Effective Mobile Web Design and Development for

JHU APL External Website

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    Wireframe: wireframe/v1/index.htm

                       wireframe/v2/index.htm

Appendices

    Consent Form: Informed-Consent-Statement.docx

    Questionnaire: User-Background-Questionnaire.docx

Abstract

Due to a global increase in smartphone ownership and an exploding use of wireless services, mobile phones have become an important means of Internet access. However, the constraints (e.g. small screen, weak network connections, etc.) of such mobile devices limit the usability of information browsing. This paper presents research on the existing constraints of mobile devices, user activities on such devices, mobile Web usability issues, methodologies for optimizing user interaction, best practices for mobile Web design/development, and design trends that can be applied to development of JHU APL mobile website. A user-based evaluation of the JHU APL mobile Web prototype used for the usability testing presents the mobile Web usability issues found during the testing procedures. The testing report suggests how the browsing usability can be improved through revisions based on the recommendations.

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Introduction

In recent years, the mobile Internet industry has worked hard to find technological solutions to make mobile access possible. As a result, mobile devices with ubiquitous connectivity have become widely in use today. Wireless Application Protocol (WAP) is a specification for communication protocols to standardize the way that wireless devices can be used for Internet access. Services using the WAP were launched in many countries in late 1990s. Most of the current mobile phones are built with this WAP feature for accessing websites through mobile browser.

Web browsing from mobile devices has become more popular in the last several years. As the number of smartphone users is growing, the number of mobile Web sites has also been growing. Currently, there are 5.3 billion mobile subscribers worldwide. Mobile devices sales rose in 2010, and global unit shipment of smartphones/tablets has already exceeded that of desktop PCs/notebook PCs. Almost 20 percent of the global mobile subscribers have access to fast mobile Internet (3G or better). According to mobiThinking (2011), many mobile Web users worldwide are mobile only, and even in the US 25 percent of mobile Web users are mobile-only.

Utilizing mobile technologies in the hiring process is a new trend, and many companies have already started making job search engines available via mobile device. One of the most important functions of the current JHU APL's external website is to hire competent young professionals, so developing a mobile version of the external website is becoming more and more important. This research paper presents various issues and topics that can be useful for designing and developing a JHU APL mobile

website, including user activities on mobile devices, user interaction optimization, usability, mobile Web design tips/best practices, design trends, etc.

Literature Review

History, current status, and future of mobile usage

The Wireless Application Protocol (WAP) is a global communication protocol standard for accessing information over a mobile wireless network. The first mobile browser for a PDA was created in 1994. Released in 1996, NetHopper 2.0 was the first commercial text-only World Wide Web browser. During the mid to late 1990s more users would want to use mobile devices for more than just making phone calls or sending text messages.

mobiThinking's (2010) study found the following:

> Currently, 90 percent of the world lives in a place where a mobile network is accessible. At the end of 2010, there were 5.3 billion mobile subscriptions – that's equivalent to 77 percent of the world population. Around 18 percent of the 5.3 billion phones are able to access the Internet.
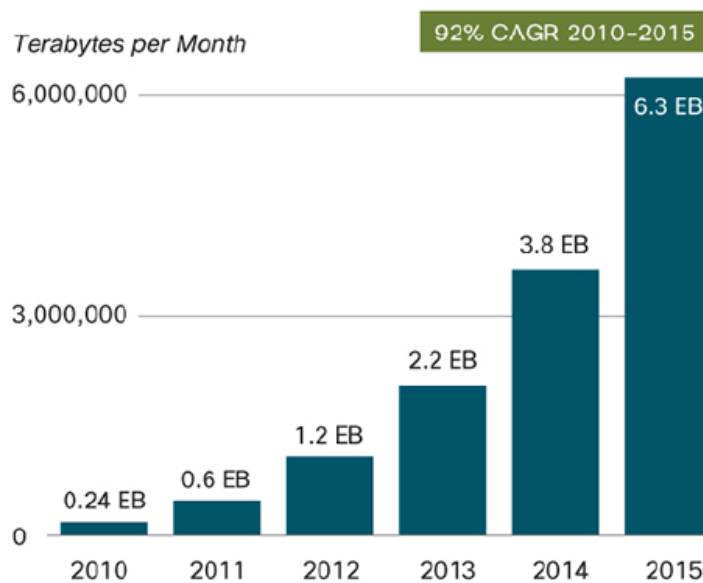
International Telecommunication Union's (2011) study found the following:

> As of October 2010, 880 million people (94.1 per 100 inhabitants) in the Americas were subscribed to mobile cellular phones, and 226 million (24.2 per 100 inhabitants), nearly half of the 514 million estimated Internet users, were subscribed to mobile broadband.

According to a new report from Cisco, global mobile data use almost tripled between 2009 and 2010. They expect mobile data use to increase by a factor of 26 by 2015 (Lasar, 2011). The report highlights are as follows:

- There will be 788 million mobile-only Internet users by 2015.

- Global mobile data traffic will increase by a factor of 26 by 2015.

- World mobile data grew by a factor of 2.6 in 2010 from 2009.

- Average Smartphone usage doubled: 79 MB per month, up from 35 MB per month in 2009.

- Millions of people around the world have cell phones but no electricity, and by 2015 a majority in the Middle East and Southeast Asia will live "off-grid, on-net."

Figure 1. Lasar, M. (2011). *Cisco VNI Mobile*. Retrieved from http://arstechnica.com/tech-policy/news/2011/03/world-mobile-data-traffic-to-explode-by-factor-of-26-by-2015.ars

This figure shows that Cisco forecasts 6.3 exabytes per month of mobile data traffic by 2015.

According to the latest mobile report from comScore, which covers the three-month period ending January 2012, there are 101.3 million U.S. smartphone subscribers. The report also mentions that, as of the end of January, there were 234 million people age 13 or older using a mobile phone in the U.S (Wagner, 2012).

User activities on mobile devices

It's been five years since Apple unveiled the first iPhone, which was the most capable and well-designed smartphone. Nowadays people use their mobile devices everywhere and at anytime – waiting for the bus, walking on the sidewalk, or watching TV. Mobile devices aren't just gadgets. Actually, they're becoming extensions of ourselves.

In August 2010, Adobe performed an online survey about mobile experiences. Adobe's first mobile consumer survey, *Adobe Mobile Experience Survey: What Users Want from Media, Finance, Travel and Shopping* (Adobe Inc., 2010), was designed to provide businesses with useful data and insightful information on how to improve the mobile user experience. The study found that just over a third of the participants were iPhone or iPad users. A quarter of them were Research In Motion's Blackberry devices users, and 20 percent of them were Android devices users. The study also found that respondents generally prefer the browser experience to downloadable mobile apps, except when it comes to games, social media, maps and music (Adobe Inc., 2010).
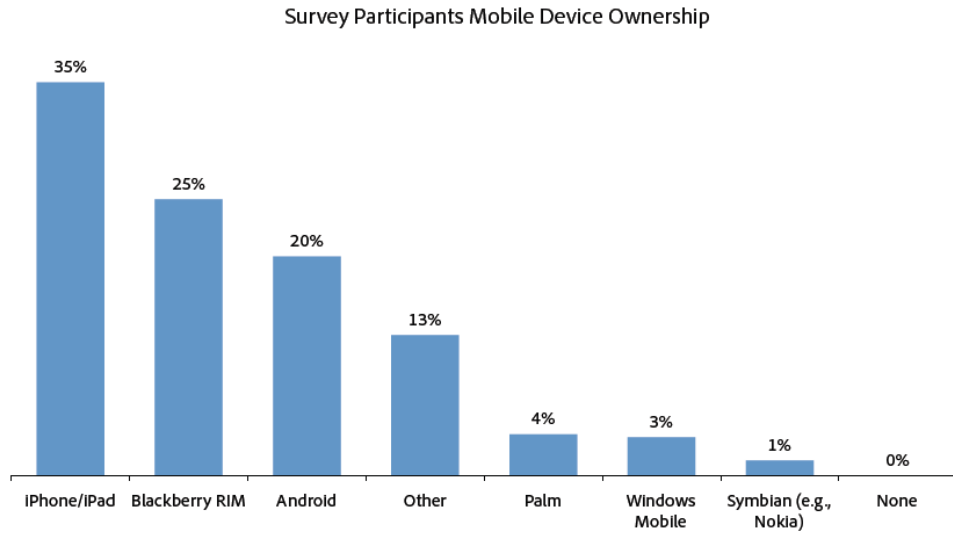
Figure 2. Adobe Inc. (2010). *Survey Participants Mobile Device Ownership*. Adobe Mobile Experience Survey: What Users Want from Media, Finance, Travel and Shopping.

