This effect can be interpreted as the perception that a slow page is difficult to use because it is slow. EOU becomes insignificant when users have no knowledge of other sources of information. Conversely, EOU is significant when alternatives are known because a user will opt to select a page that is easy to use, all other factors being equal.

The path analysis model identifies the direct effect of TIME on BI and its indirect effects through EOU and PU. Unlike DK, TIME has a significant direct effect on BI. This effect is posited to be the "bail out" effect--some people won't even allow a slow page to fully load in order to determine its usefulness or EOU.

The noted insignificance of EOU on BI is contrary to findings noted in the TAM-based evaluations of potential adopter acceptance of applications software (Davis, 1989). The mitigation of the effect of EOU was noted by Karahanna, et al (1999), in their study of the antecedents of continued applications software use. They noted that EOU was significant for potential adopters; however, EOU was not a significant factor in determining the motivation for continued use. Unlike the applications software acceptance models that rely heavily on the EOU of the user interface to achieve intial acceptance, this research indicates that web searches are predominantly utilitarian and goal oriented. Hence, one could posit that the use of a common browser navigation schema mitigates the effects of EOU. This mitigation effect would be a useful topic for future research. However, this research indicated that EOU was significant in shaping the user's perception of the usefulness (PU) of a web page, whether or not alternate sources of information are known. Although TIME and PU are important and significant factors in determining BI, EOU increases in importance when trying to attract users to revisit a particular web page.

As expected, the user's perception of the usefulness (PU) of a slow-downloading web page is significant and negative when alternate sources of information are known. Similar behavior was noted by Spool, et al (1999), when they observed that non-design issues or personal differences explained why some users returned to a particular page. For example, users may tolerate slow-loading pages on the IRS web site on April 15th if they need a particular tax form, even if that form is available elsewhere, because they perceive the IRS forms to be fully accurate and reliable. Conversely, the positive effect of PU on BI when alternatives are not known reflects the users' satisfaction when they acquire needed information. As previously stated, it is important for designers to note that, web users tend to be fickle and will continue looking for alternate sources of information, even though they currently are satisfied.

Figure 4 - Likelihood of Revisiting a Slow-Downloading Web Site if Alternate Sources are KNOWN

Path Analysis - Likelihood of Revisiting a Slow Downloading Web Site if Alternatives are Known

