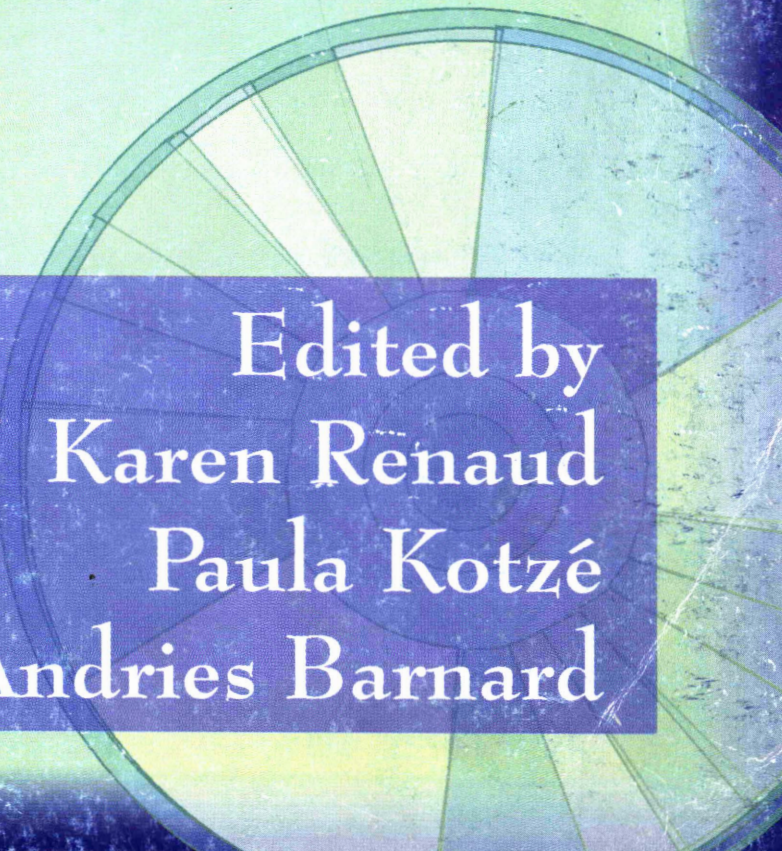# HARDWARE, SOFTWARE AND PEOPLEWARE

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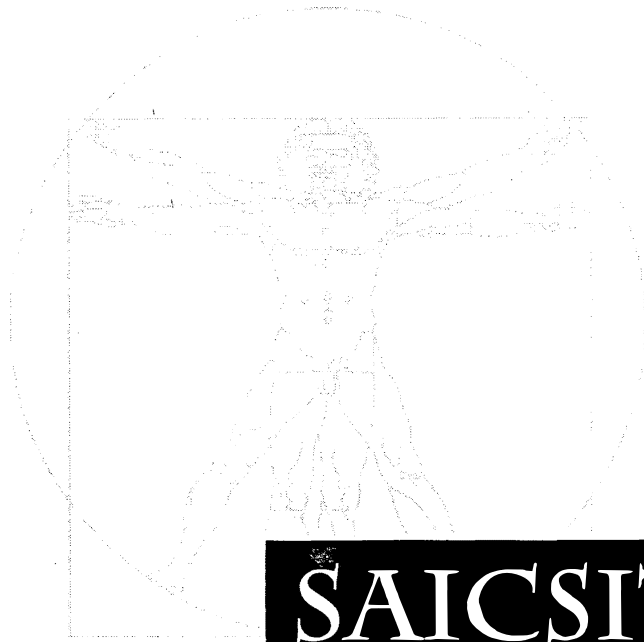
SAICSIT 2001

Edited by
Karen Renaud
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HARDWARE,

SOFTWARE

AND PEOPLEWARE

**South African Institute of Computer
Scientists and Information Technologists
Annual Conference**

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SAICSIT 2001

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Message from the SAICSIT President

The South African Institute of Computer Scientists and Information Technologists (SAICSIT) was formed in 1982 and focuses on research and development in all fields of computing and information technology in South Africa. Now in the 20th year of its existence, SAICSIT has come of age, and through its flagship series of annual conferences provides a showcase of not only the best research from the Southern-African region, but also of international research, attracting contributions from far afield. SAICSIT does, however, not exist or operate in isolation.

