A Cross-Cultural Comparison of Cell Phone Interface Design Preferences from the Perspective of Nationality and Disability

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Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in
partial fulfillment of the requirements for the degree of

Master of Science
in
Industrial and Systems Engineering

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August 31st 2006
Blacksburg, Virginia

Keywords: Cross-cultural studies, Disability culture, Cell phone interfaces, Product Interactive Focus groups, Design preferences

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ABSTRACT

A cell phone is an electronic communication device that helps break down the distance barriers between people, with added mobility advantages. For some users a cell phone is more than a communication device; it may be used as a fashion accessory, and for some the cell phone is needed to seek help in emergency situations. The cell phone market has been expanding globally over the past decade, with approximately 423 million sold globally in the year 2002 (Kiljander & Johanna, 2003). According to the CIA World Factbook (2006), the UK has more cell phones than people. The global expansion of cell phone companies may impose problems to cell phone users, since unlike the personal computer industry the cell phone industry has no standard interface, and manufacturers have the freedom to gradually improve the user interface (Kiljander & Johanna, 2003). For a user interface to be well accepted by a target population it is necessary to identify and explore the underlying design preferences. User interfaces of new technology may lead to anxiety and delayed technology acceptance, especially for users with disabilities. Even though the need for users participating in the design process has been realized, users with disabilities are not always included in the design process (Newell & Gregor, 2001). This study followed a participatory design process, to compare and contrast the cell phone interface design preferences of users from two different nations, including users with no apparent disability and users with visual disabilities.

A study was conducted to identify possible relationships between national culture, disability culture and design preferences of cell phone interfaces. The theoretical framework used to guide this study was Hofstede's (1991) five dimensional cultural model. Various studies have explored cross-cultural interface design and found some relationship of these cultural dimensions with interface design components (Choi *et. al.,* 2005; Marcus, 1999; Marcus and Gould, 2001).

This study included 13 product interactive focus groups, with a total of 69 participants, 34 in India and 35 in the United States, of the age group 19-50 years. There were 4 units of analyses in this research study. This included a control group of users without any apparent disability and a disability group with a visual disability of legal blindness. The two countries, India and the United States, were selected for this comparative study because of their diverse cultural backgrounds and the rapid expansion of cell phone usage which they are witnessing. The four units of analyses differed in their cultural dimensions. There were no significant correlations found on Design preferences of cell phone features based on Choi *et at*. (2005)'s study on mobile services with Hofstede (1990)'s cultural dimensions. However the relationships of some these features with the underlying cultural dimensions were found when group level analysis instead of the individual level of analysis was undertaken. Differences were also found in the ratings of the hardware attributes between disability groups and differences in usability ratings were found based on nationality and disability groups. The content analysis of the focus group sessions provided an insight to the preferences on cell phone interface components and the gave a better understanding of the mobile/cell phone culture in the two countries. These results are summarized to provide guidelines for designing cross-cultural user interfaces that are nationality specific and disability specific. A pyramid model for a holistic process of designing cell phones for users with disabilities integrated the findings of this thesis and Jordon (2002)'s pleasurability framework is proposed in the conclusion section of this thesis.

DEDICATION

I dedicate this thesis to my Family, my grandmother (Mrs. Vimla S. Jhangiani)
my parents (Mr. Dilip Jhangiani and Mrs. Rita Jhangiani)
and my brother (Rohit Jhangiani).

My grandmother is my source of inspiration and my achievements today are due to the love, encouragement and support my family has given me.

ACKNOWLEDGEMENTS

I extend my sincere acknowledgements and would like to thank my advisory committee, Dr. Smith-Jackson, Dr. Williges, Dr. Kleiner and Dr. Nussbaum for their guidance during this journey of my Masters thesis. I express my gratitude and appreciation, especially to Dr. Smith-Jackson for her patience, guidance, undeterred support and constant encouragement throughout my Masters Degree program. She has been a true professor, teacher, advisor and mentor to me and has instilled in me the love for the field of cultural ergonomics. I would like to extend my gratitude to Dr. Williges for his guidance, invaluable feedback and suggestions for my thesis work, as well as his service on my committee even after his retirement. I also would like to acknowledge Dr. Nussbaum for establishing my base in statistics and helping me design and refine my research for this thesis. I would also like to thank Dr. Kleiner for assisting me with my search for relevant literature and providing useful opinions about cross-cultural studies.

I express my gratitude to Kei Tomioka from Toshiba Corporation for funding my Travel to India for data collection and providing the cell phones for my research.

I also extend my appreciation to William Holbach and Hal Brackett from the Assistive Technologies Department for encouraging me throughout my thesis work and for sponsoring me for one year of graduate school.

Special thanks to my parents: my father, for encouraging me to pursue graduate school and financially supporting me; my mother, for being involved at all the stages of my thesis work, from recruiting, data collection, transcription and proof-reading. The completion of my thesis would not have been successful without them. Also thank my brothers, Rohit and Kartik for all their help in scheduling and conducting focus groups in India.

My sincere thanks to all the individuals who helped me in overcoming the challenge of recruiting the unique population for my study, by scheduling and organizing the focus groups sessions with participants with disabilities. I thank David Baquis, the Accessibility Specialist at the US Access Board in Washington DC, Kellie Hightower-Spruil, the Director of Community Outreach Raleigh Lions Clinic, Raleigh NC and Mr. Hemant Patil, the Rehabilitation Officer at the National Association of the Blind, Mumbai, India.

I owe my thanks to my friends in Blacksburg, Darshan, Prakriti, George and Marshal; I appreciate all their help in conducting focus groups. I also would like to thank Arul for proofreading my thesis document and Young Seok Lee who has been helpful to me as a colleague.

I also would like to thank my family of friends in the US. I thank Siddharth, for being my support system in the US, a source of inspiration and motivation throughout my thesis work, and also for playing a critical role in the data collection of my study. My roommates, Sampada and Nipa, for always being there for me when I needed them. My friends Vijayeta, Shweta, Karishma, Alok and Dipti for sharing the adventure of the exciting journey of studying abroad.

I also thank all the staff members from the ISE department, in particular Lovedia Cole and Teresa Coalson for their help in all the official formalities for my graduate degree.

And last but not the least I express my gratitude to all the participants for their invaluable input for this research project.

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CHAPTER 1. INTRODUCTION

1.1 Background Information

The globalization trend of the industrial era has strengthened cross-cultural communication among different nations (Rose, 2005). Globalization is the general process of worldwide economic, political, technological and social integration as defined by the Localization Industry Primer (Aykin, 2005). The primer mainly addresses the business issues associated with making a product global. In the current international market, it is important to overcome the barriers of language and culture, which have created boundaries across nations. Diverse audiences from different countries, different disability groups, and different religions speak different languages, have different values and beliefs and therefore have different perceptions and expectations from products. The current trend of globalization has lead to wide diversity among users of the same product; therefore for a product to be successful in the global market it must accommodate as much diversity as possible. During the past decade there has been a consistent increase in the number of studies on cross-cultural issues, encompassing similarities and differences between cultures. This increased interest has been inspired by various factors such as the opening of previously sealed international borders, large migration streams, the globalization of the economic market, international tourism, increased cross-cultural communications and technological innovations such as new means of communications (Vijver & Leung, 1997), particularly mobile technologies and the Internet.

Around the world, people are starved for contact and communication with friends and family, a near-universal human trait that helps to explain the mobile phone's popularity. Another reason behind this popularity is that mobile phone services (and devices) are becoming more and more reliable, extensive and affordable. Mobile phone technologies are now in the hands of almost 31% or 2 billion people (Motorola, 2006) of the 6.47 billion people on this planet ("Population Reference Bureau Statistics", 2006). The penetration of these technologies is increasing very rapidly with around 779 million ("Gartner Press Release", 2005) mobile phones sold every year and

expected to reach over 1 billion units per year sold by 2009. These numbers are a clear indicator of the growth and reach of mobile phones. “India has a middle class that is larger than the population of the United States. It is a booming market," according to Eric Miscoll, Chief Operating Officer for EMS Industry Researcher Technology Forecasters (Carbone, 2005). The latest data from March 2006 indicates that India is the fastest growing mobile market in the world with over 5 million new users added per month bringing the total to over 90 million users (“Telecom Regulatory Authority of India Press Release”, 2006). However this represents only about 8% of India’s estimated total population (“Population Reference Bureau Statistics”, 2006). The corresponding US data from December 2005 shows that there are 207 million mobile users in the US (“CTIA Semi Annual Wireless Industry Survey”, 2006).

A survey conducted by India's leading telecommunications magazine, Voice and Data, found 45 million people owned mobile phones in India, compared with 44 million who had land lines (Indian mobiles overtake land lines, 2004). According to another recent report from Telecom Regulatory Authority of India (TRAI): India has about 44 million mobile connections and about 43 million landlines. By 2007, the country is slated to have 200 million phone connections of which, about 150 million will be wireless. The rural market in India is also good business proposition for cellular operators and handset manufacturers as the mobile phone penetration is very low in this area (Gupta, 2005). Remote rural areas that have no source of telecommunication, which have been previously skipped by the fixed line networks can be connected to the world with the penetration of wireless mobile networks. The numbers of mobile phones are overtaking landline phones. They already comprise about 43 percent of all U.S. phones, according to the International Telecommunication Union, up from 37 percent in 2000. Meanwhile, the number of U.S. landline phones has dropped by more than 5 million, or nearly 3 percent, since 2000, the Federal Communications Commission reported in June (Carrol, 2003). India and the United States are considered as mature or advanced markets for mobile phone usage because of their early adoption of mobile services and the rapid increase in the number of users. Moreover, the size of the

population with disabilities in each of the countries is significantly large for any company that plans to diversify to penetrate the global market.

In the early days of mobile phones, when they were used only to make and receive calls, the design issues for the mobile phone interface were relatively very simple. Today, however, design issues are far more complex, for example the small screen sizes of mobile phones can create problems for users, in particular for users with disabilities. Therefore, there is a need for acceptable user interfaces that enable a better, more enhanced use of the limited screen size and yet provide high levels of usability. The evolution of mobile phones with the inclusion of functions such as text messaging, e-mail, phonebooks have made it a complex device. Therefore designing this interface has become a more challenging task. Design of mobile phones for people with disabilities has an additional challenge.

According to estimates of the World Health Organization, there are 600 million people in the world living with disabilities, that is around 10% of the world's population (Jenkins, 2004). Developing products for people with disabilities is a socially worthwhile activity since the provision of a usable product can make enormous differences to the educational opportunities, quality of life and employment possibilities for people with disabilities (Newell, 1995). Moreover, this population can be considered as a target market for a company considering global expansion. This population has special needs and requirements, which are not the same as the needs of people without disabilities. The user-centered design approach has been modified and termed as User-Sensitive Inclusive Design in order to include this population in the design and development of a product (Newell & Gregor, 2001). This approach emphasizes that the designers need to pay special attention to the ethical issues that arise when users with disabilities are included in the design process.

1.2 Problem Statement

Designing products for a global audience involves more than the mere translation of the interface features. In fact, it requires a deeper understanding of the special needs of the target cultures. Due to the rapid expansion of the mobile phone industry in India and the United States,

this study will focus on these two countries. There have been some studies that have concentrated on the invisible influence of culture on the design of websites (Marcus, 1999). Some studies have also incorporated the role of culture in mobile phone services (Choi *et al.*, 2005). The study by Choi *et al*. (2005) determined some attributes of mobile phone services using qualitative methods of in-depth interviews in Korea, Japan, and Finland. Using a qualitative method, this study found 11 critical attributes of mobile data services that showed a clear correlation with characteristics of the user's culture. These attributes are summarized in Table 1.

Table 1: Critical mobile phone attributes that showed a correlation with cultural dimensions from Choi *et al.*,'s (2005) Study

Cell phone attribute
Minimal steps or key strokes
Secondary information about contents
Variety of contents
Logical ordering of menu items
Clear menu labeling
Efficient layout or space usage
Variety of Font sizes
Variety of Font colors
Large Amount of Information within a screen
Various options for contents

Cell phones and mobile devices have different interface design challenges due to their limited screen size and different input mechanism as compared to websites, which are mainly viewed on larger (desktop or laptop) screens. These devices have different usability concerns as well. Also a person with a disability has different concerns and needs compared to a person without a disability. So in designing assistive technology for a global market it is important to include the target population in the design process. This study is focused on comparing the design of cell phone interfaces for different cultures, where culture may be defined by disability or nationality.

1.2 Research Purpose

This research study was grounded in the belief that culture is a discernible variable that influences the usability and preferences of product interfaces. The aim of this research was to identify the cultural influence on design preferences of a cell phone interface for users with visual disabilities and no apparent disability.

1.2.1 Primary purpose

The main objective of this study was to identify the influence of national culture, which is defined by cultural dimensions in the design of cell phone interfaces for users with and without disabilities. The study also focused on the role of disability in the design preferences of cell phone interfaces. This study compares and summarizes differences in cell phone interface design preferences between two national cultures, India and United States also categorized on the basis of disability.

1.2.2 Secondary Purpose

The secondary purpose of this research was to investigate whether culture, which is currently defined by nations (as well as other factors), can also be defined by disability. Therefore the comparison of interface design preferences was made across disability groups as well as nationality groups.

1.3 Research Questions

This study was designed to answer the following questions:

- What are the differences in cultural values between users with (and without) disabilities across the two countries? Do these differences justify the presence of a disability culture?
- Are preferences for interface design features driven more by a nationality culture, disability culture or a blend of both?

- What are the differences between cultural groups in preferences of cell phone hardware features and usability ratings of tasks?
- What are the bases of the differences in interface design preferences between nationality or disability cultural groups?

1.4 Document Overview

The remaining body of this paper is divided into six main chapters – the literature review, methodology, research objective, data analysis and results and discussion and conclusion, respectively. The literature review section examines the current literature for information relevant to this study. This chapter begins by exploring cultural dimensions and then applying these theories to designing cell phone user interfaces. In the methods chapter of this paper, the research design for the study is explained. The research design is followed by a description of the variables and measurements, an overview of the participants, and a description of all of the materials and equipment involved in this cross cultural study. The methodology chapter is concluded with a detailed description of the procedures and data analysis techniques followed. Following the methods chapter, the next chapter reports the results of hypotheses tested for the study. The results are divided into quantitative data analysis and qualitative. After the results chapter, the discussion and conclusion chapter provides a detailed description of the results and findings of this study.

CHAPTER 2. LITERATURE REVIEW

2.1 Product Design

Designing products to fit the target user population has always been a challenge for product designers. The more complex the device, the greater is the design challenge to make the full range of facilities accessible and usable to the widest possible user base (Benyon *et al.*, 2001). Human factors issues within product design are being taken increasingly seriously in the industry (Jordon, 2000). When users and customers are considered to be an integral part of the product design process, different techniques such as user-centered design and participatory design have been developed.

2.2 User-Centered Design

The User-Centered Design methodology enables product/interface developers to focus on the users as the heart of the design process (Newell & Gregor, 2001). User involvement in the design process results in products that are more likely to provide what the users need and want (Oshlyyansky *et al.*, 2004). This approach has been extensively used by usability engineers and human factors engineers, and they emphasize the participation of the end users in the design process. According to Smith-Jackson *et al.* (2003), to design for usability, accessibility and to apply universal design designers must capture user-centered requirements to ensure that the product is designed for the target group.

2.2.1 Accessibility and Usability

Accessibility is an umbrella term for all parameters that influence human functioning in the environment, thus defining accessibility as an environmental quantity (Iwarsson & Stahl, 2003). Providing accessibility means removing barriers that prevent people with disabilities from participating in substantial life activities, including the use of services, products, and information.

With increasing attention to accessibility issues extensive research is focused on providing more on accessible environments and products. The accessibility dimension in technology is

concerned with building information technology hardware, software and services in such a way that they do not create barriers and exclude people from their use. A word often used in parallel with accessibility is Usability (Iwarsson & Stahl, 2003). The concept of usability implies that a person should be able to use (i.e. to move around), be in and use the environment on equal terms with other people. Accessibility can be approached as a subset of usability. In the context of user interfaces, Usability means designing an interface that is effective, efficient, and satisfying. According to Nielson (1992), usability of a product is the extent to which a product is intuitive and easy to use. The five main features of usability are:

- Learnability (ease-of learning)
- Efficiency (high productivity)
- Memorability (easy to remember procedures)
- Errors (low error rates)
- Satisfaction (Subjective satisfaction or pleasantness of product)

In this context of usability, accessibility means designing a user interface to be effective, efficient, and satisfying for more people in more situations. However, satisfaction is much less an issue with accessibility. Accessibility is more concerned with making interfaces perceivable, operable, and understandable (Henry, 2002).

Accessibility is a necessary precondition for usability. However, usability is not based only on compliance with official norms and standards; it is mainly subjective in nature taking into account user evaluations and subjective expressions of the degree of usability (Henry, 2002).

Compliance with accessibility guidelines sometimes sidelines usability. Regulations have contributed to improving accessibility of technology, and regulation compliance is becoming the objective in designing products and interfaces for users with disabilities, even though usability must be the most important objective for accessibility technologies (Takagi *et al.*, 2004). Instead of focusing only on the technical aspects of accessibility, it is important to recognize that usability is

also an important aspect of accessibility. If 'usable accessibility' is consciously addressed by designers, it will help to clarify the difference between what meets minimum accessibility standards and what is usable by people with disabilities (Henry, 2002).

2.3 Design for All

Design for All[1], Design for Diversity (Gregor & Newell, 2001), Universal Design[2] and Inclusive Design are terms that are used interchangeably for designing to cater to the broadest possible range of abilities, skills, requirements and preferences. This brings to mind user populations that belong to different cultures, genders, language and disabilities. The scope of Universal Design is broad and complex mainly due to the issues pertaining to diverse user requirements. The Design for All movement has been very valuable in raising the profile of disabled users of products, and has laid down some important principles. The Universal Design Center at NC State University is the premier institute that developed the seven principles of Universal Design, which are listed as follows:

1. **Equitable Use**: The design is useful and marketable to people with diverse abilities.
2. **Flexibility in Use**: The design accommodates a wide range of individual preferences and abilities.
3. **Simple and Intuitive Use**: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
4. **Perceptible Information**
   The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. **Tolerance for Error**
   The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. **Low Physical Effort**
   The design can be used efficiently and comfortably and with a minimum of fatigue.
7. **Size and Space for Approach and Use**
   Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

[1] Design for All, Barcelona Spain

[2] Universal Design Center, NC State University, USA

The use of the term universal design, however has some inherent risks (Newell & Gregor, 2001). This is due to the fact that designing a product that fits all possible users is a near impossible task, due to the variability in user preferences.

Providing access to people with a certain type of disability can make the product significantly more easy to use by people without disabilities, however sometimes impossible to use by people with a different type of disability. For example a cell phone with a audio display allows the Blind to use this technology, an audio display can be useful for people without disabilities while driving. A large print cell phone will be useful for users with low vision, however of no use for the totally blind. Moreover, according to Benyon *et al.,* (2001), poor design can disable even an *abled* user, therefore some design implications for people with disabilities could also be applicable to users without disabilities. It is the role of the designer to ensure that the concept of universal design enhances, not hinders the usability and accessibility of the product. Universal design principles are also considered as guidelines to develop interfaces for a global audience.

2.4 Globalization

In an increasingly global marketplace product designers are faced with the challenge to offer usable products and services to an enormous variety of users. With companies seeking to diversify into the global market, product designers need to have an insight about the numerous factors that contribute to the differences in users' requirements. Localization of a product to the target market is the customization of a product to suit its target market. This is sometimes just a superficial process such as translation of the language on the interface (Oshlyyansky *et al*., 2004). This can lead to frustration, increased training time and sometimes the rejection of the product (Oshlyyansky *et al.,* 2004). Translation is a necessary, but not sufficient step in the design of a culture specific product, and culture is more than just a language and it must be taken into consideration in creating globally used products or product that are localized to suit a specific culture (Nelsien, 1996). The following section describes some of the many ways in which culture is defined.

2.4.1 Culture and its Dimensions

Before talking about how culture influences interface design, it is important to identify what culture actually means. Traditionally, the term culture has been used to describe a group of people who have certain aspects of life in common. Many definitions of culture have been formulated by cultural anthropologists. However there is no agreement on a specific definition for culture. Contemporary anthropologists define culture as "an ideational system referring to what humans learn, not what they do and make" (Keesing, 1981, p.68). Culture can also be defined as "the fabric of meaning in terms of which human beings interpret their experiences and guide their action" (Geertz, 1973, p.145). Cultural differences in values and beliefs distinguish societies' behavior and attitude from one another.

Hall (1973, 1976) emphasized that non-verbal language is important for intercultural communication. Hall (1973, 1976) introduced the concepts of *chronemics, proxemics and context* in intercultural communication theory (Gould, 2005). C*hronemics* are explained on the basis of two ways of how time is organized. The first is the subjective division of time into technical, formal and informal systems and the second is the connection of time with activity. Technical time is the underlying physical context of time, which is used to divide time into units (Gould, 2005). For example the phases of the moon, sunrise or solstices can all be used to divide time into units. Formal time is the conventional system of time, which is based on technical time. The formal time system of measurement helps people plan, schedule and manage time. Informal time involves culturally different perceptions of the rate at with time passes. For example, "I will see you in 5 minutes" will have a different meaning in South Asia and a different meaning in the United States. For a person from South Asia this would mean that it is reasonable to show up within an hour, and for a person from the United States it means that they need to hurry to show up (Gould, 2005). The second way in which time is organized is based on the connection of time and activity. This leads to the aspects of monochronic and polychromic time. In monochronic societies, people do only one

thing at a time whereas in polychronic societies, people do several things at once. Proxemics, which means the social use of space and which is used to determine status and group orientation is the other construct determined by Hall (1973) for intercultural communication theory. *Proxemics* are analyzed in different cultures in terms of technical, formal and informal systems. Technical systems are bound by physical constraints, formal systems arise from the process of architecture, and informal systems are interpreted from informal patterns for proximity and arrangement (Gould, 2005). The third construct developed by Hall (1976) was context. This construct emphasizes the importance of non-verbal communication in social systems. In a low-context society a message is conveyed through non-verbal behaviors and actual text is secondary. In a high context society a message must be conveyed explicitly through text and non-verbal behavior may not be interpreted appropriately. Table 2 summarizes Hall's constructs for intercultural communication.

Table 2: Summary of Hall's (1973;1976) Constructs for Intercultural Communication

Construct of Intercultural Communication Theory			Description
Chronemics	Subjective Division of Time	Technical	Physical context of experience of time
		Formal	Conventional system of measurement of time
		Informal	Perception of rate at which time passes
	Connection of Time and Activity	Monochronic	Perform one activity at a time
		Polychronic	Perform more than one activity at a time
Proxemics	Technical		Physical constraints of space
	Formal		Architecture
	Informal		Informal patterns of proximity and arrangement that determine group orientation
Context	High context		Information must be explicitly stated in the text of the message
	Low Context		Social system shapes meaning through non-verbal behavior, actual text is secondary

Hofstede's (1980,1997) theory of universal cultural dimensions is the best known, and the most applied and validated theory of intercultural communication (Gould, 2005). According to Hofstede (1997), every person carries within him or herself patterns of thinking, feeling and acting

which are learned throughout his or her lifetime. A person's childhood and upbringing have significant effects on the development of these patterns. Hofstede (1997) suggested the fact that culture is always shared with people who live or lived within the same social environment where it was learned. The definition of culture that was formulated by Hofstede (1997, p.4) is "the collective programming of the mind which distinguishes the members of one group or category of people from another."

In the definition of culture, groups or categories of people refers to people that are in contact with each other or that have something in common (e.g. nationality, gender, religion, ethnicity). Hofstede (1980, 1997) provided empirical analyses that support national cultures. Hofstede (1980, 1997) administered a survey for IBM employees of over 50 different countries around the world and came to the same conclusion - that different nationality cultures have the same issues but vary in the way they approach them. However this study has explored the two predominant boundaries of culture: disability and nationality. The issues of "dimensions of culture" have been developed because these were constructs that could be measured respectively between cultures. A dimension is an aspect of a culture that can be measured with respect to other cultures (Hofstede, 1997). Hofstede identified the following dimensions that form a model for differences among national cultures that have been defined as 1) Power distance 2) Individualism vs Collectivism 3) Feminity vs Masculinity 4) Uncertainty Avoidance and 5) Long Term Orientation.

Power distance is measured on the basis of inequality in the society. It is defined as the extent to which the less powerful people in society accept and expect that power is unequally distributed (Hofstede, 1997).

Individualism represents a preference for a loosely-knit social framework where people are expected to look out for their own interests take care of themselves, whereas collectivism indicates an inclination toward a tightly-knit social framework where people expect their companions to look out for their welfare and where personal goals are subordinated to those of the group (Hofstede, 1997).

Masculinity measures the degree to which a culture separates gender roles. Masculine cultures accept traditional and distinct gender roles, and are mostly male-dominated societies. A feminine culture does not separate traditional gender roles. Hofstede (1997) focuses on the traditional assignment of assertiveness, competition, and toughness to masculine roles, and feminine roles of orientation to home and children, people, and tenderness, in a masculine culture. However feminine cultures tend to break down these distinctions and overlap gender roles. Masculinity refers to the relative desire of material success and assertive behavior versus quality of life and modest behavior.

Uncertainty avoidance can be defined as the extent to which the members of a culture feel threatened by uncertainty, ambiguity and the unknown, along with the eagerness to avoid these situations (Hofstede, 1997). People in a high uncertainty avoidance culture perceive uncertainty as dangerous and show a low tolerance for risk and tend to reject new and unusual ideas (Choi et al., 2005). On the other hand, a culture that has low uncertainty avoidance can deal well with vagueness and its members can be characterized as risk-takers.

Long term orientation focuses on the degree to which the society embraces, or does not embrace, long-term devotion to traditional or forward- thinking values. High Long-Term Orientation indicates that the country prescribes to the values of long-term commitments and respect for tradition (Hofstede, 1997). This dimension was discovered by Micheal Bond in the 1980's while he administered a questionnaire called the Chinese Value Survey in 23 countries, and was added to the model and increased the number of dimensions to five (Gould, 2005).

