Yida Li. Usability Testing for Web Browser: A Case Study of Comparing Chrome, Firefox and IE. A Master's Paper for the M.S. in I.S. degree. April, 2014. 46 pages. Advisor: Bradley M. Hemminger

This paper compared the performance of the three web browsers: Google Chrome, Mozilla Firefox and Microsoft Internet Explorer from three different aspects: menu display/history searching, bookmark function and downloading function. A usability test was conducted based on participants from University of North Carolina at Chapel Hill. During the test, the quantitative data was reflected by task execution time and mouse-click counts while qualitative data was analyzed using task load and comments from participants. The results indicated that people were most satisfied with Chrome while some function or design of Firefox and IE may dissatisfy the users to some extent.

Headings:

Web browsers

Usability testing

Bookmarks (Websites)

Task execution time

User interfaces

USABILITY TESTING FOR WEB BROWSER: A CASE STUDY OF COMPARING CHROME, FIREFOX AND INTERNET EXPLORER

by
Yida Li

A Master's paper submitted to the faculty
of the School of Information and Library Science
of the University of North Carolina at Chapel Hill
in partial fulfillment of the requirements
for the degree of Master of Science in
Information/ Science.

Chapel Hill, North Carolina

April 2014

Approved by

_____

Bradley M. Hemminger

Table of Contents

Introduction

What's the first click when you are going to surf on the internet? Web browser! Nowadays, web browser is the inevitable tool we use every day for our web search. It is the essential icon for everyone's desktop of computer. Since it is the tool we have to use for web searching, there are several options for us to choose. Available web browsers range in features from minimal, text-based user interfaces with bare-bones support for HTML to rich user interfaces supporting a wide variety of file formats and protocols. Chrome by Google, Internet Explorer by Microsoft, Firefox by Mozilla, Safari by Apple, and Opera are the most popular web browsers people are currently using. Everyone has their preferred web browser since each person has their own habit or way to surf the internet while each web browser has different popularity. According to the StatCounter, the three most used web browsers are Chrome, Internet Explorer and Firefox. These three web browsers take up to almost 80% of the whole market share. Especially Google Chrome, it almost covers a whole world in the map visualization of most used web browser by StatCounter.

It is important to motivate us to discover what is hidden behind the web browser market share ranking. Basically, we need to find out what are the potential factors that influence users to choose one specific web browser, comparing the performance discrepancy in three functions: bookmark, menu display and download. So I wonder what factors lead people to make one choice rather than other two. The purpose of this study is

to compare the performance among three web browsers, Chrome, Firefox and Internet Explorer from three main aspects: bookmark, menu display and download. Through such comparison, we could find the sections which may confuse users, figure out how to improve the usability of these parts. We hope to help new users to find the best web browser for them.

Literature Review

Web Browser

The first web browser was invented by Sir Tim Berners-Lee in 1990. It was called WorldWideWeb and was renamed Nexus later. However, the first commonly available web browser with a graphical user interface was Erwise, and in 1993, browser software was further innovated by Marc Andreessen with the release of Mosaic (later Netscape). It is a giant leap in web browser history, which made the World Wide Web system easy to use and more accessible to common people. In 1994, Netscape quickly became the world's most popular web browser, accounting for 90% of all web use.

Then Internet Explorer hit the market in 1995, which was disaster for Mosaic since Microsoft were gaining dominance in the web browser market. By 2002, Internet Explorer usage share peaked at over 95%.

In 1998, Mozilla foundation wanted to produce a competitive browser using the open source software model, the browser evolved into Firefox later in 2004. According to StatCounter, The usage of Firefox kept going higher from 2004 to 2010, from 3.66% to 32.4%. However, due to the presence of Chrome, it reduced to 18.3% now.

Chrome was first released in September 2008, and has rapidly increased in popularity. Its take-up has increased significantly year by year, and this increase is largely at the expense of Internet Explorer, whose usage share has continued to decrease these years.

All web browsers are mature and friendly so users don't need any instruction before they use them, even novice users. After a period of time, users would be familiar with the whole interface of browsers and choose their preferred browser to use. However, there is not much research on why people make such choice. Some people may prefer browser with simple and neat interface while someone prefer browser with high loading speed. So my goal is to provide a thorough comparison among top 3 browsers, Chrome, Internet Explorer and Firefox, from several basic perspectives, which could give guidance to new users who are not that familiar with one or two specific web browsers. There are some resources related to comparison among these three web browser, from theoretical perspective, like capability, supporting operation system and security. There is not much comparison about usability of these three web browsers at this point.

Firefox

Mozilla Firefox is a free and open-source web browser developed for Windows, OS X, and Linux, with a mobile version for Android, by the Mozilla Foundation and its subsidiary, the Mozilla Corporation. Firefox uses the Gecko layout engine to render web pages, which implements current and anticipated web standards.

As the third ranking of web browser market share list, downloads have continued at an increasing rate since Firefox 1.0 was released in November 2004, and as of July 31, 2009 Firefox had already been downloaded over one billion times. This number does not include downloads using software updates or those from third-party websites. They do not represent a user count, as one download may be installed on many machines, one person may download the software multiple times, or the software may be obtained from

a third party. According to Mozilla, Firefox has more than 450 million users as of October 2012.