More than 50 years have passed since the first electronic computer appeared in our society. In the intervening years technological development has been exponential. Over the last 20 years there has been a vast growth and pervasiveness of computing and information technology throughout the world. This has led into the expansion and consolidation of research into a diversity of new technologies and applications in diverse cultural environments. During this period huge strides have also been made in the development of computing devices. The processing speed of computers has increased thousand-fold and memory capacity from megabytes to gigabytes in the last decade alone. The Southern African region did not miss out on these developments.

It is hardly possible for such quantitative expansion not to bring a change in quality. Initially computers had been developed mainly for purposes such as automation for the improvement of processing, labour-reduction in production and automation control of machinery, with artificial intelligence, which made great strides in the 1980s, seen as the ultimate field to which computers could be applied. As we moved into the 1990s it was recognized that such an automation route was not the only direction in the improvement of computers. The expansion of processing power has enabled image data to be incorporated into computer systems, mainly for the purpose of improving human utilisation. For most computer technologies of the 1990s, including the Internet and virtual reality, automation was not the ultimate purpose. Humans were increasingly actively involved in the information-processing loop. This involvement has gradually increased as we move into the 21st century. Development of computer technology based not on automation, but on interaction, is now fully established.

The method of interaction has significantly changed as well. The expansion of computer ability means that the same function can be performed far more cheaply and on smaller computers than ever before. The advent of portable and mobile computers and pervasive computing devices is ample evidence of this. The need for users to be at the same location as a computer in order to reap the benefits of software installed on that computer is becoming an obsolete notion. Time and space are no longer constraints. One of the most discussed impacts of computing and information technology is *communication* and the easy accessibility of information. This changes the emphasis for research and development – issues such as cultural, political, and economic differences must, for example, be accommodated in ways that researchers have not previously considered. Our goal should be to enable users to benefit from technological advances, hence matching the skills, needs, and expectations of users of available technologies to their immense possibilities.

The conference theme for the SAICSIT 2001 Conference – *Hardware, Software and Peopleware: The Reality in the Real Millennium* – aims to reflect technological developments in all aspects related to computerised systems or computing devices, and especially reflect the fact that each influences the others.

Not only has SAICSIT come of age in the 21st century, but so has the research and development community in Southern Africa. The outstanding quality of papers submitted to SAICSIT 2001, of which only a small selection is published in this collection, illustrates both the exciting and developing nature of the field in our region. I hope that you will enjoy SAICSIT 2001 and that it will provide opportunities to cultivate and grow the seeds of discussion on innovative and new developments in computing and information technology.

Paula Kotzé
SAICSIT President

Message from the Chairs

Running this conference has been rewarding, exciting and exhausting. The response to the call for papers we sent out in March was overwhelming. We received 64 paper submissions for our main conference and twelve for the postgraduate symposium. We had a panel of internationally recognized reviewers, both local and international. The response from the reviewers was impressive – accepting a variety of papers and *mostly* returning the reviews long before the due date. We were struck, once again, by the sheer magnanimity of academia – as busy as we all are, we still manage to contribute fully to a conference such as SAICSIT.

After an exhaustive review process, where each paper was reviewed by at least three reviewers, the program committee accepted 26 full research papers and 14 electronic papers. Five papers were referred to the postgraduate symposium, since they represented work in progress – not yet ready for presentation to a full conference but which nevertheless represented sound and relevant research. The papers published in this volume therefore represent research of an internationally high standard and we are proud to publish it. Full electronic papers will be available on the conference web site (http://www.cs.unisa.ac.za/saicsit2001/).