2.4.2 Measuring Cultural Dimensions

Hofstede (1980, 1997) summarized these dimensions into index scores based on a questionnaire he used to survey IBM employees. The questionnaire he used was called the Value Survey Module 1982 or the VSM 82. Figure 1 shows a comparison of the Index scores of IBM employees in India and the US from the VSM 82.

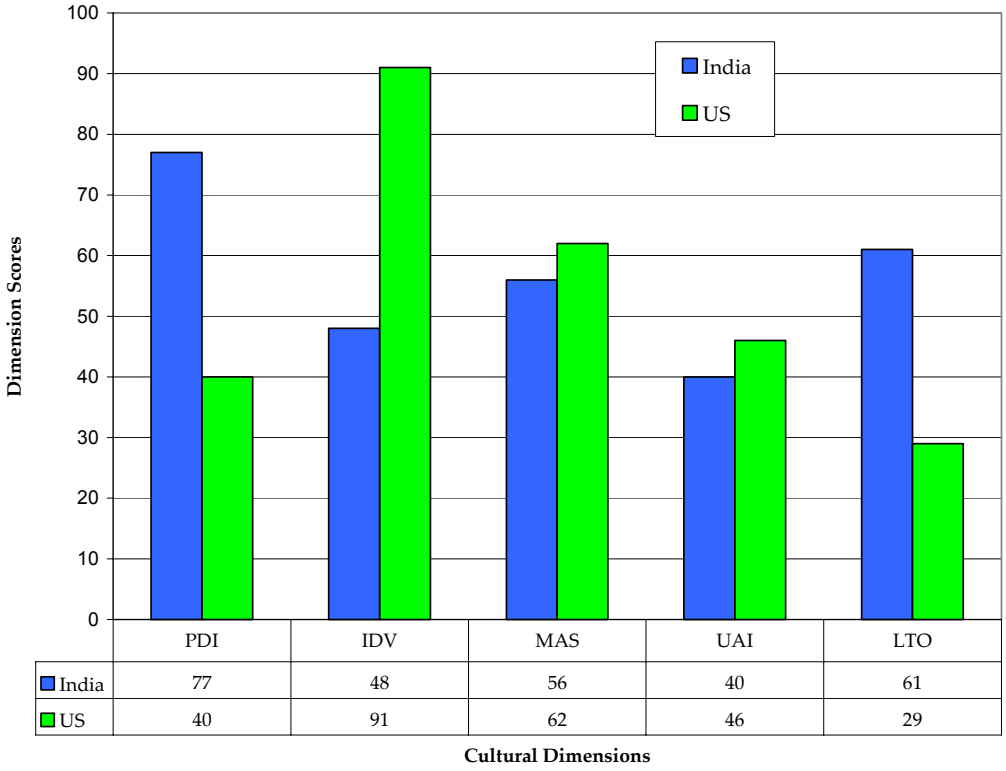

Figure 1 : Hofstede (1980; 1997) Dimension Scores for India and United States

This questionnaire (VSM 82) was an extensive questionnaire that included 47 questions. This was condensed into a questionnaire called the Value Survey Module 1994 (VSM 94) (Appendix A). This questionnaire is Likert-type scale that has twenty content questions and six demographic questions. The demographic questions have been summarized in a demographic questionnaire in Appendix B. This questionnaire has been used and tested for reliability and validity various cross-cultural studies (Christie *et al.,* 2003; (Kerston *et al.*, 2002).

For the research scope of this study, Hofstede's work was chosen as a framework, because his research has been used and validated by many researchers and practitioners in various cultural studies (Christie *et al.*, 2003). These dimensions have also been used to understand their implications in designing product interfaces (Marcus, 2000). Also Hofstede's (1991) work has defined strategies developed for countries in advertising and marketing campaigns, and more

recently in product design practices (Jordon, 2000). The availability of instruments to measure these cultural dimensions also led to the choice of this framework.

Cultural dimensions were measured using the VSM 94 questionnaire developed by (Hofstede, 1994). The Values Survey Module 1994 (VSM 94) is a 26-item questionnaire developed for comparing culturally determined values of people from two or more countries or regions. It allows scores to be computed on five dimensions of national or regional culture, on the basis of four questions per dimension: for this, it needs 5 x 4 = 20 questions. The remaining six questions are demographic relating to gender, age, education level, job type, present nationality, and nationality at birth. Research has shown that the answers to the 20 content questions vary substantially between nationality groups (Hofstede, 1994).

However, answers to the 20 content questions will also be influenced by other characteristics of the respondents, such as gender, age, level of education, occupation, kind of work, and year that the survey was administered (Hofstede, 1994) and other factors such as type of disability. Therefore, comparisons of countries or regions should as far as possible be based on samples of respondents who were matched on all criteria other than nationality or region. They should be matched on any criterion (other than nationality) that can be expected to affect the answers. The formulae for index calculation and the VSM 94 questionnaire can be referenced in Appendix A.

2.4.2.1 Limitations of VSM 94

When samples of respondents of the same nationality but with different occupations or different employers are compared (matched on criteria other than occupation or employer), the same dimensions were not found (Hofstede, 1994). The responses to most of the questions do vary somewhat from one occupation to another, and sometimes from one employer to another. The scores will also vary from one individual to another (Hofstede, 1994). If the questionnaire is used to compare responses from individuals, from respondents with different occupations or employers,

or from respondents belonging to any category other than nations or regions, the answers should be examined question by question and not combined into these five dimensions.

The following section discusses a unique aspect of culture which is integrated into the lives of people with disabilities, also termed as disability culture.

2.5 Disability Culture

According to Fine and Asch, 74% of Americans with disabilities feel a common identity with one another and 45% of them see themselves as part of a minority, with a particular group consciousness belonging to a specific group (Peters, 2000). Peters (2000) argues that disability culture not only exists, but is also a thriving concept and lived experience in the hearts and minds of many people with disabilities. According to Peters (2000), Bragg contended that in order for people with disabilities to claim a disability culture and therefore, a cultural identity, several requirements must be satisfied:

(1) a common language;

(2) a historical lineage that can be traced textually (through archives, memorials and distinctive media/press publications);

(3) evidence of a cohesive social community;

(4) political solidarity;

(5) acculturation within the family at an early age (and/or in segregated residential schools and clubs);

(6) generational or genetic links;

(7) pride and identity in segregation from others.

Based on these requirements Peters (2000) provides a solid theoretical foundation to claim that people with disabilities have a group identity, which can be termed as disability culture. They share a common history of oppression and a common bond of resilience (Brown, 2001). They generate art, music, literature, and other expressions of their lives and their culture, infused from

their experience of disability. Disability culture is a set of artifacts, beliefs, expressions created by people with disabilities to describe their own life experiences. People with disabilities are also members of different nationalities, religions, colors, professional groups, and so on (Brown, 2001). Also, no matter what the disability or location of the person with the disability, s/he has encountered oppression because of their disability. Brown (2001) states that disability culture in the Southwest of the U.S. may be very different from that Northeast U.S. or Europe or Asia, but they all will have some similarities. However, for a person to identify with a disability culture depends on when the disability was acquired and whether the presence of the disability has been accepted or not. These studies provide some theoretical foundation to the present study and served as an important foundation in the formulation of the research questions of this paper.

2.5.1 Prevalence of Disabilities

Unfortunately data are lacking on many aspects of statistics of the population with disabilities in the developing world. According to estimates of the United Nations, about 10% of the world's population is has some form of disability. According to estimates of the World Health Organization, there are 600 million people in the world living with disabilities, that is around 10% of the world's population (Jenkins, 2004). A recent (1997) projected estimate for world blindness points to some 45 million blind, and an additional 135 million are visually disabled or have low vision (Thylefors, 1998). According to Vanderheiden (1990), estimating the number of individuals with a disability is a difficult task. Disability estimates depend on the definition of a disability, and the source of the data. Many data sources may be available, which may lead to data overlap between sources that results in too may estimates. Another reason that leads to inaccurate estimates is due to the fact that sources classify data based on the type of disability, therefore those with more than one disability may be classified more than once (Vanderheiden, 1990). Also disability statistics may be not be reliable since the definition of disability is not consistent across all nations.

According to India's Census data (2001) there are 21.9 million people with disabilities (visual impairment, hearing impairment and locomotor) in India. The 2001 Census figures show

that the highest percentage (48.5) of people with disabilities is in the visual impairment category (Disability News and Information Service, n.d). According to other sources it is estimated that the population with disability in India is approximately over 90 million, of these 12 million are blind, 28.5 million are with low vision, 12 million are with speech and hearing defects, 6 million orthopaedically handicapped, 24 million mentally retarded, 7.5 million mentally ill, 1.1 million leprosy cured (Voices for all: Definition of Disability, 2003).

The National Sample Survey Organization (NSSO) conducted a survey of disability in 1991. In this survey people were classified as "disabled" if they had less than 40% "normal" functions and concentrated primarily on physical disabilities. The concept of "normal functions" was not clearly defined. The findings of this survey included:

• 9% of rural households and 7% of urban households have at least one person with disability (average household size was 5.8 people).

• 1.9% of the Indian population had severe or profound physical disabilities.

• 12% of the disabled people identified had multiple disabilities.

• 80% of people with disabilities live in rural areas.

• 4% of children aged 0-4 years living in rural areas and 3.3% of those in urban areas had a hearing loss.

The U. S. Census data (2000) indicated that 53 million Americans have some type of disability ("Disability status ", 2000). Also 10.8 million people have a sensory disability involving sight or hearing. Newell and Gregor (1997) estimated the distribution of certain disabilities within the United States as:

- 1 in 10 have a hearing impairment, and 1 in 125 are deaf

- 1 in 100 have a visual disability, 1 in 475 have legal blindness, and 1 in 2000 have total blindness

- 1 in 250 are wheelchair users

- 20% of the population has difficulty performing basic physical activities

- 7.5% are unable to walk, lift, read, or hear without help

Whatever statistics are adopted, it is a fairly safe assumption that individuals with disabilities constitute a large minority group in India and the United States and around the world. This population estimate indicates the size of the untapped market that can be targeted by a company that designs and manufactures assistive technologies for low vision. . The legal obligations are governed by the disability legislation in every country that protects the rights of people with disabilities. Understanding the design needs also need attention to the legislation for people with disabilities in a country.

2.5.2 Disability Legislation

Different countries have different laws and regulations to protect the rights of their population with disabilities. These differences can be more significant between developed and developing countries.

The Americans with Disabilities Act (ADA) was the initial legislation that brought accessibility issues into public focus (Americans with Disabilities Act Technical Assistance Program, 2001). Title 2 of the ADA, passed in 1990, required services and communications products to be accessible to those with disabilities ("The Americans with Disabilities Act," 1990). If the services or communications products were not already compliant, manufacturers had to make "reasonable accommodations" to demonstrate an effort towards compliance. After the passage of the ADA, the Federal Communications Commission passed the Telecommunications Act of 1996. Within the Act is the provision that all telecommunications equipment be designed to be accessible by those with disabilities (Telecommunications Act of 1996, 1996). Telecommunications equipment includes, but is not limited to, cellular telephones, personal computers, residential telephones, etc. In 1998, Congress amended the Rehabilitation Act to require Federal agencies to make their electronic and information technology accessible to people with disabilities. Inaccessible technology interferes with an individual's ability to obtain and use information quickly and easily. Section 508 was enacted to eliminate barriers in information technology, to make available new opportunities for people with disabilities, and to encourage development of technologies that will

help achieve these goals. The law applies to all Federal agencies when they develop, procure, maintain, or use electronic and information technology (Section 508: 508 Law, 2002).

In India the "Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995" (PWD) came into force on February 7, 1996. This law was an important landmark and is a significant step in the direction of ensuring equal opportunities for people with disabilities and their full participation in nation-building. The Act provides for both preventive and promotional aspects of rehabilitation like education, employment and vocational training, job reservation, research and manpower development, creation of a barrier-free environment, rehabilitation of persons with disability, unemployment allowance for the disabled, special insurance scheme for the disabled employees and establishment of homes for persons with severe disability (Disability India Network, n.d.).

2.5.2.1 Definition of Disability

There is no single, universally accepted definition of disability. The World Health Organization (WHO) manual defines a disability as any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being (Voices for all: Definition of Disability, 2003)

Under the ADA (Americans with Disabilities Act 1990), a person is disabled if s/he:

- has a physical or mental impairment that substantially limits one or more major life activity;
- has a record of such impairment; or
- is regarded as having such an impairment.

Persons with disabilities (PWDs) in India are defined as persons who have lost not less than forty percent of any ability as certified by a medical authority. The Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995 identifies the following four categories of disability.

1. Locomotor disability: Disability of the bones, joints of muscles leading to substantial restriction of movement of the limbs due to any form of cerebral palsy.

2. Hearing impairment: The PWD Act defines hearing disability as "loss of sixty decibels or more in the better ear in the conversational range of frequencies". A person is considered as having a severe hearing disability when the person cannot hear at all, or hear only loud sounds. In India, surveys on hearing disabilities are conducted only for people who are 5 years old and above.

3. Mental Retardation: Defined as "a condition of arrested or incomplete development of a person's mind" in the PWD Act.

4. Low vision / no vision: Low vision or no vision is a total absence of visual function even after treatment or standard refractive correction. A person who has low vision or no vision uses appropriate assistive devices or is potentially capable of using vision. In this study participants that were legally blind/ partially sighted were recruited and they reported their disability by self report.

The current research study was focused on the population with visual disabilities since is one of the more prevalent disabilities.

2.5.3 Design for People with Disabilities

People with disabilities have traditionally had lower levels of education and employment and higher levels of poverty when compared to others within society, due to inequalities related to access. The easy access and use of information through the use of information appliances or telecommunication devices can increase access to employment by allowing those with disabilities to use their cognitive skills, rather than physical skills (Langton & Ramseur, 2001). Designing for the disabled population is not just an ethical approach to design but also important for business. *Handicapitalism* (a term coined by Johnnie Tuitel, a lecturer with a disability), describes the realization in business that people with disabilities are not charity cases or regulatory burdens, but

can be on the contrary profitable marketing targets (Prager, 1999). This population represents a growing target market to which new services can be provided (Emiliani, 2001). Mainstream companies, from financial services to cell phone makers, must go beyond what is mandated by law and rapidly tailor products to attract people with disabilities (Prager, 1999). There is not only a moral and legal obligation to provide access to products and services, but also a growing awareness in the industry that people with disabilities and elderly people can no longer be considered as an insignificant minority.

Including users with disabilities in the design process, is termed as User Sensitive Inclusive Design, which has been adopted in this research.

2.5.4 User Sensitive Inclusive Design

Involvement of people with disabilities in the design process has been a new experience for all design consultancies. To understand these users' requirements, designers must meet with users with disabilities to discuss their needs and preferences, and study how they would use these devices if they had access to them. Undoubtedly designers consider their opinion very useful and valuable. Soares and Kirk (2000) believed that although this sounds simplistic, it is not simple to do. According to Dong *et al.,* (2002) people with disabilities are expert users as they always look beyond the product features to detect potential problems. These problems and design issues may not arise easily when a person without a disability is attempting to design a product for a person with a disability.

This user-centered design approach has been extended to the 'User Sensitive Inclusive Design' approach (Newell & Gregor, 2001). User Sensitive Inclusive Design is an attitude of the mind, which differs from simply and mechanistically applying a set of "design for all" guidelines. The designers need to pay special attention to the ethical issues that arise when users with disabilities are included in the design process. These ethical issues may include getting the informed consent approval from the users and ensuring that the users comfortable in the environment to communicate their thoughts easily since they may not be able to do so because of

their disability. Ethical issues were minimized first by getting an approval from the Institutional Review Board for this study and requesting the participants for informed consent. Accommodations such as large print forms and assistance with form filling was provided to all the participants that requested it.

The next section is a discussion on the role of culture in design of interfaces.

2.6 Culture-Oriented Interface Design

"There is no denying that culture influences human-product interaction" (Hoft, 1996 p.25). Concrete or overt factors that one can clearly observe are just surface features of an interface. They are tangible, straightforward and easily observable elements (Yeo, 1996). Many guidelines such as the one by Fernandez (1995) have been formulated for interface design elements that are dependent on language, presentation formats, graphical symbols and so forth. An example of this is the difference in date formats in Europe and United States. In Europe, the date format is DD/MM/YYYY, whereas in the US the date format is MM/DD/YYYY.

Cultural elements can be deeply embedded in a society and people might not be aware of them. These are covert factors that deal with elements that are intangible (Yeo, 1996). Colors, for instance, have different connotations in various cultures. The color white in most European countries is associated with purity, cleanliness and peace. In China, however, white is associated with death. A white dove to represent freedom and peace might not convey the message intended. One of these intuitive cultural factors is the flow of information. An example from Russo & Boor (1993) is the arrangement of icons on a screen. In America and the UK a series of icons would be organized from left to right and from top to bottom. Focus is placed in the top left hand corner of the screen. An example of this can be seen in Figure 2 which is a snapshot of the website http://www.bbc.co.uk/, which would be counter-intuitive for Arabic and Chinese users because written information does flow left to right and not right to left or top to bottom. An example of this can be seen in Figure 3, which is a screen shot of the website http://news.bbc.co.uk/hi/arabic/news/

for Arabic users In another example, explained by Sukaviriya & Moran (1990), some Asian scripts have no upper or lowercase letter writing. Under these circumstances, a function to change case would be completely useless. It would be irrelevant to user expectations and, to the extent that it complicates the interface, such a function would most likely be cumbersome.

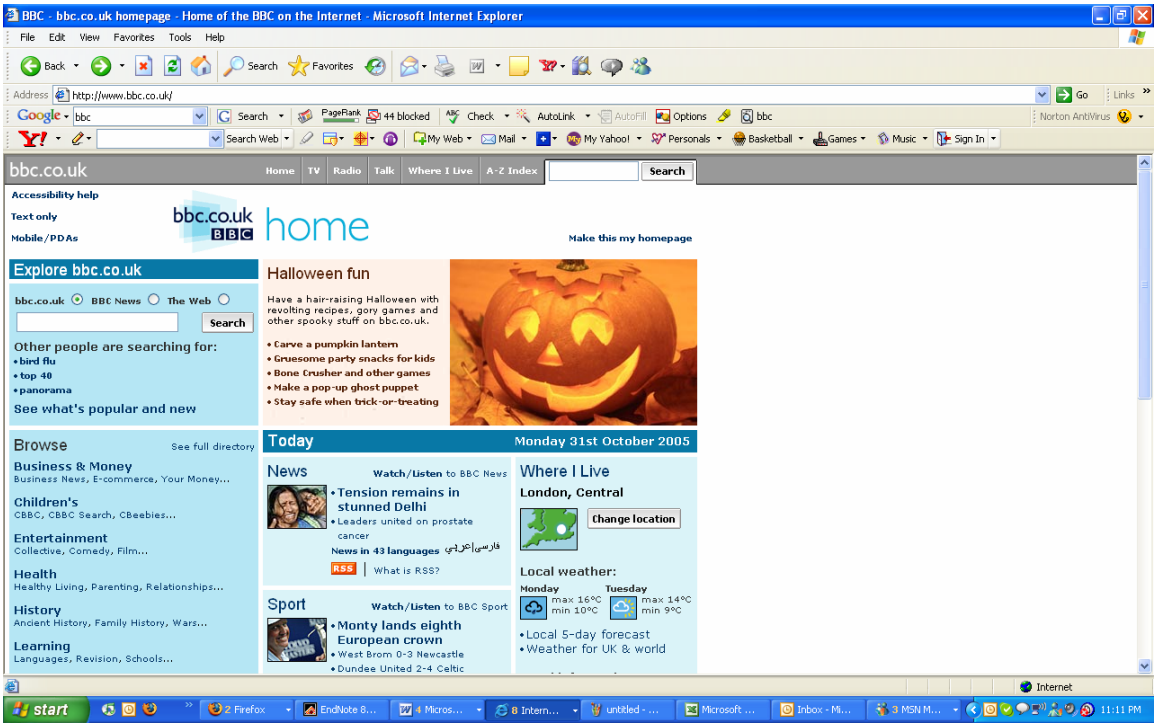

Figure 2: A snapshot of a Western website: http://www.bbc.co.uk/

Figure 3: A screen shot of an Arabic website http://news.bbc.co.uk/hi/arabic/news/

It was important to examine the existing literature for designing global interfaces, in order to avoid misinterpretation of the meaning intended by developers and to avoid offending the target culture (Yeo, 1996). However there has not been much research on identification of the invisible cultural influence on human-machine interface design. Cultural influence is invisible since it cannot be directly observed and quantified, but must be inferred from the values and beliefs of the society. In fact, culture has a strong effect on what users look for in a systems interface and how they perceive such interfaces (Choi *et al.*, 2005).

Some research was explored in the area of an increasingly important issue: the Cultural User Interface (CUI) (Yeo, 1996). The CUI is a user interface that is intuitive to a particular culture. It takes advantage of the shared or common knowledge of a culture, which could be defined by country boundaries, language, cultural conventions, ethnicity, shared activities or workplace (Yeo, 1996). Although the term CUI is not used frequently, the concept remains the same for many. The computer, ubiquitous as it is nowadays, requires an extra effort on redesigning its interface to be compatible with other cultures. "To successfully build bridges between worlds, user interface

designers must increase their awareness of cross-cultural differences, and make changes to the traditional software development process. As computer markets become more international, the research and design community must think about user interfaces in more global terms that include cultural awareness." (Russo & Boor, 1993, p. 343). In designing software for a global audience, increase global acceptance of software products will be increased and therefore will increase the user's effectiveness, efficiency and satisfaction with the product. A truly intuitive cross-cultural software should reflect the cultural orientation of its users and accommodate user's cultural differences (del Galdo & Nielsen, 1996), concerning interface design preferences as well as the attitude towards software technology. According to (Barber & Badre, 1998), *Culturability* is a term used to emphasize the importance of the relationship between culture and usability. *Culturability,* has implications in the usability aspects of software design. It is important that Usability is re-defined in terms of a cultural context, as what is "user friendly" for one culture can be vastly different for another culture.

As discussed earlier, there have been some studies that suggest that people with disabilities have their own culture. Moreover, some studies have suggested the need to incorporate a culture's values and beliefs into the design of the interface. Since research in the area of cross-cultural studies in interface design for users with disabilities remains unexplored this paper was an attempt to open the interface design community to this untapped dimension.

2.6.1 History of culture-oriented interface design

According to Gould (2005), Stewart and Bennett believed that cultural values and communication style arise from the process of human perception. Screen layout and expectation of interaction depend on values and assumptions of culture. Fernandez (1995) introduced the problem of translating cultural symbols, taboos and aesthetics into interface design. Barber and Badre (1998) introduced the term *cultural marker* to define an interface element that has a cultural

affiliation. According to the Horton and Wohl's (1956) theory of *parasocial* communication, the interaction of people with media is just an extension of face to face communication between people. Therefore the theories of communication from different cultures should transfer directly to communication between people from one culture using interfaces developed in another (Gould, 2005). All these theories do play an important role in the design of product interfaces. An in-depth analysis of these theories can further examine how they can be applied to the design of cell phone interfaces. However, due to limitations of resources of this study only one model which is Hofstede's cultural model was applied to the aspects of cell phone interfaces.

2.6.2 Mapping Cultural Dimensions to Interface Design

It is important to understand the components of an interface in order to map the cultural dimensions onto the design of the interface for a target culture. Figure 4 shows the sequence of steps that were followed to map the cultural dimensions to interface design (Marcus, 2005).

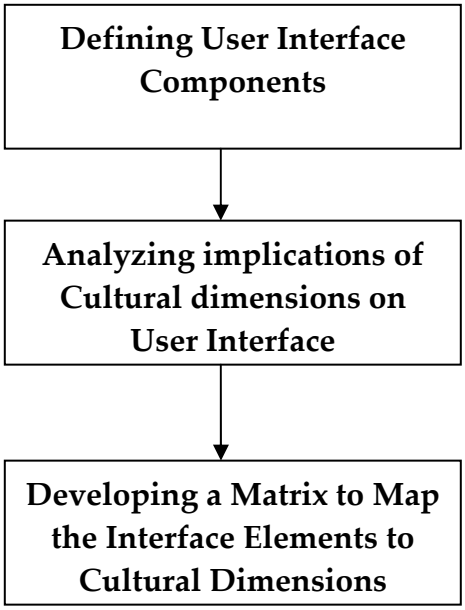

Figure 4: Steps to Map UI to Cultural Dimensions

According to Marcus (2000), a user interface has the following components:

1) Metaphors: Metaphors are fundamental concepts that are communicated through different mediums such as words, images, sounds and tactile experiences. This element of the user interface helps users understand how to interact with the system using a known concept in the real world.
2) Mental Models: Mental models are structures or organization of data, functions, tasks and roles. They are cognitive structures of concepts and procedures that users refer to when selecting relevant system goals (Rosson and Carroll, 2002). Examples of mental models are content, function, media and task hierarchies (Marcus, 2005)
3) Navigation: Navigation involves movement through the mental models, through content and tools. Examples of navigation are menus, dialogue boxes, control panels, icons etc that enable this movement (Marcus, 2005).
4) Interaction: Interaction includes input output techniques, feedback and status displays. This includes detailed behavior characteristics of keyboards, keypads, mice, or microphones for input; headsets, hands-free or loudspeakers for output; using drag and drop for selection and action sequences (Marcus, 2005).
5) Appearance: It includes perceptual attributes such as visual, auditory and tactile characteristics of the interface. Examples include choices of colors, fonts, animation, sound cues and verbal cues (Marcus, 2005).

Marcus & Gould (2000) have studied how website user interfaces are affected by the underlying cultural dimensions of the society. The design implications for each of Hofstede's (1980; 1997) cultural dimension for user interface design is summarized in Table 3.

