ASSESSING TWO APPROACHES TO A WAY FINDING TASK USING A MOBILE DEVICE

Daniel Armich, Joaquin Vila-Ruiz, James R. Carter, and Billy B. L. Lim

Illinois State University, Normal, IL USA Tel: (309) 438.8338
E-mail: dmarmic@ilstu.edu, javila@ilstu.edu, jrcarter@ilstu.edu, bllim@ilstu.edu

ABSTRACT

The main objective of this research was to investigate how efficiently users interpret lean and rich messages presented on a mobile device. In order to achieve this objective, a controlled experiment was conducted using a convenience sample taken from students at Illinois State University. The subjects were randomly assigned to a control or to an experimental group and were asked to perform a series of wayfinding tasks using a mobile device. The groups were given lean (text-based) and rich (map-based) messages respectively. Data was collected to measure how efficiently the wayfinding tasks were performed by the groups. Statistical analysis revealed that there was no difference of efficient navigation task accomplishment between the control and the experimental groups as measured by the total time to complete the wayfinding tasks.

THE PROBLEM

The main objective of this research is to investigate how efficiently users interpret lean and rich messages presented on a mobile device. Through research of computer mediated communication and Information Richness Theory, the author determined that some mobile devices have the technological capability to communicate both rich and lean tasks. Specifically, the author refers to state-of-the-art Pocket PCs capable of displaying full-color graphical user interfaces (GUI).

Information Richness Theory attempts to classify different types of communication mediums and messages along a continuum from lean to rich (Daft & Lengel, 1986; Daft, Lengel, & Klebe-Trevino, 1987). Furthermore, Information Richness Theory suggests that matching medium type to message type will affect communication effectiveness and efficiency. Efficiency is the defined here as producing a decisive impact in a given amount of time.

Message and medium richness is defined by the level of each richness factor it contains. Thus, rich messages and mediums contain greater amounts of the richness factors defined by Daft and Lengel (1986), which are multiplicity of cues, immediacy of feedback, personal focus of the message, and language variety. Therefore, a rich medium helps users to understand the meaning of a message by providing a greater amount of one or more of the four richness factors. Examples of rich channels are face to face communication and telephone conversations. On the other hand, lean mediums are best for transferring simple messages, such as data sets. Examples of lean channels are unaddressed written letters, signs, and tables of data (Daft & Lengel, 1986).

New Media is a rather broad category of media channels that includes computer mediated communication, video mediated communication, mobile devices (including Smart Phones and Pocket PCs among others), and computer software / hardware combinations that facilitate communication. New media are an extension of traditional forms of communication such as written letters, face to face communication, and phone conversations. Most new media choices have an equivalent "old" media choice. Email is similar to an addressed letter. Video conferencing is similar to face to face communication.

"Mobile cartography deals with theories, methods, and technologies of dynamic visualization and mobile usage of spatio-temporal information as well as the adaptation to this mobile usage" (Reichenbacher, 2002). Mobile cartography is strongly tied to computer hardware and software.

Because mobile cartography involves the utilization of wireless devices, the device is the largest drawback in this communication paradigm. Device drawbacks include the size, weight, power supply, network connection bandwidth

(introducing message latency), and screen size and resolution (Reichenbacher, 2001; Clarke, 2001). These drawbacks are mainly focused on the device and less with the software or the user interface of the software. In the very near future, the hardware will not be the limiting factor of mobile cartography.

Even though there are multiple hardware restrictions imposed on mobile maps, possible solutions are being rapidly developed. 3G and 4G wireless networks solve some bandwidth usage problems (Reichenbacher, 2002). More recent mobile devices have displays with higher resolution and a larger viewable area than those only a few years ago.

One possible solution to hardware problems is a software solution. Scalable Vector Graphics (SVG) is an excellent solution for mobile device screen size and resolution limitations. SVG has a small file size, searchable text, is non-static, linkable, and has a wealth of other attributes that make it adaptable to mobile development (Reichenbacher, 2002). SVG is also an open standard, which makes developing applications for mobile navigation that work with multiple devices easier.