Computer Science and Information Systems academics in South Africa labour under difficult circumstances. *The popularity of IT courses stems from the fact that IT qualifications are in high demand in industry, which leads in turn to a shortage of IT academic staff to teach the courses, even when posts are available. The net result is that fewer people teach more courses to more students. IT departments thus rake in ever-increasing amounts of state subsidy for their universities. These profits, euphemistically labelled "contribution to overhead costs", are deployed in various ways: cross-subsidization of non-profitable departments; maintenance of general facilities; salaries for administrative personnel, etc. Sweeteners of generous physical resources for the IT departments may be provided. We have yet to hear of a University in South Africa where significant concessions have been made in terms of industry-related remuneration. At best, small subventions are provided. As a result, shortages of quality staff remain acute in most IT departments – especially at senior teaching levels. What is even worse is that academics in these departments have to motivate the value of their conference contributions and other IT outputs to selection committees, often dominated by sceptical academic power-brokers from the more traditional departments whose continued survival is underwritten by IT's contribution to overhead costs.*[1]

The papers published in this volume are conclusive evidence of the indefatigability and pertinacity of Computer Science and Information Systems academics and technologists in South Africa. We are proud to be part of such a prestigious and innovative group of people.

In conclusion, we would like to thank the conference chair, Prof Paula Kotzé, for her support. We also specially thank Prof Derrick Kourie for his substantial contribution. Finally, to all of you, contributors, presenters, reviewers and organisers – a big thank you – without you this conference could not be successful.

Enjoy the Conference!
Karen Renaud & Andries Barnard

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[1] This taken almost verbatim from Professor Derrick Kourie's SACLA 2001 paper titled: *"The Benefits of Bad Teaching"*.

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Keynote Abstracts

A Comparison of the Interface Effect on the Use of Mobile Devices

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Abstract: *Designers of mobile systems continue to focus on transferring the typical workstation environment as prevalent on the desktop PC to mobile devices. The lack of specific focus on the requirements of the wireless platforms means that some interfaces for small handheld devices and cellular telephones are inadequate in sufficiently supporting wireless connectivity. This paper tests various hypotheses to identify which aspects of the mobile device interface significantly affect basic ease of use. The aspects are grouped into five categories: Screen, Readability, Input Method, Interface Capabilities and Ease of Use. Subjects were asked to perform a task on three different mobile devices. Subjects were required to make the same purchase on the Internet, using each device and in no specific order. They were then asked to record their experiences on a questionnaire. Analyses of findings reveal that four of the five factors significantly affect the usage of mobile devices. It is concluded that the interface of mobile devices, considerably affects their usage.*

Keywords: *User Interface, Mobile Computing*

Computing Review Categories: *H.5.2, H.3.5, H.1.2, H.4.3, C.0*

1. Introduction

This paper evaluates the use of mobile devices and how the various interfaces available can affect the ease of use of these devices. Specifically, it compares how the different interfaces can affect the completion of a specified internet task on each mobile device.

1.1. Background to the Investigation

This research stems from two streams of major technological development. Firstly, the vast improvements that have been made in portable computing devices, ranging from laptops to PDA's, in terms of smaller devices with increased processing power. The second stream originates from the rapid growth of mobile telecommunications, through cellular and satellite infrastructures. Although the possibility for mobile voice calls has existed for a relatively long time, more versatile wireless communication activities have started to emerge only recently.

As a result, mobile communication is still a relatively new topic of Human Computer Interaction (HCI) activity. The very nature of mobile devices has outlined a number of distinct new challenges. Smaller screen sizes, limited input methods and limited memory and computational resources are but a few of the issues that have given rise to these design challenges. The appropriateness of conventional metaphors, that have been used to describe interfaces in the past, is also being questioned. The traditional "Desktop" metaphor can no longer be used to accurately represent the integration of telecommunications with portable devices.

The implication of this is that research needs to be conducted into which aspects of mobile device interfaces affect their effectiveness in facilitating wireless data communication. Identifying and testing these aspects is the focus of this paper.

1.2. Scope and Layout of the Report

This paper tests the relationship between the screen, readability, input methods, interface capabilities and basic ease of use of a user's Internet experience, when using different mobile devices. In order to limit the scope of the study three mobile devices were selected, each with a different interface.