Table 3: Design Implications of Hofstede's Cultural Dimensions

Power-distance	Collectivism vs. individualism
• Access to information: highly structured (high PD) vs. less-highly (low PD) structured. • Hierarchies in mental models: tall (high) vs shallow (low). • Focus on expertise, authority, experts, certifications, official stamps (high) • Importance given to leaders vs. citizens, customers, or employees (high) • Importance of security and restrictions or barriers to access: explicit, enforced, frequent restrictions on users (high) vs. transparent, integrated, implicit freedom to roam (low).	• Motivation based on personal achievement: maximized (expect the extra-ordinary) for individualist cultures vs. underplayed (in favor of group achievement) or collectivist cultures. • Rhetorical style: controversial/ argumentative speech and tolerance or encouragement of extreme claims(Ind.) vs. subdued hyperbole and controversy (Col). • Prominence given to youth and action (Ind.) vs. aged, experienced, wise leaders (Col.) • Underlying sense of social morality: emphasis on truth(Ind) vs. relationships (Col.). • Emphasis on change: what is new and unique (Ind) vs. tradition andhistory(Col.)
Femininity vs. masculinity.	**Uncertainty avoidance**
• Traditional gender/family/age distinctions (Mas) • Work tasks, roles, and mastery, with quick results for limited tasks(Mas) • Navigation oriented to exploration and control (Mas). • Attention gained through games and competitions (Mas). • Graphics, sound, and animation used (Mas). • Blurring of gender roles (Fem) • Mutual cooperation, exchange, and support, (rather than mastery and winning) (Fem) • Attention gained through poetry, visual Aesthetics, and appeals for unifying values (Fem)	• Simplicity, with clear metaphors, limited choices, and restricted amounts of data (high). • Attempts to reveal or forecast the results or implications of actions before users act (high) • Navigation schemes intended to prevent users from becoming lost (high). • Redundant cues (color, typography, sound, etc.) to reduce ambiguity (high) • Less control of navigation; for example, links may open new windows leading away from the original location (low) • Mental models and help systems might focus on understanding underlying concepts rather than narrow tasks. (low) • Coding of color, typography, and sound to maximize information (multiple links without redundant cueing) (low) • Complexity with maximal content and choices (low)

Long- vs. short-term orientation dimensions
• Content focused on practice and practical value (LTO). • Patience in achieving results and goals (LTO). • Content focused on truth and certainty of beliefs (STO). • Rules as a source of information and credibility (STO). • Desire for immediate results and achievement of goals (STO).

A deeper understanding of the relationship of the user interface components with the cultural dimensions is sought by specifying the interface components of the product to be designed for the target market. Firstly the components of the cell phone interface were identified. The dependence of these specific interface components on the underlying cultural dimensions was the next step to reach the goal of mapping the dimensions to the components.

2.6.3 Cross-Cultural Studies of Mobile Devices

Handy/ Händi (pronounced "Hendi") in Germany, mobile phone in the UK, mobile in India, and cell phone in the United States are the terms used to refer to one and the same device (Answers.com, n.d.). Besides these differences in the language and terminology for the same device used in these countries, the cell phone interface preferences may also differ between these countries. These differences are governed by the cell phone service provider schemes in each country (free incoming or minute charges), the laws enforced for cell phone usage (in public places, or while driving) and the kind of technology cell phone used (GSM, CDMA etc.), that may differ in every country. Mobile device interfaces are more difficult to design due to their limited screen size, consequently there is limited research in this field. In a cross-cultural study of mobile devices, Sarker & Wells (2003) discovered many factors affecting the acceptance of mobile devices, including cultural origin affecting the pattern of use. Similarly, different cultures accepted and adopted different modes of mobile communication (SMS for example) (Sarker & Wells, 2003). Another cross-cultural study of learning methods of cell phones (Honold, 1999) provides guidelines

for the type of user manuals, German and Chinese cell phone users may prefer. However there were studies found examining the cross-cultural aspect of interface design for users with disabilities.

2.6.4 Cell Phone Interaction Research Model

The interaction between the users and the device is through the device's interface. Most cross-cultural user interface designs focus on how to present information appropriately in different cultures (Ito & Nakakaoji, 1996). This interaction with the cell phone interface consists of four phases of cognitive activity. The model is derived from the basic model of cognitive activity that has been described by Ito & Nakakaoji, (1996). The block diagram of the model applicable to cell phone interaction for this study can be seen in Figure 5.

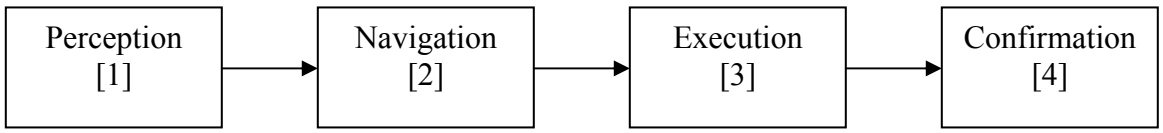

Figure 5: Interaction Phases of User's Cognitive Activity

This model in Figure 5 has been described by Kim & Lee (2005). In this model the dependency on culture increases as the stages progress. These phases are described as follows:

1) Perception: The affordance perception phase when users identify what the system has to offer by viewing the initial presentation on the screen. This is the first phase of the cognitive activity and where the user perceives what affordance the system has to offer, and then goes on to check the applicability of the affordance to the task at hand. The user will first perceive the start up view of the cell phone interface.
2) Navigation (Applicability Check): This phase is where the users validate their choice of actions (Ito & Nakakaoji, 1996). Culture affects the users' attitude in this phase. In this

phase the user will enter the menu structure in order to search for a specific item or a menu which will lead to the completion of the task goal.

3) Execution: This third phase of the activity is where the users enact their action plan (Ito & Nakakaoji, 1996). The users have to follow a certain path in order to achieve the ultimate goal. For example sending an SMS or looking up a number in the phone book.
4) Confirmation: The user performs a task with the expectation of confirmation whether the task has been completed or not.

This model is further analyzed to list specific cell phone user interface elements in the following section.

2.6.5 Cell Phone Interface Components

According to Ketola & Roykkee (2001), mobile handsets or cell phones can be observed from two points of view, the point of view of design and that of a user. From the design point of view, a cell phone is an interactive system. An interactive system is a combination of hardware and software components that receive input from and communicate output to a human user in order to support his or her performance or a task, according to ISO 13407 (Ketola & Roykkee, 2001). The cell phone can also be viewed as an information appliance from the point of view of the user. An information appliance is designed to perform a specific activity, such as music, photography or writing and has the ability to share information (Ketola & Roykkee, 2001). In this study they proposed that the cell phone user interface has three components:

- User Interface
- Service Interface
- External Interface

The cell phone usability is dependent on all three of these interfaces. If any one of these interfaces is poorly designed or is temporarily dysfunctional, it affects the users' performance and perceived ease of use of the other interfaces (Ketola & Roykkee, 2001) . Table 4 summarizes the UI

components proposed by Ketola and Roykkee (2001), along with items that correspond to each of these components.

Table 4: Cell Phone User Interface Components

Interface	Category	Items
User Interface	**Input tools (functionality, industrial and mechanical design)**	Navigation tool, Softkeys, Keypad/keyboard, Special keys (Power, Call management, Voice)
	Display	Icons, Indicators, Language, Familiarity, Localization
	Audio, Voices	Ringing tones, Quality, Interruption
	Ergonomics	Touch and feeling, Slide, one-hand operating Balance, Weight, Size
	Detachable parts	SIM card, Battery, Snap-on (Color) cover
	Communication method	Radio link, Bluetooth, Infrared, Cable
	Applications	Fun, Utility, Usability
External interface	**User Support**	Local help, Manuals, Documentation
	Accessories	Charger. Hands-free sets, Loopset, External keyboard
	Supporting software	PC software, Downloadable applications
Service Interface	**Services**	Availability, Utility, Interoperability

2.6.5 Mapping interface components to cultural dimensions

Cell phone interface features are analyzed on the basis of the interaction model by Ito & Nakakaoji, (1996) and cell phone interface components by Ketola and Roykkee (2001), in the previous sections. UI components for each interaction phase are listed in the Figure 6. These components have been summarized from the research papers by Kim & Lee (2005) and Choi *et al.* (2005).

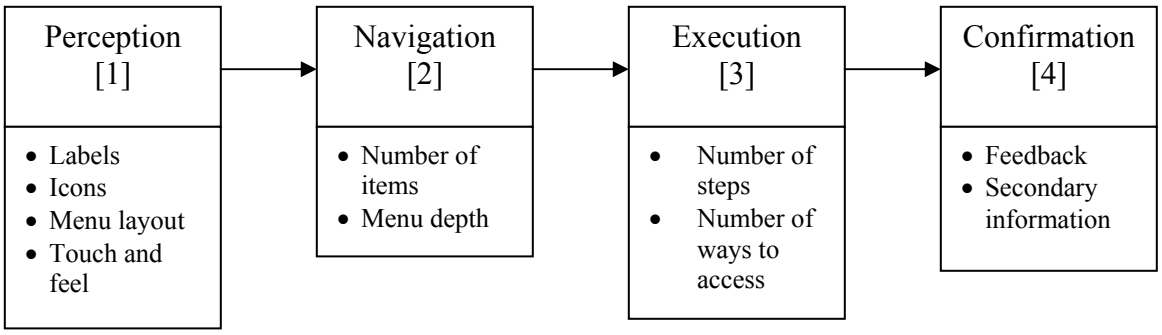

Figure 6: Research Model of Cell Phone Interaction with Interface Components

These cell phone UI components are mapped to specific attributes of the cell phone interface described by Kjeldskov & Stage (2004). Each attribute is described below along with its relationship with the cultural variables. This relationship is summarized from the cross-cultural study of websites by Marcus & Gould (2000). A description of the cell phone attributes and their relationship with Hofstede (1991)'s dimensions is provided in the following section.

1) Minimal Steps or Keystrokes: This feature of the cell phone indicates that to search for the desired function while navigating through the menu, the task would require few/minimal steps to search for desired contents. According to (Hofstede, 1997) a highly uncertainty avoidant culture is one that has a low tolerance for uncertainty and ambiguity. Therefore the feature can be related to a high uncertainty avoidant score, since the subjects prefer to avoid ambiguity and would prefer minimal steps or keystrokes to execute the desired function.

2) Secondary information about contents is a feature of the cell phone where the menu provides information (such as help) about each function. This can again be related to highly uncertainty avoidant cultures since they prefer to avoid situations with which they are unfamiliar (Hofstede, 1997). Therefore this feature can be related to uncertainty avoidance. The user will be asked if s/he prefers to have secondary information displayed at all times or would like to see(or hear) it only when asked for.

3) Variety of Contents (additional features): The cell phone provides a variety of additional features, such as movie ratings, weather, restaurants etc. A culture that has high power distance accepts large distances in social hierarchies and prefers limited choices on the interface (Marcus, 2005). This feature can be related with a culture that has a low PDI distance score.

4) Clear Menu Labeling: The menu is clearly labeled with text labels below icons. As explained earlier, a culture that is highly uncertainty avoidant prefers not to encounter unfamiliar situations. Therefore this feature can be correlated with a high UAI score.

5) Efficient screen space utilization: The small screen space must be used optimally and efficiently. The screen could display one icon (or menu function) at a time or all at one instance. The former can be related to low UAI scores and the latter to a high UAI score since this feature ensures that ambiguity of the interface is reduced considerably.

6) Large amount of information within a screen: A large amount of information in the form of icons or menu items will be available at one instance. This feature of the interface which provides information of the variety of options available (Marcus, 2005), avoids ambiguity and is therefore related to a high UAI score. A culture that is highly long term oriented, emphasizes patience(Marcus, 2005), and therefore does not need many options at one instance therefore a low LTO score is related to the preference for this feature.

7) Personalizable interface (concept of Profiles): The phone options of ringer tones, volume etc. can be changed according to the profiles selected. This feature can be related to a high IDV

score, since highly individualistic cultures are oriented to individual goals vs group goals (Marcus, 2005).

8) Familiar interface: The interface of the cell phone must be similar to previously used cell phones. A familiar interface avoids ambiguity and a radically new interface would increase uncertainty. Therefore it can be related to a high UAI score

9) Using default folders: Storing messages in default folders such as (my messages, my pictures etc.) vs personalizing folder names. This feature is more oriented to the group achievement vs an individual achievement. By using default and not personalized folders, the SMS (messages), MMS or pictures taken from the camera, can be accessed by more than one individual. This feature can be correlated to a low IDV score since it favors the achievement of the individual's goals.

10) Using hotkey, softkey, shortcut functions: The functions that are assigned to the softkeys can be accessed in one keystroke. This feature is correlated with high uncertainty avoidant cultures, since they would prefer situations which are less ambiguous. A shortcut cut key will reduce the ambiguity in the interface and lead to the desired menu or item in just one keystroke. Moreover, since a highly masculine culture has clear and distinct gender roles, according to (Marcus & Gould, 2000) a highly masculine culture prefers quick results for limited tasks. The use of softkeys on a cell phone interface can be related to MAS, since its use has a distinct clear functionality.

11) Programmable softkeys: The softkeys should not have fixed assigned functions but should be programmable by the user. This feature allows more user control over the cell phone interface. Since masculine cultures accept distinct gender roles and individualistic cultures focus on individual goals, programmable functions can be related to low MAS scores and high IDV scores.

12) Group SMS: Providing a function for sending a message (SMS), MMS or email to members of an assigned group. A collectivist culture prefers an interface that emphasizes on relationships (Marcus & Gould, 2000), therefore this feature can be related to low IDV scores.

13) Variety of Fonts and Font Sizes: This feature on the cell phone interface will allow the user to select from a variety of fonts and font sizes. This feature provides a variety of options, which is preferred by cultures that have low power distance (Marcus, 2005). Selecting fonts allows the achievement of individual goals of personalizing the interface. This feature can be correlated with (negatively) PDI and (positively) IDV scores.

14) Appearance of phone body: The feature of the cell phone refers to the ergonomics of the cell phone body. It includes aspects of aesthetic appeal and touch and feel of the cell phone. As discuss previously feminine cultures emphasize on the aesthetics of the interface, therefore this feature can be (negatively) correlated to the MAS scores.

All these features and the corresponding cultural variables are summarized in Table 5.

Table 5: Cell Phone features and correlated cultural dimensions

	Cultural Dimensions				
Cell Phone Feature	**PDI**	**IDV**	**MAS**	**UAI**	**LTO**
Minimal Steps or Keystrokes				×	
Secondary information				×	
Variety of Contents	×				
Clear Menu Labeling				×	
Efficient screen space utilization	×			×	
Large amount Information within	×			×	×
Personalizable interface (concept of		×			
Familiar interface				×	
Using default folders		×			
Hotkey, softkey, shortcut functions					
Programmable softkeys		×			
Group SMS		×			
Variety of fonts and font sizes	×	×			
Appearance of phone body			×		

The next section describes the justification behind the choice of the two countries, India and the US for cross-cultural comparison.

2.7 Choice of National Cultures

Two nations (India and the United States) were selected for this cross-cultural research using a systematic sampling procedure. Systematic sampling, a procedure "in which cultures are selected in a systematic, theory-guided fashion" (Vijver & Leung, 1997), is recommended for the selection of cultures in cross-cultural comparative studies where cultural variation is significantly different for meaningful comparisons. Cultures are chosen in such a way that they represent different values and cultural dimensions. Since this study correlates Hofstede's cultural dimensions with cell phone interface design preferences; it would be relevant to use systematic sampling in the selection of cultures which exhibit significant differences in Hofstede's cultural dimensions. The United States and India have been chosen based on the results of earlier studies which have confirmed significant cultural differences among these countries in practically all of Hofstede's cultural dimensions (Hofstede, 1980; Hofstede & Bond, 1984 & 1988; Trompenaars, 1992). In addition, each of the countries chosen for this research has different traditions, history and economic development.

India is predominantly a Hindu country, with 82.4% of its one billion population adhering to Hinduism. In the United States, Christianity is the predominant religion, with 85.3% of its population embracing it while other major religions are Judaism (2.1%) and Islam (1.9%). These differences in religion between the two countries may be one of the reasons for differences in cultural values. Hindi is the official language of India, spoken by about 30% of the population. The Indian Constitution also recognizes 17 regional languages. English is an associate language for many official purposes. English is the official language in the United States. India has a parliamentary form of government based on universal adult franchise. The executive authority is responsible to the elected representatives of the people in Parliament for all its decisions and actions. The United States has a constitution-based federal republic, with a strong democratic tradition. The political system of a country has a role in the formation of cultural values and dispositions of its people.

India is ranked 12th among the world's largest economies, with a per capita income of $3100 (for 2003). The United States of America has the largest economy in the world with per capita income of $34,870 and it is the home for 153 of the 500 world's largest corporations. All these factors influence the values and beliefs and hence the culture of the nation. The differences in these two nations are summarized in Table 6.

Table 6: Comparison Chart of United States and India Source: CIA-The World Fact Book (2005)

Sr.No.	Parameters	USA	INDIA
1.	Median age (2005)	*total:* 36.27 years *male:* 34.94 years *female:* 37.6 years	*total:* 24.66 years *male:* 24.64 years *female:* 24.67 years
2.	Religion	Protestant 52%, Roman Catholic 24%, Mormon 2%, Jewish 1%, Muslim 1%, other 10%, none 10% (2002)	Hindu 80.5%, Muslim 13.4%, Christian 2.3%, Sikh 1.9%, other 1.8%, unspecified 0.1% (2001)
3.	Language	English 82.1%, Spanish 10.7%, other Indo-European 3.8%, Asian and Pacific island 2.7%, other 0.7% (2000 census)	English has an associate status Hindi is the national language and primary tongue of 30% of the people; there are 14 other official languages: India (2001)
4.	Literacy *Definition:* age 15 and over can read and write	T*otal population:* 97% *male:* 97% *female:* 97% (1999 est.)	*total population:* 59.5% *male:* 70.2% *female:* 48.3% (2003 est.)
5.	Population (2005)	295,734,134	1,080,264,388
6.	Population growth rate (2005 est.)	0.92 %	1.4%
7.	GDP- PPP (2004)	$11.75 trillion	$3.3 trillion
8.	GDP- Per capita (2004)	$40,100	$3,100
9.	Labor Force(incl. Unemployed-2004)	$147.4 million	$482.2 million
10.	Unemployment Rate (2004)	5.5%	9.2 %
11.	Internet Users (2002/2003)	159 million	18.5 million
12.	Cell Phone Users(2003)	158,722,000	26,154,400

Besides these economic, political, religious and language differences, India and the United States, significantly differ on 3 of the 5 cultural dimensions of Hofstede's (1990) model which has been previously discussed in the this section. Therefore, India and the United States were chosen as the focus of the cross cultural comparison in this research using the systematic sampling procedure (Vijver & Leung, 1997). An additional reason for the choice of these two nations was the convenience and possibility of data collection by the author of this paper, in the respective countries.

CHAPTER 3. RESEARCH OBJECTIVE

The use of cell phones has spread across the globe and the role of cultural differences in design of user interfaces has emerged as a critical issue. Cultural factors that play an important role in the design of mobile phones have not yet been explored extensively. Only a few authors such as Choi *et al*. (2005), and Honold (1999) have addressed these issues. The role of culture in the design of cell phones for people with disabilities is a new dimension of culture oriented product design that has not been examined till date. This study was an attempt to address this unexplored dimension of product/ interface design. Even though this study mainly focused on the cell phone design preferences, some results may be used in general interface design.

Brown (2001) stated that disability culture in the Southwest of the U.S. may be very different from that of Northeast U.S. or Europe or Asia; however, they all will have some similarities. This study first examines the presence of a disability culture, in two different countries. At this stage the disability groups in the United States and India were compared for differences in values and beliefs, using the Value Survey Module 94 (VSM94) (Appendix A). This research further explored how selected attributes of cell phone interfaces as perceived by users with visual disabilities and no apparent disabilities differed among countries. The two countries for this comparative study were selected based on parameters such as economic status, cultural differences and cell phone prevalence and an expanding market. India and United States were selected also since they have different political structures, stages of economic development and cultural dimensions. This study was an extension of the research project that involved gathering of cell phone design preferences of users with disabilities in the Germany and UK markets, conducted by Drs. Smith-Jackson and Nussbaum. In this study, focus groups were organized, and participants were questioned about their preferences for cell phone attributes. The results of this study were used to develop product-specific guidelines to assist user interface designers in the inclusive design of cellular telephones. The present study delivers a cross-cultural comparison of cell phone design

preferences from the perspective of nationality and disability. Cell phone interface design preferences which are disability specific and country specific are summarized at the end of this study. Some guidelines for conducting cross-cultural research are also provided in the conclusion section.

CHAPTER 4. METHODS

4.1 Research Design

A mixed methods approach using qualitative and quantitative data analyses techniques was adopted in the current study. This study was designed to answer the following questions:

- What are the differences in cultural values between users with (and without) disabilities across the two countries? Do these differences justify the presence of a disability culture?
- Are preferences for interface design driven more by a nationality culture, disability culture or a blend of both?
- What are the differences between cultural groups in preferences of cell phone hardware features and usability ratings of tasks?
- What are the differences in interface design preferences between nationality or disability cultural groups?

The hypotheses corresponding to the above research questions are listed as follows:

1. Hypotheses on the Cultural Dimensions

1.A The cultural dimension scores on the VSM 94 for users with disabilities will differ from those without disabilities, within the same nationality group.

1.B The cultural dimension scores for disability groups in India will differ from those in the United States.

2. Hypothesis on the Cell phone Hardware Attributes

The Hardware Attributes of the Cell Phone will be rated differently by the Nationality groups, Disability group and the interaction of Nationality × Disability groups.

3. Hypotheses on the Software Attributes and Tasks

3.A The group with higher uncertainty avoidance will have higher ratings on all the tasks.

3.B The group with a low individualism (therefore collectivist) score will rate significantly higher on the task sending an SMS.

3.C The group with a high individualism score will have a significantly higher score on the overall usability rating on the task of setting the ring-tone.

3.D The Overall Software Usability Attributes will be rated significantly different by the Nationality groups, Disability group and the interaction of Nationality × Disability groups.

3.E The General Features of the use of the cell phone features will be rated significantly different by the Nationality groups, Disability group and the interaction of Nationality× Disability groups.

4. Hypotheses on Cell Phone Interface Ratings

4.A The cell interface feature preferences will be rated significantly different by the Nationality groups, Disability groups and the interaction of Nationality × Disability groups.

4.B The scores of the interface preferences will be related to the corresponding group cultural dimension score.

4.C The scores on the ratings questionnaire will be correlated with the corresponding individual level cultural dimension score.

5. Hypothesis on the User Requirements and Design Preferences of Cell phone Interface Components:

There will be differences in the user requirements of cell phone interfaces based on Nationality groups, Disability groups and the interaction of Nationality × Disability groups.

This study was a 2×2 between subjects design. The main factors were Nationality (N) and disability (D) type. Detailed information about the levels and types of these factors is provided in Table 7.

Table 7: Factor Levels and Types

Factor Name	Levels	Type
Disability Group(D)	Control(no apparent disability), Legal Blindness	Between-Subjects, Fixed Effects
Nationality Group (N)	United States, India	Between Subjects, Fixed Effects
Subjects	S_1…….S_{69}	Between Subjects, Random Effects

4.1.1. Context Variables

Since culture is a global concept and is not meaningful as an explanatory variable, it should be replaced by its constituents (Vijver & Leung, 1997). These constituents are referred to as context variables (Vijver & Leung, 1997) or cultural dimensions. These are variables that are used to validate an interpretation of cross-cultural differences (Vijver & Leung, 1997). The context variables used in this study were Power Distance, Individualism, Uncertainty Avoidance, Masculinity and Long Term Orientation. These context variables are not shown in the data matrix, since the culture group cannot be assigned to any cultural variable by the experimenter. These variables were determined by the response in the instrument VSM 94, which has been discussed in the previous section. For data analysis purposes these variables are considered as the dependent variables.

4.1.2 Control Variables

Control variables were monitored to evaluate potential extraneous influences. These variables include demographics such as age, gender, nationality, country of birth, presence of disability and when it was acquired. More specifics were asked to provide a detailed cultural background, these include amount of time spent overseas, country of birth for each parent. These questions have been summarized in the demographic questionnaire in Appendix B.

4.1.3 Data Collection Method: Focus Groups

One of the most widely used research tools in social sciences are in-depth group interviews, also called focus groups (D. W. Stewart & Shamdasani, 1990). A focus group involves 6-8 individuals who discuss a topic under the topic of interest under the supervision of a moderator, who promotes the interaction between participants and ensures that the discussion does not digress from the topic of interest (D. W. Stewart & Shamdasani, 1990). One of the advantages of using focus groups as an research tool is that it produces a very rich body of data that is expressed in the respondent's own words, which in turn minimizes the artificiality of responses. Through focus

groups a researcher can identify shared and common knowledge. This makes focus groups- a data collection technique sensitive to cultural variables, therefore it is often used in cross- cultural research (Kitzinger, 1995). Focus groups have been successfully used in various user centered design studies. In the current study product interactive focus groups were the primary research tool to gather data. Product interactive focus groups, which allow participants to interact with products during the discussion, were conducted in India and the United States. Product interactive focus groups were coupled with tasks and questionnaires in order to gather data that was used for the cross-cultural comparison. Product interactive focus groups are an efficient method previously used to generate product related discussions (Y. S. Lee *et al.*, 2006; Young Seok Lee *et al.*, 2004; Mooney *et al.*, 2002; Smith-Jackson *et al.*, 2003). Focus groups for each of the disability types (without any apparent disability and with legal blindness) were held in India and the United States. A total of 13 focus groups, 6 in India and 7 in the United States were conducted. As mentioned before, 6 participants were recruited for each group, however some participants did not show up for the focus group, therefore the samples size for each of the groups was not equal.