Firefox has lots of advantages, such as speed, security and tabbed browsing. It is reported to be the fastest browser when it comes to download speed. Not only do programs and files download faster, but users get a record of all their download in the form of a table, so they can erase or move them at their convenience. Meanwhile, Firefox takes a lot of memory to run. Even with an up-to-date computer, some users may find that it becomes hard to run the browser when several other programs are open. So it is easy to crash when user open many tabs when searching.

Chrome

Google Chrome is a freeware web browser developed by Google. It used the WebKit layout engine until version 27 and, with the exception of its iOS releases, from version 28 and beyond uses the WebKit fork Blink. It was first released as a beta version for Microsoft Windows on September 2, 2008, and as a stable public release on December 11, 2008.

So Google Chrome is a very new web browser since its first version was released in 2008. However, the acceptance of Chrome has continued to increase these years and now it covers most countries in the world and has millions of users.

Like Firefox, Chrome is also very fast and it also gives the idea of tabbed browsing new power. You can grab a tab and drag it out into its own individual window. It also gives you the options of starting up in any tab configuration you want -- whether a custom setup or the set of tabs you had to open in your previous session. Unlike Firefox, Chrome is not likely to crash; it’s stable in this way.

IE

Internet Explorer (formerly Microsoft Internet Explorer and Windows Internet Explorer, commonly abbreviated IE or MSIE) is a series of graphical web browsers developed by Microsoft and included as part of the Microsoft Windows line of operating systems, starting in 1995. It was first released as part of the add-on package Plus! for Windows 95 that year. Later versions were available as free downloads, or in service packs, and included in the OEM service releases of Windows 95 and later versions of Windows.

Internet Explorer is one of the most widely used web browsers, attaining a peak of about 95% usage share during 2002 and 2003. Its usage share has since declined with the launch of Firefox (2004) and Google Chrome (2008), as well as with the growing popularity of non-Windows operating systems such as OS X, Linux and Android that do not automatically include and run Internet Explorer.

IE is always a controversial topic in web browser, some people love it while some people think that IE is way too uncomfortable to use. So one reason I conduct this usability test is to find what makes IE a web browsers full of topics.

Usability Testing

Usability testing is often used rather indiscriminately to refer to any technique used to evaluate a product or system (Rubin, 1994). According to him, usability testing is a research tool, with its roots in classical experimental methodology. The range of tests one can conduct is considerable, from true classical experiments with large sample sizes and complex test designs to very informal qualitative studies with only a single participant. Each testing approach has different objectives, as well as different time and resource requirements. The overall goal of usability testing is to inform design by

gathering data from which to identify and rectify usability deficiencies existing in products and their accompanying support materials prior to release. Then he also came up with the process of conducting a usability testing:

1. Develop the test plan.
2. Set up a testing environment.
3. Find and select participants.
4. Prepare Test Materials.
5. Conduct the test session.
6. Debrief the participants and observers.
7. Analyze data and observations.
8. Report findings and recommendations.

The goal and objectives of usability testing must depend on the specific circumstances, even the term usability itself must be defined with your organization. An operational definition of what makes your product usable may include (Rubin, 1994): Usefulness, Efficiency, Effectiveness, Satisfaction and Accessibility.

According to "The UX Book Process and Guidelines for Ensuring a Quality User Experience" (Hartson, 2012), monitoring note group is essential for the WAAD, which is Work Activity Affinity Diagram. Affinity diagramming is a technique for organizing and grouping the issues and insights across all users in your contextual data and showing it in a visual display that can cover one or more walls of a room. By pulling together work activity notes with similarities and common themes, a work activity affinity diagram, guided by the emerging flow model, helps consolidate contextual data and generalizes

from instances of individual user activities and issues to highlight common work patterns and shared strategies across all users.

In simplest terms, formative evaluation helps you form the design and summative evaluation helps you sum up the design. A cute, but apropos, way to look at the difference: “When the cook tastes the soup, that’s formative; when the guests taste the soup, that’s summative” (Stake, 2004, p. 17).

Formal summative evaluation is typified by an empirical competitive benchmark study based on formal, rigorous experimental design aimed at comparing design hypothesis factors. Formal summative evaluation is a kind of controlled hypothesis testing with an m by n factorial design with y independent variables, the results of which are subjected to statistical tests for significance. Formal summative evaluation is an important HCI skill, but we do not cover it in this document (Hartson, 2012). This usability is test three already existing systems, so it’s summative evaluation.

There are both quantitative and qualitative data involved in this test, so knowing how to analyze them is part of important work to do. According to Hartson, The first step in analyzing quantitative data is to compute simple descriptive statistics (e.g., averages) for timing, error counts, questionnaire ratings, and so on, as stated in the UX targets. Be careful about computing only mean values, though, because the mean is not resistant to outliers and, therefore, can be a misleading indicator. Because we are not doing formal quantitative analysis, the small number of participants typical in formative evaluation can lead to a mean value that meets a reasonable UX target and you can still have serious UX problems.

Qualitative data involves emotional impacts in test, and UX problems involving emotional impact are, by nature, usually broader in scope and less about details than usability problems. Therefore, for UX problems about emotional impact, it is important to get at the underlying essence of the observations while the explanatory context is still fresh. Otherwise, in our experience, you may end up with a vague problem description of some symptoms too nebulous to use.

Methodology

The basic methodology for conducting a usability test has its origin in the classical approach for conducting a controlled experiment. With this formal approach, often employed to conduct basic research, a specific hypothesis is formulated and then tested by isolating and manipulating variables under controlled conditions. Cause-and-effect relationships are then carefully examined, often through the use of the appropriate inferential statistical technique(s), and the hypothesis is either confirmed or rejected (Rubin 1994). The methodology for an assessment test is a cross between the informal exploration of the exploratory test and the more tightly controlled measurement of the validation test.