The paper begins with a review of the related literature. Research into the field of HCI for mobile systems is still in its early stages. The review briefly describes the problems observed in mobile interface design.

The primary and secondary hypotheses are stated, followed by a description of the re-

search methodology and data collection. The research findings are then presented based on the analysed data. Lastly conclusions to the paper are drawn whilst outlining the limitations to the study. Recommendations for possible areas of further research are made.

The study that the researchers conducted involves relatively current technology. As a result there has been little to no research into the human computer interaction (HCI) of mobile systems for this specific technology. The area of research, therefore, focuses on conventional HCI and those components relevant to mobile interfaces.

2. Survey of Related Literature

According to Dix et al [10] Human Computer Interaction is the study of people, computer technology and the way these influence each other. The methods of interaction between the human and computer have changed dramatically since the earliest research on HCI. The Common Font Group portrayed a dashboard of flashing lights and mechanical switches in their article on User Interface Design [8]. However, this is nothing like the graphical user interfaces that are so common today.

2.1. The Human Computer Interaction of Mobile Systems

Johnson C. [18] comments that research in Human Computer Interaction has recently begun to acknowledge the importance of the user's context and environment when designing interactive systems. Since the context and environment of a mobile device user is constantly changing, even greater emphasis needs to be placed on research in this area.

Technological developments in wireless communication and increases in the power and interactive capabilities of portable and handheld devices make increasing demands on the quality of the user interface and offer the potential to further improve the functionality of these computing devices [19]. More importantly, Rodden et al [26] point out that in various ways mobile systems break assumptions that are implicit in the design of fixed-location computer applications. Brewster et al [4] are in agreement, although they are more specific in saying that much of the research on effective screen design and information output cannot be generalised to mobile devices. Much of the work on presentation in standard desktop

interfaces relies on large, high-resolution screens [4].

The nature of mobile devices presents many problems for the interface designer. It is these problems that the researchers wish to emphasise and discuss further in this study:

2.1.1. Screen Design

Brewster et al [4] identify the lack of screen space as one of the main problems of the output from small, handheld mobile computing devices. As the device must be small enough to fit into the user's hand or pocket there is no space for a large screen [4].

Kristoffersen et al [20] as well as Rodden et al [26] examine the need for highly adaptive, contextual interfaces that become necessary for acceptable integration and that can be adapted to the dramatically smaller mobile device screens.

2.1.2. Input Interface

There are three types of input interfaces currently available on mobile devices. Firstly the traditional QWERTY keyboards in a significantly reduced form, with no more than a few of the function keys and no numeric pad. There is also a stylus pen that can be used to manipulate a touch screen interface. Lastly, there is the traditional telephone keypad, where characters are mapped onto each key in a many-to-one fashion [13].

2.1.3. Wireless Telecommunication and the Internet

Herstad et al [16] observed that the need for making the Internet available on current mobile handheld devices is obvious and urgent. However, the integration of these two technologies is currently done in an ad-hoc, inefficient, functionally limited and less than user-friendly manner [16]. The convergence of the "desktop computer" and the "plain old telephone" has identified the need for a new and common metaphor that can describe both fields, although it will take time for this to happen [16].

Another important factor for mobile technologies that Kristoffersen et al [20] and Rodden et al [26] both note is that in almost any mobile environment, connections are going to be unpredictably unreliable. So, user interfaces to mobile applications should be designed to cope

with the level of uncertainty that is inevitably introduced into any system that uses wireless communication.

2.1.4. Conventional Design for "Fixed Systems"

HCI has developed a good understanding of how to design and evaluate forms of human computer interaction: in "fixed" contexts of use, in a single domain, with the users always using the same computer, to undertake tasks alone, or in collaboration with others [19]. Unfortunately these design models cannot simply be applied to mobile computing. Kristoffersen et al [20] found that mobile applications are all too often designed as miniature desktop systems. New metaphors and human computer interaction techniques that extend the "mobile desktop" are needed to improve the design of mobile computing [20].