This figure shows that over a third of the participants were iPhone or iPad users.
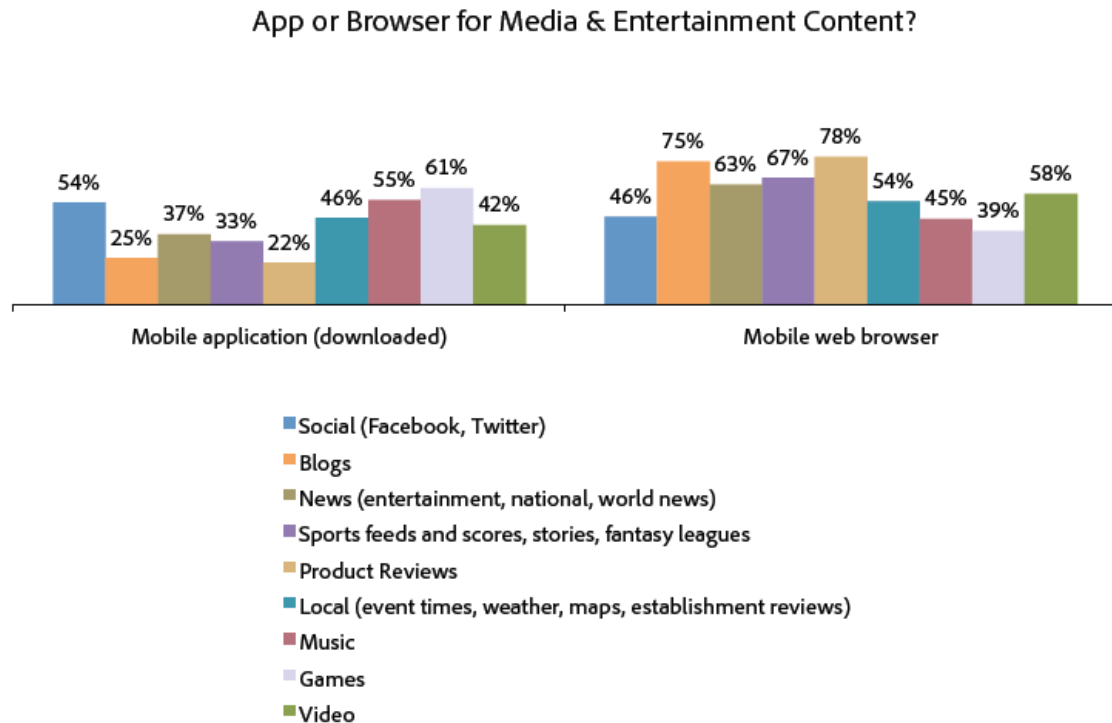

Figure 3. Adobe Inc. (2010). *App or Browser for Media & Entertainment Content?*. Adobe Mobile Experience Survey: What Users Want from Media, Finance, Travel and Shopping.

This figure shows that respondents generally prefer the browser experience to downloadable mobile apps.

However, a recent report detailing smartphone usage released by the Nielsen Company in 2011 shows that the Android operating system is 10 percentage points above Apple iOS in the second place.
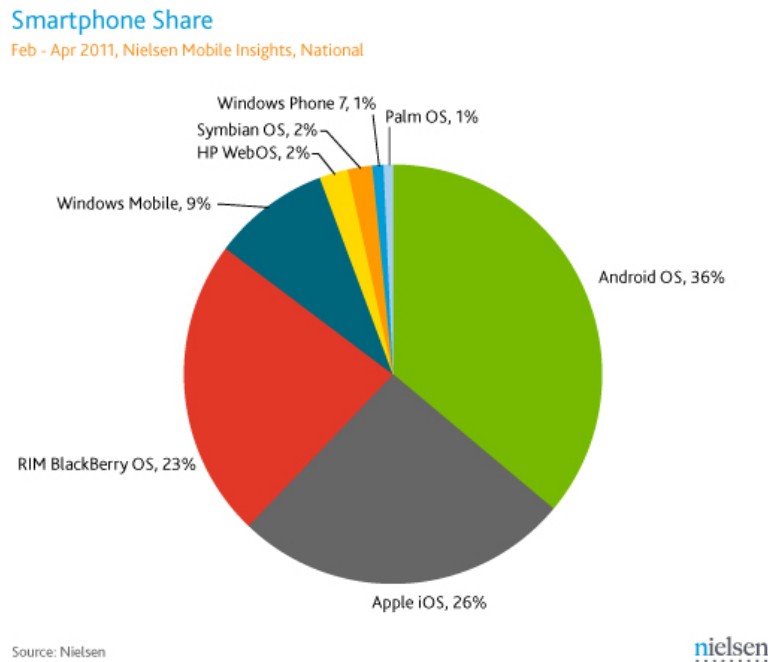
Figure 4. Spike, J. (2011). *Nielsen publishes report on smartphone usage that shows Android OS ahead.* Retrieved from http://www.broadbandexpert.com/blog/smartphones/nielsen-publishes-report-on-smartphone-usage-that-shows-android-os-ahead/

In March 2011, ABI Research performed an online survey conducted by 2,000 consumers. Survey respondents were asked a wide range of questions about how they use mobile devices. All respondents owned at least one mobile phone, smartphone or media tablet. According to the survey, almost three quarters (73%) of mobile phone users (both smartphones and other types) in the United States use their phones to visit social networking sites daily. Other popular phone-based activities included (ABI Research, 2011):

- Checking email (80%)

- Checking weather and reading news (63% each)

- Playing music or viewing stock quotes (53% each)

- Checking sports scores (51%)

- Searching for information (48%)

- Playing games (39%)

Video has become more popular among smartphone owners. According to Titlow (2011), smartphone users watched about 35 percent more video content on their devices than they did last year. A recent report (Lunden, 2012) shows that mobile video now accounts for half of all mobile traffic.

Constraints of mobile devices

Browsing the Web from mobile devices has several usability-related concerns in performing Web-related activities. The mobile devices make online information much harder to interact with – the small screen makes it difficult to read what's displayed, the lack of a full-sized keyboard makes it difficult to input text, and the lack of multiple windows and mechanisms for easy copy/paste makes it difficult to move data from one Web page to another.

Smaller screen size. The most obvious constraint of a mobile device is screen size. Mobile screens are smaller than those of a desktop, so they can only display a limited number of characters. Screen sizes and keyboard layouts vary across the range of mobile devices. There's a lot more diversity in the physical characteristics of the mobile devices than those of desktop PCs. While most of the current regular LCD monitors for personal computers have display resolutions that range from

1024x768px to 1920x1080px, mobile devices have smaller display resolutions (e.g. 320x240px for iPhone). Also, pixel densities for regular LCD monitors and mobile devices are different (e.g. 163 ppi for iPhone 3's pixel density, 326 ppi for iPhone 4's pixel density). For example, the Retina Display, which squeezes a 960 by 640 resolution into a 3.5-inch area, is used on the iPhone 4 and 4S.

These screens should be grouped into a few different classes of devices to reduce the number of screen sizes designers should worry about. When designing for the mobile Web, designers need to think about the different kinds of mobile devices that users will be using (e.g. featured phones, smartphones, PDAs, etc.). Content should be optimized for these smaller screen sizes, and only the information that mobile users need should be displayed.

According to Suda (2011), mobile screens are not only different in screen sizes and resolutions but also different in shapes. Therefore, tailoring websites for mobile phones is mandatory – it's best to keep the shape and style of the mobile site as minimal and linear as possible.
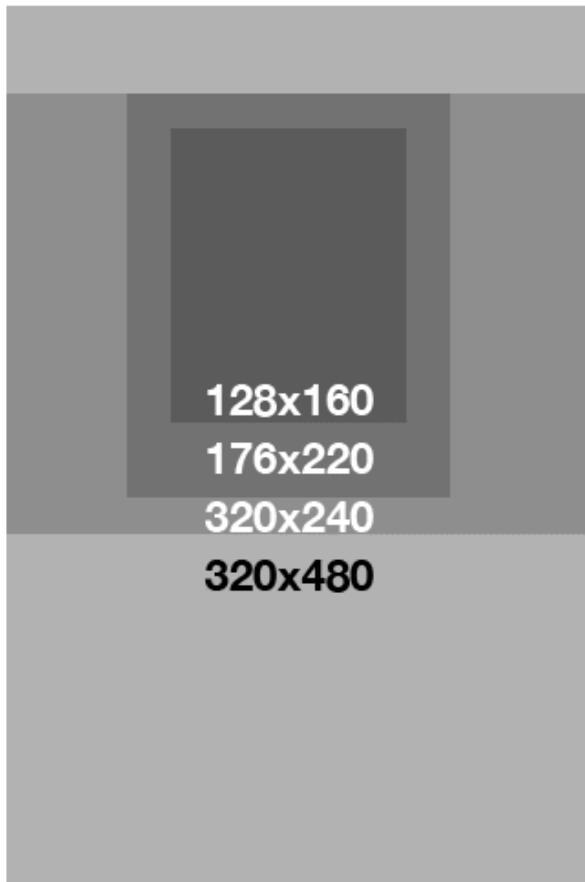
Figure 5. Suda, B. (2011). [common mobile phones categorized on the basis of screen size]. Retrieved from
http://designfestival.com/user-targeting-for-the-mobile-web/

The figure shows various mobile phone screen sizes and resolutions categorized into four categories.