In “Handbook of Usability” (Rubin, 1994), there are seven basic elements of usability test in methodology:

Development of research questions or test objectives rather than hypotheses. Use of a representative sample of end users which may or may not be randomly chosen. Representation of the actual work environment.

Observation of end users who either use or review a representation of the product.

Controlled and sometimes extensive interviewing and probing of the participants by the test moderator.

Collection of quantitative and qualitative performance and preference measures. Recommendation of improvements to the design of the product.

Method

Test set up

This usability test is conducted in February of 2014 in the University of North Carolina at Chapel Hill campus. In the process of the test, both qualitative and quantitative data was collected. Quantitative data includes mouse-click and time for each task, and also the rating in post-task questionnaire given by each participant. Qualitative data includes participants' comments and their responses to questionnaire and final survey. All participants used the same device, Lenovo ThinkPad X230 installing the latest version of Firefox, Chrome and IE to complete the usability test.

Participants

All participants were recruited via listservs in University of North Carolina at Chapel Hill, including students from a variety of departments. Students who have basic computer skill could attend this test. All students were selected on a first come, first serve basis. A total of ten college students participated in this study. Everyone is anonymous and separate from each other, so everyone is independent and doesn't know what others' response or action.

Task Construction

In this usability test, participants finished three tasks. There's no time limit for the task, participants could finish the task using as much time as they want. All participants

were invited to a study room to finish the task, which could ensure a quiet and comfortable environment for tasks.

The first task is to ask participants to retrieve website information using search bar in history information searching. In this scenario, participants would receive two keywords to find out the exact websites they browsed two weeks ago. Then participants would be asked to delete the browsing history of today. This task is aiming to test the menu display and design of web browsers, and the complexity of users finding history browsing information and deleting the browsing record.

The second task is to ask participants to bookmark two assigned webpages and put them into the same folder which could be seen on the top of the web browsers. This task is to test the how easy user bookmark webpage and the function of categorizing bookmarks.

The last task is to test the download function of each web browser. It requires users to download a file and save it on “desktop”. It involves the speed of download and how difficult users choosing where to save.

There was one moderator, also as a note-taker for all tasks. He recorded the time every participant used for each task and also, wrote down the comments from participants, since every participant is required to think out aloud.

Survey

There are total three different kinds of survey through all usability test: pre-test questionnaire, post-task questionnaire and post-test questionnaire. Participants completed these surveys using pen as moderator required.

Pre-test Questionnaire

Before usability test, participants were required to finish a short pre-test questionnaire, in which, some preference and regular behavior of users were asked. For example, participants were asked to choose their favorite web browser, their opinions about the three most important factors of a web browser and how they bookmark their favorite websites.

The most important question here is "Name three factors that you think the most important for a web browser". The answer could reflect for what reason a user choose a web browser. Does the participant care more about user interface, security or speed?

Post-task Questionnaire

After each task, participants were asked to complete a questionnaire about the performance of the web browser they just used. The questionnaire consisted of five questions and first four questions used 1 to 5 scale to represent negative to positive. The last question is using 1-10 scale to show the difficulty/frustrating of this task. The questions are:

How confident are you that you successfully completed this task?

Overall, I am satisfied with the ease of completing this task. (disagree->agree)

Overall, I am satisfied with the amount of time it took to complete this task. (disagree->agree)

Overall, I am satisfied with menu display/bookmark function/loading and downloading speed. (disagree->agree)

On a scale of 1 – 10, how difficult/frustrating was this task? (Hardly -> Very)

These questions aim to obtain the opinions of participants, including their emotional impact and basic judgment about web browser. The rating of these questions could be analyzed to reflect the performance of web browsers.

Post-test Questionnaire

After all the tasks were finished, participants were asked to complete a questionnaire for how they think of web browsers. There is an overall rating for each browser scaled from one to ten, also, there are questions about one thing users like and dislike about the browsers. The rest of questions are asking participants some advice and comments for menu display, bookmark function and download.

Results

In-task Mouse-clicks and Time

Menu Display and History Searching

In each task, we recorded the mouse-clicks and time, which are two important measurements for the performance of web browsers. In Figure 4.1.1, it shows the mouse-clicks and time of every participant for the Task 1 which is testing menu display and history information searching:

Task 1(Mouseclick)	Firefox	Chrome	IE
p1	42	40	71
p2	33	19	42
p3	20	22	38
p4	12	16	78
p5	29	18	23
p6	12	13	61
p7	26	18	55
p8	25	22	44
p9	29	20	50
p10	23	25	47
Average	25.1	21.3	50.9

Task 1(Time/sec)	Firefox	Chrome	IE
p1	131	123	249
p2	290	138	282
p3	141	98	247
p4	70	85	288
p5	160	96	176
p6	84	65	175
p7	120	58	221
p8	150	110	201
p9	178	99	199
p10	144	101	248
Average	146.8	97.3	228.6

Figure 4.1.1

Then we created a bar chart to visualize average count of mouse-click and time for Task 1, see Figure 4.1.2:

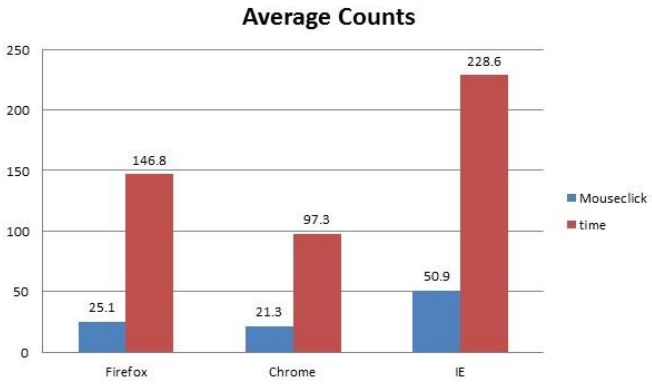


Figure 4.1.2

From the chart, we could see Google Chrome has the least time consuming and mouse-click counts while IE possesses the most mouse-clicks and time.

Bookmark Function

For the Task 2, which is testing bookmark function, Figure 4.1.3 below shows the mouse-click and time of each participant:

Task 2(Mouseclick)	Firefox	Chrome	IE
p1	35	30	33
p2	32	12	20
p3	18	15	14
p4	25	12	36
p5	39	22	28
p6	36	12	14
p7	54	20	23
p8	36	18	22
p9	33	17	24
p10	37	14	27
Average	34.5	17.2	24.1

Task 2(Time/sec)	Firefox	Chrome	IE
p1	180	167	161
p2	274	140	152
p3	130	107	120
p4	120	47	122
p5	225	69	108
p6	156	61	70
p7	181	109	80
p8	188	115	98
p9	180	103	133
p10	177	97	145
Average	181.1	101.5	118.9

Figure 4.1.3

We also created a bar chart visualization to present the average performance, Figure 4.1.4:

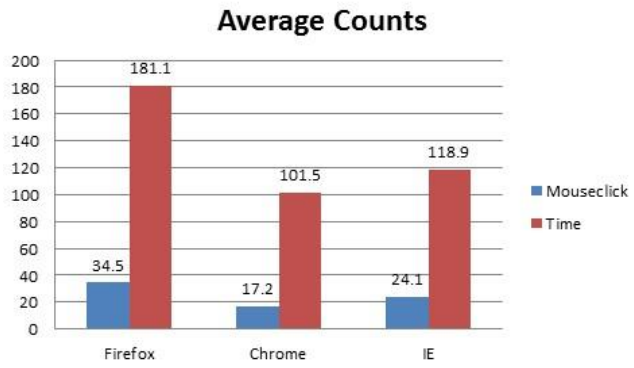


Figure 4.1.4

From this chart, we could see, Chrome still take least time and mouse-clicks of all three web browsers, and Firefox is the most time-consuming web browser which also has the most mouse-clicks counts in this task.

Downloading Function

For Task 3, downloading function testing, the result shows in Figure 4.1.5:

Task 3(Mouseclick)	Firefox	Chrome	IE
p1	16	17	21
p2	6	9	7
p3	7	6	6
p4	10	5	7
p5	7	6	6
p6	14	4	4
p7	6	5	5
p8	8	7	9
p9	9	8	9
p10	7	6	8
Average	9	7.3	8.2

Task 3(Time/sec)	Firefox	Chrome	IE
p1	140	98	106
p2	84	89	77
p3	82	40	53
p4	61	45	40
p5	80	37	50
p6	174	39	33
p7	55	67	44
p8	99	60	60
p9	101	75	55
p10	96	67	50
Average	97.2	61.7	56.8

Figure 4.1.5

In this diagram, we could find that the mouse-click counts participants have on these three web browsers are almost the same, but Firefox took the most time and mouse-clicks in Task 3.

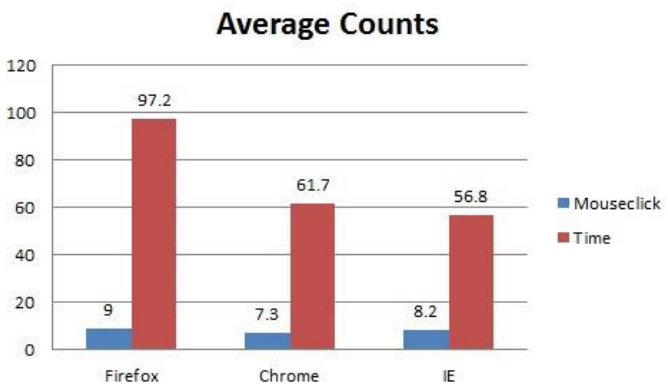


Figure 4.1.6

Post-task/test Rating Results

Figure 4.2.1 below shows the average rating of questionnaire for each task.

Task 1 Menu Display and History Searching	Firefox	Chrome	IE
How confident are you that you successfully completed the task	4.7	4.9	3.6
Overall, I am satisfied with the ease of completing this task	4.1	5	2.4
Overall, I am satisfied with the amount of time it took to complete this task	3.9	4.9	2.1
Overall, I am satisfied with menu display	3	4.7	1.4
On a scale of 1 – 10, how difficult/frustrating was this task?	3	1.4	6

Task 2 Bookmark Funtion	Firefox	Chrome	IE
How confident are you that you successfully completed the task	4.6	5	4.4
Overall, I am satisfied with the ease of completing this task	4.1	5	4.1
Overall, I am satisfied with the amount of time it took to complete this task	4	5	4.1
Overall, I am satisfied with bookmark funtion	4	5	4
On a scale of 1 – 10, how difficult/frustrating was this task?	2.6	1.7	2.9

Task 3 Download Function	Firefox	Chrome	IE
How confident are you that you successfully completed the task	5	5	4.7
Overall, I am satisfied with the ease of completing this task	5	5	4.9
Overall, I am satisfied with the amount of time it took to complete this task	4.9	5	5
Overall, I am satisfied with loading and download speed	5	5	4.9
On a scale of 1 – 10, how difficult/frustrating was this task?	1.4	1.3	1.9

Figure 4.2.1

For each task, the first four questions are scaled from 1 to 5, one means strongly disagree while five means strongly agree; the last one is scaled from 1 to 10, one means hardly, ten means very.