4.1.4 Sample Size Estimation

The minimum number of respondents per country or region to be used in comparisons is 20 (Hofstede, 1997). This study included 2 disability types and 2 nationality groups with a total of 18 participants recruited in each cell. The number seems to be reasonable as it is close to the ideal number of 20, for the cross cultural comparison. Therefore, a total of 36 participants were recruited in India and 36 in the United States, however since a few of the participants did not show up for the focus groups, the final number of participants was 34 in India and 35 in the United States.

4.2 Independent Variables

The independent variables used in this study were disability group and nationality group. The levels of these independent variables are described below in Figure 7.

Main Factor		Disability Group (D)	
(Country) (C)	Levels	Legal Blindness	No Apparent Disability
	United States	$S_1 \ldots S_{18}$	$S_{19} \ldots S_{36}$
	India	$S_{37} \ldots S_{54}$	$S_{55} \ldots S_{72}$

Figure 7: Data Matrix assigning participants to Independent Variables

4.2.1 Disability Group

The two levels of the independent variable disability group are:

- Control group (with no apparent disability)
- Legal Blindness/Partially Sighted

Participants with disabilities or no apparent disability were included based on self-reports. Legal blindness is defined as visual acuity of 20/200 or less in the best eye with corrective lenses. Eighteen participants were recruited for the visual disability and control group, in India and the United States, on the basis of self report (Appendix B).

4.2.2 Nationality Group

The two nationality groups (two levels of country variable) are India and United States. These two nationalities are the basis of the cross-cultural comparison. The detailed comparison of cultural dimensions and other economic factors for these two nations is given in the literature review section.

Before discussing the dependent variables used in this study, the cell phone test model, manufactured by Toshiba was evaluated. Screenshots of the interface of the cell phone were evaluated for their underlying dimensions. Some tasks were also analyzed when broken down into constituent steps.

4.3 Cell Phone Interface General Evaluation

Figure 8 is a screen shot of the cell phone interface. It clearly indicates that the screen space is utilized efficiently, since it includes a large number of icons. Since it displays a large number of icons at one instance, it reflects high uncertainty avoidance. This screen displaying a large number of icons, avoids uncertainty since it reflects immediate results and completion of goals (Marcus & Gould, 2000).

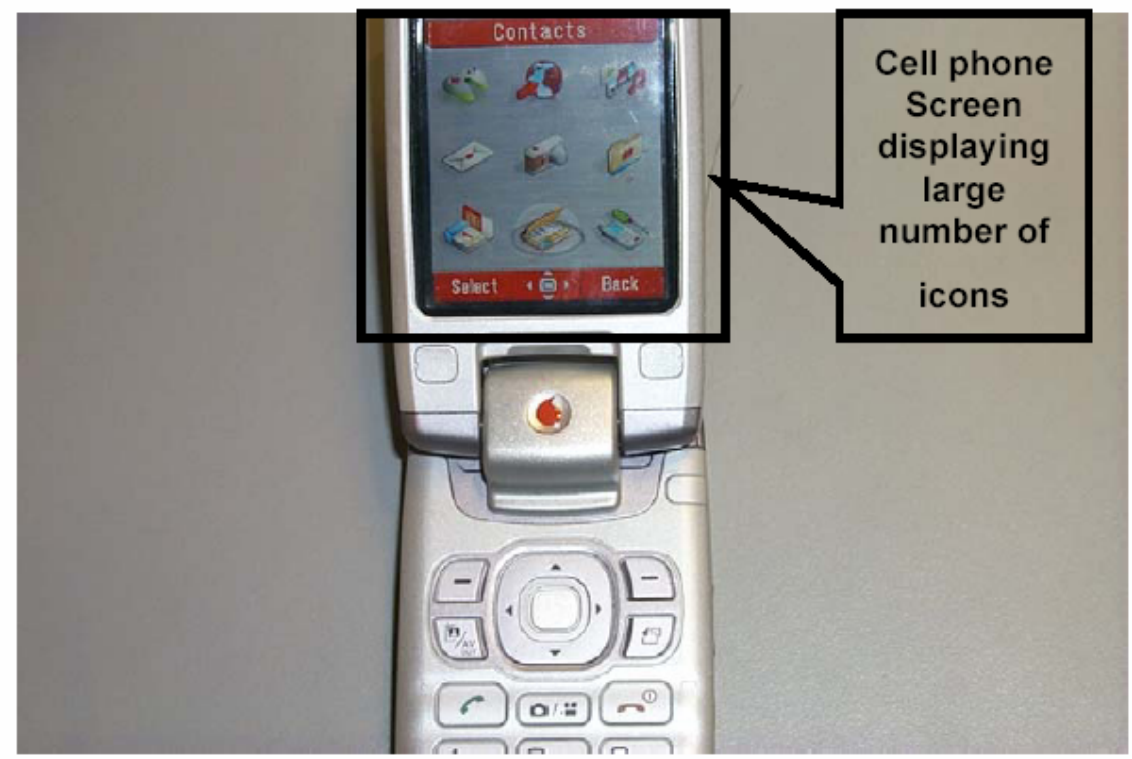

Figure 8: Startup menu of cell phone

Figure 9 indicates that each icon has a label indicating its function on the screen, which again prevents ambiguity in the interface.

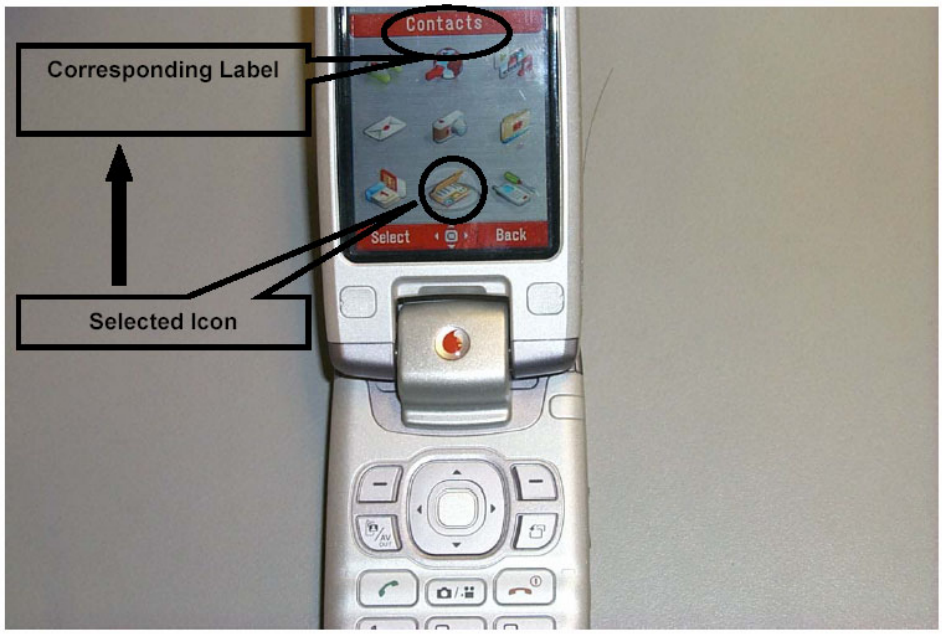

Figure 9: Cell Phone Screen shot of Icons and Corresponding Labels

Figure 10 shows that there is secondary information about every function selected. This is another feature that reflects highly uncertainty avoidant cultures.

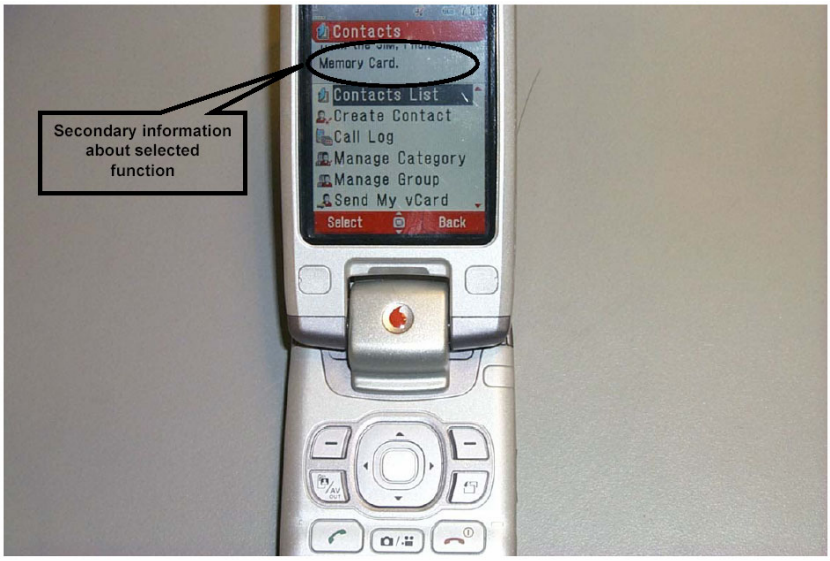

Figure 10: Screen shot of Cell phone Secondary Information

After completion of a task the interface provides information about what was done by the system as a feedback. This can be seen in Figure 11. This feature has a strong relationship with the uncertainty avoidant dimension, since it does reduce ambiguity of the outcome of the action performed by the system.

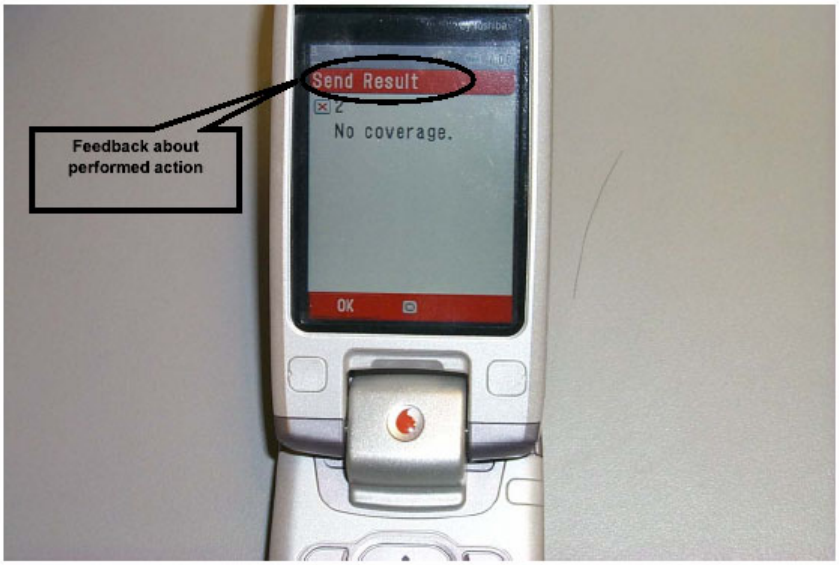

Figure 11: Screen Shot of Cell Phone Interface Feedback

All the features discussed above reflect a high degree of uncertainty avoidance since a considerable amount of secondary information is present at all times and feedback is provided at all times.

4.3.1 Task Specific Evaluation

The legally blind groups and the control groups performed the following tasks scenarios:

Turn on the phone

- Calling a number (without using the phone book)
- Storing a phone number
- Sending a text message (SMS)
- Setting the ringer sound

The names and phone numbers used in the scenarios were adapted for each country so that the scenarios were compatible with common names and phone numbers used in the respective

countries. Software task scenarios were counterbalanced to avoid confounding due to learning transfer. The partial counterbalancing scheme is shown in Table 8.

Table 8: Order of Tasks Used for Each Focus Group

Group	Task1	Task2	Task 3	Task 4
India_LB1	Dial a number	Set the Ringtone	Store a Number	Send a SMS
India_LB2	Set the Ringtone	Send a SMS	Dial a number	Store a Number
India_LB3	Store a Number	Dial a number	Send a SMS	Set the Ringtone
India_CG1	Dial a number	Set the Ringtone	Store a Number	Send a SMS
India_CG2	Set the Ringtone	Send a SMS	Dial a number	Store a Number
India_CG3	Store a Number	Dial a number	Send a SMS	Set the Ringtone
US_LB1	Dial a number	Set the Ringtone	Store a Number	Send a SMS
US_LB2	Set the Ringtone	Send a SMS	Dial a number	Store a Number
US_LB3	Store a Number	Dial a number	Send a SMS	Set the Ringtone
US_LB4	Send a SMS	Set the Ringtone	Store a Number	Dial a Number
US_CG1	Dial a number	Set the Ringtone	Store a Number	Send a SMS
US_CG2	Set the Ringtone	Send a SMS	Dial a number	Store a Number
US_CG3	Store a Number	Dial a number	Send a SMS	Set the Ringtone

Note: LB=Legally Blind, CG=Control Group

A detailed hierarchical task analysis of the action sequences that is needed to perform each task follows:

- Sending a message: In a study of usage patterns of mobile phone users in Korea, it was concluded that the use of SMS is higher in a collectivist culture (Kim *et al.*, 2003). This study focused on the cultural usability of mobile phone usage and concluded that users in a highly collectivist culture use SMS as a means of communication with their close social circle. As explained before 'cultural markers'

are those elements of an interface that are most prevalent, and possibly preferred within a particular cultural group. According to Barber & Badre (1998) cultural markers can directly impact the perceived usability of a product. Therefore the usability of an interface for a particular task depends on the underlying cultural dimension. The usability rating of this task is dependent on a collectivist culture.

- Setting the ringer sound: This task's sequence can be seen in Appendix D. This task sequence clearly indicates that the user needs to be aware of the concept of user profiles to personalize the interface to select the required ringer sound. The concept of user profiles deals with customizing the interface features to individual preferences. This feature is related to the individualism dimension which focuses on the preferences of the individual versus the collective preferences of a group. Therefore usability rating of this task is dependent on the IDV dimension.

Table 9: Summary of Tasks with the Related Cultural Dimensions

Task	Related Cultural Dimension
Sending an SMS	Collectivism
Setting the ring-tone	Individualism

The tasks that were performed by the participants and the related cultural dimensions are summarized in Table 9. The other two tasks, dialing a number and storing a number in the phone book were not related to any cultural dimensions. The mean ratings on the post task questionnaires were compared for the nationality and disability for all the 4 tasks are summarized in the Results section.

4.4 Dependent Variables

The dependent variables that were measured in this study are discussed in the sections that follow.

4.4.1 Cultural Dimension Scores

The cultural dimensions are context variables or dependent variables. The scores that each culture group obtained on the VSM 94 are a construct to measure the cultural dimension of the group. The scores of the cultural dimensions were calculated using the formulae summarized in Appendix A. The dimension scores for 4 units of analyses obtained are shown in Table 10.

Table 10: Summary of Mean Dimension Scores and Standard Error from VSM 94

	Group			
Cultural Dimension	**India_LB**	**India_CG**	**US_LB**	**US_CG**
PDI	54.44(15.63)	57(9.03)	12.63(12.66)	37(15.10)
IDV	94.72(13.76)	75.66(16.73)	74.21(8.49)	111.33(7.5)
MAS	60.55(21.86)	21(29.69)	18.42(22.79)	13.33(24.98)
UAI	53.33(12.66)	16.33(17.15)	74.47(15.09)	22.33(13.2)
LTO	34.44(8.05)	42.66(7.77)	42.1(5.27)	37.33(8.4)
Sample size	*n=18*	*n=16*	*n=19*	*n=16*

4.4.2 Cell Phone Interface Ratings

Cell phone interface features have been identified and classified using existing literature (Choi et al., 2005). Hofstede's cultural dimensions have also been used to classify features of the cell phone interface that reflect specific cultural constructs. The user's preferences for these features were acquired using a Likert-type ratings questionnaire (Appendix E). The mean scores obtained for each group is summarized in Table 11.

Table 11: Summary of Mean Ratings and Standard Deviations of Interface Ratings

	Mean Ratings and Standard Deviation							
Interface item	**India_CG**	**SD**	**India_LB**	**SD**	**US_CG**	**SD**	**US_LB**	**SD**
Minimal Keystrokes	3.69	1.14	4.61	0.98	4.60	0.51	4.58	0.51
Secondary info	2.75	1.06	4.28	0.89	3.23	0.94	4.26	0.73
Variety of Contents	3.88	1.02	4.17	0.92	3.40	0.74	3.89	1.37
Menu Labeling	4.19	0.83	4.06	1.06	4.07	0.59	4.53	0.84
Screen utilization	4.31	0.70	3.44	1.58	4.27	0.59	4.63	0.76
Large amt. of info.	3.38	1.31	3.56	1.46	3.27	0.70	3.58	1.50
Personalizable interface	3.81	1.11	4.61	0.61	3.47	1.25	4.05	1.03
Familiar interface	3.75	0.93	3.50	1.20	4.40	0.63	4.21	1.13
Using default folders	4.00	1.03	3.94	0.94	3.27	0.88	3.74	1.24
Softkey functions	4.06	0.93	4.50	0.62	3.73	1.03	4.16	0.90
softkeys	3.81	0.98	4.06	1.06	3.33	1.23	4.37	0.68
Group SMS	3.63	1.26	3.61	1.50	3.00	1.07	2.32	1.29
Variety of fonts	3.50	1.15	3.06	1.51	3.07	1.22	4.26	1.05
Aesthetic appeal	4.56	1.03	3.78	1.22	4.13	0.83	4.05	1.22

4.4.3 Hardware Ratings

The Hardware ratings of the test phone model were summarized in a Likert-type ratings questionnaire. The items which were the different hardware attributes measured with the corresponding mean ratings are summarized in Table 12.

Table 12: Mean and Standard Deviations of Cell Phone Hardware Ratings

Group	India_LB		India_CG		US_LB		US_CG	
Cell Phone Hardware Feature	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Size	3.72	1.07	2.63	1.09	4.37	1.67	2.20	0.75
Shape	3.89	1.02	3.56	1.46	4.21	1.78	3.93	1.24
Weight	3.22	1.66	2.44	1.26	4.21	1.69	2.67	1.40
Feel when dialing	3.61	1.61	4.50	1.03	4.89	1.20	3.67	1.14
Feel when holding (to speak)	4.06	1.51	4.31	0.95	5.05	0.85	4.40	1.02
Key size	3.22	1.59	4.81	1.11	4.11	1.66	3.73	1.34
Key shape	3.33	1.64	4.88	0.96	4.53	1.43	3.60	1.25
Ease of pressing buttons	4.00	1.46	4.88	1.26	3.95	1.61	4.60	0.71
Ease of reading labels on the keys/buttons	3.06	1.76	5.13	0.89	3.58	1.74	4.53	1.45
Size of the LCD screen	4.65	1.11	5.56	0.63	4.68	1.34	5.67	0.47
Ease of opening the LCD screen	4.88	0.86	5.00	1.26	5.11	1.24	4.93	1.18
Rotating the LCD screen	4.65	1.27	5.31	1.35	5.74	0.45	4.93	1.06
Contrast of the LCD screen	5.35	0.61	5.44	0.51	4.68	1.67	5.47	0.50
Brightness of the LCD screen	4.94	1.14	5.44	0.73	5.11	1.41	5.47	0.62
Font size of menus	3.35	1.73	4.94	0.93	4.05	1.99	4.93	0.93
Overall look	4.61	1.42	4.13	1.02	4.74	1.63	3.27	1.06
Overall satisfaction	4.17	1.42	4.13	0.72	4.68	1.29	3.60	0.71
Total Hardware Rating	67.16	12.73	77.06	17.15	77.68421	24.65064	71.6	16.83

4.4.4 Post-Task Software Usability Ratings

The software attributes that were measured, were based on different usability aspects of the cell phone interface. The rating sheets contained a series of questions related to these software usability aspects. Participants answered the questions by marking their opinions on a six-point Likert-type rating scale Appendix I. Rating scale anchors were 1-6 with negative at the lower end (e.g., 1=Very Difficult, Not Clearly, Very Bad) and positive at the higher end (e.g., 6=Very Easy, Very clearly, Very Good). The usability attributes are listed as follows:

- Ease of completing the task
- Ease of locating a function in the menu hierarchy
- Ease of identifying relevant keys on the phone keypad
- Meaningfulness of the icons associated with specific functions
- Ease of understanding the menu labels for each function
- Feedback of the phone when performing tasks

The three general questions on the cell phone feature were:

- Importance of this cell phone function
- Frequency of using this feature
- Whether the function is essential in cell phone

The ratings of first 6 features were totaled to calculate an overall usability rating for each task. The mean overall usability rating and the general ratings for each task were compared across groups and the outcomes can be found in the Results section. The four tasks that were included in the Product Interactive Focus Group were Dialing a number, Storing a Number, Sending a text message and Changing the Ringtone, which are the most frequently used features of a cell phone.

4.4.5 Interface Design Preferences

The focus group discussion raised issues regarding the interface design of the cell phone. These issues included hardware, software features and other additional advanced features required for cell phones. Product interactive focus groups are an efficient method previously used to generate product related discussions (Lee *et al*, 2006; Lee *et al.,* 2004; Mooney *et al.,* 2002; Smith-Jackson *et al.,* 2003). The focus group discussion were transcribed and further analyzed for similarities and differences in design preferences and user requirements across the 4 groups, using the Overview grid method summarized in a following section.

4.5 Participants

Participants were matched as closely as possible on demographic characteristics so that the cultural differences can stand out clearly (Vijver & Leung, 1997). A demographic questionnaire (Appendix B) was used to confirm the similarities among participants. Due to constraints in time and resources gender will not be matched while recruiting the participants. The participants were recruited matched on the following criteria:

- Age group 19-50 years
- Have owned a cell phone within the past year
- Have been employed at some point in their life

The age group was initially restricted to range from 19-35 years of age, in order to strictly control the influence of age on design preference. However due to challenges in recruitment of participants with disabilities the age group was relaxed. This was mainly due to the fact that visual disabilities increase with age. Every participant was recruited on the criterion that s/he has used a cell phone within the past year. This is an important criterion, since only some previous knowledge of using cell phones will allow the participants to perform the tasks and comprehend the task related questionnaires. The employment criterion ensures that the participants will comprehend and relate to the questions on the VSM 94 instrument which revolve around the values in the workplace.

Controlling the demographics of the participants enhanced the validity of the responses on the questionnaires.

Despite careful matching of samples in this study, the possibility that the background variables may influence the results is recognized. The VSM 94 (Hofstede, 1994) manual warns that:

"Comparisons of countries or regions should as much as possible be based on samples of respondents who are matched on all criteria other than nationality or region. So respondents from one country to another should be chosen from the same gender, age, education level, occupation, manager/non-manger status, employer etc. They should be matched on any criterion other than nationality that can be expected to affect the answers."

4.5.1 Recruitment of Participants

Participants with disabilities in the US were recruited through the following contacts:

- The Access Board, Washington DC
- Raleigh Lions Clinic for the Blind, NC

In India the following agencies helped to recruit participants for this study

- National Association for the Blind, Mumbai, India

All the above listed organizations provided a location to conduct the focus groups as well. Detailed contact information of these institutes and their locations can be found in Appendix C.

Participants with no apparent disabilities were recruited using Newspaper advertisements and personal contacts, through the snowballing method in India and the United States. Where immediate contacts, that fit the criteria were asked to recruit their immediate contacts, for participation.

4.6 Equipment and Apparatus

Camcorders and voice recorders were used to capture the focus group discussion as well as the participants' interaction with the cell phone during the tasks. The cell phone model used for this study is a model manufactured by Toshiba Corporation.

4.7 Procedure for Data Collection

The IRB for this study was an amendment to the previously approved IRB for the study of inclusive design of cell phones in the UK and in Germany. The approved IRB amendment for this study is attached in Appendix G. Participants were recruited and the focus groups were conducted in India and the United States. The procedure that was followed for data collection is summarized in Figure 12.

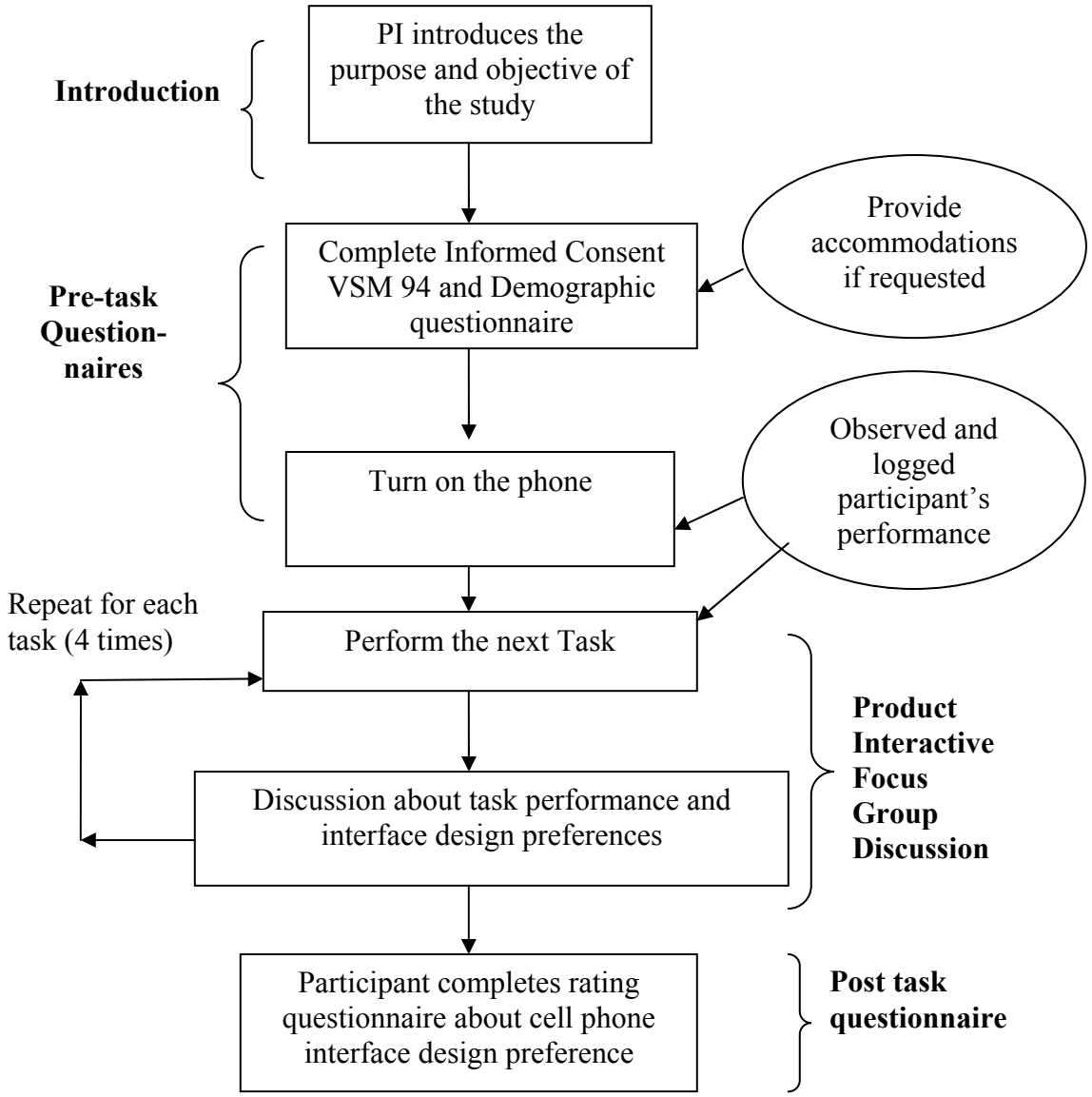

Figure 12: Procedure for Data Collection

4.7.1 Procedure during the Product Interactive Focus Group

The steps that were followed are summarized in this section. The script provides details of the probes and questions posed by the moderator (Appendix K).