1.1. In Summary (Literature)

Human Computer Interaction, with respect to mobile computing, has resulted in many new issues arising that cannot be addressed by traditional HCI research. The researchers feel that the effectiveness of interface design for mobile systems is influenced by several factors, which will become variables in this empirical study on mobile interface design. The way in which these variables are grouped and manipulated will be made clear in the section on research methodology. The factors for effective interface design are:

- How the dimensions of the screen on the mobile device affect the amount of information that can be displayed at one time, how that information is laid out and whether the information is easy to view.

- How the output in the form of text and graphics (with or without colour), influence the readability of information on the screen.

- How the input interface defines the ease of data entry, as well as the time taken to navigate through screens and capture information.

- How the mobile device hardware capabilities and software availability influence ease of task completion, with respect to familiarity and navigation techniques.

Although many issues and problems for designing mobile interfaces have been covered in this review, only a few will be included in the study in order allow a focused study to be conducted. From the variables identified above, the primary and secondary hypotheses can be drawn and tested.

3. Research Objectives and Hypotheses

The objective of this research is to compare the interfaces of three mobile devices and test whether users found any significant differences between them.

The primary hypothesis is stated as follows:

H10: There are no significant differences between the mean scores of the interfaces of different mobile devices.

H11: Two or more of the mean scores for the interfaces of different mobile devices are significantly different.

In order to prove the primary hypothesis true, any of a number of the following secondary hypotheses could be proven true. Furthermore, an aggregate result, pooling the significances of the results for the individual questions, could be used to prove the secondary hypotheses. The secondary hypotheses have been developed based on five specific factors applicable to the interface of the device. These factors consist of a number of variables, on which the design of the mobile device usability questionnaire has been based.

The secondary hypotheses are stated as follows:

H20[1]: There are no significant differences between the mean scores for the screens of the mobile devices.

H21[1]: Two or more of the mean scores for the screens of the mobile devices are significantly different.

The screen factor includes variables such as screen dimensions, layout and concentration of information on the screen.

H20[2]: There are no significant differences between the mean scores for the readability of text and graphics on the mobile devices.

H21[2]: Two or more of the mean scores for the readability of text and graphics on the mobile devices are significantly different.

Readability refers to identifying text or images and whether the use of colour in these images make completion of the task easier.

$H20^3$: There are no significant differences between the mean scores for the **input method** of the mobile devices.

$H21^3$: Two or more of the mean scores for the **input method** of the mobile devices are significantly different.

The input method for each device influences the ease and efficiency of capturing information.

$H20^4$: There are no significant differences between the mean scores for the **interface capabilities** of the mobile devices.

$H21^4$: Two or more of the mean scores for the **interface capabilities** of the mobile devices are significantly different.

This factor evaluates the effect of navigation, interface familiarity and the use of colours on the time taken to complete the task.

$H20^5$: There are no significant differences between the mean scores for the **usability** of the mobile devices.

$H21^5$: Two or more of the mean scores for the **usability** of the mobile devices are significantly different.

The ease of use of the device measured the user's ability to complete the task and use the device on the whole.

4. Research Methodology

Simulation was used as the research methodology to test the stated hypothesis. The nature of this methodology facilitates the user's understanding of the mobile device used, with regards to the interface and input methods, because it involves the user directly interacting with the device. It provides an improved means for the measurement of the user's perception of particular aspects of the mobile device. The data gathered through the use of a questionnaire can be effectively analysed to substantiate the conclusions reached.

4.1. Research Design: The Simulation

The simulation program was identical for all three devices and was developed using Wireless Markup Language (WML), Hyper Text Markup Language (HTML), Active Server Pages (ASP) and JavaScript. For the cellular phone, the only difference was that WML instead of HTML was used to develop the website with which to interact. The program designed was web based and the researchers compared the interface across three different types of mobile devices according to specific

factors in completing a specified task through the Internet. The study was conducted in this manner, because the Internet provides a standard platform over which to compare the interface of these devices. The comparison included information layout and clarity on the screen, readability of graphics and characters, input method, interface capabilities and ease of use of the device.