Mobile Devices Can Be Rich Mediums

Mobile devices are the conduits of many complex communication interactions. Mobile devices have the capacity to communicate rich messages in some contexts. These devices are adapting to richness demands through multi-modal technology and adaptations of software.

New media are defined as having a set of characteristics including new ways of representing the world, new relationships between subjects and media technologies, and other means of representing "old" media (Lister, Dovey, Giddings, Grant & Kelly, 2003). Since Information Richness Theory did not address new media, this study attempts to clarify the relationship between Information Richness Theory and new media. Mobile devices such as Pocket PCs, PDAs, and Tablet PCs use a variety of techniques to mimic traditional ways of communicating.

Technology makes mobile devices suited as a rich medium by providing each of the four richness factors (multiplicity of cues, immediacy of feedback, personal focus of the message, and language variety) through standard features or add-on modules. For example, immediacy of feedback is supported by wireless networks and real time applications. Email is another technology that is classified as a lean medium but used as a rich medium. Email can be sent and received at any location and replied to immediately. In addition, Markus (1994) and Sproull and Kiesler (1986) both explain that email enables users to build personal focus in their messages.

The context of use is an important factor determining the richness capacity of a medium. Although email is used as a lean medium in some organizations, in others, email is a staple of rich communication (Markus, 1994; Kydd & Ferry, 1995; Wilson & Zigurs, 2001). Markus (1994) performed a case study showing that the right context created an environment where email became a rich medium. In her case study, she found that when managers promoted email usage while discouraging phone usage, email was adapted for richer communication.

RESEARCH TOOLS

Design

The tools used in this research are based on a method of mobile cartography where the application and data files needed to run the application reside on the device (Vita, Pirras & Sanna, 2003). There are two versions of the tool representing rich messages and lean messages, the text-based (lean) navigation application and the map-based (rich) navigation application. Both tools have the same basic design; they create and display route information that the participant follows to find the answers to a series of wayfinding task questions. Participants interact with both rich and lean interfaces by using a stylus. A book metaphor, where the user can navigate linearly through pages of a book, is the basis for the interface of both tools. Linear navigation is accomplished by means of "Next Task" and "Previous Task" buttons, allowing the user to navigate one task forward or one task backwards per click of the button.

The navigation applications were developed to transmit distinctly rich or lean wayfinding directions to the participants. The reasons the text application is the lean version of the navigation instructions are because there are fewer cues than

the map-based navigation application, less feedback than the map-based navigation application, no personal focus, and little language variety (See Figure 2). This design conforms to the richness factors of a lean message proposed by Daft, Lengel and Klebe-Trevino (1987) and is also similar to another lean medium, the bulletin.

On the other hand, the map-based application design is rich primarily because it provides more cues to the user, but also because there are elements of feedback incorporated into the design of the map-based application (See Figure 1). Even though there was no personal focus or language variety in the map-based navigation application, there were multiple cues represented by color coded start and end points, navigation paths, and landmarks on each static map image. Feedback was incorporated in the form of a zoom-in feature and the "Task?" button. The zoom-in feature and the "Task?" button provide the user with feedback about the wayfinding task. Neither of these features was included in the lean navigation application.

Implementation

The navigation applications were designed using Visual Basic.NET. Each application was designed for use on a Pocket PC and was thus developed for use with WinCE by utilizing Visual Studio.NET's compact framework. The Pocket PC is a HP IPAQ 5550 with a 3.8 inch color TFT (thin-film transistor) display.