4.7.1.1 Introduce the study

In the first step of data collection, the moderator (the author of this thesis) of the focus group first introduced the objective and goals of the research to the participant. An important issue

communicated to the participants at this stage was that the study is focused on evaluating the cell phone and not the participant. The participants were asked if they needed any accommodations, such as large print forms and/or assistance in filling out the forms. The participants were not assisted with the tasks as they were required to perform them independently.

4. 7.1.2 Turn on the phone and Examine hardware

The participants were all asked to examine the hardware features of the test phone model. Hardware attributes include the weight, size and shape of the phone. They are then asked to turn on the phone which is followed by the completion of the hardware ratings questionnaire.

4. 7.1.3 Perform Tasks

The participants of all groups were asked to complete 4 tasks. First all the participants were asked turn on the phone. The other 4 tasks that were counterbalanced as mentioned before to minimize order effects on task performance are as follows:

- Calling a number
- Sending a message
- Setting the ringertone
- Storing a number in the phone book.

The participants were instructed to discontinue the task once the pre-determined time (3 minutes) to complete the task was completed.

The interaction with the cell phone facilitated the expression of their ideas and they were able to communicate their views about the present design and provide suggestions and design recommendations. The focus group discussion script covered areas such as task difficulty level and why/ why not they found the task difficult/easy. They were also asked how they would have preferred the interface to be designed in order to perform the task more efficiently. Also they were questioned about their perceived performance level and the expectations from the cell phone

interface during their interaction with the cell phone. These interactions and the discussions will be video taped and voice recorded. The focus groups were transcribed and the transcription was further analyzed to quantify content data to provide specific information such as cell phone interface design preferences. This was done using the ATLAS.ti, software that is used to quantify qualitative data such as transcripts and video recordings.

4.7.1.4 Post-task Ratings Questionnaire

Participants were asked to complete a ratings questionnaire, based on the preference of each of the cell phone features which has a scale from 1-5 (Appendix E).

4.8 Summarizing Independent and Dependent Variables

Table 13 summarizes the above discussed independent and dependent variables used in this study.

Table 13: Summary of Independent and Dependent Measures

Independent Variables	Dependent Variables
Disability Group (D) (D_1,D_2)	Cultural Dimension Scores
Nationality Group (N) (N_1,N_2)	Cell phone interface rating
	Hardware Features rating
	Usability Ratings on Tasks
	Design Preference/User Requirements

4.9 Revisiting Research Questions

The hypotheses tested in this research study are summarized in this section.

1. Hypotheses on the Cultural Dimensions

1.A. The cultural dimension scores on the VSM 94 for users with disabilities will differ from those without disabilities, within the same nationality group.

1.B. The cultural dimension scores for disability groups in India will differ from those in the United States.

2. Hypothesis on the Cell phone Hardware Attributes

The Hardware Attributes of the Cell Phone will be rated differently by the Nationality groups, Disability group and the interaction of Nationality × Disability groups.

3. Hypotheses on the Software Attributes and Tasks

3.A. The group with higher uncertainty avoidance will have higher ratings on all the tasks.

3.B. The group with a low individualism (therefore collectivist) score will rate significantly higher on the task sending an SMS.

3.C. The group with a high individualism score will have a significantly higher score on the overall usability rating on the task of setting the ring-tone.

3.D. The Overall Software Usability Attributes will be rated significantly different by the Nationality groups, Disability group and the interaction of Nationality × Disability groups.

3.E. The General Features of the use of the cell phone features will be rated significantly different by the Nationality groups, Disability group and the interaction of Nationality× Disability groups.

4. Hypotheses on Cell Phone Interface Ratings

4.A. The scores of cell preferences on the interface ratings questionnaire will differ between the control group and the disability group within the same nationality grouping.

4.B. The scores of the interface preferences will be related to the corresponding group cultural dimension score.

4.C. The scores on the ratings questionnaire will be correlated with the corresponding individual level cultural dimension score.

5. Hypothesis on the User Requirements and Design Preferences of Cell phone Interface Components:

There will be differences in the user requirements of cell phone interfaces based on Nationality groups, Disability groups and the interaction of Nationality × Disability groups.

The following section describes techniques for data analysis used for cross-cultural studies:

4.10 Cross-Cultural Research Methods and Data Analysis

One way to improve the quality of cross-cultural studies is to combine qualitative and quantitative research methods. This also ensures that the findings are culturally relevant and accurate (Hines, 1993). This research has used this mixed methods approach where extensive quantitative and qualitative data was collected.

4.10.1 Quantitative Data Analysis

The central theme of this thesis is integrated into the broader framework of existing theory and research of culture, consequently enlarging the scope of the field of cross-cultural studies. Seeking to broaden the theories of cross-cultural comparisons to nationality culture and disability culture, this thesis is a focused review of the research questions with a formal testing of the research hypotheses. The data analysis is focused on comparisons of responses between the disability groups, country groups and interaction of the disability×country groups. The data analysis techniques are summarized in this section.

Hofstede, Bond and Luk (1993) have repeatedly stated that it is necessary to be clear about the level of analysis considered in quantitative comparisons among cultural entities. They distinguish four types or levels of analysis based on Leung and Bond (1989) cross-cultural studies.

4.10.1.1 Comparison of group means

The most frequently used method is the comparison of group means, either in simple or descriptive form or through statistical formal procedures using tests of significance. Majority of comparative culture quantitative studies take groups of individuals as a unit of analysis, and compare group means of individual scores based on numerical responses to questionnaires. When group means are compared using statistical methods as analysis of variance or paired comparisons it is referred to as group means analysis. The level of analysis here is the cultural group. This method

was used to compare group means of the VSM scores, Hardware Ratings, Software Usability Attribute Ratings.

4.10.1.2 Correlations

Another method of analysis is the calculating correlations between variables. Correlations can be computed at different levels of analysis. Correlation between two variables can be obtained taking all individual observations regardless of the cultural unit to which the observation belongs. According to Hofstede, Bond & Luk (1993) this is referred to as *pan-cultural analysis.* This method was used to correlate cultural dimensions with the cell phone interface ratings.

Correlations can also be computed between two variables using the group mean scores where groups are cultural units instead of individual scores. This method mitigates the individual variations and the scores that are used for data analysis are cultural indicators. The unit of analysis here is the cultural group, and we obtain information on the relationships between variables across groups. According to Hofstede, Bond and Luk (1993) this is referred to as *ecological level analysis.* Even though correlations were not calculated, this level of analysis was followed to establish a relationship between the interface ratings mean scores and the group level cultural dimension scores.

Data analysis for cross-cultural research is divided into two stages according to Vijver & Leung (1997). The preliminary analysis stage is the first stage and it consists of computing the reliability of the instrument: VSM 94.

The second stage of the study explores the research questions and hypotheses testing (Vijver & Leung, 1997). The dependent variable measures were tabulated for the cultural groups and will be compared for differences. The responses from the control group will be compared with the disability group to compare the differences between cell phone design preferences and ratings of users without and with a disability. To measure the differences between the control and the experimental group a post hoc pair-wise comparison will be performed.

For all the Analyses of Variance and post-hoc tests (LS means), the alpha will be set at a level of 0.05. A folded-F test was used to test for equality of variances, given the differences in the number of users in each group. None of the folded-F values were significant at $p < .05$, indicating that the variances were not unequal.

4.11 Qualitative Data Analysis

Focus groups were selected as a method for qualitative data gathering for this cross-cultural study on design preferences, after an indepth understanding of the strengths and weaknesses of this method. Focus groups have been used as a method for exploratory research to investigate the prevalence of any given attitude or experience (Ward, *et al*. 1992). When it was compared to other methods, it lead to the conclusion that the real strength of focus groups is not simply in exploring what people have to say, but in providing insights into the sources of complex behaviors and motivations (Morgan & Krueger 1993). Morgan & Krueger (1993) also argued that the advantages of focus groups for investigating complex behaviors and motivations were a direct outcome of the interaction in focus groups, which has been termed "the group effect" (Carey, 1994; Carey & Smith 1994). An emphasis on the specific kinds of interactions that occur in focus groups is also an improvement over vague assertions that "synergy" is one of their strengths. What makes the discussion in focus groups more than the sum of separate individual interviews is the fact that the participants query each other as well as explain themselves to each other. As Morgan & Krueger (1993) have also emphasized, such interaction offers valuable data on the extent of consensus and diversity among the participants. This ability to observe the extent and nature of interviewees' agreement and disagreement is a unique strength of focus groups (Morgan & Krueger, 1993). An added strength comes from the researcher's ability to ask the participants themselves for comparisons among their experiences and views, rather than aggregating individual data in order to speculate about whether or why the participants differ. Therefore focus groups were selected as a tool for data collection for this cross-cultural study that seeks to identify the differences and similarities between groups.

4.11.1 Data Analysis Techniques of Focus Groups

The most challenging step of a research project is the analysis of the data collected. Unfortunately there is more written about how to conduct focus group discussion sessions than how to go about analyzing the data gathered from the focus group sessions (Knodel, 1993). The first step towards data analysis was to transcribe the video recordings of the focus group sessions to extract information by content analysis. Content Analysis is a technique used to extract desired information from a body of information usually verbal by systematically and objectively identifying specified characteristics of the material. By means of content analysis a large body of qualitative data may be reduced to a smaller more manageable form of information (Smith, 2000). Converting to these smaller and more manageable forms of information is also referred to as coding. In social sciences other than psychology content analysis has been used to describe and compare cultures (Smith, 2000).

Given the qualitative nature of the data gathered by focus group methodology, a considerable amount of subjective judgment is necessarily involved in its interpretation and analysis. Not all statements and comments made in a focus group session can be considered at face value (Knodel, 1993). Interpretation of statements is facilitated by examining them in the context of the discussion session. According to Seidel & Clark (1984), there are two basic parts in the analysis of focus group data: a) mechanical and b) interpretive (Knodel, 1993). The mechanical part involves physically subdividing and organizing the data into meaningful segments. The coding system developed specifically for the study in question is the foundation for the mechanical part of the analysis. The interpretative part involves determining the criteria to organizing the data into analytically useful subdivisions. The next step in the interpretation of data is to look for patterns, within and between these subdivisions, to draw meaningful conclusions. Qualitative data analysis software such as *Atlas.ti* and *The Ethnograph* enables the analyst to interactively code the textual data files into analytic categories. With the help of such software segments of the text which is associated with a particular code or a combination of code

can be automatically sorted and retrieved. In this way all statements relating to a particular topic of focus group sessions or all of the views of a specific nature concerning that topic can be assembled and organized for further analysis (Knodel, 1993). The coding system is the heart of the content analytic method. If appropriate categories of analysis are not used, vital information may not be detected and the analysis may reveal nothing of interest (Smith, 2000). The coding system is the basis or foundation for the objectivity of the content analytic method. This system is what makes the distinctions explicit and public so other researchers can use the same procedure (Smith, 2000) and therefore enhance the validity of the outcome.

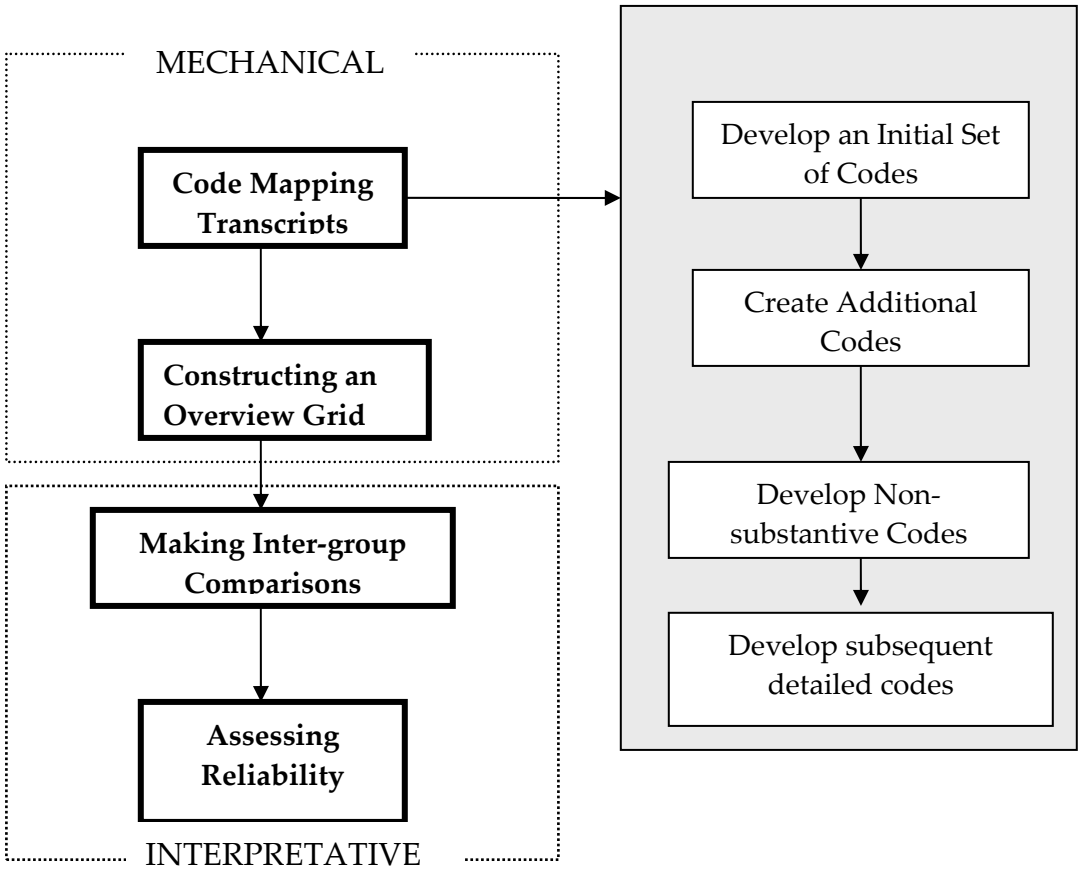

Figure 13: Data Analysis Steps for Focus Group Transcripts

The systematic approach for data analysis of focus group transcripts is depicted in Figure 13 above. The grounded theory that was used to develop the codes was based on the cell phone UI

components proposed by Ketola and Roykkee (2001). The steps of cross-cultural qualitative data analysis used for this thesis are explained as follows:

I. Code Mapping Transcripts

The transcripts of the focus groups were coded systematically following the steps:

i. Develop an Initial Set of Codes: The initial set of codes was corresponding to each category and item of the cell phone interface proposed by Ketola and Roykkee (2001). Separate codes were assigned to every item at each of the three levels. Therefore some codes were general and some were specific. The three levels of the cell phone interface can be referred to in Table 4. Atlas.ti was used to build up these initial codes. The *type of interface* was categorized as a *code family* as it was a general categorization of the cell phone interface. The category specific to each of the 3 types of interface and items specific to each of the categories were coding using the *free coding* feature in Atlas.ti.

ii. Create Additional Codes for Topics That Arise and Are of Special Interest: As the transcript for each focus group was analyzed, cell phone features that were not included in the focus group guideline were coded as well. These additional codes were added to the list of existing using the *open coding* feature in Atlas.ti

iii. Develop Non-substantive Codes that will be of particular help in the analysis and write-up phases: These codes were also added using the *open coding* feature in Atlas.ti.

iv. Develop subsequent detailed codes to user for analyses of specific topics: The Atlas.ti software allows a view of the quotations corresponding to each code that was assigned to the transcript. The quotations are the statements pertaining to user requirements gathered from the focus group sessions. These quotations (user requirements) were added to the overview grid for further analysis.

Figure 14 provides a summary of the coding levels of the cell phone interface as well as the corresponding Atlas.ti coding mechanism.

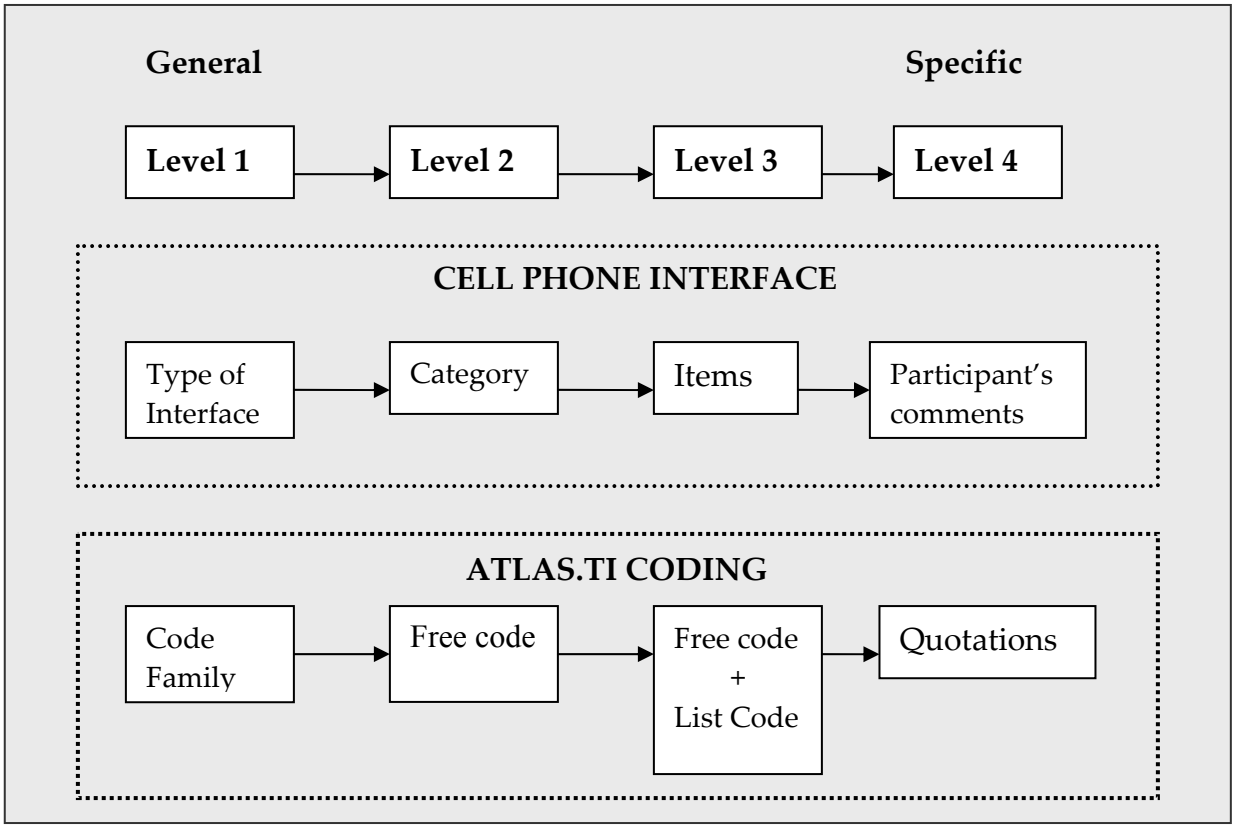

Figure 14: Levels of Code in the Cell Phone Interface and corresponding Atlas.ti

II. Constructing an Overview Grid

Constructing a large chart or table is an effective way of proceeding with the interpretation of the focus group transcripts. This chart or grid is also referred to as an overview grid and it provides a descriptive summary of the content of the focus group discussions (Knodel, 1993). A grid for this cross-cultural comparison will have topic headings on one axis and focus group identifiers on the other axis. Each cell of the grid contains the statements (quotations) which were identified as user requirements specific to the cell phone interface item code. Some quotations in a cell were not isolated quotations but illustrating discussions between participants, indicating the impact of group dynamics (Kitzinger, 1995).

Items	Focus Group 1	Focus Group 2	Focus Group 3
Item1	Quotation11;	Quotation12	Quotation13
Item2	…	…	…
…	…	…	…
Item n	…	…	Quotation n

Figure 15: Overview Grid format for focus group comparisons

III. Making Inter-group Comparisons

In this study, 3-4 focus group sessions were conducted for each of the 4 nationality specific disability groups. The first step was to make inter-group comparisons for the successive focus group sessions conducted specific to these 4 demographics.

Figure 15 shows the overview of the grid made corresponding to each of the 4 groupings. Each column represents a different focus group session. A total of 4 such grids were developed that summarized quotations specific to each cell phone interface component. When similar opinions are expressed by different subsets, despite the differences that characterize the conduction of any two sessions, it is likely that the views or experiences being tapped are common to a shared underlying culture within the broader population (Knodel, 1993). The difficulty in distinguishing differences between groups may arise due to a particular way a moderator conducted the session or related to the group dynamics related to the different personalities of participants in the group. To ensure consistency of the successive focus group sessions the focus group moderator was consistent for all the 13 focus group sessions. A measure for inter-group comparisons can be referred to as a coding dimension which represents a continuous variable. Intensity or degree can be measured by means of a numerical scale such as 0 (no conflict) to 6 (extreme conflict). Coding for intensity may be problematic since it is implied by words in the text and it is difficult for a researcher to make reliable judgments. Another type of coding dimension is a frequency of occurrence of a variable (Smith, 2000). Even though the each occurrence is given equal weight, this dimension is highly dependent on the length of the coding unit, such as the transcript for one group. Due to the

advantages and disadvantages of both these coding mechanisms, a combination of both was used as a decision rule to explore differences and similarities between groups in this study. After developing these overview grids the user requirements were summarized for each item of the cell phone interface that was coded. An example of an overview grid constructed can be found in Appendix L. The next step was to compare the different groups which were selected as the unit of analysis of this cross-cultural study, which was done using an overview grid as seen in Figure 16.

Items	**India_LB**	**US_LB**	**India_CG**	**US_CG**
Item1	User Requirement summary 1	User Requirement summary 2	User Requirement summary 3	User Requirement summary 4
Item2	…	…	…	…
…	…	…	…	…
Item n	…	…	…	User Requirement summary n

Figure 16: Overview Grid to Compare the Units of Analysis

IV. Assessing Reliability

The accuracy of the interpretive analysis is enhanced if the analyst is involved in the focus group session, and possibly even serves as the moderator. This considerably reduces the distance between the analyst and the subject being studied and will lead to a better understanding of the content in the data collected during the focus group sessions.

According to Wikan (1991) the culture analyst or ethnographer not only needs to observe performances in the target cultures, but more fundamentally needs to experience culture personally (Stewart, 1998). The analyst of the data for this study has been a resident of the two countries for the cross-cultural comparison and therefore has a personal insight to the two nationality cultures and therefore has a better understanding of the different communication techniques.

CHAPTER 5. DATA ANALYSIS AND RESULTS

5.1 Participant Demographics

A total of 13 focus groups were conducted in this study, 6 in India and 7 in the United States. The session conducted and corresponding number of participants are summarized in Table 14.

Table 14: Summary of the Focus Group Sessions Conducted

Focus Group No.	Group Identifier	Number of Participants	Total number of Participants
1	India_LB	6	18
2	India_LB	6	
3	India_LB	6	
4	India_CG	6	16
5	India_CG	6	
6	India_CG	4	
7	US_CG	6	16
8	US_CG	6	
9	US_CG	4	
10	US_LB	3	19
11	US_LB	6	
12	US_LB	6	
13	US_LB	4	

The demographics of participants are summarized in Table 15. The type of cell phone model owned by users is shown in Figure 17 (in percentages).