The program simulates the use of a "dummy" credit card transaction where the user has the ability to purchase either books or music CDs on-line. The user was required to complete a standard task of performing a commercial transaction over the Internet (i.e. Mobile Commerce), using all three mobile devices. The user's perception and measurement of each of the different factors of the device was captured, compared and analysed.

The user was initially presented with a screen introducing the contents of the website. He or she was required to choose whatever items he or she wished to purchase and thereafter enter relevant personal data to facilitate the completion of the transaction.

The three mobile devices were each presented in their activated mode to the user, displaying their respective browsers and the website. The user was then allowed to select the items that he or she wished to purchase and to proceed to the next web page on which relevant personal data was entered. All three mobile devices have similar sets of options through which the user had to navigate in order to complete the task at hand. The technique used for inputting data differs for each device.

The study used three different *types* of mobile devices. These were: the **Compaq Pocket Sized PC**, the **Psion 5MX**, and a **Nokia 7110** or the **Ericsson R320S cellular phone**.

4.2. Sampling Issues

There were no specific characteristics required of a sample except for a basic level of computer literacy. This is a result of developing the simulation as an on-line web application. Most computer literate users have basic familiarity with using a web browser.

A relatively small sample size of only forty-nine respondents was taken, with each experiment completed successfully. Due to the constraints of time, issues involved in obtaining the mobile devices and the nature of this

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experiment (simulation), a larger sample size could not be selected.

4.2.1. Problems Relating to the Sample Used

The nature of the simulation meant that the user was required to quickly become familiar with the device even if he or she had not used one previously, and as a result it slowed down the testing process. Another drawback was that the researchers could only obtain these devices for a total period of five days. Each test across all three devices took on average 25 to 30 minutes, which meant that only a limited number of tests could be conducted.

4.3. Data Collection

4.3.1. Data Capture

All respondents performing the tests were required to complete a questionnaire rating the three devices on five main categorized factors. The rated factors were: the screen, readability, input method, interface capabilities, and ease of use.

The rating scale used ranged from '1' (i.e. strongly disagree) to '7' (i.e. strongly agree), with '4' being neutral. Above '4' would be tending towards agreeing and below, the opposite. The seven point Likert rating scale is used on a number of different questionnaire instruments specifically designed to assess aspects of usability, validity and/or reliability. (E.g. Questionnaire for User Interface Satisfaction - Maryland, Perceived Usefulness and Ease of Use - IBM, Nielsen's Attributes of Usability – Bellcore, Computer System Usability Questionnaire – IBM, etc.)

These instruments are available through the use of a web-based system that generates a number of different types of questions based on specific criteria (www.netraker.com). The questionnaire used in this study was generated in this manner.

Questions were asked to focus the user's attention specifically on the differences between the mobile devices. For example, in the section on readability, the user was asked if colour made the information easier to read or view. It was obvious that the user would rate this as '1' or strongly disagree on the Nokia and Psion devices because it does not have a colour interface whereas on the Compaq it does.

External factors related to home language, age, computer skill level, familiarity with the Internet and mobile device accessibility were recorded, because the researchers felt that they could gauge an understanding of the user's ability to rate the devices according to a specific set of factors. However, due to time limitations, this analysis was not conducted.

Data confidentiality was ensured by not having the user enter his or her personal details on either the questionnaire or online forms. If, however, the user entered relevant personal information on the form, this information was not stored.

4.3.2. Data Analysis

The data was captured in Microsoft Excel™ and was imported into Statistica™ statistical package in order for the analysis to be conducted.

5. Research Findings

The findings analyse the 49 successfully completed experiments (questionnaires). Each experiment was conducted individually at an average observed completion time of approximately 25 minutes. This involved the completion of a similar task (using a web-browser to purchase a product over the Internet) on each of the three devices.

5.1. Overview of demographics

The following demographic data was gathered, but remains beyond the scope of this study. Some interesting points are noted before discussing the results of the statistical analysis.

The demographics revealed that the majority of sample subjects were male (63%) and that most respondents had an intermediate (53%) level of computer skill. The skill level of a subject might have been relevant to the subject's perception of the various aspects of the interface.