Absence of certain input mechanisms. Another constraint is the absence of
certain input mechanisms, such as mice, full-sized keyboards, etc. On handheld devices,
users' hands become the main input of the device. According to Wromblewski (2010),
many standards are forming around these new gesture capabilities: tap to select, double
tap to open, press to change mode, pinch to zoom-out, spread to zoom-in, swipe to scroll,
etc.
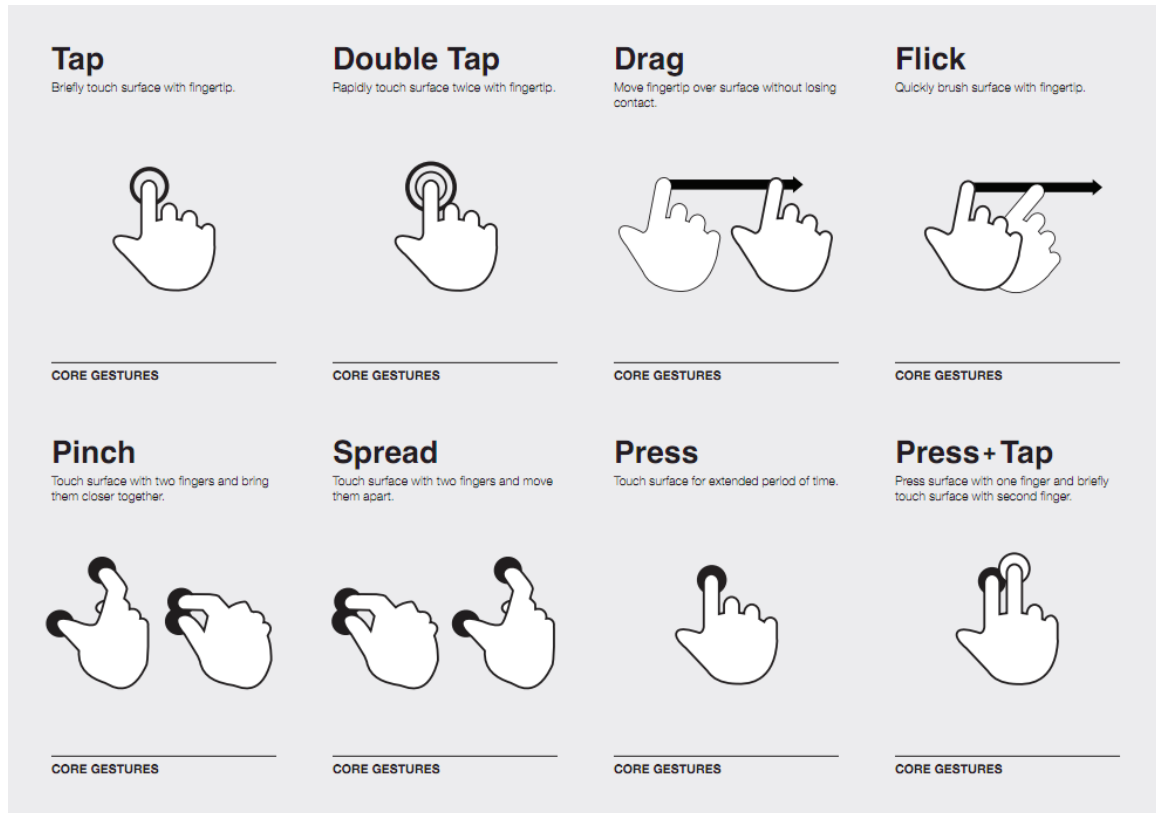
Figure 6. Wroblewski, L. (2011). *Touch gesture reference cards.* Retrieved from

http://www.lukew.com/touch/TouchGestureCards.pdf

The figure shows several examples of touch screen gestures, such as tap, double tap, drag, flick, pinch, spread, etc.

Weak network connections. Cellular network connections are still weaker and

less stable than fixed-line network. Because mobile devices transmit data at slower speed,

the weight of a website is more critical. According to Leggett (2011), even though many

mobile devices are now offering packages with much faster transfer rates, it's still

common for users to have sub-256Kbps connections. Therefore, optimizing mobile

websites to load as quickly as possible is important.

Website	Page Size	256Kbps (32KBps) Download Rate	987Kbps (123KBps) Download Rate
m.CNN.com	77.95KB	2.6 seconds	.6 seconds
mobile.Reuters.com	36KB	1.2 seconds	.3 seconds
BBC.co.uk/mobile	31.14KB	1 second	.3 seconds
m.YouTube.com	21.76KB	.7 seconds	.2 seconds
m.Facebook.com	17.4KB	.6 seconds	.1 second

Figure 7. Leggett, D. (2011). *Mobile website load times*. Retrieved from http://www.uxbooth.com/blog/considerations-for-mobile-design-part-1-speed/

This figure shows page loading time differences depending on download rates.

Mobile Web usability issues and user interaction optimization

      Mobile website usability issues. Designing mobile sites is a different kind of Web design. The constraints of mobile devices (i.e. small screen sizes, absence of certain input mechanisms, weak network connections, etc.) cause several unique usability issues. Mobile Web designers should be aware of what the mobile Web usability issues are and how different the mobile Web is from the desktop Web.

      Along with several other groups, Buchanan et al (2001) focused their work on wider usability issues of Web-like browsing on small screens. Their first step was to understand and to quantify the user impacts on conventional Web pages designed for large-screen viewing. In a user-based evaluation they found that "users of small screens were only half as successful in completing tasks than large-screen users" (Buchanan et al, 2001). They also found that "users of small screens made many more incorrect choices while navigating the Web pages and were less willing to browse deeply" (Buchanan et al,

2001).

The mobile Web is used by people on the move. For this reason, designers need to create user experiences that fit this situation. Designers should think about the type of content and services that people will need in these environments (e.g. in trains, planes, and automobiles). The mobile Web is a great place to help people find restaurants or news headlines, but it's the wrong place to make people sit down and read long articles, such as research papers. Therefore, designers need to consider how user interaction should be optimized while designing mobile websites.

Simplified navigation. A simple task for PC users can be considerably more demanding on mobile devices. For example, copying several sentences from one page to another is hard on mobile devices. Even simple navigation can become intolerable because of waiting for page loading, if the user is at a place with slower network coverage. In those situations, users will be frustrated easily by poor navigation schemes. Clear and intuitive navigation is crucial in completing tasks quickly. Therefore, the mobile Web needs to be simpler than its desktop counterpart and more task-based.

Simple Information Architecture. Designers need to make sure to get users to what they need in a fast, logical fashion. The best way to create strong mobile Information Architecture (IA) is to keep it as simple as possible. In order to structure the mobile IA, it is necessary to take the content that's relevant to a mobile user and discard the rest. According to mobiThinking (2008), content categories should be limited because users become disoriented as they navigate deeper into a Web site. The number of categories and levels of navigation should be reduced, and the most important categories should be presented first. Also, clear, concise and consistent labels for navigation should

be used across the site. A link to the full site should be located at the bottom of the mobile website homepage so users can switch over to the desktop site.

Immediate feedback. Since less computer-savvy users tend to click on a button more repeatedly trying to force it to do whatever they want to achieve, providing immediate feedback is critical in mobile web design. Todish (2011) argued that designers should design the page to provide users with some indication that the page has registered the user's interaction (e.g. a subtle color change at the tap of a button). He also argued that this will inform users that something is happening even if the screen isn't updating immediately due to slow network connection.

Prioritized content. Mobile website content needs to be prioritized for multi-tasking users on the move. Mobile device users are usually in a hurry and often access the Internet for short periods only. When choosing mobile website content, designers should focus on features which are local, mobile, and easy to complete.

Mobile devices only have little room for navigation bars and drop down menus. Mobile users are in a hurry so they will often search rather than navigate. Therefore the search box should be big and obvious and located near the top of the page.

According to Google Conversion Team (2011), users usually scan from top to bottom, scrolling with their thumb to access more information. Many mobile users scroll really quickly to the bottom of a page if they don't find what they need at the top. Therefore, it is a good idea to put important buttons at the bottom of a page, particularly when the page is very long.

Mobile web design/development tips & best practices

Related content detection and adaptive presentation. In their research paper

Efficient Web Browsing on Small Screens, Ahmadi & Kong (2008) suggested the

efficient adaptive style for mobile browsing in three steps.