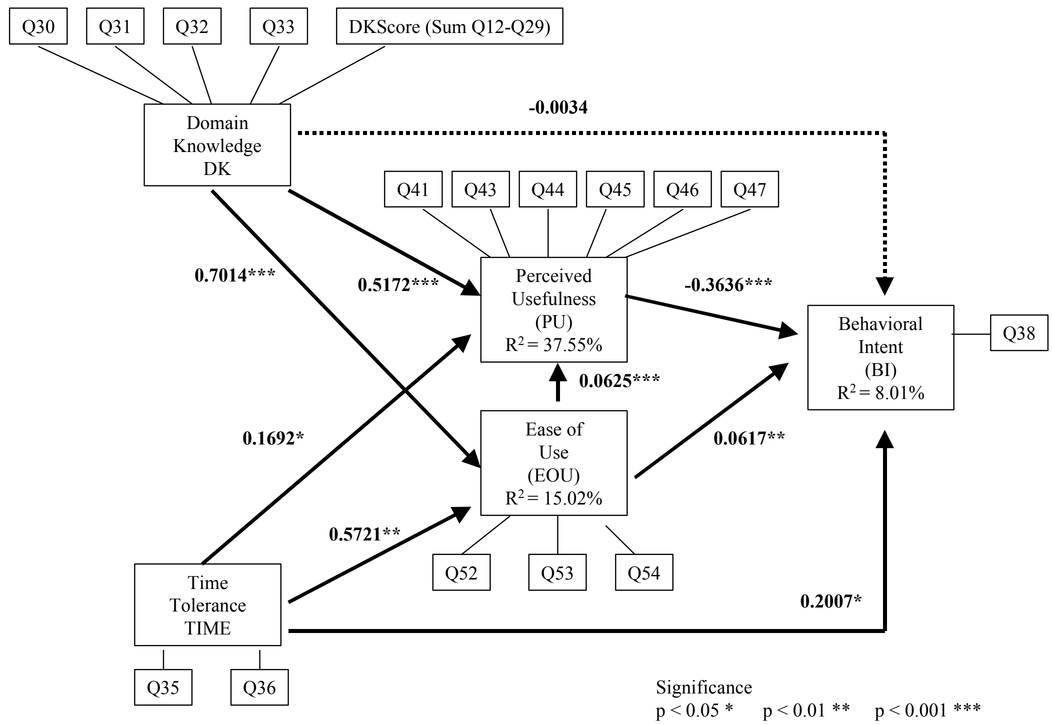
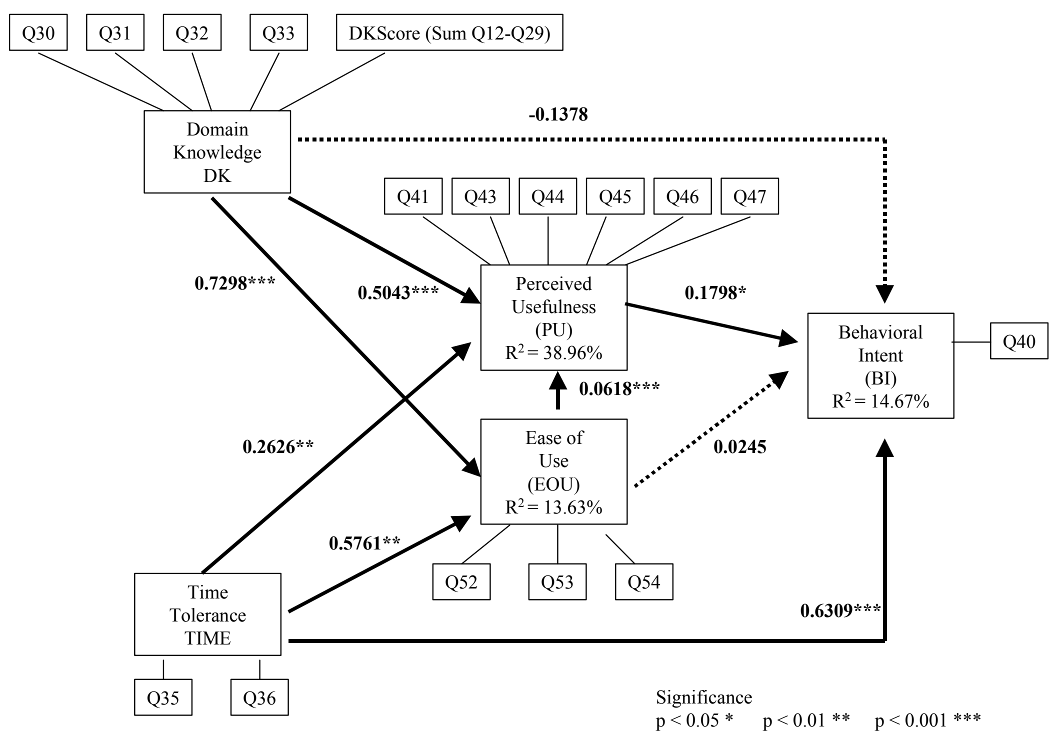


Figure 5 - Likelihood of Revisiting a Slow-Downloading Web Site if Alternate Sources are NOT KNOWN

Path Analysis - Likelihood of Revisiting a Slow Downloading Web Site if Alternatives are NOT Known



DISCUSSION AND IMPLICATIONS

The purpose of the study was to access the antecedent effects of web page size on web page PU and EOU. The download time of a web page was clearly shown to affect the PU of a web page as well as the EOU. When applied in a web context, the TAM proved capable of explaining only a small portion of the variability (R^2 = 8 percent) in the behavioral intent to use a particular web page when alternatives are known and (R^2 = 15 percent) when alternatives are not known. This finding was not wholly unexpected in that, Spool, et al (1999), noted that some users tended to select pages with which they had seen previous success, while others did not. The users who did not choose pages with which they had experienced previous success tended to select pages because of content and personal differences. This finding would tend to be supported by this study, in that domain knowledge had a smaller effect on PU than on EOU. One could posit, as domain knowledge or the ability to locate alternate sources of information increases, that other factors, such as the actual information content of a page, may have a greater effect on PU. To the contrary, this study and other anecdotal evidence suggest that users will tolerate extraordinarily slow-loading pages presented by a sole source, such as the Internal Revenue Service and other authoritative bodies, for which there is no alternative. For web sites, user preference is not as adequate a proxy for measuring PU as it is in traditional applications software (Spool, et al, 1999). Clearly, the Spool, et al (1999), concept of usability, including navigation, links, within-site searching, layout, and graphic design, should be included in any robust research seeking to test all of the antecedents to behavioral intent.