Table 15: Summary of participant demographics

Demographic	India_LB	India_CG	US_LB	US_CG
Sample Size	18	16	19	16
Male: Females	9:9	8:7	10:9	9:6
Age (SD) years	25(3.5)	25(5.62)	43(5.67)	23(3.2)
Number of School Years (Mean)	14	15	14	16
Cell Phone Usage (Mean Years)	3.52	4.43	6	4.7

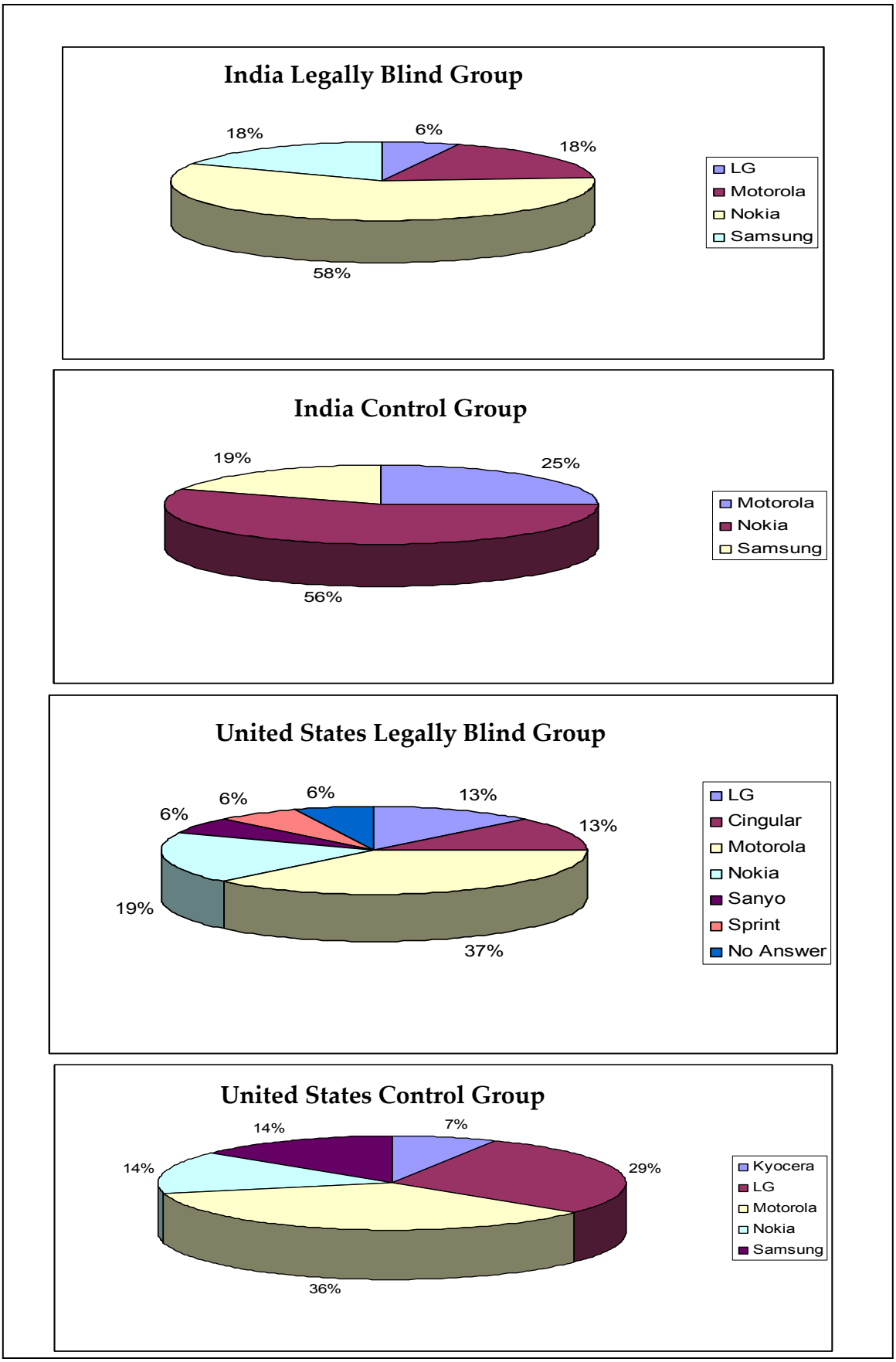

Figure 17: Cell Phone Model Owned by Users (in Percentages)

5.2 Primary Data Analysis and Results

The internal consistency of any instrument is the extent to which the components of the instrument are interrelated, that is the extent to which they produce or predict similar results (Crano & Brewer, 2002). A technique to measure the internal consistency is to calculate the Cronbach's α for the instrument (Crano & Brewer, 2002). The internal reliability of the VSM 94 questionnaire was measured using this Cronbach's α. The higher the α value, the more reliable the instrument. Usually a value of 0.7 and above is acceptable (Nunnally, 1978). The reliabilities the 5 cultural dimensions in each of the groups were tested and are reported here. Internal consistency reliability was assessed with coefficient alpha. Table 16 shows the raw alpha values for each dimension, which is a subscale in the VSM 94 questionnaire. As it can be seen the alpha values are low. None of the alpha values achieved the acceptable 0.70 criteria set by Nunnally (1978). Even with the less stringent criteria of 0.60 for a research scale, only a few more alphas reached a minimum acceptable level.

Table 16: Internal consistency Reliabilities (coefficient alpha) for Five Hofstede's VSM 94 dimensions

	Hofstede's Dimensions				
Group	**PDI**	**IDV**	**MAS**	**UAI**	**LTO**
India_LB	-0.45	-0.29	0.64	0.40	0.18
India_CG	0.28	0.40	-2.01	0.18	-1.44
US_LB	-0.19	0.37	0.17	-0.02	0.71
US_CG	0.44	0.44	-1.69	-0.03	-2.34
US	-0.04	0.46	-0.28	0.04	0.13
India	-0.14	-0.20	0.29	0.35	-0.66
LB	-0.22	-0.25	0.48	0.25	0.40
CG	0.08	0.01	-2.56	0.19	-1.75
Mean	-0.03	0.12	-0.62	0.17	-0.60
Standard Deviation	0.28	0.33	1.26	0.16	1.12

For the 4 country ×disability interaction groups the alpha values are higher as compared to the country grouping. Only for the Long Term Orientation (LTO) dimension, for India a lower value of cronbach's alpha was obtained for the disability group and control group, as compared to the overall nationality grouping. The negative values are obtained since some items were negatively correlated with the dimension indices.

Despite careful matching of samples in this study, the possibility that the background variables may influence the results is recognized. The VSM 94 (Hofstede, 1994) manual warns that:

" Comparisons of countries or regions should as much as possible be based on samples of respondents who are matched on all criteria other than nationality or region. So respondents from one country to another should be chosen from the same gender, age, education level, occupation,

manager/non-manger status, employer etc. They should be matched on any criterion other than nationality that can be expected to affect the answers."

The participants recruited for this study were matched in most of the criteria mentioned in the VSM manual. However the occupation, manager/non-manager status and employer could not be perfectly matched between and within the subject groups. Since perfect matching of the participants could not be achieved, the reliabilities could have been affected and therefore be considerably low. According to Hofstede (2002) despite of poor matching of sampling of criteria, some studies have still found significant correlations with the original country index scores. Hofstede (2002) further justifies that although due to the low internal consistency of the scale the construct validity of the questionnaire may be questioned, testing the internal consistency of a cross-cultural instrument is a job for which the instrument is not prepared. Hofstede (2002) continues to explaining that the reliability of an instrument can be implicitly tested through its proven validity. An unreliable test will not produce valid results, so if validity is proven the reliability can be assumed (Hofstede, 2002). The validity can be shown by correlating the test results to theory and logical explanations. The next section provides descriptive statistics of the cultural dimensions for the 4 cultural groups, with an explanation of mean score differences.

5.2.1 Data Analysis of Cultural Dimension Scores

This section tests for the first set of hypothesis on cultural dimensions. The hypotheses that related to the cultural dimensions of the disability groups were:

1.A. The cultural dimension scores on the VSM 94 for users with disabilities will differ from those without disabilities, within the same nationality group

1.B. The cultural dimension scores for each disability group in India will differ from the corresponding group in the United States.

Cultural Dimensions were calculated using the formulae in Hofstede (1994)'s VSM manual. The VSM 94 is a Likert-type ratings questionnaire with 20 questions, and the formulae that

calculate each dimension index are listed in (Appendix A). The mean scores and standard errors of the four groups are listed in Table 17.

Table 17: Summary of Dimension Scores and Standard Error of VSM 94

	Group			
Cultural Dimension	**India_LB**	**India_CG**	**US_LB**	**US_CG**
PDI	54.44(15.63)	57(9.03)	12.63(12.66)	37(15.10)
IDV	94.72(13.76)	75.66(16.73)	74.21(8.49)	111.33(7.5)
MAS	60.55(21.86)	21(29.69)	18.42(22.79)	13.33(24.98)
UAI	53.33(12.66)	16.33(17.15)	74.47(15.09)	22.33(13.2)
LTO	34.44(8.05)	42.66(7.77)	42.1(5.27)	37.33(8.4)
Sample size	*n=18*	*n=16*	*n=19*	*n=16*

Table 18: Ranking of the Cultural Groups in terms of Dimension Scores

Cultural Dimension	**India_LB**	**India_CG**	**US_LB**	**US_CG**
PDI	2	1	4	3
IDV	2	3	4	1
MAS	1	2	3	4
UAI	2	4	1	3
LTO	4	1	1	3

Note: Rank 1= Highest Score

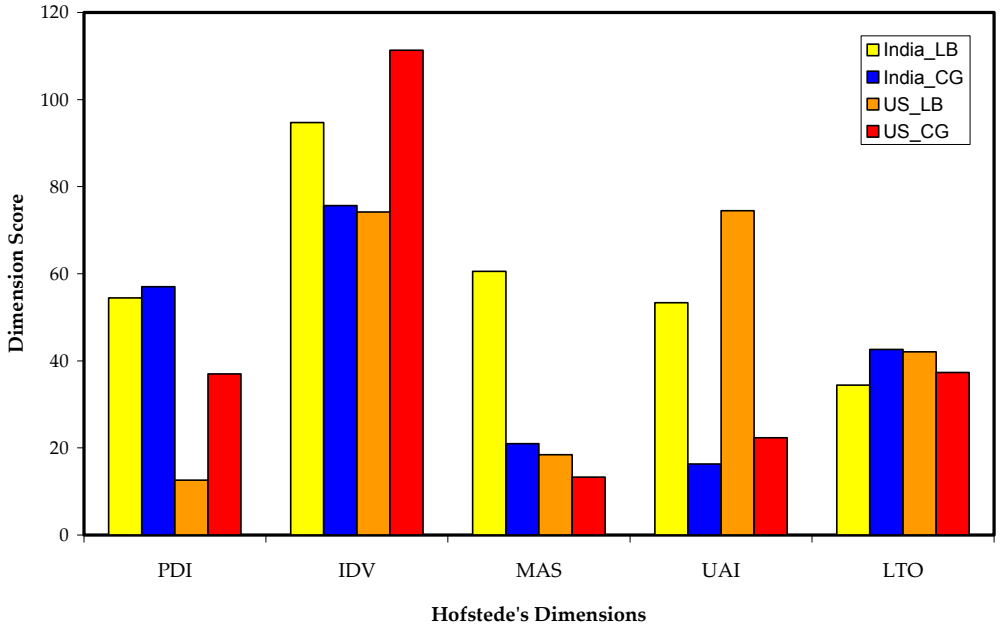

Figure 18: Graph Showing the Mean Dimension scores for 4 cultural groups

Questionnaire responses were summarized and a multivariate analysis of variance (MANOVA) was performed to test differences among the 4 nationality specific and disability specific groups on the five dimensions. MANOVA is performed as a repeated measures and the time variable is assigned to the five cultural dimensions that are calculated using the VSM 94 formulae. The MANOVA results for main effect measures are summarized in Table 19.

Table 19: MANOVA results of Dimensions, Disability and Country Effects

	Wilk's Lambda	***F***	***Pvalue***
Time effect[3]	0.511	*F(4,60)=14.030*	*p<0.0001*
Time × Disability effect	0.839	*F(4,60)=2.87*	*p=0.03*
Time× Country effect	0.90	*F(4,60)=1.55*	*p=0.19*
Time×Disability× Country effect	0.90	*F(4,60)=1.55*	*p=0.198*

[3] ***Note: Time Effect=Cultural Dimension Effect***

The results of the MANOVA indicate that a significant effect of time exists. The $F(4,60)=13.03$ and the $p\text{-value}<0.0001$. This indicates that there exists a significant difference in the mean scores of the dimensions indices. Significant differences also exists in the time×disability interaction effect, where $F(4,60)=2.87$ and $p\text{-value}=0.03$. This indicates that the means scores of the dimension indices differ for the legally blind disability and control groups. The results of the MANOVA are further explored using an ANOVA model.

An informative technique using Analysis of Variance (ANOVA) to test for the differences in cultural dimensions (dependent variables) was also applied, which allows for statistical confirmation of the hypotheses. A two way 2×2 ANOVA was performed using the General Linear Model. The dependent variables were the scores on the five dimensions; the independent variables were the identified as nationality and disability. Nationality has 2 levels, 1: India and 2: United States, and disability has 2 levels, 1: Legal Blindness and 2: Control Group (with no apparent disability). Results of the ANOVA type III model were reported, since sample sizes were different in each cell. For all analyses statistical significance was set at a level of 0.05. Table 20 below summarizes the significant effects of the country, disability independent variables on the dependent variables. The MAS and LTO dependent variables showed no significant effects.

Table 20: Summary of Significant effects of Cultural Dimensions with Disability and Country Sources

Dependent Variable	Source	*F value*	*P-value*
PDI	Country	$F(1,63)=5.09$	$p=0.03$
IDV	Disability×Country	$F(1,63)=5.37$	$p=0.03$
UAI	Disability	$F(1,63)=9.17$	$p=0.001$

The three dependent variables that showed significant effects on the disability and country sources were PDI, IDV and UAI dimensions. For the dependent variable Power Distance Index PDI, the independent variable Country showed significant effects, with *F(1,63)=5.08* and *p-value=0.03.* With the post-hoc test of LS Means it was found that, *p=0.027* and for (Country=1) India, the mean PDI score was 55 and for (Country=2) the United States the mean PDI score was 24. No significant effects were found for disability and Disability×Country variables. For the dependent variable of Individualism IDV the interaction of Disability×Country showed significant effects, with *F(1,63)=5.37* and *p-value=0.03.* The post-hoc test of Least Square Difference (LS Means) *p-value=0.05* showed differences in the India Control Group, with IDV mean score of 75 and the United States Control Group with a IDV mean score of 111.33. The post-hoc test of LS Means *p-value=0.03* showed differences in the United States Legally Blind Group, with IDV mean score of 74 and the United States Control Group with a IDV mean score of 111.33. Figure 19 shows a graph depicting the interaction effect of Country and Disability on the IDV index.

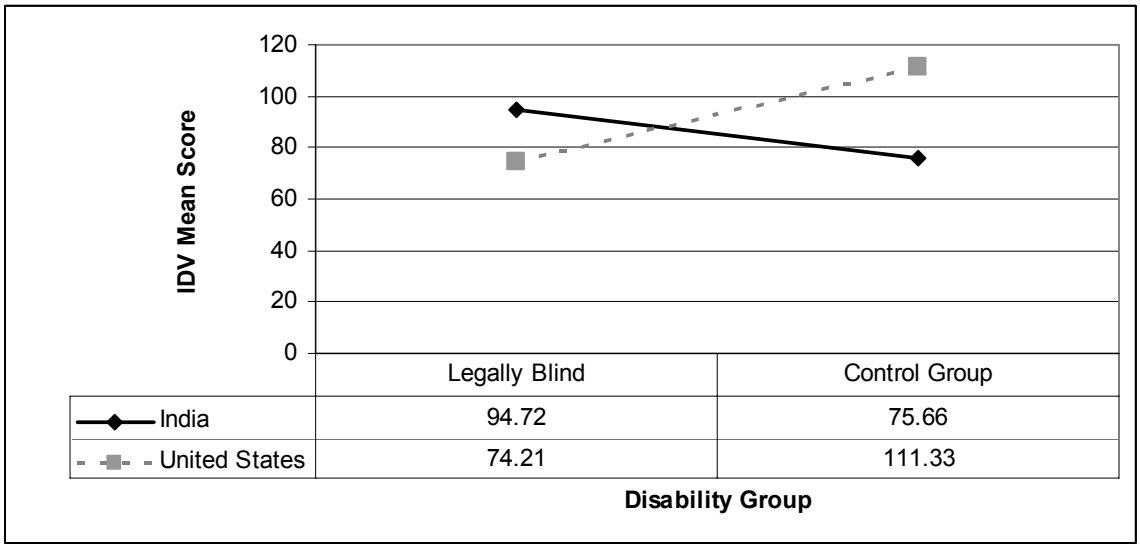

Figure 19: Interaction effect of IDV Dimension index

For the dependent variable Uncertainty Avoidance Index (UAI) the independent variable Disability showed significant effects, with *F(1,63)=9.17* and *p-value=0.001.* With the post-hoc test of Tukey's LSD it was found that, *p=0.003* and for (disability=1) Legally Blind Group, the mean

UAI score was 63.903 and for (disability=2) the Control Group the mean UAI score was 19.33. No significant effects were found for country and disability×country variables.

5.2.2 Explanation of Differences in Cultural Dimension Scores

The Power Distance Index score was tested to be significantly different between the two countries. Moreover it was found that the mean score of India was greater than the United States mean score. This is commensurate with Hofstede (1990)'s findings that India has Power Distance (PDI) as the highest Hofstede Dimension for the culture, with a ranking of 77 compared to a world average of 56.5. This Power Distance score for India indicates a high level of inequality of power and wealth within the society. This condition is not necessarily subverted upon the population, but rather accepted by the population as a cultural norm. Also according to his findings United States has a Power Distance (PDI) score of 40, compared to the world Average of 55. This is indicative of a greater equality between societal levels, including government, organizations, and even within families. This orientation reinforces a cooperative interaction across power levels and creates a more stable cultural environment. Since no significant effects were found between the disability groups and the country specific disability groups, it may be concluded that the nationality overrides the power distance dimension.

Comparing the control groups, the mean of IDV dimension India has a lower score compared to US. This is in concordance with Hofstede (1990)'s findings where he found that India is more collectivist than the US therefore would score lower in the IDV means score. When the mean scores of the legally blind groups are compared to the corresponding control groups it was found that the India Legally blind group had a mean (94.72) greater than its control group (75.66). Comparing the groups in the US, it was observed that the mean IDV score of the legally blind group (74.21) was lower than the Control group mean score (111.33). This was an interesting finding as according to Hofstede (2000)'s literature, as IDV is negatively correlated to the country's GDP. A country that has high GDP and economic, has more rights and legislation for their population with

disabilities. According to Westbrook, Legge and Pennay (1993), Individualistic and Collectivist societies deal differently with disabilities (Hofstede, 2000). In individualistic societies, people with disabilities plan for the future as a normal population would. They are more cheerful, optimistic and they resent dependency. However in collectivist societies there is more of an association of shame, grief and guilt with disability. This also explains that the IDV scores of legally blind group in India (a collectivist country) are greater than that of the legally blind group in the US. The higher IDV score describes that the feeling of community and societal inclusion is lacking, in the India (legally blind) disability group.

Both the legally blind groups show a greater UAI score than their corresponding control groups in each country. Uncertainty avoidance dimension in a culture is defined as a measure of preference for strict laws and regulations over ambiguity and risk (Hofstede, 1994). People with disabilities, especially with visual disabilities would like to avoid any form of uncertainty and risk. This would lead to them scoring higher on the UAI dimension as compared to the control groups in their respective countries. Avoiding uncertainty can related to the need for clear and important feedback to avoid any ambiguity as well. People with disabilities would prefer to avoid such situations and therefore score higher on the uncertainty avoidance index.

5.3 Comparison of Cell Phone Hardware Ratings

Hypothesis 2: The Hardware Attributes of the Cell Phone will be rated differently by the Nationality groups, Disability group and the interaction of Nationality × Disability groups

The above stated hypothesis was tested by applying a 2 (Nationality) × 2 (disability type) ANOVA, on the total hardware ratings and the ratings of the 17 Hardware Features. Table 21 lists the means and standard deviations for each hardware attribute rating for the nationality × disability interaction groups.

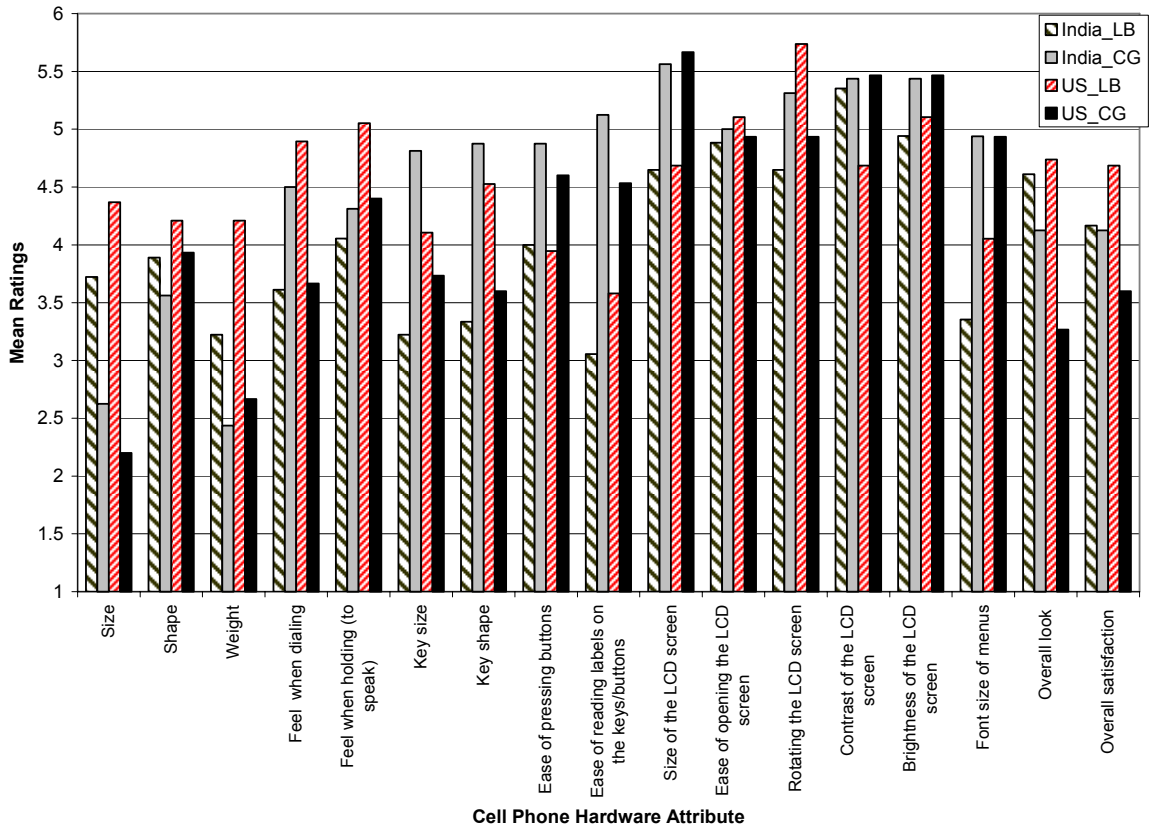

Figure 20: Graph of Mean Ratings of Cell Phone Hardware Attributes

Table 21: Mean and Standard Deviations of Cell Phone Hardware Ratings

Group	India_LB		India_CG		US_LB		US_CG	
Cell Phone Hardware Feature	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Size	3.72	1.07	2.63	1.09	4.37	1.67	2.20	0.75
Shape	3.89	1.02	3.56	1.46	4.21	1.78	3.93	1.24
Weight	3.22	1.66	2.44	1.26	4.21	1.69	2.67	1.40
Feel when dialing	3.61	1.61	4.50	1.03	4.89	1.20	3.67	1.14
Feel when holding	4.06	1.51	4.31	0.95	5.05	0.85	4.40	1.02
Key size	3.22	1.59	4.81	1.11	4.11	1.66	3.73	1.34
Key shape	3.33	1.64	4.88	0.96	4.53	1.43	3.60	1.25
Ease of pressing buttons	4.00	1.46	4.88	1.26	3.95	1.61	4.60	0.71
Ease of reading labels on the keys/buttons	3.06	1.76	5.13	0.89	3.58	1.74	4.53	1.45
Size of the LCD screen	4.65	1.11	5.56	0.63	4.68	1.34	5.67	0.47
Ease of opening LCD	4.88	0.86	5.00	1.26	5.11	1.24	4.93	1.18
Rotating the LCD screen	4.65	1.27	5.31	1.35	5.74	0.45	4.93	1.06
Contrast of the LCD screen	5.35	0.61	5.44	0.51	4.68	1.67	5.47	0.50
Brightness of the screen	4.94	1.14	5.44	0.73	5.11	1.41	5.47	0.62
Font size of menus	3.35	1.73	4.94	0.93	4.05	1.99	4.93	0.93
Overall look	4.61	1.42	4.13	1.02	4.74	1.63	3.27	1.06
Overall satisfaction	4.17	1.42	4.13	0.72	4.68	1.29	3.60	0.71
Total Hardware Rating	69.41	2.4	77.06	2.5	77.68	2.3	71.6	2.62

Sample size for the ANOVA was $n = 67$ due to incomplete questionnaires by some users. For the total hardware rating, significant differences were found between groups on the basis of the country × disability interaction, with $F(1,63)=7.57$, $p\text{-value}=0.007$. As expected the cell phones were rated higher by the control groups as compared to the legally blind group since the test phone

model had few accessibility features. From the LS Means post hoc tests (α=0.05) it was found that the India Legally Blind (*M=69.41, SD=2.4*) and India control Group (*M=77.06, SD=2.5*) were significantly different (*p-value=0.093*). Also was found that the US Legally Blind (*M=77.67, SD=2.3*) and US control Group (*M=71.6, SD=2.62*) were significantly different (p=0.01).

The preference of the Size of the LCD screen of the test phone model significantly differed on the basis of the disability groups, with *F(1,63)=14.96* and *p-value=0.0002*. The legally blind groups rated the preference of the size of the LCD screen lower as compared to the control group. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=4.66, SD=1.2*) and Control Group (*M=5.46, SD=.86*) were significantly different (*p=0.0002*). There were no significant effects of country or country × disability interaction.

The preference of font size on the menus of the cell phone test model also significantly differed on the basis of the disability groups as well, with *F(1,63)=11* and *p-value=0.001*. The legally blind groups rated the preference of font size on the menus lower as compared to the control group. From the LS Means post hoc tests (α=0.05) it was found that the Legally Blind Group (*M=3.70, SD=1.53*) and Control Group (*M=4.93, SD=0.93*) were significantly different *(p=0.001)*. There were no significant effects of country or country × disability interaction.

Sample size for the remaining ANOVAs was n = 68 due to incomplete questionnaires by some users.

The preference of the Size of the phone of the test phone model significantly differed on the basis of the disability groups, with *F(1,64)=29.90* and *p-value=0.0001*. The legally blind groups rated the preference of the size of the phone higher as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=4.04, SD=1.52*) and Control Group (*M=2.41, SD=.89*) were significantly different *(p<0.0001)*. There were no significant effects of country or country × disability interaction.

