Internet-Based Research for the Desktop and Beyond: Building a Foundation of Excellence for Information Design on the Web

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Abstract

The internet has become a primary vehicle for delivering information, but the online platforms used to access that information are constantly shifting. Web users are more sophisticated in the ways they access information online, but it is unclear whether design best practices have kept pace. The need to develop a set of effective best practices for web design, based on empirical research, becomes even more critical as people migrate from desktops to mobile browsing. We strongly support the use of internet-based research to ensure the ecological soundness of information design best practices.

KEYWORDS: internet-based research, mobile browsing, empirical research, remote user testing, web-design best practices

Introduction

Internet-based research, a methodology that allows researchers to conduct remote studies of users interacting with the web, provides empirical support for best practices in web design. As delivery of information and consumption of it moves increasingly online to a variety of new platforms, including the fast-growing mobile space, we are moving farther away from the traditional print media on which so many of our current best practices are based. By conducting internet-based studies of today's users, as they interact with the web using recently introduced technologies such as small-screen, mobile devices, we can better understand not only how these new tools are used, but also how people's goals and choices have adjusted because of their availability. The results of such studies will provide a foundation on which to base guidelines for information design on the web that take into account the variety of access platforms used today.

Internet-based research is a powerful tool for studying user behavior patterns *in the wild,* capturing qualitative as well as quantitative data, and serving as an effective complement to ethnographic field studies and other *in situ* research techniques. As such, internet-based research can be used to conduct not only remote, web-based experiments, but also remote usability tests. These online, remote usability tests work in concert with standard usability testing performed in a laboratory, and allow usability specialists to capture usage data as users perform real-world tasks that meet their own needs, as well as tasks called for in research-based scenarios.

In this paper we examine the current directions in internet-based research in the field of information design. We describe some developments and challenges surrounding information design for mobile device displays and cloud computing paradigms, and look at studies of web browsing and searching behavior with small screen devices. We conclude by suggesting ways in which internet-based research tools and methodologies can extend empirical findings on which to base the design of information for use on mobile devices.

Directions in internet-based research

In 2005, Spyridakis et al. [1] reported on the use of research to support best practices for web design. They cited an overall lack of large-scale studies of web-design issues, and pointed out that current and previous research tended to fall into four categories: expert evaluations, usability tests, surveys of users' perceptions, and true experiments conducted either in laboratories or remotely via the internet. They called for the increased use of internet-based tools to conduct large-scale user studies, leveraging the internet's inherent advantages, such as the ability to study users *in situ* and to test large sample sizes.

Four years later, we revisited the state of research to support best practices for web design. We found that few frameworks are in place to support large-scale internet-based user studies, and that research continues to fall into roughly the same four categories that Spyridakis et al. [1] identified in 2005. We also found that web-design prac-

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tices continue to be informed by these studies as well as print-design research. The 2006 edition of the *Research-Based Web Design and Usability Guidelines* [2] contains 300 guidelines, including 22 new and 30 updated guidelines since the 2004 edition. Each guideline is given a "strength of evidence" rating, ranging from one to five stars. A rating of five stars indicates "strong research support" and requires "at least one formal, rigorous study with contextual validity." In the previous edition, 27 of the 188 guidelines earned a five-star rating, while in the 2006 edition, only 18 of 210 guidelines earned five stars. None of the new guidelines achieved a top rating.

However, several interesting developments have occurred involving the use of the internet for research to inform web design. Expert evaluations continue to be popular, usually in the form of checklists or surveys with questions based on current best practices, and there have been some developments with respect to automation. Some evaluation tools can be automated and made available for use over the internet; for example, guidelines for accessibility, which rely on specific HTML coding techniques, lend themselves well to automation [3]. Evaluation tools are often aimed at web developers who are interested in measuring the quality of a particular site, but this type of tool can also be used in more formal research. Unfortunately, the evaluations these tools produce tend to rely on best practices that have little basis in empirical research, and so do not contribute to a much-needed knowledge base of empirical, large-scale user studies that can inform future information design guidelines for the web. In addition, evaluation tools are limited to collecting perceptions of usability rather than actual usage patterns [4]. Finally, in their 2006 survey of 15 Dutch municipal websites, de Jong and Lentz point out an additional limitation of the scenario-based evaluation mechanism, concluding that "a strict HCI perspective on website evaluation may not suffice: it is the interplay between context, content and interface that will be crucial for the optimization of municipal websites" [5].