LIMITATIONS

As with all research, the current study has limitations. The study respondents consisted of high school and college students predominantly under 25 years old. Although this age group represents a large proportion of web users and these students will continue to use the web in the future, further research should reach out to include larger proportions of older individuals as well as those in professional settings. This weakness tended to be mitigated by the fact that approximately half the respondents had ordered a product or service over the Internet, and 28 percent of the respondents had purchased goods or services over the Internet, despite their inherently limited financial resources. These proportions are similar to the findings noted in the GVU User Surveys (1998).

The survey did not attempt to assess the effects of other design issues, such as content, navigation, etc. on PU or EOU. As clearly demonstrated by the relatively low R-squared values generated by the research model, there are potentially more factors that effect these constructs, and hence, a user's behavioral intent to use a particular web page. Many of these factors have been addressed by Spool, et al (1999), in the context of web site usability; however, it would be useful for future research to incorporate these constructs into a comprehensive model of web behavior.

Similarly, this study addressed relative tolerable web page download times and did not specifically attempt to address a specific quantitative measure for web page download time tolerance. Specific tolerable download times stated in terms of various demographic variables would be extremely practical for guiding designers in determining the appropriate size of a web page based upon the tolerances of their target audiences.

The survey also did not attempt to compare respondent's expected download time versus the actual download time of a particular page. For example, a user with an ISDN or cable modem connection may have an inherent expectation of a faster download time than that of a dial-up user with a 14.4Kbs modem. Although the study showed that the mean tolerable download time was relatively uniform across all demographic variables, except age, it is obvious that those respondents with higher connection speeds can receive more information in a shorter time period. As bandwidth and higher connection speeds become more cost-effective, further investigation would be warranted into the effects of connection speed on user expectations.

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Appendix A

GVU WWW User Survey Skill Level Assessment

In the General Demographics questionnaire, one question asked whether or not the respondent had performed the following activities online:

1. Ordered a product/service from a business, government or educational entity by filling out a form on the web
2. Made a purchase online for more than $100
3. Created a web page
4. Customized a web page for yourself (e.g. MyYahoo, CNN Custom News)
5. Changed your browser's "startup" or "home" page
6. Changed your "cookie" preferences
7. Participated in an online chat or discussion (not including email)
8. Listened to a radio broadcast online
9. Made a telephone call online
10. Used a nationwide online directory to find an address or telephone number
11. Taken a seminar or class about the Web or Internet
12. Bought a book to learn more about the Web or Internet

Respondents are classified into the following categories:

- Novice - 0-3 of the activities
- Intermediate - 4-6 of the activities
- Experienced - 7-9 of the activities
- Expert - 10-12 of the activities

Source: http://www.gvu.gatch.edu/user_surveys/survey-1998-10/

Appendix B

Web Usage Opinion Survey

All questions pertain to Internet usage. The questions do not relate to your use of e-mail.

General

1. What is your gender?

   A. Male.
   B. Female.

2. Which hand do you write with a majority of the time?

   A. Left.
   B. Right.

3. Which hand do you use most often to control the mouse on your computer?

   A. Left.
   B. Right.

4. What is your current age?

   A. 18 or under.
   B. 19-24.
   C. 25-29.
   D. 30-34.
   E. 35-39.
   F. 40-44.
   G. 45 or over.

5. What is your current education level?

   A. High School Student
   B. College freshman
   C. College sophomore
   D. College junior
   E. College senior
   F. Masters student

6. Who/what is mostly responsible for the speed at which Web pages download to your PC?

   A. I am primarily responsible.
   B. Telephone Company.
   C. Internet Service Provider.
   D. Web Page Designer/Owner.
   E. Other Internet users clog the system.

7. If you had a modest amount of money to spend today on one PC upgrade, how would you spend it?

   A. Computer Hardware (monitor, printer, CPU, etc.).
   B. Communications (conventional modem, cable modem, etc.).
   C. Software.
   D. Input Device (keyboard, mouse, joystick, scanner, etc.).
   E. Storage Device (DVD, CD, hard disk, etc.).

8. At what time of day do you usually log on to the Internet?

A. Midnight to 8am.
B. 8am-Noon.
C. Noon-4pm.
D. 4pm-8pm.
E. 8pm-Midnight.

9. How often do you use the Internet without a specific or general objective in mind?

A. Never
B. Sometimes
C. Half the Time
D. Frequently
E. Always

10. How many times in the past month have you clicked-through on an advertisement on a web page?

A. 0
B. 1
C. 2
D. 3
E. 4
F. 5
G. More than 5

11. The search for information is just as entertaining as actually finding the information I am looking for.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

Domain Knowledge

For Questions 12-29, bubble letter A if answer is YES, bubble letter B if answer is NO.

If you do not understand the question, you should answer NO.