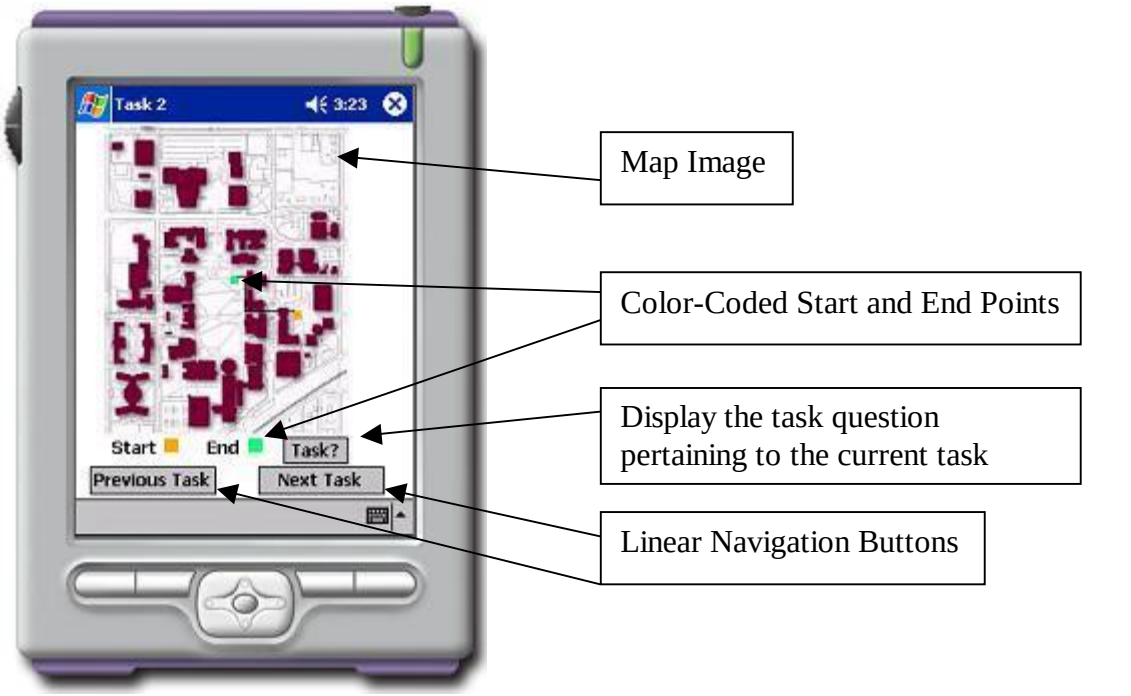
METHOD

This study was conducted in the School of Information Technology at Illinois State University, Normal, Illinois during the Fall semester of 2004. Participants navigated a series of wayfinding tasks using either rich (map-based) or lean (text-based) navigation instructions. Data were collected by the Pocket PC mobile device used to display navigation instructions. The data were used to compare the efficiency of the two types of route instructions. The procedure that was followed is detailed in the following paragraphs.

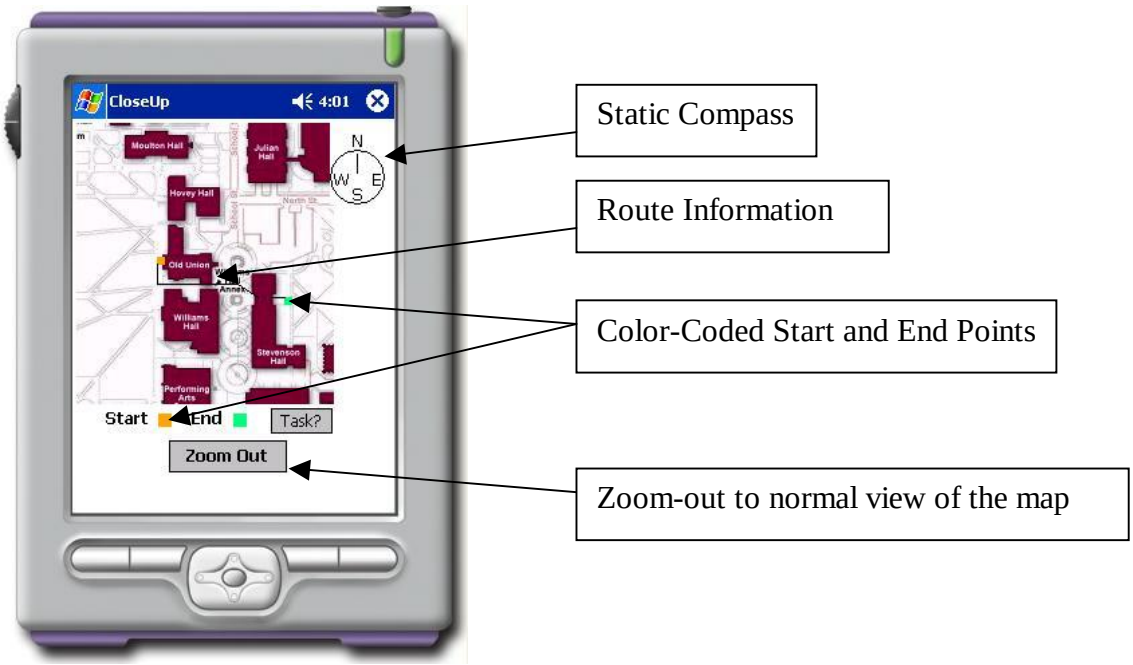
A convenience sample of students from the School of Information Technology and Department of Geography courses was taken. The sample size was 28 students selected from Multimedia Applications (ITK 352), Geographic Techniques (GEO 204), and Earth's Dynamic Weather (GEO 211) courses. Four students were removed from the sample due to incomplete experimental data. Participant ages range from 18 to 65 years old, and all subjects were physically capable of carrying out the experimental tasks.