Another interesting development is that usability testing has embraced the opportunities offered by internet-based research. This development eliminates some, although not all, of the concerns raised by Spyridakis et al. regarding the practice of generalizing results of small-scale usability tests [1]. The need for rigorous control of independent variables continues to be an issue with any kind of *in situ* testing. However, the internet significantly lowers the cost barrier of conducting large-scale studies, enabling researchers to conduct long-term studies and work with large sample sizes for relatively little increase in overall study cost. Much of the advancement in this area has been driven by the desire to commercialize websites. For example, e-commerce sites like Amazon.com use custom tools that enable them to deploy experimental versions of their webpages to random samples of visitors allowing the companies to collect and analyze user reactions to specific changes in page design and features.

Experiment platforms, such as SiteSpect [6] and Google's Website Optimizer [7], offer web designers the ability to conduct A/B tests and multivariate tests on webpages. Such platforms allow designers to deploy two or more versions of a webpage and compare user reactions. They control the percentage of visitors who see each webpage version, track certain aspects of user behavior, and perform statistical analyses on the results. These types of experiment platforms are developed specifically to help e-commerce sites optimize their ability to "convert" casual visitors into buyers by fine-tuning the design of a webpage. They rely on the experiment designer's ability to define a specific user action, able to be tracked by the experiment platform, that represents the webpage's "goal." For example, the percentage of visitors who click a "Buy Now" button is a clear indicator of the success of an e-commerce webpage design. Optimization software that offers a free-form experiment platform has the potential to support web-design studies outside of e-commerce, as long as it is possible to identify a specific user action that is meaningful. For example, if the goal of a webpage is to inform the reader on a topic, an experiment would need to specifically define the user action(s) that could indicate success.

Recently there has been some flirtation with a new approach to conducting user research over the internet. It is based on the concept of "crowdsourcing," which is an attempt to leverage the huge population base of the internet to outsource small, well-defined bits of work for small fees. The developers of the Mechanical Turk software, a platform developed to connect people needing work done with potential workers, explored the possibility of using Mechanical Turk to collect human subjects for user studies [8]. They concluded that the limitations of the software itself, such as the difficulty of separating well-meaning responses from malicious ones, were significant but not insurmountable barriers.

In spite of these new directions, there is a persistent shortage of experiment platforms for empirical, internet-based user research. Not surprisingly, there is a corresponding shortage of large-scale studies with findings that can be generalized and used to inform best practices for web design.

Challenges in mobile and cloud computing

We have seen large percentages of the population become increasingly dependent on the internet for information consumption, driving the need for more large-scale internet-based studies to inform design best practices. This need is becoming even more critical in light of two advances in everyday computing: (1) the migration of users from desktops to mobile spaces, and (2) the new paradigm of "cloud" computing, a model that

removes a majority of data processing and storage demands from devices to more powerful central servers. Some industry analysts predict that the combination of the mobile internet and cloud computing will surge in popularity in the near term [9].

Mobile spaces

The last few years have seen a dramatic increase in the number of users who access the web via mobile devices. Current studies have placed the number of mobile web users worldwide at between 500 and 600 million, with some predicting that number to surpass 1.7 billion people by the year 2013 [10]. Indeed, the increase in mobile web users has been even more pronounced over the past year, with one study finding that U.S. mobile users doubled between January 2008 and January 2009 [11].

The growth of the mobile web's popularity has been due in large part to improvements in mobile online technology, as well as to adaptations that have been made to provide mobile users an experience suited to their specific needs. With more powerful processors, faster networks, and larger screens that have better resolution, mobile devices have come to provide a web experience that is similar to that of the desktop of several years ago [12].

Today, a mobile internet device can be anything from a pocket-sized flip phone used to check train schedules over a cellular internet connection while rushing to the station, to a high-end, wide-screen laptop used to watch YouTube videos over a high-speed wireless connection at a café. For the purposes of this paper, we focus on small-screen devices ranging from internet-capable cell phones to multimedia smart-phones and tiny handbag-sized netbooks designed for cloud computing. Unlike desktops and traditionally sized laptops, these devices are used to access and consume web information on the go. In some nations, particularly in Asia, users with inexpensive mobile internet devices represent a large percentage of the internet traffic. In nations where high-end, multimedia smartphones are popular, these devices are used for web-based information seeking, content generation, and communication. [13]

Although the mobile online experience has approached that of the desktop in terms of power, speed, and screen resolution, it nonetheless has challenges of its own, particularly in how it adapts to the changing needs of the mobile user. In spite of the improvements in technology, challenges such as network speed, reliability, and privacy still constrain the mobile user [14], as do the limitations inherent in working with small devices. With these challenges, though, there are also unique opportunities. Applications that make use of the mobile device's context awareness, touch screens, cameras, and ringer/vibration motors have helped provide mobile users with a web experience that keeps pace [15] with their changing needs. These applications, while essential for successful mobile web browsing, also serve to differentiate the mobile web browsing experience from that of desktop and laptop computers.