Ahmadi & Kong's (2008) study suggested the following:

The first step optimizes the Web page by removing unnecessary HTML

elements (e.g. empty <div> element) and unrelated content (e.g.

advertisements). Simplifying the Web page and removing clutter can

facilitate the next step and highlight the main content. Then all the visible

HTML elements, such as images, are resized in both width and height to

fit into the small screens of handheld devices. The second step is to divide

the page into several subpages based on the screen size. The dividing

procedure splits the page in a way that all closely related content detected

in the previous phase is placed in the same subpage. Furthermore, each

subpage provides navigation links to other subpages. The last step is to

construct navigation links between different subpages. The global

navigation is set up based on navigation links and menu bars recognized in

the first phase (i.e., related content detection). Then, a table of contents is

built to provide a quick switch between different topics in the main

content.

According to Ahmadi & Kong (2008), the following heuristic rules are applied in

order to recognize the major sections of a Web page:

- If a list of hyperlinks (i.e. a menu bar) or a table including a list of hyperlinks is

  placed within the top 200 pixels of the page, it is considered to be the top section.

- If a table is placed within the lowest 150 pixels of the page, it is considered to be

the bottom section.

- If a list of hyperlinks or a table including a list of hyperlinks is placed on the left (right) side of the page, occupying up to 30 percent of the page width, and its upper boundary is below the top section and its lower bound is above the bottom section, then it is considered to be the left (right) menu section.

- The remaining area is considered to be the main content.

Horizontal and vertical scroll bars could improve interaction. However, since mobile devices usually do not have mice, they have to use direction keys, which are very inconvenient to control scroll bars. The common solution is to divide the screen into many small ones and display them respectively. In their research paper *A Constraint-based User Interface Design Method for Mobile Computing Devices*, Niu et al (2006) presented optimized adaptive Web pages of the Yahoo website. After determining the hierarchical structure of the table of contents on the Web page, they generated a good title for each subpage. Then they developed a prototype called the SSD Browser (Small Screen Devices Browser) to implement their approach. The browser allows users to customize the adaptive layouts: "(a) change the size of the display window in the browser, (b) remove or preserve dynamic objects and clutter, (c) remove or preserve the formatting style of the Web page, and (d) change font sizes to small, medium, or large" (Niu et al, 2006).
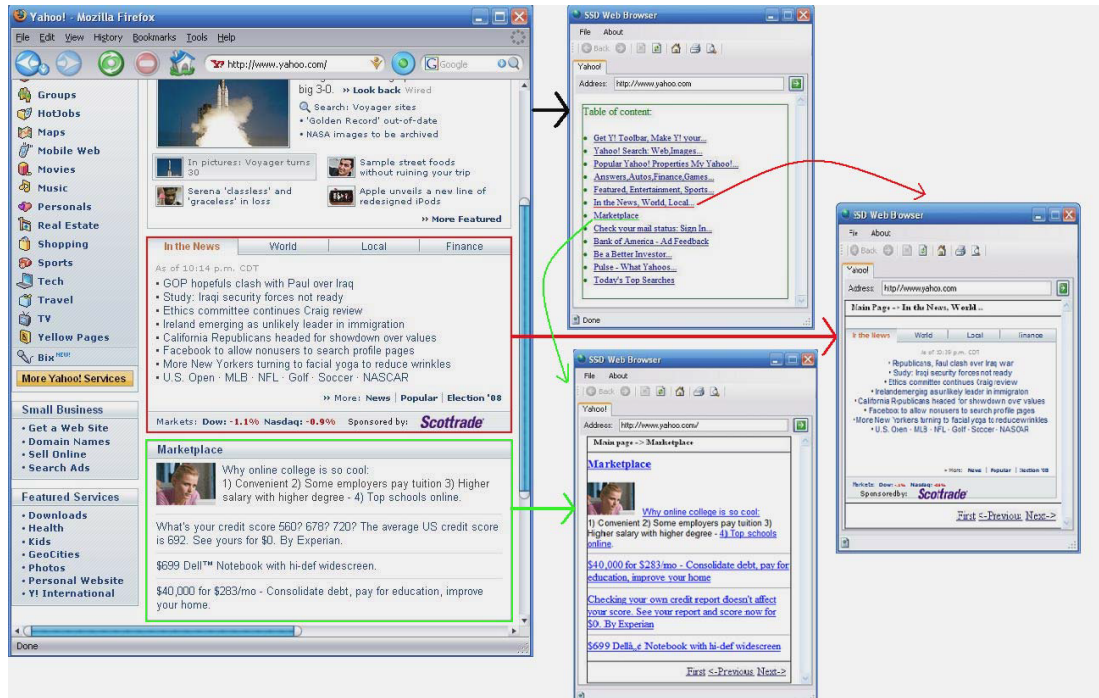
Figure 8. Ahmadi & Kong (2008). *Adaptive presentations of a Yahoo Web page.* Efficient Web Browsing on Small Screens

The figure shows how the Yahoo home page was divided into three pages on the mobile website to improve usability.

Flexible CSS layout. Mobile devices' screen sizes vary. Even though most of the recent smartphones have resolutions greater than 800x480px, older models (e.g. iPhone 3) or PDAs have lower screen resolutions (e.g. 320x240px).

According to Fling (2011), traditionally mobile Web developers have chosen fixed-width layout rather than fluid layout since fixed-width has provided more reliable rendering across devices. However, the problem with fixed-width design is that the viewable content is limited when the page is viewed on larger screens. Since the trend is moving toward larger screens, the default layout should be fluid layout.

Figure 9. Chang, E. (2010). *Smartphones: The Latest Generation*. Retrieved from

http://www.billshrink.com/blog/9032/iphone-4g-vs-evo-4g/

This figure shows smartphones' various screen sizes and resolutions. Although iPhone 4's Retina display has the highest resolution on all the phones listed above, it's also the phone with the smallest screen size (3.5 inches).

Single-column layouts. There are historical, technical reasons why mobile Web designers do not want to use a multicolumn layout on a lower-end mobile device. Typically, mobile devices with smaller screens have poor support for positioning or floats, so two columns would make the page cluttered. Also, if the user has a device with a directional pad (D-pad), then multiple columns would create an awkward scrolling pattern (Fling, 2011).

Viewport metadata. In the head element, developers put viewport metadata tag along with all the typical pieces like stylesheets, content type, title, etc. Viewport is a metadata tag needed to specify something that looks good with the content for various screen widths (e.g. 320px, 480px, 768px, and 1024px wide). It essentially auto-fits the page to the viewport and prevents zooming (Steen, 2010).

<meta name="viewport" content="width=device-width; initial-

scale=1.0; maximum-scale=1.0; user-scalable=0;"/>

For example, if a developer sets a viewport of 640px wide, and an initial-scale of

0.5, it will display normally on the iPhone (scaled 0.5x to fit 640px into 320px).

Media Query. According to Kosh (2012), developers can define special CSS

rules that are executed only if the width of the page is larger than, equal to, or smaller

than a certain size. For instance:

div.sidebar {

    width: 360px;

}

 media all and (max-width: 480px) {

    // styles assigned when width is smaller than 480px;

    div.sidebar {

      width: 120px;

    }

}

Now the sidebar is 360px wide, except when the width is smaller than 480px, in

which case the sidebar becomes 120px wide.

Image optimization. Unlimited data plans are becoming rare unfortunately. So,

designers should be sensitive to the amount of data transferred to and from the website.

There are some ways to minimize load times for faster user experiences. One way is

optimizing images for the Web. If transparency in an image is needed, PNG should be

used. On the other hand, if an image of reasonable size is needed, it should be saved as a

JPG. Somewhere in the middle, GIF files can be used. When an image is saved for the web it is generally run through a compression algorithm. Setting the quality drop-down at around 70 percent is recommended because that setting usually creates the least amount of JPG artifacts with the smallest file size (Maier, 2009).

Form interactions. While there isn't widespread support across mobile devices yet, declaring input types will be important in form design in the near future. The latest input types are outlined in the HTML5 spec, and some devices (e.g. iOS 4 and Android 2.2 devices) already have some support for them.

Mobile Web developers can configure the type of keyboard that is displayed along with several attributes of the keyboard. By setting the properties programmatically, they can make the system display the keyboard of the designated type.

A few common useful newly introduced input types are shown below:

```
<input type="text" />   <!-- Default text entry -->

<input type="email" />  <!-- Email addresses -->

<input type="url" />    <!-- URLs -->

<input type="tel" />    <!-- Telephone numbers -->
```

Apple.com's *Text, Web, and Editing Programming Guide for iOS* (Apple Inc., 2011) shows several different keyboard types configured by different attributes. According to Adobe (2011), "The default keyboard displays an alphabetical keyboard initially but the user can toggle it and display numbers and punctuation as well. Most of the other keyboards offer similar features as the default keyboard but provide additional buttons that are specially suited to particular tasks. However, the phone and numerical keyboards offer a dramatically different layout that is tailored towards numerical input".