In the post-test questionnaire, participants were asked to finish an overall rating for each web browser, and Figure 4.2.2 shows the result:

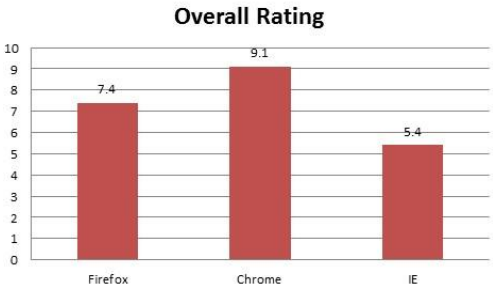


Figure 4.2.2

We could find that Chrome is the most satisfying web browser among three, and then followed by Firefox. IE only got 5.4 out of 10 and obviously, participants thought that IE needed to be improved in many ways.

Data Analysis

Menu Display and History Searching

Firefox

From the results shown above, most participants were satisfied with the performance of Firefox, but there are still some designs which confused or frustrated participants.

The button shown above is the main drop-down menu of Firefox, which is at the top-left corner of the interface. The comments during the test indicated that participants were not likely to find this button at first although it's obvious. The reason is that normally people get used to search pull-down menu at the right section of web browser. There are several menus on the right of Firefox, which are on-doing downloads, bookmark display and Fire-bugs. During the interview, participants said that they would not think of the possibility that main menu is on the top-left of the interface until they

failed to find it on the right. So participants spent more time finding out where main menu located, which added up more time to total task time.

The menu shown above is the history information options in Firefox. After participants clicked the “Show All History”, a new window jumped out, where participants would think of all operations could be done there. However, not all participants could go back here to select “Clear Recent History” because they thought a new window would include all options about history.

Chrome

The results indicated that most participants were satisfied with the performance of Chrome. During the questionnaire after the test and think out aloud process, they thought the user interface of Chrome is clean, simple and user-friendly.

This small icon shown above is the main menu icon of Chrome, and it locates at the top-right corner of the web browser. Several participants liked the design since it embraces all options in its drop-down menu, like bookmark, history and other settings, so participants didn’t need to look for other buttons all over the web browser, which reduced the time of task significantly.

IE

Obviously, 228 seconds average time, 2 times than Chrome and 1.5 times than Firefox, 51 seconds average mouse-clicks, 2 times than Chrome and Firefox, all these results shows that IE performed more poorly in satisfying participants. 1.6 out of 5

satisfaction rating and 6 out of 10 frustrating rating could indicate that participants were frustrated during using IE.

These three icons shown above are the only three icons could be seen on the interface of IE. When task began, most participants went to the “gear” because the “house” icon means homepage and “star” means bookmark or favorite pages from their perspective. What happened next was that these participants spent minutes to look for history searching bar under the “gear”. However, they couldn’t find what they want there, because the history information is under the “star”. IE puts both bookmark and history in the drop-down of “star” so it’s really difficult for participants who would automatically treated “star” as bookmark to find out the history searching section in a short time.

After participants spent much time finding the history information was under the “star” icon, they may spend another couple of minutes searching the search bar of history record, which hides at the end of a drop-down menu. The image above indicates that you would not notice there’s “Search History” unless you click the arrow. However, the title of the main menu is “View By Date”, which is so confusing. People would assume under “View By Date”, there should be “View By Site” or some other classifications, but it is a small chance they would think of that “Search History” is one of them. This is another point which took much time from participants and upset them. These two designs I mentioned just now are the two main reasons which build up the time and mouse-click counts of IE.

The last is there's a menu "Internet Options" (shown below) under the "gear" icon. Inside there's a section for delete browsing history. Some participants went here to delete "history of today", but then they found there's no date selection here, history delete here is to delete all browsing records at the beginning of time, so it's easy for participants to delete all history information accidentally.

Bookmark Function

Firefox

Firefox has the most mouse-click counts and time in this task, some participants are not familiar with the bookmark process on Firefox, and some usability design cannot satisfy participants.

When asked to bookmark a webpage, most participants noticed the "star" icon and clicked it, and the "star" would change into a golden one:

However, nothing happened after it turned into golden, no pop-out menu or confirmation button returned, which made participants not confident about whether they had bookmarked this page. Some participant would click one more time, a menu will come out at this point, enables them to bookmark this page while other participants may give up here and try somewhere else.

Another design which most participants disliked about is when participants bookmarked a page, it would be saved as default in “Unsorted Folder”, where participant needed spent another minutes searching for. When dragging the bookmark to the toolbar of the web browser, it required participants first minimized the new window, which may be inconvenient for most participants.