For example, an advanced user might have adapted quickly to using a mobile device but could have been very critical when comparing the interfaces of each device. However, the majority (intermediate users) would have been less sensitive to the differences between the interfaces.

The majority of subjects (86%) owned cellular phones while only a small percentage of subjects (4%) owned Personal Digital Assistants.

The user's previous experience with the mobile devices used in the study was not tested for significance, although the statistics indicate that a greater part of the subjects were familiar with the cellular phone and this could possibly have influenced their comparison of devices.

An interesting point to note is that a significant proportion of respondents (94%) indicated that they would be interested in using a mobile device to access the Internet in the future. Such a great potential for future usage is one of the many reasons for further research into this area.

Additional demographics collected regarding age and language of the respondents revealed no significant areas of interest.

5.1.1. Summary of Secondary Hypothesis Test: Screen

All null sub-hypotheses for this factor were *rejected* at the 5% level. Based on the initial assumption, the secondary null hypothesis, relating to the screen of the mobile device, could also be *rejected*.

Notable differences were observed between screen elements of the Nokia and the Compaq, and the Nokia and Psion respectively. This is evident from the small screen dimensions of the Nokia (38 x 33 mm) compared to that of the Compaq (68 x 90 mm) and the Psion (133 x 50mm). As a result of the smaller screen of the cellular phone, subjects possibly found it more difficult to view information on the Nokia as opposed to the other devices. From the high mean scores for both the Compaq and Psion, it is suggested that subjects found these two devices similarly capable of displaying sufficient information clearly, and making it easy to view, during their task.

5.1.2. Summary of Secondary Hypothesis Test: Readability

All null sub-hypotheses for this factor were *rejected* at the 5% level. Based on the initial assumption, therefore, the secondary null hypothesis, relating to the readability of the mobile device interface, could also be *rejected*.

In summary, it should be noted that the Compaq presented graphics and text in a more aesthetically pleasing manner than any of the other devices, as shown by the results. The lack

of colour and graphics on the Nokia significantly affected completion of the task.

5.1.3. Summary of Secondary Hypothesis Test: Input Method

All null sub-hypotheses for this factor were *rejected* at the 5% level. Based on the initial assumption, the secondary null hypothesis, relating to the input method of the mobile device, could also be *rejected*.

To summarise: the miniature QWERTY keyboard of the Psion generally appeared to be the most popular method for inputting information when compared to the stylus and the numpad of the Compaq and the Nokia respectively.

5.1.4. Summary of Secondary Hypothesis Test: Interface Capabilities

All null sub-hypotheses for this factor were *rejected* at the 5% level. Based on the initial assumption, the secondary null hypothesis, relating to the interface capability of the mobile device, could also be *rejected*.

In summary, the capability of the interface was only partly significant as users were generally comfortable with performing the task on all the different devices.

The lack of a colour interface was a significant influence on the users ability to complete the task, but this was not true when testing the effect of a user's familiarity with the interface. Users generally agreed that the task was completed in a reasonable time for each device.

5.1.5. Summary of the Secondary Hypothesis Test: Usability

All the null sub-hypotheses for this factor were *not* rejected at the 5% level. Based on the initial assumption, therefore, the secondary null hypothesis, relating to usability of the mobile device, could *not* be rejected.

Although no significant differences were found across the devices, the researchers would like to maintain that this finding was, nonetheless, relevant as seen from the factor rating analysis.

5.2. Review of Significant Findings

Four out of the five secondary null hypotheses were rejected. The researchers can therefore reject the primary hypotheses based on the

assumptions previously stated. This implies that certain aspects of its interface significantly affect the use of a mobile device.

5.3. Summary of Factor Rating Analysis

The findings suggest that usability was the most significant factor (38.78%), as was also illustrated by the aggregate of the factor ratings for all respondents shown below.

It is interesting to note that although no significant differences were found between devices for the usability factor, it was still rated as the most important aspect of the interface by the users. This alludes to the fact that basic ease of use for a mobile device is a key feature for both designers and ultimately the end users of these mobile systems.