Figure 10. Apple Inc. (2011), *Several different keyboard types from the iPhone OS.* Retrieved from

http://developer.apple.com/library/ios/#documentation/StringsTextFonts/Conceptual/TextAndWebiPhoneOS/Keyboard

Management/KeyboardManagement.html#//apple_ref/doc/uid/TP40009542-CH5-SW3

This figure displays the default keyboard along with several other keyboard configurations.

Design trends

White space. White space is referred to the space between different design

elements, such as text, paragraphs, images, links and footers, etc. White space is a must

for any good Web design. Too much visual clutter can be distracting and frustrating

because it is too difficult to click on the link. White space makes it easier to navigate

mobile websites. It also reduces the amount of text that a visitor is required to scan at

once. Visual separation of different designing elements can be done effectively by using

white space. A number of current mobile websites include plenty of white space that is

very helpful and easy to use (Peterson, 2011).

Simplicity. Complicated mobile websites are clumsy and difficult to navigate. For

this reason, functional and minimalist layouts are more prominent in

current mobile website design. With a small section of the whole navigational choices, these scaled-down versions make the Internet experience much more accessible to mobile Web users, who are more time-constrained than ever (Marqui, 2011).

Prioritized content. The content plays an important role because the visitors are deeply interested in it. The plain pages and the simple options make it easy for the users to go through the content. Even though the banner advertisements are now universally accepted by the Internet industry, the mobile websites are free of advertisements. The common users who regularly visit the mobile website pay great attention to the content material (In, 2011).

jQuery/CSS3/HTML5. The growing popularity of HTML5 and CSS3 has played a critical role in expanding the realm of Web design possibilities. While CSS3 mass adoption is still a little ways off, some designers have already started using some of the great new features. New CSS3 properties from rounded corner, box shadow, glow effects, @font-face, and more have started appearing suddenly all over the place. Recent advances in the jQuery library and CSS3 specifications allow for excellent effects with ease than ever before. jQuery is the major frontend browser effects but doesn't contain 100 percent major support. Therefore, a fallback method should be used to make the website compatible with most of the visitors (Rocheleau, 2011).

Use of icons and circles. Many of the current mobile websites are being built for fingertip navigation. Mobile website designers have used the mobile app layout on the mobile websites and adapted menu items into buttons or icons similar to those used in mobile apps. Also, circular shapes that are smooth and encourage eye contact from the visitors have become more popular (Rocheleau, 2011).

Social networks integration. These days, social networks are an important channel for business organizations to expand reach on their mobile websites and apps. Since the nature of mobile usage is extremely social, lots of mobile websites are incorporating links to all their social media channels (Marqui, 2011).

Summary

As the number of Smartphone users is growing, web browsing from mobile devices is getting more popular. Mobile devices aren't just gadgets: they're becoming extensions of ourselves. In mobile web design, several constraints of mobile devices need to be taken into consideration. The most obvious constraint is screen size. Mobile screens are smaller than those of desktop, so they can display a limited number of characters. Therefore, content should be optimized for these smaller screen sizes.

Another constraint is the absence of certain input mechanisms, such as mouse, full-sized keyboard, etc. Mobile website screens should be divided into many small ones and displayed on demand in order to remove the scroll bars, which are inconvenient to the mobile web users. Cellular network connections are still weaker and less stable than fixed-line network. Therefore, mobile websites should be optimized to load pages as quickly as possible.

The mobile Web is used by people on the move, so designers need to create user experiences that fit this situation. Because of the slow network connection, users can be frustrated by poor navigation schemes. Therefore, the mobile Web needs to be simpler than its desktop counterpart and more task-based. Simple content and limited categories are necessary for a strong mobile Information Architecture. Providing some indication that the page has registered the user's interaction is critical because it informs users that

something is happening even if the screen isn't updating immediately due to slow network traffic.

The first step to create mobile website is optimizing and simplifying the Web page by removing unnecessary HTML elements, dividing the page into several subpages based on the screen size, and constructing navigation links between different subpages. Then designers should design and develop the pages using various techniques related to the mobile Web development, such as viewport metadata, media query, flexible CSS, etc.

Current mobile Web design trends should be reflected when designing the JHU APL mobile Web in order to make it attractive to the young professionals who visit the website. Visual separation of different design elements can be done effectively by using white space appropriately, and it will make it easier to navigate mobile websites. Functional and minimalist layouts are more prominent in current mobile website design. Using CSS3/HTML5 properties is getting more popular, and the available jQuery library allows for outstanding effects with more ease than ever before. Icons or circular shapes similar to those used in mobile apps are popular for the mobile menu items. Since the nature of mobile usage is extremely social, JHU APL's mobile website should incorporate links to all its social media channels.

Usability Test Report

Overview

Usability test is a test of a web site in which a user conducts tasks while being observed and recorded by a usability expert. A detailed testing protocol has been developed so that a facilitator can use to conduct each test. Open-ended questions were

asked during the usability testing, and the vocalized thoughts of the test participants through the test were recorded and noted by the facilitator. By watching how they are actually doing the task, a pattern of task failures was identified through the usability testing, and subsequent improvements were recommended.

Methodology

What happened during the usability test. The usability evaluation of the APL mobile website was conducted by the APL external website usability team in March 2012.

During the usability evaluation, five participants, matching the user profile(s), were asked to spend thirty minutes with the site. During this time, participants:

- Completed a user background questionnaire

- Performed real-world tasks on the site while thinking aloud

- Answered questions about their overall satisfaction

- Made suggestions for improvements

Who we tested. Five participants, having the following profile characteristics, evaluated the APL mobile website. Participants consist of male and female professionals who are in the age range of 30-45 years old. Three out of the five testers were APL employees who don't visit APL external website frequently. Two testers were non-APL employees who never visited APL website before.

Audience Type		Mobile Device	
Technical professional	1	iOS-based	1
Non-technical professional	4	Android-based	4
TOTAL (participants)	**5**	**TOTAL (participants)**	**5**

Age			Gender		
30-35	3		Female	3	
36-40	1		Male	2	
41-45	1		**TOTAL (participants)**	**5**	
TOTAL (participants)	**5**				

What participants did. During the usability evaluation, participants were asked to complete seven (7) scenarios or "real-life" tasks on the site. The following tasks were identified from user data collection efforts and assistance from the project team.

#	Task
1	You've heard that APL is one of the best places to work in the Baltimore area, so now you'd like to find out general information about the Laboratory (i.e., who they are, what they do, size of the company, etc.). How would you find this information?
2	You want to know more about what kind of business areas APL is involved in because you may want to apply for a job. Let me watch what you would do.
3	You want to see if there are any job openings available for you. Let me watch what you would do.
4	Let's say that the most recent job posting is of interest to you. Now you want to get more information about the job posting and email it to yourself so you can fill out the online application on the full website later. How would you do that?
5	You would like APL to send you e-mail notifications when new job openings are posted. Let me watch what you would do.
6	You have an appointment on APL's main campus and you don't know how to get there. Let me watch what you would do.
7	Someone told you that an interesting news article about APL's revolutionary prosthetic arm was posted on CNN's website. How would you find this information?

Where we tested. Following is a summary of the participants' computing environment:

URL of tested website:	http://www.henryihm.com/apl_mobile/ (1st round) http://www.henryihm.com/apl_mobile2/ (2nd round)
Computer platforms:	Smartphones (iPhone & Droid phones)
Browser tested:	Safari mobile & Chrome mobile
Screen resolution:	Various (640 x 960, 480 x 800, etc.)
Operating system:	iOS & Android
Connection speed:	3G network & Wi-Fi
Testing room:	TST group conference room & Henry's home
Video equipment:	Sony NEX-5 with 18-55 mm zoom lens (1080p)