The data collected during the experiment included the total time to complete the wayfinding tasks and the number of correct responses to wayfinding task questions. In addition to these variables, the time taken for each task, subject interaction with the application, and the time each interaction occurred were recorded in a text file stored on the Pocket PC.

The two groups of participants performed a series of nine wayfinding tasks on the campus of Illinois State University. Each participant used the navigation application (by means of a Pocket PC) to complete the wayfinding tasks. A participant carried a clipboard with the task questions, a writing utensil, and a Pocket PC. The participant started when ready and walked in the vicinity of the campus of Illinois State University for approximately forty-five minutes. The participant recorded the answer to each task question on a piece of paper with the wayfinding task questions printed on it.



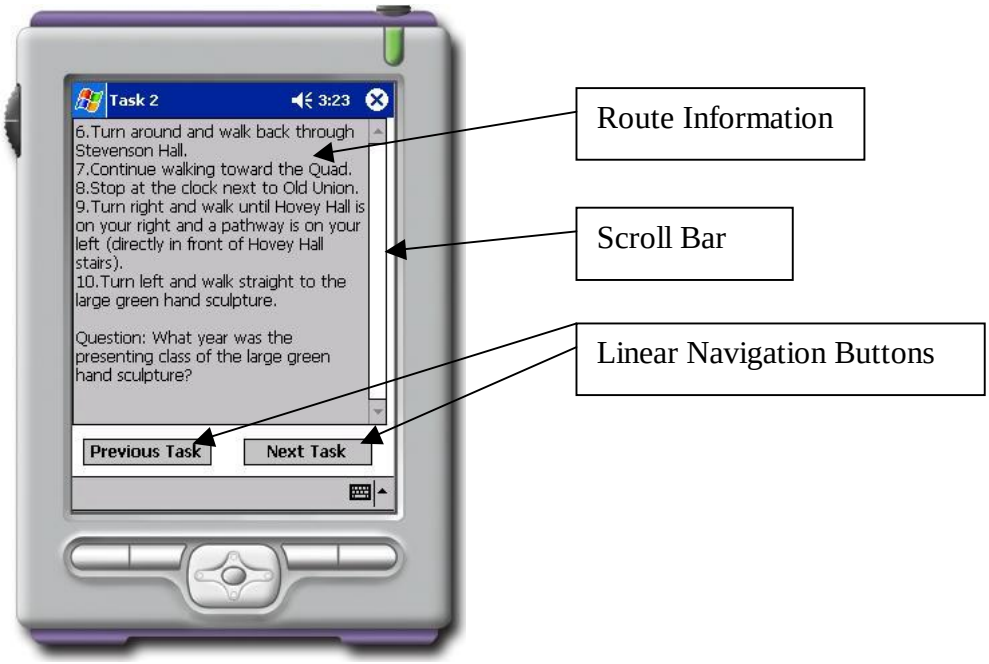
Task 2 Screen



Zoomed-in View of Task 1

Figure 1. Map-Based Navigation Application Features

Note. From "Interactive Campus Map" by Illinois State University, n.d., Retrieved August 15, 2004, from http://www.ilstu.edu/map/. Used with permission.