The description of the five factors used: Screen, Readability etc. are fairly self-explanatory, except for the factor referred to as "Interface Capabilities". The researchers believe that some confusion may have arisen when subjects were asked to compare this factor to Screen, Readability, Input Method and Usability, as subjects possibly did not fully understand the description for this factor. As a result, Interface Capability was rated as the least important factor (18.5%).

The ranking for all the factors were as follows: Usability (1st), Input Method (2nd), Readability

(3rd), Screen (4th), Interface Capability (5th).

6. Conclusion

This paper tests the effects of various aspects of mobile device interfaces on completing a specific task. Human Computer Interaction has historically been limited to the study of fixed (desktop) systems and, as a result, a limited amount of research into HCI for mobile systems has been conducted. The very nature of mobile devices necessitates research has been undertaken into designing interfaces that are suitable for these kinds of systems and user requirements.

The interfaces of the mobile devices were categorised into the following factors: Screen, Readability, Input Method, Interface Capabilities and Usability. By isolating variables within these categories, a set of sub-hypotheses was identified, that could be tested independently. By rejecting all of the null sub-hypotheses for a factor, the secondary hypothesis for that factor could also rejected.

The following conclusions were reached as a result of this testing. All factors, except for usability, were found to significantly affect the use of the mobile device. Consequently, based on the stated assumptions, the primary hypothesis (there are no differences in the mean scores between the interfaces of different mobile devices) was rejected.
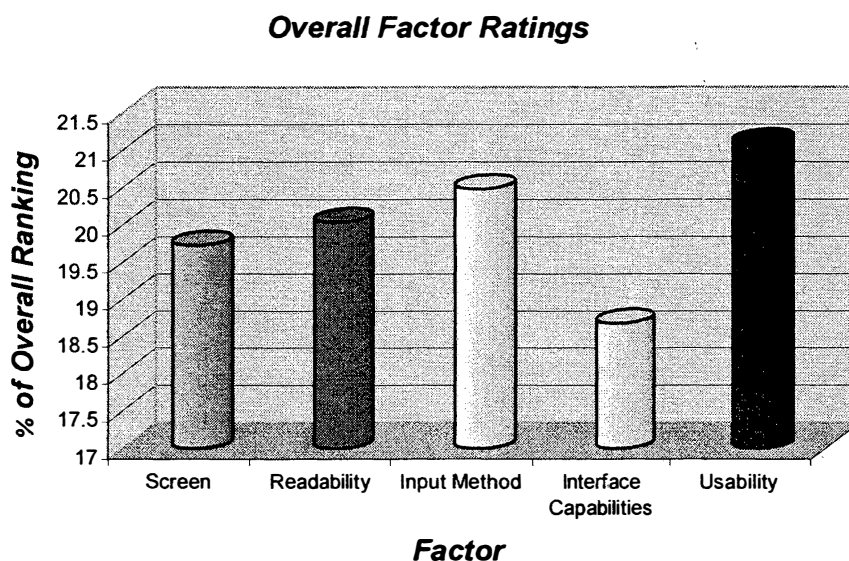
Overall Factor Ratings

Figure 1: Total Ratings of Factors over all Questionnaires

Subjects were required to rank each factor in terms of its perceived importance. Usability was ranked the highest (most important). The findings prove that the interface of a mobile device can significantly affect the user's ability to interact with the device in completing a specific task.

6.1. Recommendations for Further Research

Although this paper concludes that various aspects of the mobile device interface need to be addressed when designing future interfaces, the factors analysed remain at a very high level. It is therefore suggested that a more in-depth analysis of each factor be conducted to test for significance at a lower level.

The influence of external elements (demographics, etc.) on the outcome of the results is another area for potential research.

No significant differences were found between the usability of the mobile devices, even though this factor was rated the most important. Reasons for this should be investigated in greater depth.

The ergonomics and design of mobile devices was beyond the scope of this paper, but may have influenced the outcome of results. This could be explored in a further study.

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