Chrome

Chrome continues being a leader in this task, least mouse-click counts and time spent. After collecting the questionnaire results and comments recording, we found several reasons:

1. Easily to add bookmark: After participants clicked the “star” icon, a menu immediately came out, so it’s very easy for participants to bookmark webpages.
2. User-friendly: After participants created a new folder named “Entertainment” as request, next time they bookmark a page, the saving option will be default as the folder they just created, which could save some time for users.

Bookmark function is one of the most used function for a web browser, and obviously, Chrome presents a very simple and easy way for users to operate, which could win them more user in this way.

IE

Most participants said that the bookmark function of IE is good, very easily done. Unlike Firefox and Chrome, which need some mouse-clicks to bookmark a webpage and put it on toolbar, there’s just one button for IE users to bookmark:

This button is on the top-left corner of web browser, in the tool bar. Once users click it, the current webpage would be bookmarked and shown on the tool bar. It's a very convenient way for users to bookmark a page, however, most participants are not familiar with this shortcut since IE is not their first choice for web browsing. That's the reason that though IE holds this amazing design but both time and mouse-click counts exceed Chrome.

Downloading Function

In this task, the performances of all three web browsers are almost the same, since it's a relatively simple task, there's not much for participants to do, so mouse-click counts are no different. As to the time, since the order of finishing task is Firefox first, then Chrome and IE the last, so there's a big chance for participants using the least time on IE because of they already knew where to find file to download.

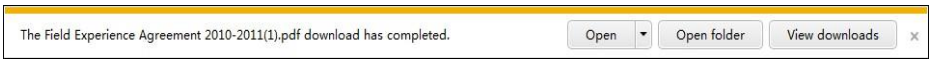
Some usability problems were also mentioned by participants, mainly for Firefox:

1. After participants find the link of target file, most of them would right click them and save it on desktop while some participants wanted to click in to preview, but Firefox makes left-click as default download.
2. Since in Microsoft Office, when you are to look for something, after "Alt+F", the search bar would pop out at the top-right corner, so some participants disliked the search bar shown at the bottom-left corner of Firefox.

After downloading mission completed, there's no obvious response for whether the task is finished in Firefox except the black arrow turns into green one:

For Chrome and IE, there's obvious notice for tasks completed:

IE:



Questionnaire

After the usability test, from the results, all participants would continue using the web browser they are using now, mostly Chrome (9/10).

The most time mentioned one thing participants like about web browser:

1. Firefox: loading speed is fast.
2. Chrome: user interface design is great, simple and clean.
3. IE: bookmark a webpage is fast and convenient.

The most frequently mentioned thing participants dislike about web browser:

1. Firefox: hard to find the main menu.
2. Chrome: compatibility with flash plugin.
3. IE: too many confusing button and menu.

Overall, the same as the rating, participants thought that Chrome is the most user-friendly web browser among the three, followed by Firefox, then IE. According to participants, IE does have a slightly better bookmark and download function than Firefox, however, because of confusing button and overall unpleasant user interface design, IE has to face the situation that embraces the least preference.

Discussion

Significance

This usability test is not only a simple test for users, but also a comparison standard for web design software engineers from Mozilla, Google and Microsoft. Through the result, we could compare these three web browsers in several ways, like user interface, bookmark function and downloading speed. Some fancy features could be borrowed from to give users better usability experience, like IE's one-button bookmark function.

What's more, this test could enable users to learn more about web browsers. Participants could get to know more functions of the browser which they may not know before the test. Also, participants could learn more advantages of other web browsers and try to switch to use the web browser which is truly best for them.

Limitations

During the test, we found several limitations that may affect the final result. Most of these limitations are inevitable, but somehow, future study could optimize them in a more scientific way.

Background of Participants

In this usability test, the ideal participants should be people who have basic computer skills, and also never used any of Firefox, Chrome or IE, because in this way, participants would have no previous knowledge about web browser and treat these three

as same. However, Firefox, Chrome and IE are the three most popular web browsers in the world and it's nearly impossible to find a student who never used these three before. Through the whole process, we found that most participants were more confident and faster when they were using Chrome since most participants in this test (8/10) are choosing Chrome as their preferred browser. In this way, Chrome is more likely to have a better performance than Firefox and IE.

Test Order

In every task of this test, we arranged participants to finish task in this order: Firefox first, then Chrome and IE. Participants may spend less time on Chrome and IE because they had already been aware of some task operations, like Task 3. They could find the file they were asked to download in a shorter time on webpage. Besides, some menu layouts are similar among web browsers, so participants would locate the button or menu immediately after they had used a similar one before.

Browsing Behavior

During the process, we found some participants using hot keys instead of mouse in some situations. For example, one of our participants used "Ctrl + B" to bookmark a page, which saves much time for him. That's not what we want to see because if the user interface of this browser is awful, which is supposed to spend participants much time. Hot keys cut off much time and may cover the problem like this since from the result we may think this browser is user-friendly incorrectly.

Additionally, we found that during the test, some participants like to click their mouse frequently, even they are not using it. This would increase the mouse-click counts for no reason and it involves with participants' habit, so it's inevitable.

Interview and Test Process

A structured interview with participants may be helpful during the test. In the pre-test questionnaire, instead of simply answering the questions, every participant should receive a complete interview about their search behavior and the reason they choose the web browser. After all participants select a web browser from these three as a most used one, during the test, they are only asked to use the other two browsers to do the test. This cross test plan would reduce the factor that people are likely to spend less time on their preferred web browser and produce a much more accurate result.