	(A) YES	(B) NO	
12.			Ordered a product/service by filling out a form on the web
13.			Made purchases online totaling more than $100 in the past year
14.			Created a web page
15.			Customized a web page for yourself
16.			Changed your browser's "startup" or "home page"
17.			Changed you cookie preferences
18.			Participated in an online chat or discussion (excluding email or listserv discussion groups)
19.			Listened to a radio broadcast or watched streaming video online
20.			Made a telephone call online
21.			Used a nationwide online directory to find an address or phone number
22.			Taken a seminar or class about the Internet or building web pages
23.			Bought a book to learn how to better use the Internet or how to build web pages

	(A) YES	(B) NO	
24.			Filed a tax return, renewed a vehicle registration, or voted over the Internet
25.			Regularly use more than one search engine to find information on the Internet
26.			Registered, or attempted to register, a domain name
27.			Regularly add AND delete bookmarks
28.			Do you use the history feature in your browser, versus the back button, to return to previously viewed page?
29.			Do you open more than one browser window at the same time?

30. On average, how many **hours** do you spend on the Internet **per week** (excluding e-mail)?

A. 0-3
B. 3-6
C. 6-9
D. 9-12
E. More than 12

31. On average, how many **days per week** do you access the Internet (excluding e-mail)?

A. 1
B. 2
C. 3
D. 4
E. 5
F. 6
G. 7

32. On average, how many **Internet sessions** do you have **per week** (excluding e-mail)?

A. 1
B. 2
C. 3
D. 4
E. 5
F. 6
G. 7 or more

33. On average, how many **hours** do you spend on the Internet **per session** (excluding e-mail)?

A. 0-1
B. 1-2
C. 2-3
D. 3-4
E. More than 4

34. On average, how many **different web pages** do you visit **per session**, including those you do not allow to fully download?

A. 0-10
B. 11-20
C. 21-30
D. 31-40
E. More than 40

Web Page Download Time

35. How likely are you to allow a web page to completely download once a promising hyperlink is displayed?

A. Not at All
B. Slightly
C. Maybe
D. Likely
E. Very Likely

36. On average, how long are you willing to wait for a Web page to download in seconds?

A. 0-5
B. 5-10
C. 10-15
D. 15-20
E. 20-25
F. 25-30
G. More than 30 seconds

37. How likely are you to return to a web site that has slow loading web pages, even if the information you need is readily available?

A. Not at All
B. Slightly
C. Maybe
D. Likely
E. Very Likely

38. How likely are you to return to a web site that has slow loading web pages, if you **KNOW** that other sites have the same or similar information?

A. Not at All
B. Slightly
C. Maybe
D. Likely
E. Very Likely

39. How likely are you to return to a web site that has slow loading web pages, if you **THINK** that other sites have the same or similar information?

A. Not at All
B. Slightly
C. Maybe
D. Likely
E. Very Likely

40. How likely are you to return to a web site that has slow loading web pages, If you **DO NOT KNOW** that the same or similar information is available on another site?

A. Not at All
B. Slightly
C. Maybe
D. Likely
E. Very Likely

Perceived Outcomes/Usability

41. Using the Web increases my efficiency and/or effectiveness

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

42. I spend less time finding information on the Web than I would using the library or other alternative sources of information

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

43. I can increase the QUALITY of work that I can accomplish if I use the web

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

44. I can increase the QUANTITY of work that I can accomplish if I use the web

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

45. I tend to revisit web pages that I have had previous success with

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

46. The more I use the Internet, the better I become at locating information

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

47. I tend to bookmark pages that provide a high information value.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

48. I tend to visit web pages based upon the information that they provide.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

49. The speed at which a page downloads affects my perception of how USEFUL the page will be in locating the information that I need.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

50. I am willing to tolerate a slow loading page if I know the page has the information I need.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

51. I am willing to tolerate a slow loading page if I have no previous knowledge of the page.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

Ease of Use

52. On most web pages, I can usually find the information I am looking for.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

53. In general, web pages are easy to follow and interact with.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

54. Most web pages are well designed for me.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

55. Most web pages contain too much information.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

56. Animated graphics are distracting when I am searching for information.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

57. I don't like to scroll (up/down or left/right) on a web page to find information.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

58. I am frequently frustrated finding information on most web pages.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

59. It is hard to determine whether or not hyperlinks are useful

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

60. Web pages frequently use terminology that I don't understand.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

61. Site designers should make web pages easier for me to use.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

62. The visual appearance of a web page is important.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree

63. The speed at which a page downloads affects my perception of how EASY A PAGE IS TO USE.

A. Strongly Disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly Agree