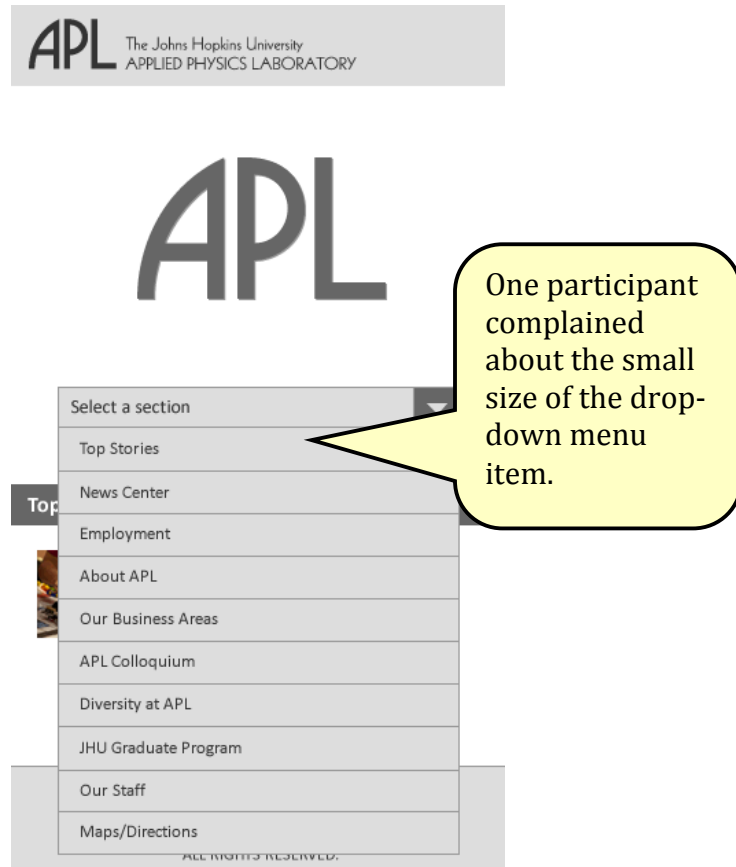**Findings & Recommendations**

Task #1   You've heard that APL is one of the best places to work in the Baltimore area, so now you'd like to find out general information about the Laboratory (i.e., who they are, what they do, size of the company, etc.). How would you find this information?

Number of participants	5
% successful	100%

Usability Findings	• Size of the drop-down menu item

Supporting Evidence	Recommendations/Comments
"The only thing I would suggest is having larger area to push for the menu options."	Each drop-down menu option needs to be bigger so users can push the target item with a finger without errors. Also, the drop-down menu needs to be located at the top of the home page so users can view all of the menu items without scrolling down the page.

Task #3

You want to see if there are any job openings available for you. Let me watch what you would do.

Number of participants	5
% successful	80%

Usability Findings	• Job postings are not organized by categories • Job search box is needed because users might want to search jobs by keywords

Latest Job Postings

02-24-12 Oracle Database Administrator
Professional - Technical Experienced
(Exempt)

One participant suggested a search box for the job postings.

02-10-12 Supervisor Radar System Engineering Section
(A2A)
Professional - Technical Experienced (Exempt)

02-07-12 Network Architect
Professional - Technical Experienced
(Exempt)

One participant suggested categorization of the job postings.

02-06-12 Missile Systems Engineer
Professional - Technical Experienced
(Exempt)

01-30-12 Cyber Situational Awareness Implementati...
Lead
Professional - Technical Experienced (Exempt)

Supporting Evidence	**Recommendations/Comments**
"...probably by type of work, so when you click on Employment, there will be options of type of work."	'Latest job postings' needs to be organized into different types.
"I want to be able to see more…", "...as a way to SEARCH for the latest jobs postings"	'Latest job search' field needs to be incorporated. Instead of presenting a list of different types of job postings, incorporating a job search box will be more useful and efficient on the mobile website.

Task #4	Let's say that the most recent job posting is of interest to you. Now you want to get more information about the job posting and email it to yourself so you can fill out the online application on the full website later. How would you do that?

Number of participants	5
% successful	100%

Usability Findings	• Users can't find the Email button without scrolling all the way down to the bottom of the page • Labeling for Email button is unclear

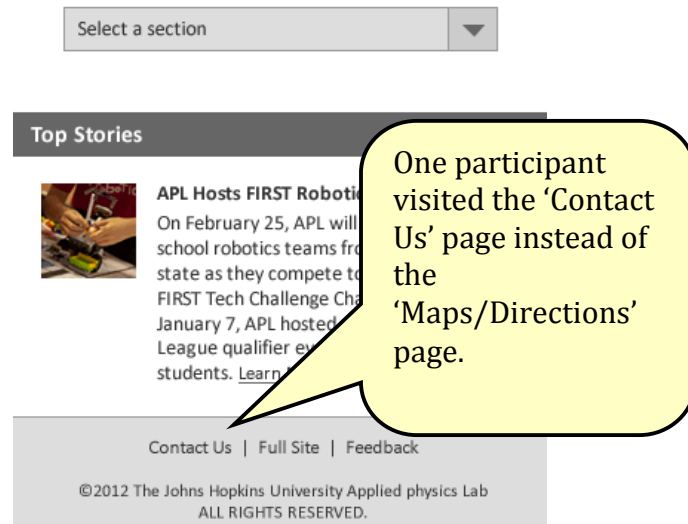| Supporting Evidence	Recommendations/Comments
"I'm not sure what the 'Email' button is used for."	Better labeling for the 'Email' button is required (e.g. 'Send Email').

Task #6   You have an appointment on APL's main campus and you don't know how to get there. Let me watch what you would do.

Number of participants	5
% successful	80%

Usability Findings • 'Contact Us' page and 'Maps/Directions' page are overlapping

Select a section ▼

Top Stories

APL Hosts FIRST Roboti
On February 25, APL will
school robotics teams fr
state as they compete t
FIRST Tech Challenge Ch
January 7, APL hosted
League qualifier e
students. Learn

One participant visited the 'Contact Us' page instead of the 'Maps/Directions' page.

Contact Us | Full Site | Feedback

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ALL RIGHTS RESERVED.

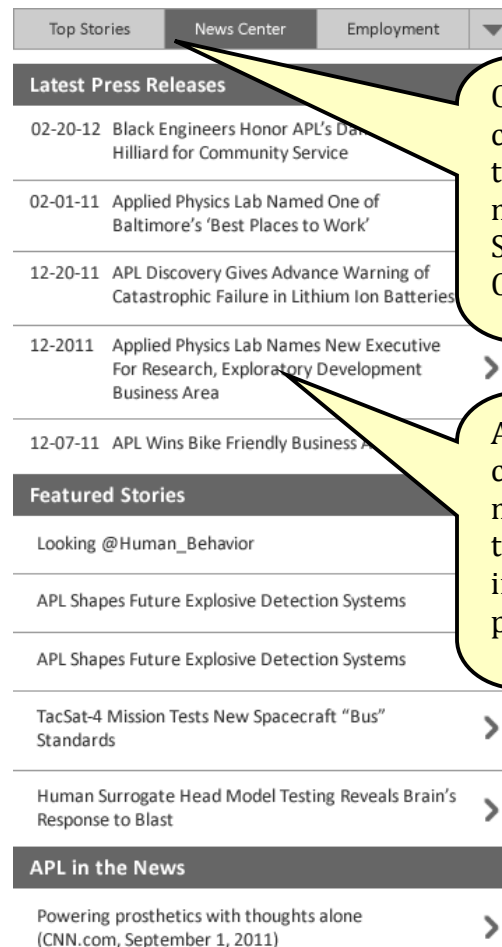| Supporting Evidence	Recommendations/Comments
"Let's see… sometimes it's here." (One of the participants said this while in pushing Contact Us link.)	'Contact Us' and 'Maps/Directions' pages need be merged into one. 'Maps/Directions' shouldn't be a main menu option and can be part of 'Contact Us' page.
"I think I just missed… (the Maps/Directions menu item). It was because I wasn't aware that I could scroll down and see other options."	The drop-down menu on the home page should be moved to the top of the page so users can view all of the menu options without scrolling down the page.

Task #7   Someone told you that an interesting news article about APL's revolutionary prosthetic arm was posted on CNN's website. How would you find this information?

Number of participants	5
% successful	60%

Usability Findings
• Labeling issues on 'Top Stories' and 'News Center' – not sure on which page the news article can be found.
• Too many sub-sections and too much text information on the 'News Center' page.

Supporting Evidence	Recommendations/Comments
"…or have something like Coverflow that's in iTunes where they have images…"	Thumbnail images that represent news titles can be more efficient (an interactive jQuery picture gallery plug-in can be implemented).

Other Usability Findings

Usability Findings	Recommendations/Comments
The APL logo at the top of the page was supposed to be used as a button to go to the home page, but none of the participants used it.	Put an icon for Home button at the top right of each page.

|	
Some participants tried to push the sub title bar to go back to the main page of the section.	Use the sub title bar as a button to go the section's main page as needed.

Revisions & Test results

Task #1	You've heard that APL is one of the best places to work in the Baltimore area, so now you'd like to find out general information about the Laboratory (i.e., who they are, what they do, size of the company, etc.). How would you find this information?