Built in Bias

Since participants are likely to be faster on their preferred browser, we could add an analysis about the correlation between their preferred browser, which they would be asked in pre-test questionnaire and their best performance browser, which is the browser with least mouse-click counts and task time. If their best performance browser is not their preferred browser, we could ask them about their opinions about the reason why their preferred browser is not at best performance, what could be done to improve the usability and the design discrepancy between the best performance browser and their preferred browser.

Sampling Bias

Since participants in the study were all students from the University of North Carolina at Chapel Hill who are mostly from 21 to 25, there were not very representative of the population of users that user web browsers. They are more likely to be younger, more educated and more tech savvy. According to a usability test(Elie Bursztein, 2012), it shows that approximately half of Americans 45 years or older prefer Internet Explorer, with the remainder of senior citizens opting for Firefox, Chrome, Safari, or Opera, in that

order. There's a big chance that this group of participants are probably more likely to prefer tools from Google or Mozilla. Thus, these study results, plus the small sample size (10) is likely to bias the results.

Conclusion

Factors

The purpose of this usability study is to find out for what reason people will choose a web browser, especially among Firefox, Chrome and IE, which are the top three web browser at present. From the result of pre-test questionnaire, participants would treat high speed, user interface and compatibility as three most important factors to choose a web browser. As we mentioned before, although with better bookmark and downloading function, IE still dissatisfied participants because of unpleasant user interface design. We could conclude that user interface design, including menu display , button layout, is the first thing participants consider to decide which web browser to use.

Future Work

The purpose of our study is to compare the performance of menu display, bookmark and downloading function for three web browsers. Each web browser has its feature and advantage which could attract more users, however, no matter fancy features or amazing speed a web browser has, a user-friendly interface design comes first. People tend to choose the web browser with simple and clean interface, because nowadays, most people use web browser mainly to view webpage, watch video and search for materials, not much plugins or applications involved, so a simple user interface would help a lot for common users.

Also, we found that icon or button design is essential for user interface. Icons should be correlated with their function, they serve to help users instead of confusing them. Maybe the user interface designers could come up with a better idea to organize icon layout.

Reference

1. Rubin, J. (1994). *Handbook of Usability Testing*. New York: John Wiley & Sons, Inc.
2. Weiser, M. (1991). The Computer for the 21st Century. Scientific American, 94–100, September.
3. Hartson, R. (2012). The UX Book Process and Guidelines for Ensuring a Quality User Experience. San Francisco: Morgan Kaufmann, Inc.
4. Tullis, T. (2008). Measuring the User Experience. San Francisco: Morgan Kaufmann, Inc.
5. Nielsen, J (1994). Usability Inspection Methods. New York: John Wiley & Sons, Inc.
6. Nielsen, J. (1993). Usability Engineering. San Francisco: Morgan Kaufmann.
7. Nielsen J. Finding usability problems through heuristic evaluation. In: Proceedings of the SIGCHI conference on human factors in computing systems. Monterey, California, USA: ACM Press; 1992. p. 373–80.
8. Nielsen J, Molich R. Heuristic evaluation of user interfaces. In: Proceedings of the SIGCHI conference on human factors in computing systems: empowering people. Seattle, Washington, USA: ACM Press; 1990. p. 249–56.

9. Jeffries R, Miller JR, Wharton C, Uyeda K. User interface evaluation in the real world: a comparison of four techniques. New Orleans, Louisiana, USA: ACM Press; 1991.
10. Currie LM, Graham M, Allen M, Bakken S, Patel V, Cimino JJ.Clinical information needs in context: an observational study of clinicians while using a clinical information system. AMIA Annu Symp Proc 2003:190-4.
11. Rieman J, Franzke M, Redmiles D. Usability evaluation with the cognitive walkthrough. In: Conference on human factors in computing systems; 1995. Denver, Colorado, United States; 1995. p. 387–8.
12. Smith C. Transforming user-centered analysis into user interface: the design of new-generation products. In: Wood L, editor. User interface design bridging the gap from user requirements to design. Boca Raton, FL: CRC Press; 1998. p. 291–2.
13. "What are the Pros and Cons of Firefox" http://www.wisegeek.org/what-are-the-pros-and-cons-of-firefox.htm
14. Wikipedia of Firefox http://en.wikipedia.org/wiki/Firefox
15. Wikipedia of Chrome http://en.wikipedia.org/wiki/Google_Chrome
16. Wikipedia of IE http://en.wikipedia.org/wiki/Internet_Explorer
17. Stake, R. (2004). Standards-Based and Responsive Evaluation. Sage Publications.
18. Elie Bursztein. (2012). Survey: Internet Explorer users are older, Chrome seduces youth http://www.elie.net/blog/web/survey-internet-explorer-users-are-older-chrome-seduces-youth#.UzrYpVejn7c

Appendix A

Observation Guide

Moderator Guide of Web Browsers Usability Test

Moderator Checklist

Before Tests

Procure task documents

Procure moderator script

Before each session

1. Confirm study room reservation at least 24 hours before scheduled test time

2. Turn on laptop

3. Arrange room (moderator next to participant, and not to close to make participants uncomfortable while not too far to have problem taking notes)

4. Turn off phone(s) and/or set to silent mode

5. Make sure the laptop is installed with three web browsers: Internet Explorer, Google Chrome and Firefox.

Orientation Script

Moderator will meet the participants in the lobby of Davis Library and walk with them to the group study room that has been reserved for the session.