The preference of the Weight of the phone of the test phone model significantly differed on the basis of the disability groups as well, with *F(1,64)=9.65* and *p-value=0.0028*. The legally blind

groups rated the preference of the weight of the phone higher as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=3.7, SD=1.36*) and Control Group (*M=2.55, SD=1.32*) were significantly different *(p=0.0028).* There were no significant effects of country or country × disability interaction.

The preference of the Ease of pressing the keys/buttons of the test phone model significantly differed on the basis of the disability groups, with *F(1,64)=5.51* and *p-value=0.02*. The legally blind groups rated the Ease of pressing the keys/buttons of the phone lower as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=3.97, SD=1.55*) and Control Group (*M=4.73, SD=1.02*) were significantly different (p=0.02). There were no significant effects of country or country × disability interaction.

The Ease of reading the Menu labels of the test phone model significantly differed on the basis of the disability groups as well, with *F(1,64)=16.32* and *p-value=0.0001.* The legally blind groups rated the Ease of pressing the keys/buttons of the phone lower as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=3.31, SD=1.75*) and Control Group (*M=4.83, SD=1.53*) were significantly different (p=0.0001). There were no significant effects of country or country × disability interaction.

For the feel of the phone when dialing rating, significant differences were found between groups on the basis of the country × disability interaction, with *F(1,64)=11.46*, *p-value=0.0079.* As expected the cell phones were rated higher by the control groups as compared to the legally blind group. From the LS Means post hoc tests (α=0.05) it was found that the India Legally Blind (*M=4.06, SD=1.51*) and India control Group (*M=4.5, SD=1.03*) were significantly different *(p=0.093).* Also was found that the US Legally Blind (*M=4.89, SD=1.2*) and US control Group (*M=3.66, SD=1.34*) were significantly different (p=0.01).

For the preference in key size on the test phone significant differences were found between groups on the basis of the country × disability interaction, with *F(1,64)=11.46, p-value=0.0079.* From the LS Means post-hoc tests (α=0.05) it was found that the India Control Group (*M=4.81,*

SD=1.11) and US Control Group (*M=3.73, SD=1.34*) were significantly different *(p=0.04).* Also was found that the India Legally Blind (*M=3.22, SD=1.59*) and US Legally Blind (M=*4.11, SD=1.66*) were significantly different *(p=0.0025).*

The Overall look and feel ratings of the test phone model significantly differed on the basis of the disability groups as well, with *F(1,64)=9.00* and *p-value=0.0038*. The legally blind groups rated the Overall Look and feel of the phone higher as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=4.67, SD=1.51*) and Control Group (*M=3.68, SD=1.04*) were significantly different (p=0.003). There were no significant effects of country or country × disability interaction.

The overall satisfaction ratings of the test phone model significantly differed on the basis of the disability groups as well, with *F(1,64)=4.27* and *p-value=0.04.* The legally blind groups rated the overall Satisfaction of the phone higher as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (*M=4.4, SD=1.35*) and Control Group (*M=3.68, SD=0.71*) were significantly different *(p=0.04*). There were no significant effects of country or country × disability interaction.

Looking at the above found results where the main effects mainly were found on the basis of disability (or control) group, it may be concluded that the influence of nationality is minimum on the physical aspects of the hardware design of the cell phone. The next section explores the influence of disability and nationality of software usability ratings.

5.4 Comparison of Software Usability Ratings

The first few hypotheses in this section are related to the cultural dimension scores of the different groups. Therefore the groups were ranked according to their cultural dimension scores as shown in Table 18. The following are the set of hypotheses tested for the software usability attributes ratings.

Hypothesis 3.A: The group with higher uncertainty avoidance will have higher ratings on all the tasks.

The Group identified by ranking (according to higher mean scores) the UAI scores is the Legally Blind Group in the United States (US_LB Rank=1). Descriptive statistics are reported to test this hypothesis.

The United States legally blind group does not rate the usability of the any of the tasks higher than the other group. This is due to the fact that most of the participants could not see the screen due to their visual disability and therefore could not complete the task. The low scores indicated that the participants rated the usability of the interface, very bad, very difficult, not easy.

Hypothesis 3.B: The group with a low individualism (therefore collectivist) score will rate significantly higher on the task sending an SMS.

The groups identified by ranking the IDV scores are the India Control Group (India_CG Rank=3) and United States Legally Blind (US_LB Rank=4). Looking at the descriptive statistics of the total score of the task sending a text message, it was found that the India Control Group rated this task higher than the other groups. This indicates that this group rated the task higher, as there were more responses on very good, very easy spectrum of the scale. This finding is in concordance with (Kim et al., 2003)'s findings that the use of SMS is higher in a collectivist society. Due to more frequency of use and familiarity with this feature this group must have rated this feature higher as compared to the other groups. Also in the test phone model, there is use of the term SMS, which was not a familiar term with the US population. While comparing the legally blind groups as

well, it was also found that this task was rated higher by the India group as compared to the US group.

3.C. The group with a high individualism score will have a significantly higher score on the overall usability rating on the task of setting the ring-tone.

The group identified by ranking the IDV scores is the US Control Group (US_CG Rank=1). Observing descriptive statistics for the overall usability rating of the task setting the ringtone it was found that the United States Control group did not have the higher usability rating among the four groups. It was observed that the India Control group had a higher score on the total usability ratings of this task. This can be explained with the focus group discussion results which are summarized in the Qualitative data analysis section. It was found that the India control group was more familiar with the concept of Profiles and frequently changed their ringtone as compared to the US group. The US group was more familiar with the term 'mode' as compared to profile and therefore found this task more difficult, as compared to the India group. This can be explained with the statistics on the cell phone model owned found in Figure 17. It was observed that in the US the more popular cell phone model was Motorola, which uses the term mode (Manner mode, Silent mode, Normal mode), whereas in India the more popular phone was Nokia which used the term 'profiles' for personalizing their interface. The test phone used in this study also used the term 'profiles' therefore the India groups were more comfortable performing this task.

3.D. The Overall Software Usability Attributes will be rated significantly different by the Nationality groups, Disability group and the interaction of Nationality × Disability groups

3.E. The General Features of the use of the cell phone features will be rated significantly different by the Nationality groups, Disability group and the interaction of Nationality× Disability groups.

The above stated 2 hypotheses were tested using a 2×2 ANOVA model which was applied to the all the task rating items (dependent variables).

The overall software usability of a task was the sum of the attributes:

- Ease of completing the task
- Ease of locating a function in the menu hierarchy

- Ease of identifying relevant keys on the phone keypad
- Meaningfulness of the icons associated with specific functions
- Ease of understanding the menu labels for each function
- Feedback of the phone when performing tasks

The three general questions on the cell phone feature were:

- Importance of this cell phone function
- Frequency of using this feature
- Function is essential in cell phone

The results of the hypothesis tests are summarized for each of the tasks:

5.4.1 Placing a Call

For the overall usability rating of the task placing a call a 2×2 ANOVA was applied with disability and country as predictors. The three general questions on the cell phone features, were Importance of this cell phone function, Frequency of using this feature, whether the function is essential in cell phone. A 2×2 ANOVA was applied to all these three dependent variables as well, with disability and country as predictors. The overall rating of the task placing a call on the test phone model significantly differed on the basis of the disability groups, with $F(1,63)=6.34$ and $p\text{-value}=0.014$. The legally blind groups rated the task placing a call lower as compared to the control groups. From the LS Means post-hoc tests ($\alpha=0.05$) it was found that the Legally Blind Group (total=42.35) and Control Group (total=47.18) were significantly different ($p=0.01$). There were no significant effects of country or country × disability interaction.

5.4.2 Storing a Number

The overall rating of task of storing a number on the test phone model significantly differed on the basis of the disability groups, with $F(1,55)=19.94$ and $p\text{-value}<0.0001$. The legally blind groups rated the task placing a call lower as compared to the control groups. From the LS Means

post-hoc tests (α=0.05) it was found that the Legally Blind Group (total=19.95) and Control Group (total=28.218) were significantly different *(p<0.0001).* There were significant effects on the basis of disability × country on the overall rating of storing a number as well, with *F(1,55)=4.52* and *p-value=0.03.* From the LS Means post-hoc tests (α=0.05) it was found that the India Legally Blind Group (total=18.73) and India Control group (total=30.90) were significantly different (p<0.0001).

The rating of Importance of this cell phone function was rated significantly different by group on the basis of disability, with *F(1,57)=7.14* and *p-value=0.009.* From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind group (*M=4.8, SD=1.52*) and Control group (*M=5.73, SD=.22*) were significantly different *(p=0.0098).* The importance of storing a number was also rated significantly differently on the basis of nationality groups, with *F(1,57)=8.26* and *p-value=0.005*. From the LS Means post-hoc tests (α=0.05) it was found that the India Group (*M=5.71, SD=.24*) and US group (m=4.82, SD=1.02) were significantly different (p=0.0005).

The Frequency of using the feature of storing a phone number was rated significantly different by group on the basis of disability, with *F(1,57)=5.97* and *p-value=0.01*. The legally blind group rated with feature lower, indicating that they use it less frequently. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind group (*M=4.43, SD=1.13*) and Control group (*M=5.43, SD=0.38*) were significantly different (p=0.01). The frequency of using the feature of storing a number was also rated significantly differently on the basis of nationality groups, with *F(1,57)=14.33* and *p-value=0.004*. From the LS Means post-hoc tests (α=0.05) it was found that the India Group (*M=5.59, SD=.33*) and US group *(M=4.18, SD=1.53*) were significantly different (p<0.0001). There were significant effects on the basis of disability ×country on storing a number as well, with *F(1,57)=5.76* and *p-value=0.05.* From the LS Means post-hoc tests (α=0.05) it was found that the India Legally Blind group (*M=5.59, SD=.44*) and US Legally Blind Group (*M=4.18, SD=1.03*) were significantly different at (p=0.005) and US legally blind group (*M= 3.36, SD=1.2*) was significantly different from the US control group (*M=5.6, SD=.35*)

The ratings of whether the function of storing a cell phone is essential in cell phone, was rated significantly different by groups on the basis of nationality/country, disability and country×disability interaction groups as well. This item was rated significantly differently by groups on the basis of disability, with *F(1,57)=11.46, p-value 0.0013*. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind group (*M=4.85, SD=1.1*) Control group (*M=5.77, SD=1.3*) were significantly different (p=0.0013). This item was rated significantly differently by groups on the basis of country as well, with *F(1,57)=11.77, p-value=0.0011*. From the LS Means post-hoc tests (α=0.05) it was found that the India group (*M=5.78, SD=.21*) and US group (*M=4.84, SD=1.21*) were significantly different *(p=0.0011)*. This item was rated also significantly differently by groups on the basis of disability ×country interaction as well, with *F(1,57)=13.07, p-value 0.0006*. From the LS Means post-hoc tests (α=0.05) it was found that the India Legally Blind group (*M=5.18, SD=.79*) and US Legally Blind group (*M=3.89, SD=1.2*) were significantly different *(p=0.0006)* and US Legally Blind group (*M=3.89, SD=1.2*) and US Control Group (*M=5.8*) were significantly different *(p=0.0006)*.

5.4.3 Changing the Ringtone

The overall rating of changing the ringtone on the test phone model significantly differed on the basis of the nationality groups, with *F(1,61)=12.13* and *p-value=0.0009*. The India groups rated the changing the ringtone higher as compared to the US groups. From the LS Means post-hoc tests (α=0.05) it was found that the India Group (total=19.46) and Control Group (total=13.83) were significantly different *(p<0.0002)*. The overall rating of changing the ringtone significantly different on the basis of disability as well, with *F(1,62)=6.46* and *p-value=0.0135*. From the LS Means post-hoc tests (α=0.05) it was found that the Control Group (total=14.59) ratings where significantly higher than the legally blind disability group (total=18.70).

The rating of Importance of this cell phone function (Changing the Ringtone) was rated significantly different by groups on the basis of disability, with *F(1,62)=4.06* and *p-value=0.04*. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind group (*M=5.06,*

SD=.89) and Control group (*M=4.3, SD=1.2*) were significantly different (p=0.04). This was an interesting observation since the ringtone feature is used as caller identification by legally blind/visually impaired groups (since they are unable to see the screen) and hence could be of more importance to them. The importance of changing a ringtone feature was also rated significantly different on the basis of disability ×nationality groups, with *F(1,57)=8.26* and *p-value=0.005.* From the LS Means post-hoc tests (α=0.05) it was found that the India Legally Blind Group (*M=5.5, SD=1.1*) and US Legally Blind group (*M=3.36, SD=1.3*) were significantly different (p=0.0005).

The Frequency of using the feature of changing the ringtone was rated significantly different by group on the basis of disability, with *F(1,62)=4.18* and *p-value=0.04.* The legally blind group rated with feature higher, indicating that they use it more frequently. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind group (*M=4.43, SD=1.31*) and Control group (*M=3.67, SD=1.2*) were significantly different (p=0.01). The frequency of using the feature of changing the ringtone was also rated significantly different on the basis of nationality groups, with *F(1,62)=8.45* and *p-value=0.0051.* From the LS Means post-hoc tests (α=0.05) it was found that the India Group (*M=4.43, SD=.89*) and US group (m=3.36, SD=1.22) were significantly different (p=0.04). There were significant effects on the basis of disability ×country on storing a number as well, with *F(1,62)=8.12* and *p-value=0.0059.* From the LS Means post-hoc tests (α=0.05) it was found that the India Legally Blind group (*M=5.5*) and US Legally Blind Group (*M=3.36*) were significantly different at (p=0.005) and India legally blind group (*M= 5.5*) was significantly different from the India control group (*M=3.68*) (at p=0.005).

The ratings of whether the function of changing the ringtone is essential in a cell phone, was rated significantly different by groups on the basis of nationality/country, groups, with *F(1,62)=4.18* and *p-value=0.032*. From the LS Means post-hoc tests (α=0.05) it was found that the India group (*M=5.09, SD=.72*) and US group (*M=4.29, SD=1.21*) were significantly different *(p=0.0032).*

5.4.4 Sending a Text Message

The overall rating of task of sending a text message on the test phone model significantly differed on the basis of the disability groups, with *F(1,62)=57.11* and *p-value<0.0001*. The legally blind groups rated the task sending a text message lower as compared to the control groups. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind Group (total=18.27) and Control Group (total=27.27) were significantly different *(p<0.0001)*.

The rating of Importance of this cell phone function (Sending a Text Message) was rated significantly different by groups on the basis of country, with *F(1,62)=8.97* and *p-value=0.0039*. From the LS Means post-hoc tests (α=0.05) it was found that the India group (*M=6.0, SD=0*) and US group (*M=3.45, SD=1.2*) were significantly different *(p=0.04)*.

The Frequency of using the feature of sending a text message was rated significantly different by group on the basis of disability, with *F(1,62)=15.4* and *p-value=0.0002*. The legally blind group rated with feature lower, indicating that they use it less frequently. From the LS Means post-hoc tests (α=0.05) it was found that the Legally Blind group (*M=3.01, SD=1.23*) and Control group (mean=4.37) were significantly different *(p=0.0002)*. The frequency of using the feature of sending a text message was also rated significantly different on the basis of nationality groups, with *F(1,62)=54.2* and *p-value<0.0001*. From the LS Means post-hoc tests (α=0.05) it was found that the India Group (*M=4.96, SD=.82*) and US group (*M=2.42, SD=1.3*) were significantly different *(p=0.04)*.

The ratings of whether the function of sending a text message is essential in a cell phone, was rated significantly different by groups on the basis of nationality/country, groups, with *F(1,62)=44.63* and *p-value<0.0001*. From the LS Means post-hoc tests (α=0.05) it was found that the India group (*M=5.76, SD=.11*) and US group (*M=3.31, SD=1.22*) were significantly different *(p<0.0001)*.

Overall it was observed that for all the four tasks, significant effects were found on factors of country, disability and the interaction between the two, on the usability ratings and general features ratings. This indicates that the presence (and absence) of a disability, plays a more important role in the rating of attributes of hardware/accessibility features. However nationality (which can be disability specific) plays an important role in the rating of usability features of the interface.

5.5 Data Analysis of Cell Phone Interface Feature Ratings

The participants in this research study completed a cell phone interface feature ratings questionnaire at the end of the focus group session. The features that were included in this questionnaire were described the Methods section. The responses from the ratings questionnaire were summarized and mean ratings were calculated for each group. Figure 21 summarizes the mean ratings on items of the Interface ratings questionnaire (Appendix E). This section provides results of the tests of the following hypotheses relating to the cell phone interface ratings.

4.A The cell interface feature preferences will be rated significantly different by the Nationality groups, Disability groups and the interaction of Nationality × Disability groups.

The above stated hypotheses were tested by applying a 2 (Nationality) × 2 (disability type) ANOVA, on the cell phone interface ratings and the ratings on the 14 features. The significant effects found are summarized in Table 23, which includes the mean scores from the LS Means post-hoc test.

Table 22: Summary of Mean Ratings and Standard Deviations of Interface Ratings

	Mean Ratings and Standard Deviation							
Cell phone Interface item	**India_CG**	**SD**	**India_LB**	**SD**	**US_CG**	**SD**	**US_LB**	**SD**
Minimal Keystrokes	3.69	1.14	4.61	0.98	4.60	0.51	4.58	0.51
Secondary info	2.75	1.06	4.28	0.89	3.23	0.94	4.26	0.73
Variety of Contents	3.88	1.02	4.17	0.92	3.40	0.74	3.89	1.37
Menu Labeling	4.19	0.83	4.06	1.06	4.07	0.59	4.53	0.84
Screen space utilization	4.31	0.70	3.44	1.58	4.27	0.59	4.63	0.76
Large amt. of info. (screen)	3.38	1.31	3.56	1.46	3.27	0.70	3.58	1.50
Personalizable interface	3.81	1.11	4.61	0.61	3.47	1.25	4.05	1.03
Familiar interface	3.75	0.93	3.50	1.20	4.40	0.63	4.21	1.13
Using default folders	4.00	1.03	3.94	0.94	3.27	0.88	3.74	1.24
Softkey functions	4.06	0.93	4.50	0.62	3.73	1.03	4.16	0.90
Programmable softkeys	3.81	0.98	4.06	1.06	3.33	1.23	4.37	0.68
Group SMS	3.63	1.26	3.61	1.50	3.00	1.07	2.32	1.29
Variety of fonts	3.50	1.15	3.06	1.51	3.07	1.22	4.26	1.05
Aesthetic appeal	4.56	1.03	3.78	1.22	4.13	0.83	4.05	1.22

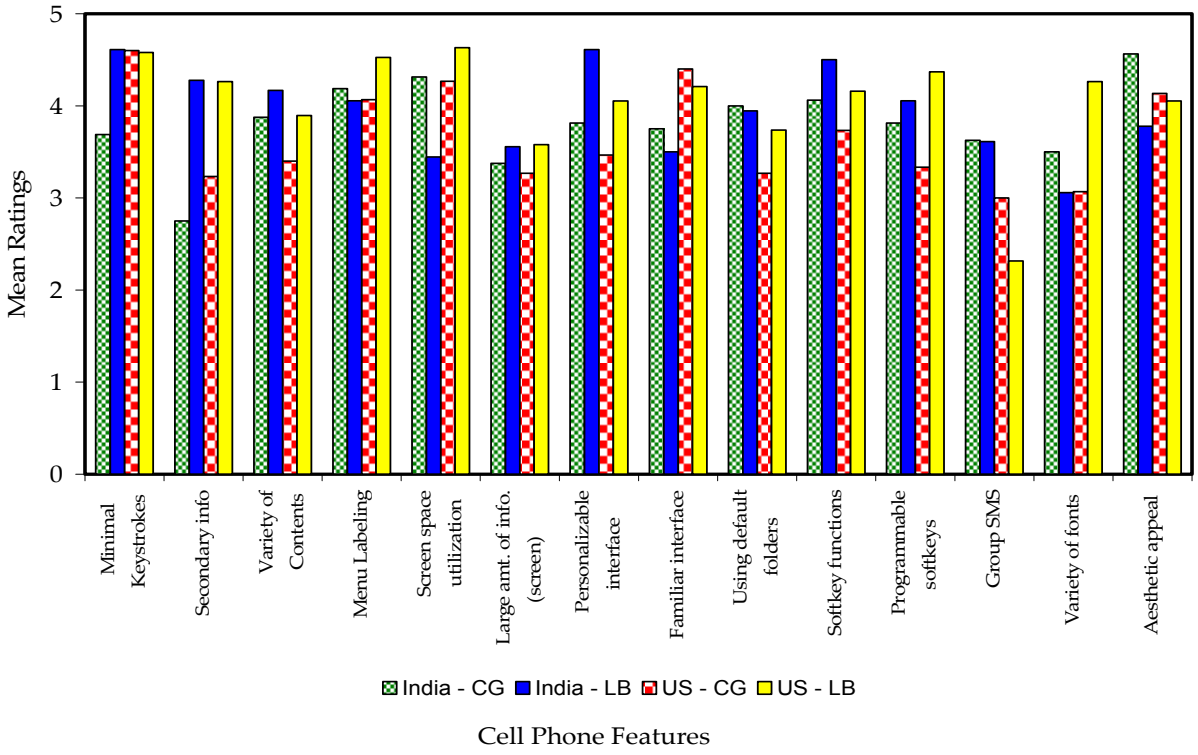

Figure 21: Graph Comparing Means Scores of Interface Ratings for Disability×Country Interaction Groups

Table 23: ANOVA significant effects on the Mean Ratings of Cell phone Interface Features

Cell Phone Attributes	Main Effects	*F (1,64)*	*p- Value*	Mean Scores from LS Means	
Minimal Steps or Keystrokes	Disability	*5*	*0.02*	LB= 4.59	CG=4.14
	Country	*4.76*	*0.03*	I= 4.5	US=4.5
	DisabilityxCountry	*5.48*	*0.02*	I-LB=4.6 I-CG= 3.68	I-CG=3.6 US-CG=4.6
Secondary information	Disability	*33.45*	*<0.0001*	LB= 4.2	CG= 2.9
Efficient screen space utilization	Country	*5.38*	*0.023*	I= 3.8	US= 4.44
	DisabilityxCountry	*6.28*	*0.014*	I-LB=3.44 US-LB= 4.63	I-LB=3.44 I-CG= 4.31
Personalizable interface (Concept of Profiles)	Disability	*7.9*	*0.065*	LB=4.33	CG= 3.63
	Country	*3.37*	*0.07*	I= 4.2	US= 3.7
Familiar interface	Country	*7.53*	*0.0079*	I= 3.62	US= 4.3
Softkey, shortcut functions	Disability	*4.1*	*0.047*	LB= 4.32	CG= 3.89
Programmable softkeys	Disability	*4.1*	*0.04*	LB= 4.21	CG= 3.57
Group SMS	Country	*9.2*	*0.003*	I= 3.6	US= 2.65
Variety of fonts and font sizes	DisabilityxCountry	*7.29*	*0.0089*	I-LB= 3.05 US-LB= 4.2	US-LB= 4.2 US-CG=3.06

5.5.1 Relationship between Interface Ratings and Cultural Dimensions

The following hypothesis was tested to find the relationship between interface ratings and cultural dimension scores.

4.B The scores of the interface preferences will be related to the corresponding group cultural dimension score.

A group level analysis was undertaken and the means scores on the preferences of the cell phone interface features were observed. The significant effect of the Disability variable was found on the mean score of the feature of cell phone Minimum steps or Key strokes, which was rated significantly higher by the legally blind group as compared to the control group. This could be

related to the underlying cultural dimension score of uncertainty avoidance index (UAI), since the legally blind group had a higher score as compared to the control group. A similar effect was found on the Secondary information feature, where a significant effect of disability variable was calculated. A relationship between this cell phone interface feature and the UAI score could be established observing the mean scores from the LS means post-hoc test, where it was found that the legally blind group had a higher means score, indicating they have greater preference as compared to the control group of this feature. Looking at the significant effect of DisabilityxCountry interaction, on the feature of efficient screen space utilization it was observed that the India control group had a mean score significantly greater than the India legally blind group. This observation was contrary to the relationship that was proposed, between UAI and Efficient screen space utilization. The experimental scores however can be explained by the observations of critical incidents in the focus group sessions. It was found that the legally blind group could not see the screen due to their visual disability (they depended only on audio feedback) and therefore they rated the importance of this feature lower as compared to the control group in India.

Also looking at the country significant effect on the feature of personalizable interface on a cell phone, it was found that India rated this feature higher as compared to the US. This was contrary to the proposed relationship between the Individualism index and personalizable interface (concept of profiles). The observed mean score differences however could be explained using the qualitative data analysis results. It was found that the term 'profiles' was familiar to participants in India as compared to the US, since Nokia phones which were more popular amongst the participants, used this term. In the US Motorola was more popular amongst the participants, which uses the term 'mode' to personalize the cell phone interface.

Looking at the feature of variety of font and font sizes, it was found that there was a significant interaction effect of disabilityxcountry. Observing the mean scores from the post-hoc test it was found that the legally blind group in India rated the importance of this feature lower as compared to the US legally blind group. This relationship justifies the proposed (negative) relationship between

PDI (power distance index). Since India scored higher on the PDI as compared to US, it was found that there was a lower preference for this feature of Variety of fonts in India.

Another relationship could be established between the feature of group SMS and IDV. It was observed that there was a significant effect of country on this feature and from the post hoc test it was found that the mean scores in India were greater (indicating a greater importance/preference) for this feature. This was commensurate with previous theory (Kim et al., 2003) that proposed that the SMS feature was more popular in collectivist cultures.

Based on the above relationships that were established between the underlying cultural dimensions of the group and the preference of a cell phone feature, one may conclude that some of the proposed relationships were observed in a group level analysis.

4.C The scores on the ratings questionnaire will be correlated with the corresponding individual level cultural dimension score.