Task 2 Screen

Figure 2. Text-Based Navigation Application Features

FINDINGS AND CONCLUSIONS

The main objective of this research is to investigate the impact of rich and lean messages on mobile communication efficiency. Because the sample size was small (<30), Independent-Samples *t*-Tests were performed on the data collected (Mann, 2003, p. 367). The outcome of this research shows that there is no difference of efficient navigation task accomplishment between participants given rich navigation instructions and participants given lean navigation instructions as measured by the total time to complete the wayfinding tasks. Therefore, based on the findings of this research, rich and lean messages do not affect the time taken to complete certain wayfinding tasks performed using a mobile device. An example where this finding could be important is when designing applications to provide routing directions (e.g. www.mapquest.com). Mapquest is a website that provides driving directions in two formats, text-based and map-based. According to the outcome of this research, either format for routing directions would be as efficient.

Recommendations for Future Work

The factors that impact efficiency of navigation task accomplishment provide many areas for future research. Additional research could be performed in order to describe the impact of rich and lean messages on mobile communication, especially their impact on mobile navigation systems. The following sections discuss opportunities for future research.

Tool Improvements for Future Research.

Because this study was primarily aimed at finding the impact of rich and lean messages as presented on a single mobile device, there is a limitation to the inferences that can be made about mobile communication using other mobile devices. In order to develop richer navigation applications for all mobile devices, a more flexible interface could be developed. The main purpose of the map-based navigation application is to communicate a rich message. This has clearly been achieved, but there are aspects of the user interface that could be improved for usability while at the same time providing richer messages. For example, the current option for enlarging the map image is static zooming. A future

improvement for the map-based application is a multi-level zoom capability. A way to perform this feature and gain clearer images during zooming is vector based mapping, implemented through a technology called Scalable Vector Graphics (SVG). SVG would provide the opportunity to create maps that are accurate and scale to any size without the loss of clarity, create landmarks, insert text labels into the map, and construct maps with stored geographic information. Another aspect of the application that could be improved for future research is the flexibility of viewing enlarged images. When the map is viewed with more detail, users might want to see the area in between the start and end points to determine the best navigation route. This requires the use of vertical and horizontal scroll bars or some other method of moving the map image while enlarged.

Larger Sample Size.

In order to make more robust assertions about the value of mobile communication, researchers could replicate this study with a larger sample size. A larger sample size would help researchers make more accurate conclusions about the impact of message type on mobile communication. Also, larger sample sizes would give researchers more insight into what factors affect efficiency.

Demographics.

All participants in this study were students, and most participants were between 18 and 25 years old. The homogeneity of the sample pool may have affected the interaction between message type and task accomplishment. This impact could be reduced by utilizing a more diverse and balanced group of participants, and thus the results will have broader validity. In addition, most of the participants were on-campus residents with more than average knowledge of the area over which the wayfinding tasks covered. Knowledge of the wayfinding area impacts this study by reducing the likelihood of error due to poorly constructed navigation instructions. Participants most likely did not know the answers to the wayfinding task questions, but could have interpreted the instructions better than a participant with no knowledge of the area.

Future Research Areas.

The map-based navigation application design gives researchers another area for future research. The author has justified a map as a rich message earlier in this study; however, the map-based application usability could be investigated. In addressing those interface issues, a group of map-based interfaces could be compared to each other to determine the most usable interface. The most usable of those interfaces could then be utilized in research comparing text-based and map-based mobile navigation applications.