Welcome [Participant Name] — thank you for agreeing to participate in our research study.

"I'm [moderator's name], and my job today is to explain what we are going to do today and help guide you through the process. For the better research study, I'm also taking notes on the study during the process. During the rest of the session, I'll be working from a script to ensure that my instructions to everyone who participates in the study are the same.

Before we get started, I'd like to tell you a little bit about what we are doing today. We're collecting feedback by comparing three most popular web browsers: IE, Chrome and Firefox. During the session, I'll ask you to use the three web browsers to complete three tasks while I observe how you interact with the browsers. As you complete the tasks, please be yourself—do whatever you would normally do. Also, please **think out loud** as you're working to help us gain insight into how you work your way through the tasks. Please know that we are here to test the browsers and not you. There are no wrong answers or questions in this study.

By the way, I'm an independent researcher who had nothing to do with the design of the web browsers you're trying out. So please be honest with your positive and negative thoughts—I need to know exactly what you think, not what you think I want to hear. You will not hurt my feelings.

This session will take about 25 – 30 minutes. Before we begin, please look over the informed consent form and sign if you agree. Please let me know if you have any questions, as you look it over.

Do you have any other questions before we begin?

Appendix B

Questionnaire

Pre-test Questionnaire

1. What device do you use most often to do web searching?

a. Lap-top/Desktop

b. Tablet (like iPad, Nexus)

c. Mobile

2. Which web browser do you usually use?

a. Internet Explorer

b. Google Chrome

c. Mozilla Firefox

d. Opera

e. Apple Safari

f. Other

3. Name three factors that you think most important for a web browser?

a.

b.

c.

4. How do you think the interface of web browser you used most often?

a. Very good

b. Fine, needs improvement

c. Not satisfying

5. Have you ever used bookmark to save the page you would use in the future.

1. If yes, have you ever used folders to categorize different bookmarks?

2. Have you ever used search bar to search any history information in web browser?

3. How do you think the download function of web browser you are using now?

Participant Task Sheets

Please read the task descriptions out loud for each task.

Task 1

Now you are asked to open two web pages you browsed several weeks ago, but you can't remember the exact name. All you know are some keywords, so you decide to use the search bar to look for history information. Open them in two web tabs in browse, then delete the history today/past day. (if there's an option).

Web page1: Start with "Deal" and it's a website about deal, coupon.

Web page2: There is a word "DOTA" in its name and it's a website about statistical data about a game named "DOTA 2".

Post Task Questionnaire

1. How confident are you that you successfully completed this task?

Not Very Confident 1 2 3 4 5 Very Confident

2. Overall, I am satisfied with the ease of completing this task.

Strongly Disagree 1 2 3 4 5 Strongly Agree

3. Overall, I am satisfied with the amount of time it took to complete this task.

Strongly Disagree 1 2 3 4 5 Strongly Agree

4. Overall, I am satisfied with menu display

Strongly Disagree 1 2 3 4 5 Strongly Agree

5. On a scale of 1 – 10, how difficult/frustrating was this task? (Hardly -> Very)

1 2 3 4 5 6 7 8 9 10

Task 2

Go to the website “YouTube” and “Youku”. After you looked through, you find both are interesting and want to create a shortcut to revisit easily. Bookmark them and put them in a folder named “Entertainment” which could be seen in top of the web browser (tool bar).

Post Task Questionnaire

1. How confident are you that you successfully completed this task?

Not Very Confident 1 2 3 4 5 Very Confident

2. Overall, I am satisfied with the ease of completing this task.

Strongly Disagree 1 2 3 4 5 Strongly Agree

3. Overall, I am satisfied with the amount of time it took to complete this task.

Strongly Disagree 1 2 3 4 5 Strongly Agree

4. Overall, I am satisfied with bookmark function.

Strongly Disagree 1 2 3 4 5 Strongly Agree

5. On a scale of 1 – 10, how difficult/frustrating was this task? (Hardly -> Very)

1 2 3 4 5 6 7 8 9 10

Task 3

You need "Field Experience Agreement" since you are about to begin your summer internship. So you go to http://sils.unc.edu/current-students/forms to download this form. Download this agreement and put it in "desktop" so you could use conveniently.

Post Task Questionnaire

1. How confident are you that you successfully completed this task?

Not Very Confident 1 2 3 4 5 Very Confident

2. Overall, I am satisfied with the ease of completing this task.

Strongly Disagree 1 2 3 4 5 Strongly Agree

3. Overall, I am satisfied with the amount of time it took to complete this task.

Strongly Disagree 1 2 3 4 5 Strongly Agree

4. Overall, I am satisfied with loading/downloading speed.

Strongly Disagree 1 2 3 4 5 Strongly Agree

5. On a scale of 1 – 10, how difficult/frustrating was this task? (Hardly -> Very)

1 2 3 4 5 6 7 8 9 10

Post Test Interview

1. What were your overall impressions of three web browsers?

a. Firefox

b. Chrome

c. IE

2. Name one thing you liked about for each browser.

a. Firefox

b. Chrome

c. IE

3. Name one thing you did not like about for each browser.

a. Firefox

b. Chrome

c. IE

4. If you could make one significant change to this browser, what change would you make?

5. If the browser you are using now is one of these three, would you continue using it or change into the other two?

6. Were there any buttons or labels that were problematic or confusing? What would make more sense to you?

7. Do you have any other questions, comments or suggestion about these three web browsers?