Revisions made	• Relocation of the drop-down menu • Enlarged drop-down menu items • Reorganized drop-down menu
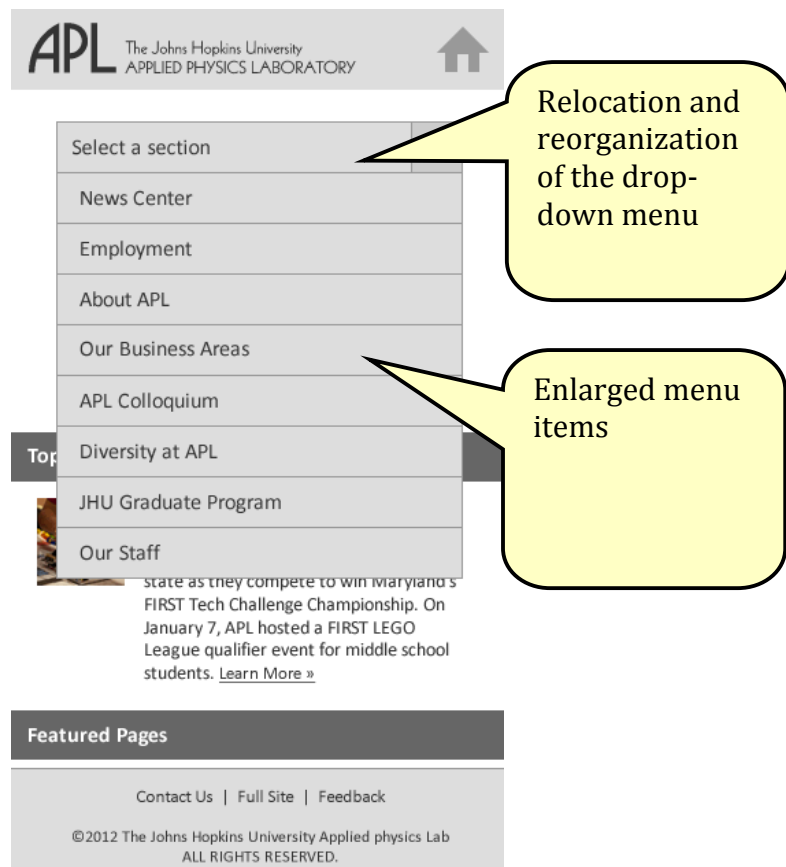
Supporting Evidence	**Recommendations/Comments**
"Now I can see all of the menu items, which is very good."	• None

Task #3	You want to see if there are any job openings available for you. Let me watch what you would do.

Revisions made	• Job search box has been added. • 'Latest Job Postings' has been changed to 'Featured Jobs'. • 'Benefits' section has been removed from the page.

Supporting Evidence	**Recommendations/Comments**
"I like that there is a 'Search by keyword' box at the very top – this is what most people use, I think." *"The changes made it easier to find job postings."*	• None

Task #4	Let's say that the most recent job posting is of interest to you. Now you want to get more information about the job posting and email it to yourself so you can fill out the online application on the full website later. How would you do that?

Revisions made	• Labeling for Email button has been changed to 'Send Email'.

Supporting Evidence	Recommendations/Comments
"I think using 'Send Email' as the button label makes it more clear."	• None

Task #6	You have an appointment on APL's main campus and you don't know how to get there. Let me watch what you would do.

Revisions made   • 'Maps/Directions' page has been merged with 'Contact Us' page.

> 'Maps/Directions' section has been added to the 'Contact Us' page.
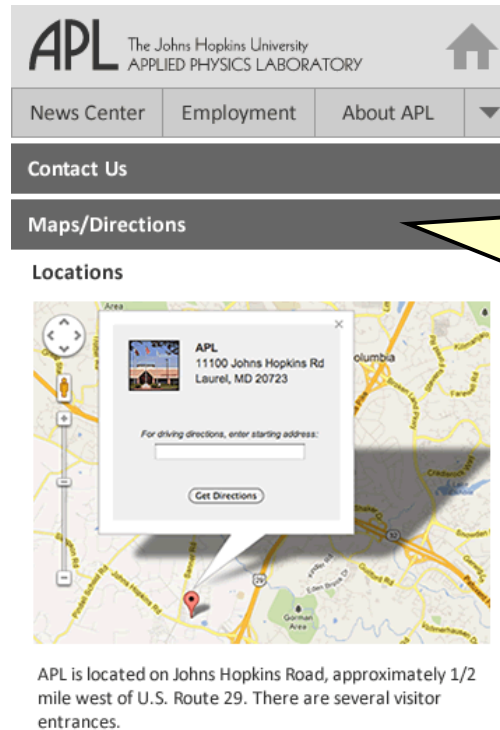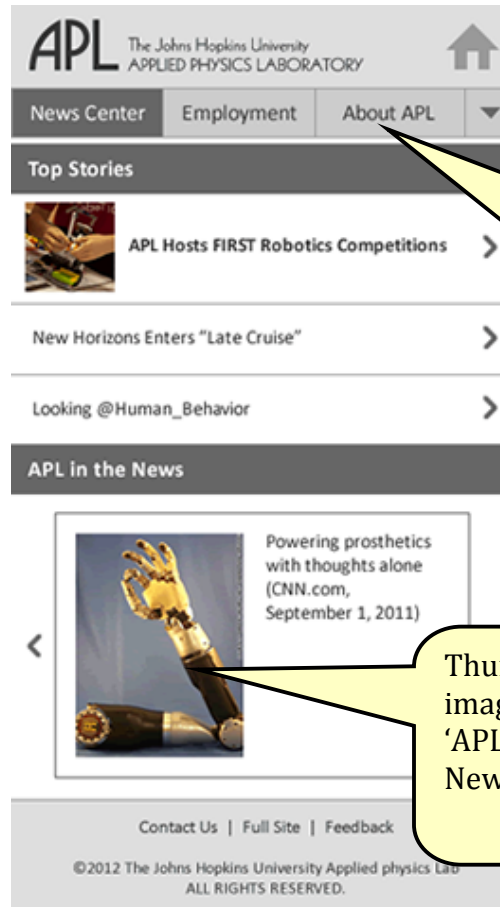
Supporting Evidence	Recommendations/Comments
"The Directions are now where I'd expect them to be – with the contact info."	• Make the map visible on load – people are quicker to notice that.

Task #7   Someone told you that an interesting news article about APL's revolutionary prosthetic arm was posted on CNN's website. How would you find this information?

Revisions made	• 'Top Stories' main menu has been removed, and 'About APL' menu has been added. • 'Latest Press Releases' section on the 'News Center' page has been removed. • Thumbnail image has been added to the 'APL in the News' section.

Supporting Evidence	Recommendations/Comments
"It's easy to find!" *"I found the visual search made it easier to identify the news article."*	• Users should be able to "Swipe" between 'APL in the News' articles. • Use thumbnail images on all of the 'Top Stories'.

Conclusion

The usability evaluation of the APL mobile website was conducted by the APL external website usability team in March 2012. During the usability evaluation, five participants were asked to complete a user background questionnaire, perform real-world tasks on the site while thinking aloud, answer questions about their overall satisfaction, and make suggestions for improvements.

Several usability issues have been found during the first round of usability testing. Some participants found that size of the drop-down menu item is too small, the search box on the job posting page is missing, the labeling for Email button is unclear, the 'Contact Us' page and 'Maps/Directions' page are overlapping, too many sub-sections and too much text information are on the 'News Center' page, etc. Also, the APL logo at the top of the page was supposed to be used as a button to go to the home page, but none of the participants used it. On the second round of the usability testing, participants found that most of the issues had been resolved. However, one participant commented that users should be able to "Swipe" between 'APL in the News' articles, and this change will be implemented if possible before the site is released.

It is important to understand the problems visitors encounter navigating on smaller screens. The most common difficulty with viewing web pages on a smartphone is selecting small text links accurately. Fingers are too thick to hit a small link accurately, so it's easy to accidentally tap the wrong link if there are two or more links close together. Therefore, some padding around links should be added to make the clickable area large enough. Lengthy text can be hard to read so lengthy text may need to be divided into several pages. Showing only the major news section on the main page and breaking the

news articles into small portions are recommended. User behaviors including the preference for 'swiping' through content are increasingly conventional on touch-screen smartphones. Implementing jQuery-based image gallery plug-ins that offer nice 'swiping' mobile browsing features is recommended.

As smartphone use increases it is becomes ever more important to develop an effective user experience on mobile devices. Mobile web is different from standard web so there are some different usability issues that people face when interacting with a mobile website. Extra attention must be paid to page load speeds, access, usage, etc. This paper presented research on various mobile Web usability issues, user behaviors and interactions, etc. and recommendations to improve usability on the mobile Web, such as simplified navigation and information architecture, prioritized content, etc. Once a wireframe version had been created based on research into industry best practices, the usability of this wireframe was evaluated through two rounds of usability testing. The revisions on the wireframe and the testing results show that the recommendations for usability improvement were effective.