Cloud computing

The nature of computing itself is further changing as more people make use of cloud computing, which is particularly appropriate for mobile computing. Cloud computing reduces the requirements for computing capabilities at the user's end, and instead stores data and applications in the "internet cloud." The user's computing device needs only network connectivity and lightweight client software. The majority of popular cloud applications are written as Web 2.0 software that runs inside web browsers [16]. As software for cloud computing becomes more sophisticated and accessible, people will be able to migrate more types of computing activities away from their desktops.

Studies of users in the mobile space

To ensure the ecological soundness of internet-based research on mobile browsing and searching, we must take into account the users' environment when using mobile devices. This section discusses empirical studies of users browsing and searching the web with mobile devices.

Browsing and small screens

In a recent study, researchers investigated how the mobile environment contributes to shortages in cognitive resources [17]. They did so through the use of a semi-naturalistic field study investigating user attention while moving through typical urban situations during the performance of web search tasks on a mobile phone. One noteworthy finding was that continuous attention to completing the task on the mobile device was recorded to last only about 4 to 8 seconds, and there were 8 recorded interruptions, during which users' attention was disrupted by glancing up to the environment. These findings, as well as others, reflect on the importance of taking into consideration the natural context in which users engage in mobile browsing [17, 18]. By investigating user behavior in natural settings, researchers are able to establish greater external validity for the results of such studies.

Results from a recent study suggest that information access using mobile devices is dominated largely by web browsing activities [19]. This reminds researchers of the need to understand the ways in which users interact with websites on mobile devices as the trend toward using mobile devices to access the internet increases.

Some of the main user experience problems facing all mobile applications are the limited display features and the lack of input resources available to the system [20]. Additionally, the tendency for mobile browsers not to display audio effects makes web usage over mobile de-

vices less pleasurable [20]. It also has been suggested that completing tasks such as navigating and searching is more difficult on small screen interfaces [9].

Searching and input habits

Given the very nature of mobile web use, there are distinct search patterns in mobile user behavior that differ from search patterns in desktop or even laptop user behavior. In one study, mobile web users were noted to have typed in fewer words than the typical desktop and laptop users. Users were also more likely to access the first page only of search results [21].

The evolution of mobile web use over the last few years has given rise to search patterns that are distinct not only from desktop and laptop search patterns, but also from mobile search patterns of only a few years ago. The above study, originally done in 2005, showed markedly changed search behaviors when revisited in 2007. Users were typing in nearly double the amount of words in their search queries, and clicking on more than one query in a number of instances. The category of sites that users looked for was becoming more heterogeneous as well, with the most frequently accessed category of website, that of adult topics, accounting for less than one percent of all queries [21].

Internet-based research in mobile spaces

A few internet-based research tools are available that allow researchers to investigate the delivery of information and consumption of it on mobile devices. A key attribute of an effective internet-based research tool is the ability to collect quantitative data on usage patterns as well as user perceptions of website usability.

WebLabUX remotely tests the effectiveness of website designs by recording users' perceptions, comprehension, and navigational behavior as they interact with design variations [22, 23]. Originally designed to investigate information consumption with laptops and desktop computers, WebLabUX has recently been adapted for use with mobile devices.

Another research tool, User Zoom, is designed to test mobile interfaces and provide quantitative data regarding the user experience with the mobile interface. User Zoom may be used for more applied research, allowing researchers to measure data such as effectiveness ratios, efficiencies, user satisfaction, detailed path analysis and click mapping.

With tools such as these, researchers can obtain empirical evidence to support best practices for effective design of websites delivered through mobile devices.

Conclusion

As new platforms and new tools for information access become available, the ways in which people look for and consume information are changing significantly. The wider range of environments in which people can consume information, as well as the enhanced capabilities of the tools themselves, affects not only how people perform familiar tasks but also their underlying goals and priorities.

To ensure that our information design best practices keep pace with this changing environment, we must continually refine and extend the body of empirical research on which our best practices are based. The use of internet-based research tools offers our best chance to achieve this goal, enabling researchers to gather relevant usage data in real-world environments for significantly lower resource costs than in the past. If we expect to continue to effectively deliver information to users as computing environments change, we need to develop new and better tools for internet-based research, and we need to use them to conduct relevant research.

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