In addition to the usability of the map-based navigation application, the environment where wayfinding tasks were performed is an important factor that future research should consider. The map use environment includes the physical location of the user, the weather, and the map delivery method (device type) among other aspects. The environment places limitations on the efficiency of map use. That limitation is an area that could lead to research which measures how much the map use environment impacts mobile navigation applications.

The author has discussed sample size, demographics, and other issues such as map usability for further research. Those issues are by no means exhaustive of the possibilities for further research. In a broader sense, this study points to further research potential in the development of mobile communication applications, richness factors in mobile communication, and mobile navigation applications for wayfinding tasks.

REFERENCES

Clarke, K.C. (2001). Cartography in a Mobile Internet Age. *Proceedings of The 20th International Cartographic Conference, Beijing*, (3), 1481-1488.

Daft, Richard L., & Lengel, Robert H. (1986, May). Organizational Information Requirements, Media Richness and Structural Design. *Management Science*, *32*(5). 554-571.

Daft, Richard L., Lengel, Robert H., & Klebe-Trevino, Linda. (1987, September). Message Equivocality, Media Selection, and Manger Performance: Implications for Information Systems. *MIS Quarterly*, *11*(3), 355-366.

Illinois State University. (n.d.). Interactive Campus Map. Retrieved August 15, 2004, from http://www.ilstu.edu/map/.

Kydd, Christine T., & Ferry, Diane L. (1995, August). Electronic Mail and New Methods for Measuring Media Richness. *Proceedings of the Association for Information Systems*, 246-248.

Lister, Martin, Dovey, Jon, Giddings, Seth, Grant, Ian, & Kelly, Kieran. (2003). *New Media: A Critical Introduction*. New York, NY: Routledge.

Markus, Lynne M. (1994, November). Electronic Mail as the Medium of Managerial Choice. *Organizational Science*, *5*(4), 502-527.

Mann, Prem S. (2003). *Introductory Statistics*. Eastern Connecticut State University: John Wiley & Sons, Inc.

Reichenbacher, Tumasch. (2002, July). SVG for Adaptive Visualizations in Mobile Situations. *SVG Open / Carto.net Developers Conference, Zurich, Switzerland*, Retrieved July 8, 2004 from http://www.svgopen.org/2002/papers/reichenbacher__svg_in_mobile_situations/.

Reichenbacher, Tumasch. (2001, August). The World in Your Pocket – Towards a Mobile Cartography. *Proceedings of The 20th International Cartographic Conference*, *Beijing*, (3). Retrieved July 8, 2004 from http://129.187.92.218/publications/reichenbacher/ICC2001_Paper.pdf.

Sproull, Lee, & Kiesler, Sara. (1986, November). Reducing Social Context Cues: Electronic Mail in Organizational Communication. *Management Science*, *32*(11), 1492-1512.

Vita, Emanuela De, Piras, Andrea, & Sanna, Stefano. (2003, May). *Using Compact GML to Deploy Interactive Maps on Mobile Devices.* Poster session presented at The Twelfth International World Wide Web Conference, Budapest, HUNGARY. Retrieved July 8, 2004 from http://www2003.org/cdrom/papers/poster/p051/p51-devita.html.

Wilson, Vance E., & Zigurs, Ilze. (2001). Interpersonal Influence Goals and Computer-Mediated Communication. *Journal of Organizational Computing and Electronic Commerce*, *11*(1), 59-76.

BIOGRAPHY

After receiving both his Bachelors of Science in History and Masters of Science in Information Systems, Daniel Armich accepted a faculty role with the School of Information Technology at Illinois State University teaching ethics and logical problem solving. This paper is based on the primary author's Masters Thesis. It was refined into a conference paper and abstract during the author's time as a faculty member at Illinois State University. Daniel Armich currently works for Hewitt and Associates, LLC as a programmer / analyst. He may be reached at danielarmich@yahoo.com. Drs. Vila-Ruiz and Lim are Professors in the School of Information Technology and Dr. Carter is a Professor in the Department of Geography-Geology at Illinois State University. Each of these professors was a member of the primary author's thesis committee.