References

ABI Research (2011). Mobile Social Networks Are the Biggest Smartphone Use Next to

    Email: ABI Research Technology Barometer[TM] Finding. Retrieved from

    http://www.businesswire.com/news/home/20110715005775/en/Mobile-Social-

    Networks-Biggest-Smartphone-Email-ABI

Adobe (2010). Adobe Mobile Experience Survey: What Users Want from Media,

    Finance, Travel & Shopping. Retrieved from

    http://www.keynote.com/docs/news/AdobeScene7_MobileConsumerSurvey.pdf

Ahmadi, H. & Kong, J. (2008) Efficient Web Browsing on Small Screens. *AVI*

    '08: Proceedings of the working conference on Advanced visual interfaces

Buchanan, G., et al. (2001). Improving Mobile Internet Usability. *Proceedings of the 10th*

    international conference on World Wide Web

Chang, E. (2010). *Smartphones: The Latest Generation*. Retrieved from

    http://www.billshrink.com/blog/9032/iphone-4g-vs-evo-4g/

Engadget.com (2011). Android leads US market share, iOS may have stopped growing, RIM is

    still falling. Retrieved from http://www.engadget.com/2011/12/14/shocker-android-

    grew-us-market-share-after-q2-ios-was-static/

Fling, B. (2011). Mobile Web Development: Chapter 11 - Mobile Design and

    Development. Retrieved from

    http://oreilly.com/iphone/excerpts/iphone-mobile-design-development/mobile-

    web-development.html

Google Conversion Team (2011). Part 1: Mobile Website Optimization - 5

    Considerations when Prioritizing Content. Retrieved from

http://conversionroom.blogspot.com/2011/03/part-1-mobile-website-optimisation-5.html

International Telecommunication Union (2011). Key Global Telecom Indicators for the World Telecommunication Service Sector. Retrieved from http://www.itu.int/ITU-D/ict/statistics/at_glance/KeyTelecom.html

In, A. (2011). Mobile Web Design Trends and Best Practices. Retrieved from http://designmodo.com/mobile-web-design-trends/

iOS Developer Library (2011). Text, Web, and Editing Programming Guide for iOS. Retrieved from http://developer.apple.com/library/ios/#documentation/StringsTextFonts/Conceptual/TextAndWebiPhoneOS/KeyboardManagement/KeyboardManagement.html#//apple_ref/doc/uid/TP40009542-CH5-SW3

Kosh, P. (2012). A tale of two viewports. Retrieved from http://www.quirksmode.org/mobile/viewports.html

Lasar, M. (2011) World mobile data traffic to explode by factor of 26 by 2015. Retrieved from http://arstechnica.com/tech-policy/news/2011/03/world-mobile-data-traffic-to-explode-by-factor-of-26-by-2015.ars

Leggett, D. (2011). Considerations for Mobile Design (Part 1): Speed. Retrieved from http://www.uxbooth.com/blog/considerations-for-mobile-design-part-1-speed/

Leggett, D. (2011). Considerations for Mobile Design (Part 2): Dimensions. Retrieved from http://www.uxbooth.com/blog/considerations-for-mobile-design-part-2-dimensions/

Leggett, D. (2011). Considerations for Mobile Design (Part 3): Behavior. Retrieved from

http://www.uxbooth.com/blog/considerations-for-mobile-design-part-3-behavior/

Lunden, I. (2012). Report: Video Accounts For Half Of All Mobile Traffic; Android

Biggest For Mobile Ads.

 Retrieved from http://techcrunch.com/2012/02/22/report-video-accounts-for-half-

of-all-mobile-traffic-android-biggest-for-mobile-ads/

Maier, A. (2009). How-to Minimize Load Time for Fast User Experiences. Retrieved

from http://www.uxbooth.com/blog/how-to-minimize-load-time-for-fast-user-

experiences/

Marqui (2011). Top Mobile Website Design Trends for 2012. Retrieved from

http://www.marqui.com/blog/top-mobile-website-design-trends-for-2011.aspx

mobiThinking (2011). Global mobile statistics 2012: all quality mobile marketing

research, mobile Web stats, subscribers, ad revenue, usage, trends… Retrieved

from http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats

mobiThinking (2010). 5.3bn mobile subscribers; nearly 1bn with high-speed mobile Web

access: an interview with ITU statistics chief Susan Teltscher .Retrieved from

http://mobithinking.com/interview-susan-teltscher-itu

mobiThinking (2008) A Three Step Guide to Usability on the Mobile Web. Retrieved

from **http://mobithinking.com/best-practices/a-three-step-guide-

usability-mobile-web**

Niu, Y., Li, X., Meng, X., Sun, J., and Dong, H. (2006). A Constraint-based User

Interface Design Method for Mobile Computing Devices. *2006 1st International

Symposium on Pervasive Computing and Applications*

Pen Lab Review (1996). NetHopper 2.0. Retrieved from

http://www.pencomputing.com/archive/PCM_11/nethopper.html

Peterson, R. (2011). Reasons Why White Spaces are Good in Web Designing. Retrieved

from http://designmodo.com/white-spaces-web-design/

Rocheleau, J. (2011). Web Design Trends in 2012. Retrieved from

http://webdesignledger.com/tips/web-design-trends-in-2012

Spike, J. (2011). *Nielsen publishes report on smartphone usage that shows Android OS

ahead*. Retrieved from

http://www.broadbandexpert.com/blog/smartphones/nielsen-publishes-report-on-

smartphone-usage-that-shows-android-os-ahead/

Steen, B. (2010). Flexible, Mobile-First Layouts with CSS3. Retrieved from

http://net.tutsplus.com/tutorials/html-css-techniques/flexible-mobile-first-layouts-

with-css3/

Suda, B. (2011). How to Enhance Your User Targeting for the Mobile Web. Retrieved

from http://designfestival.com/user-targeting-for-the-mobile-web/

Titlow , J. P. (2011). Most Adults Under 35 Own a Smartphone. Retrieved from

http://www.readwriteweb.com/archives/most_adults_under_35_own_a_smartpho

ne.php

Todish, T. (2011). Not Your Parent's Mobile Phone: UX Design Guidelines For

Smartphones. Retrieved from

http://uxdesign.smashingmagazine.com/2011/10/06/not-your-parents-mobile-

phone-ux-design-guidelines-smartphones/

Wagner, A. (2012). Number of U.S. Smartphone Subscribers Surpasses 100 Million,

     Says comScore. Retrieved from http://www.phonedog.com/2012/03/08/number-

     of-u-s-smartphone-subscribers-surpasses-100-million-says-comscore/

Wromblewski, L. (2010). Touch Gesture Reference Guide. Retrieved from

     http://www.lukew.com/touch/TouchGestureGuide.pdf

Appendices

Informed Consent Statement

INTRODUCTION

Technical Services Group at the Johns Hopkins University Applied Physics Laboratory supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the Johns Hopkins University Applied Physics Laboratory.

PURPOSE OF THE STUDY

The purpose of this study is to examine the user interaction on mobile devices and to suggest methodologies to improve APL mobile website in terms of information architecture.

PROCEDURES

The test facilitator will instruct and observe users performing fairly simple, common tasks. Facilitators will verbally lead you through the series of questions, encouraging you to think out loud and respond to what you are looking at, and ask questions about your thought processes and decisions as you work. You will be asked to perform total of seven tasks. It will take approximately 15 minutes to complete the tasks.

The testing procedures will be videotaped. The video tape will be used by the researchers only.

POTENTIAL BENEFITS FROM THIS STUDY

This project will provide no direct benefit to individual participants, but the process may provide benefits to the community. You will be contributing to knowledge about user experiences and behaviors on mobile devices.

POTENTIAL RISKS

No risks or discomforts are anticipated from taking part in this study.

PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher(s) will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless required by law or you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the Johns Hopkins University Applied Physics Laboratory or to participate in any programs or events of the Johns Hopkins University Applied Physics Laboratory. However, if you refuse to sign, you cannot participate in this study.

CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: Henry Ihm, The Johns Hopkins University Applied Physics Lab, 11100 Johns Hopkins Road, Laurel, Maryland.

If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher(s) listed at the end of this consent form.

PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (443) 778-2437, write the Technical Services Group (TST), The Johns Hopkins University Applied Physics Laboratory,11100 Johns Hopkins Road, Laurel, Maryland, or email Henry.Ihm@jhuapl.edu.

_____   _____

Type/Print Participant's Name   Date

_____

Participant's Signature

Researcher Contact Information:

Henry Ihm

Web and Multimedia Designer

The Johns Hopkins University Applied Physics Laboratory

11100 Johns Hopkins Road, Laurel, Maryland

443-778-2437

User Background Questionnaire

Name: _____   Tester ID: _____

Age: 30-35 ( ), 36-40 ( ), 41-45 ( )

Sex: Male ( ), Female ( )

Occupation: _____

Mobile device: iOS-based ( ), Android-based ( )