On the basis of results of the VSM 94 data analysis, it was found that only the dimensions of Uncertainty Avoidance (UAI), Individualism (IDV) and Power Distance (PDI) were found to be significantly different across some groups. Therefore these dimensions are considered in this individual level analysis of calculating the values of correlation co-efficient. Table 24 shows the summary spearman's correlation coefficients of the items of the interface ratings questionnaire with corresponding cultural dimensions.

Table 24: Correlation Co-efficients of Cultural Dimensions with Interface Ratings

PDI	IDV	UAI
Variety of Contents R^2= 0.018	**Personalizable interface (concept of Profiles)** R^2=0.0004	**Minimal Steps or Keystrokes** R^2=0.02
Efficient screen space utilization R^2=0.04	**Using Default folders** R^2=0.0004	**Secondary information** R^2=0.08
Large amount Information within a screen R^2=0.0004	**Programmable softkeys** R^2=0.0008	**Clear Menu Labeling** R^2=0.001
	Group SMS R^2=0.057	**Efficient screen space utilization** R^2=0.01
	Variety of fonts and font sizes R^2=0.068	**Large amount Information within a screen** R^2=0.001
		Familiar interface R^2=0.0069

Overall it may be concluded that the expected outcomes of the relationship between the cultural dimension and the preferences on the importance of certain cell phone features were found when a group level analysis was adopted as compared to the individual level of analysis.

5.6 Qualitative Data Analysis Results

The user requirements in terms of design preferences corresponding to the components of the cell phone interface are summarized in this section. These design preferences were extracted from the qualitative data analysis using the Overview grid method of the focus group transcripts (Knodel, 1993). The user requirements for the four disability-specific and nationality-specific groups are summarized in this section, which is followed with an insight to the differences between these groups.

5.6.1 India Legally Blind Participants

5.6.1.1 Cell Phone User Interface

In term of Input tools used in the User Interface, the users of this group stated that the navigation keys must be easily discernable in terms of color and tactile feedback, in-order for them to distinguish easily between all four arrow keys. The softkeys are useful but the users have to memorize the function assigned to them, since they cannot read the screen display easily. A prominent tactile dot on the 5 key was also essential. This protrusion helps in identification of keys tactilely. With the flat key design the users requirement was that the lateral pitch between the keys must be raised. A keypad design with a deeper key protrusion was preferred by users in this group. A flat keypad design must be avoided. Tactile feedback from the keys was also a required essential feature.

The phone was turned on mainly by trial and error and the users stated that the 'end call key' is used as the power key is not intuitive. They desired a clear and well contrasted symbol must indicate the power function on the end key. The users also mentioned that if the power function is clearly depicted on the key, then a separate power key is not needed on the phone. In-terms of identifying the relevant keys for each task the users said that the identification of keys is simplified after some training and practice on the cell phone.

While talking about Shortcut Keys it was learnt that they were used extensively for frequently used functions as an alternative to navigating in to the menu structure.

In terms of Call Management the users stated that for frequently used phone numbers they use speed dial keys more frequently as opposed to the phonebook dialing. They also claimed that the Registered calls (Last dialed, Missed, Received) lists are more frequently used as compared to looking up the phone book to dial numbers. The users required a feature for easy adjustment of call volume to adapt to noisy environments such as local trains in India. In terms of Call Feedback the users stated that it is necessary for the cell phone to provide audio or tactile feedback for call end is

required to ensure that a dialed call has ended. When the users were asked about the preference of voice keys on the cell phone they stated that they prefer voice feedback as compared to audio feedback as beeps from key presses. This user group also stated that they would like to use the feature of voice dialing however they do not trust the reliability of its accuracy.

In terms of ergonomics and hardware design of the test cell phone the users all said that the size of the phone is too large and bulky. The reason that was stated for this was that it is inconvenient to carry a large and bulky phone in crowded places such as local trains. The users would like to have the option of increasing the font size on the display screen.

Users with residual vision need larger screens on cell phones, however some partially sighted individuals who could not see the screen said they would like to have a phone without a screen to reduce the size of the phone. The users found the weight of the phone too heavy and users preferred lighter phones. The users preferred the flip mechanism of the cell phone to ensure that the keys are well protected from unintentional key presses.

The users also did not like the large size of the text phone model. They said they would prefer a phone size that fits easily in their pocket. Large phone sizes are cumbersome for users to carry in crowded environments such as local trains. Most of the users did not want to compromise on the phone size, but also required a large screen size, incorporate larger icons and larger font sizes. The user requirements on screen size varied with the degree of visual impairment. Users with minimal residual vision stated a high importance to screen reading software as compared to the size of the screen.

5.6.1.2 The External Interface

The users also explained that they have difficulty using some detachable parts of the cell phone. The users require easy to use method of changing SIM cards on cell phones
The users also required an accessible method of remove the cell phone battery.

While talking about some advance features of communication methods in cell phones, it was learnt that the users are aware of the Bluetooth technology and would like to use this feature if it

were accessible. Some of the fun features in the cell phone software the users stated that they use were features such as Games, Radio and Composing Ringtones frequently.

Users state that they are unable to perform the tasks on the cell phone due to lack of training and lack of familiarity. They did not state many usability problems with the interface. Users explained that they have issues with the learnability of new cell phones and hence avoid purchasing newer models.

In reference to the learning methods of cell phones, participants of the India legally blind group stated that they mainly depend on friends and family to train them to use the cell phone advanced features. Users also said that they would like to refer to instruction manuals for cell phones, however are unable to do so due to unavailability of accessible formats. Users would like have option of all different formats of accessible formats including Large print hard copies, Audio based, web-based, braille and electronic. However some users said that they prefer a phone that is intuitive enough so that there is no need for a manual.

In reference to supporting software of cell phones, the legally blind participants have repeatedly mentioned the need for magnification and screen reading software for the cell phones.

5.6.1.3 Service Interface

In regard to services and service providers users with disabilities in the India group express the lack of customer service through phone calls, emails etc. The users express the need for customer support to solve their problems with service issues and cell phone compatibility issues.

Responses to the post task questions relating to each of the 4 tasks implied the preferences of the software design of the function as well as the general usage of the features.

5.6.1.4 Changing the Ringtone

For the task of Changing Ringtone, the users claimed that their inability to complete the task was due to the fact that they require training or manuals before using a feature in a new phone. They stated that they currently use shortcut keys to change ringtones in profiles. They also do prefer to use this feature of changing the ring tone frequently. Most users were familiar with the

concept of profiles. Another feature that is used is to assign ringtones to frequently used numbers. Therefore they require a feature that would allow them to easily use this feature in minimum steps.

5.6.1.5 Storing a Number

For the Task of Storing a number, the users stated that looking up the phonebook to dial is difficult therefore users do not use this function often. They prefer to dial numbers that they have memorized as opposed to looking up the phone book. They also prefer shortcut keys as compared to looking up the phonebook.

5.6.1.6 Sending a Text Message

For the Task Sending an SMS, the participants expressed the need for a screen reading software called 'talks' to be installed in order to complete this task successfully. Users found too many options at each stage of the menu confusing. A fewer number of options at each stage would make this task more intuitive. The task was unsuccessful since the interface was unfamiliar. Therefore they feel they would be more successful if the interface was similar to their current cell phone. Users state that for some features such as SMS it is either the use of screen reader/talking software or asking others to help

5.6.1.7 General Cell Phone Features

In general most users stated that voice feedback to indicate task completion is needed in current phones. Some of the essential functions in a cell phone that were reported were Organizer, scheduler, Calendar, SMS, Volume Control, Ringtones.

For the advanced features cell phones such as image recognition function, the users stated that instead of being used as a barcode reader it would be more useful for the same technology to work as a money recognizer and color recognizer.

For this user group an Accessible cell phone was defined as one:

- Hardware and software both should be so comfortable that we can use it without assistance;
- Without any limitations, frustration, confusion;

- Which is like a computer used with the help of Jaws (screen reading software);
- It should be affordable
- Screen reader and Talking software is an important feature in an Ideal cell phone

5.6.2 United States Legally Blind Participants

5.6.2.1 The User Interface

In terms of navigation keys users of the United States legally blind group were aware of the functionality of the Multifunction key. They stated that they require that the labels of the center button and the 4 arrow keys are well contrasted and provide tactile feedback. With reference to the keypad design users require better contrast, lateral pitch and key protrusion of keys on the keypad. There was an general awareness among participants that cell phone manufacturers have to comply with the section 508 requirement for the key size, protrusion and lateral pitch. The users preferred a lighter background with a darker foreground for the keys on the keypad.

The users expressed the tactile dot on the 5 key was essential for the keypad. They users require a dot that has a greater protrusion. The users identified the need to have separation on the key pad between the function keys and the numeric keys. These keys must be separated with a color, physical distance and shape for easy identification.

Another feature identified by the users was that they require a clearer symbol on the key designated the end call key. The red color did not intuitively indicate power on to them. The users do not require a separate key designated as the power key. The most prominent key (in terms of color contrast and protrusion) is mistaken to be the power key.

In terms of call management the users claimed that they find it difficult to identify incoming calls since they cannot read the font size on their phones. The users needed a simpler method for caller identification. Most of the users did not use the assigning a different ringtone to the contact feature.

The users expressed the need for voice commands for all the functions. Some of the current phone have this feature, however the users are unable to use it as they find it difficult to program.

The users found that most of the icons on the test phone model were not clear since their size were too small. None of the participants mentioned the intuitiveness of the icons. Most users said that they use the icon as the identifier or the text in the menu. Therefore clear and large icons and related text were desired by the users. Also color contrast on the screen and the keypad is very essential for accessibility.

Most of the participants did express that the size of the phone was too big, however they liked the fact that the phone piece extended from their ear to the mouth.

The participants liked the bulkiness and the weight of the phone as it gave them the impression of being a sturdy phone. Users prefer to have phones that appear to be sturdy.

Users would not like phones larger than the current size, however do prefer fonts of a larger size. However they were willing to compromise on the size if larger fonts are provided. Most of the participants emphasized on the high learnability curve of using a new cell phone.

In terms of Usability, ease of use was emphasized as more important as compared to having many functions on a cell phone.

5.6.2.2 The External Interface

In reference to instruction manuals, some of the users stated that they currently use manuals however trying it out, asking friends were more commonly used. Users wanted the option of ordering an accessible format of the instruction manuals. In this manner they would have a choice from a variety of formats. They understood that it was not practical to have different formats (large print etc) packaged in the phone box.

In terms of chargers some users said that they prefer the cradle charger as compared to the one without a cradle, since it was easier to plug in. Users also stated that instant feedback after completing any task is extremely necessary. Since most of the time they cannot view the screen, they would like audio feedbacks for confirmation.

5.6.2.3 The Service Interface

The participants stated that they consistently change their cell phone provider and hence have to change their cell phone manufacturers as well. This leads to a great deal of confusion due to lack of consistency. Therefore they expressed the need for consistency for standard in the UI across cell phone and cell phone manufacturers.

5.6.2.4 Dial a Number

While performing the dial a number task the clear key was not well understood by the participants. They had difficulty in clearing a number if they typed the wrong number and eventually gave up the task. Most of the participants said that they currently dial numbers that they remember, however they did state that this was a limitation since they cannot remember too many numbers

5.6.2.5 Changing the Ringtone

During the task of setting the ringtone the users found that there were too many steps and too many options at each stage to complete the task. Another observation was that the users were not familiar with the concept of profiles. They refer to them as phone modes.

Some of the users presumed that the cell phone was not manufactured by a US based company. They explained that the confusing menu structure was due to a foreign manufacturer.

5.6.2.6 Storing a Number

Participants did not find the task storing the number confusing, but mainly pointed out accessibility issues regarding font size and icon size. Participants mostly claimed that they currently do not use it due to its lack of accessibility. They agreed on the need for using this feature if they included voice recognition. Users agreed on the usefulness of the varied options of the storing a name and thought that would be useful in retrieval. When looking up a phonebook,

participants also asked for the feature of looking up a number and finding the corresponding name instead of looking up a name and finding the number.

5.6.2.7 Sending a Text Message

After the task of sending a text message (SMS), it was found that most of the participants had not used this feature before. They did not understand the SMS and MMS terminology. Text messaging was the commonly used term. They pointed out that the default options that are selected are not intuitive. For example to complete this task, the MMS function was a default selection. This MMS feature is uncommon in the US)

Users found difficulty in some of the functions such as placing a space between consecutive words, and inserting symbols. They differed from the method that they used in previous phones, therefore they found the task confusing.

5.6.2.8 General Cell Phone Features

Some of the essential features that were listed were emergency calls, shortcuts, camera for (emergency situations such as taking a picture during an accident). Other features such as tip calculator, magnifier were also specified as important features.

In summary an accessible phone was defined by the United States Legally Blind Group as:

- One where I should not have to strain my eyes;
- For me it is something simple to use and easy to use
- I should be able to use everything on it;
- I should be comfortable using it
- A talking cell phone

5.6.3 India Control Group

5.6.3.1 The User Interface

With reference to navigation tools for cell phone interfaces the users stated that all phones not necessarily have the multifunction key. It is not an essential tool for navigation. The users liked the keypad of the test phone model, but would prefer a greater lateral pitch for easier use of the keys.

The End call key was well understood as the power on/off key. They did not require a separate key designated as the power key. The power key turns off the phone too soon, therefore they would prefer longer time the key must be pressed to turn off the phone. For Shortcut Keys, the users liked the feature in the test phone model that 11 shortcut keys were programmable.

In terms of Call Management, the call volume must be easily adjusted; they require a shortcut key for this feature. The speaker phone is an essential feature for call management. Users mentioned that they used the speed dial feature frequently to dial numbers. They use call history more often than looking up the phonebook to dial. The users also said they would like a feature to allow an incoming call to be set to Silent, instead of ending the call when you do not want to answer it.

The users in the India control group explained that voice keys were not suitable for noisy environments. If the voice dialing feature is reliable then they would like to use it. It would allow the keys to last longer.

For Icons and Menu the test cell phone's menu structure displays all the items in one screen. The users like this feature of displaying all items at once on the screen as compared to the sequential display of items in consecutive screens.

The participants stated that some Non English speaking users in India may not be familiar with the term profiles on cell phones. Therefore it is important that the cell phone explains the meaning of this feature clearly. With reference to Localization in India most places are crowded and noisy therefore the voice dial feature does not work reliably. Most of the users refrain from using it. The users were apprehensive about using any voice functions since they thought the voice recognition has not been well developed for the Indian accent.

The users did not complain about the font size of the text phone model. For them clear fonts on the alpha numeric key pad are important. The fonts on the test phone received no complaints. The users liked the big screen of the test phone model. They also liked the colors and contrast on the screen. When asked about the voice feature, they stated that voice messaging is useful, especially if for the visually impaired users.

With reference to the ergonomics of the cell phone, the users stated that the aesthetic look and feel of the phone body and keypad must be appealing. They thought that the rotation feature was good and would prefer to have the cell phone screen rotate 360 in order to use the screen for the camera. They found that the test phone model was too heavy. They all liked the flip design of the phone to protect the keys from unintentional key presses.

The preferred size of the phone was much smaller than the test phone. The phone must not be as big as a cordless phone. They also stated that the phone body must be sturdy. The cell phone should be able to withstand falling. The life of the cell phone battery was considered as an important cell phone feature.

In terms of communication methods users stated that Bluetooth is an essential feature. With the phones with such advanced features it is needed to transfer data to the computer, an Bluetooth was the preferred method.

Users enjoy changing their incoming call ringtones frequently to the latest Hindi movie songs, which are available for purchase by the service providers. Games on the cell phone were also considered to be an essential feature.

In terms of Usability of the cell phone, Ease of use was rated higher than having many functions by the India Control Group. However the users said that even though some tasks are difficult initially they can always be figured out after using the phone for a while.

5.6.3.2 The External Interface

In terms of User Support, users liked the feature in cell phone in-built help, however they would also like to have the option of switching it off. In terms of instruction manuals it was important for the users to have a good table of contents and a keyword index in order to facilitate easy searching. The instruction manual also must have many pictures to graphical represent the phone's functionality.

With reference to accessories such as the Hands-free sets, the voice recognition and voice feedback features must be used with a head set. They users may not always want the speaker on the cell phone to be heard loudly.

5.6.3.3 The Service Interface

The network availability was pointed out an essential feature on the cell phone. They users stated that due to interruptions in the service availability SMS was considered a preferred method as compared to calling in certain situations. Some of the users stated that an accessible cell phone is one that has good cell phone service at all times. Interoperability, it was mentioned that an ideal phone would be one that interacts and synchronized with your PC as well;

5.6.3.4 Dialing a Number

Users preferred to use call history to place a call, as opposed to the phonebook since it was faster.

5.6.3.5 Changing the Ringtone

Some of the user thought that the changing ringtone settings would be under 'sounds and ringtones'. They thought menu should avoid using too many options and too many steps. The users found that even though this task can be set as a shortcut key, however it was important for the cell phone to have this function easily accessible in the cell phone menu.

The users were extremely familiar with the concept of profiles and like to use profiles such as airplane profiles.

The user group explained that they enjoy changing their incoming call ringtones often to the latest Hindi movie songs. These ringtones could be purchased from the cell phone service provider by sending a text message.

Assigning the ringtone to a contact is a feature that must be available as an option in contact list in the phonebook.

5.6.3.6 Storing a number

The feedback for task storing the number was positive. Most of the users liked the way the menu structure was organized. They understood the sequence of the menu stages well which lead to their successful task completion.

The users liked the options of storing the different types of information for the contact stored (Email, address, Birthday etc). They mentioned that these details may be more useful to business people but they would like to have the option of storing this information as well. They also liked the feature of the storing a display name in the phonebook. They would like to store a picture with the contact name as well.

5.6.3.7 Send a Text Message

The users found that the T9 dictionary was extremely useful and time saving while typing an SMS. They stated that this task on the test phone model had too many steps and too many options. It is important that this function has minimum steps. The choice of SMS over placing a call is mainly due to the fact that it is cheaper and fast as compared to dialing. Also due to the fact that the sender and the receiver do not have to depend on the availability of the service in order to send the SMS. The cell phone messages double checks your actions for task completion, which is not necessary. The most important feature is to complete the task in the minimum number of steps possible. Also it was important for them to be able to easily edit the number that was entered.

The users would like additional symbols and animations (smileys) to be easily inserted in the body of the text. The user said that they liked the feature in the test phone that a large number

of characters were allowed for the message, since they would like to send large text messages. Since the phone allows for large storage this feature could be useful for storing notes as well. Some of the users preferred sending an SMS over calling. One participant made an interesting comment: "I can type faster than I can talk". This indicates that this feature is used as frequently as or more frequently than dialing a number that allows the user get so efficient at it.

5.6.3.8 General Cell Phone Features

When asked about important functions in a cell phone, SMS, calling, and Ringtones were mentioned across the groups.. In terms of advanced functions, users mention that text to speech will be useful for listing to SMSs while driving. They also would like to use the speech to text technology to input text messages. The Image recognition feature as Barcode reader not useful, but scanning would be useful. TV calls (video calls) would be useful but would not want to pay more for this feature.

When asked how they would define an accessible phone the following responses were obtained:

- A phone with a good network
- You have a cell to be accessible

To summarize the discussion some of the features of an ideal phone were as follows:

- Should be usable by people with disabilities
- User friendly, and Light and handy
- If you have a camera phone the camera should work well.

5.6.4 United States Control Group

5.6.4.1 The User Interface

In reference to Navigation tools used in the cell phone interface the users were aware of the Multifunction key and liked its functionality. However it was important that the center button of the multifunction key must be labeled "OK". In terms of the keypad/keyboard, the users found that the

keys were easy to press to dial and they liked the size of the keys. However they would prefer that the lateral pitch of the keys was increased.

The users found that the Power button (End call key) was understandable and intuitive. They understood that this was generic in all phones and they would not like a separate power key.

In terms of call management they mentioned that they use the call history feature as often as they use the phonebook. The users would like a shortcut key to easily access the call history (missed calls, received calls, last dialed numbers).

Some of the users said that they do have the voice key/ audio display feature in their phone, however they would like to use it only with a headset. They would like to use an audio display while driving. Users found the key beeps annoying. Users would like to have the option of turning this off quickly.

The control group in the US found that the icons on the cell phone menu were clear and descriptive however the functions under the icons were not relevant and did not lead to successive task completion (especially the task of setting the ringtone). Some users also said that the icons all look similar and they should be more distinguishable in terms of color and contrast.

In reference to the Display/Screen, the users stated that they loved the screen of the test phone, the size as well as the contrast and colors. The users further explained that they would prefer if the secondary screen be larger and it must be well contrasted; a dim screen was of no use. The secondary screen must display the number of the incoming call, and the clock on the secondary screen is essential

In reference of the cell phone appearance and touch and feeling the users stated that they prefer to have a thin and slim phone. They concluded that men and women do prefer slimmer phones. Also that it was important for the phone to be sturdy and durable. The users did not like the rotation of the screen, they felt that the phone was fragile and therefore would prefer something sturdier. The users thought that the phone was too heavy; they would prefer a lighter phone. All the

users like the flip design of the phone, however they found the phone to be too bulky, they would prefer something smaller and slimmer. However they liked the fact that the phone piece was lengthy enough to reached their ear and mouth, which felt that they were talking into the phone.

In terms of the communication methods the users found that the test phone model had blue tooth, USB and infrared, which made it very useful for data transfer. They said that they would like to use this feature in their cell phones. They would like to use this feature of the phone synchronized with the computer for the contact list and other data. In reference to the utility and security, they said would avoid adding too much personal information in their cell phones. They would like to include a security code to secure information such as their SSN. In reference to cell phone usability, the users said they prefer ease of use over having many functions. In terms of feedback, the users claimed that the explanations on the phone about each of the software features were not self explanatory, they would like the text to be clearer and more descriptive.

5.6.4.2 The External Interface

Most of the users said that they figured out how to use their phone by trying it out themselves. They said that they would use an instruction manual only when the phone stops working. They would like an instruction manual with lots of graphics pictures and a fewer number of pages.

In reference to external components the users claimed that they would like to have a cradle charger, instead of the plug in type for the cell phone.

5.6.4.3 Service Interface

In terms of service availability the users stated that they currently have issues with their network and desire a better service/ reception from their service provider. Also they would like a phone with the pull antenna for better reception. Also they would use features like the internet if the service providers would offer them at no additional cost.

The users found that the large number of intermediate steps made the tasks difficult. Users would prefer fewer steps and would like the option of shortcut keys for the important and frequently used functions. The responses to the post task questions are summarized as follows:

5.6.4.4 Changing the Ringtone

For the task setting the ringtone, the users thought that the most intuitive place to find ringtones would be under 'sounds', therefore finding it under 'settings' was difficult. The users were familiar with the concept of profiles, however used the term modes as well. They mainly used the vibrate/silent and normal (profile) mode options.

All the users changed their ringtones often, therefore they would like few steps for completing this task. For frequently used functions the users said they would like minimum steps, some said that 3 steps were the maximum.

5.6.4.5 Storing a Number

For the task storing a number, the phone feedback was useful for saving the name under a number and avoided unnecessary loss of information if the forgot to enter a name. However the users would prefer the feedback to be worded better (in more direct terms). The users also would like to have the different options/ categories for a contact while storing a number. However they expressed that storing so many details will be useful for a business purposes as compared to personal purposes. They would like to save the name of the service provider of the contact on the contact list. The users expressed that they use the call history more frequently as compared to their phonebook

5.6.4.6 Sending a Text Message

For sending an SMS or text message, the users stated that there were too many levels and options to complete this task. Users use the instant messaging feature through their online messaging functions more often as compared to sending messages through their cell phones.

Usually they disable the shortcut to SMS since they do not use the SMS feature often. Users stated that they prefer using the dictionary while inputting text to send a message. They said that they should have the option of: choosing the contact first before typing the message to be sent or typing the message and then choosing the contact.

5.6.4.7 General Cell Phone Features

When asked about the essential features they users listed Calling Receiving, Games, MP3, music, Clear reception.

In-terms of advanced features, users were not extremely enthusiastic about the voice recognition function, image recognition and TV call. Some of the users expressed the privacy issues related to the TV call feature.

The participants were asked to define an accessible cell phone. The responses are as follows:

- You should be able to figure it out without a manual
- The phone should teach you how to use it.
- Being in range (service) all the time to send and receive calls at all times.

Also in summary they were asked to describe an ideal cell phone, the responses are as follows:

- Minimum number of steps for all the frequently used functions
- Some of the users said that they would like to be able to program the phone to change the mode (profile) according to the time of the day.
- Alarm feature in current phones are too easy to turn off. They would like a security code to stop the camera.

CHAPTER 6. DISCUSSIONS AND CONCLUSIONS

The global nature of mobile technologies has highlighted the importance of this cross-cultural study to identify differences in interface design preferences of cell phones. The data analysis results in the previous section indicated that there are several aspects of cell phone interfaces which are similar and different in both countries and across the disability groups. Overall this study indicates that there are more differences on the usability aspects than accessibility aspects of cell phone interfaces between the legally blind groups across the two countries, India and the United States. The results of this study indicate the presence of a relationship of culture and interface design. This section highlights some of significant the differences across these groups.

6.1 Research Questions Answered

The research questions that were proposed in this thesis are answered and summarized in this section.

The first research question was as follows:

- What are the differences in cultural dimensions?
  (And whether these differences substantiate the existence of a disability culture)

It was hypothesized that differences would be found on certain dimensions of the cultural model. This research study found differences between the control and legally blind groups on the uncertainty avoidance (UAI) cultural dimension, indicating disability overrides nationality. For the Power Distance Index (PDI) it was found that the India group score was significantly different as compared to the United States group, indicating that nationality overrides disability. For the individualism (IDV) dimension, it was found that the India legally blind group scored higher as compared to the control group with no apparent disability. In the United States, the control group scored higher on this cultural dimension as compared to the group with legal blindness. Therefore to summarize, differences in cultural dimensions were driven by disability and nationality and the

interaction between these two independent variables. These significant effects and differences were explained based on theory, and point toward the presence of a disability culture.

Another research question was as follows:

- What are the differences in cell phone hardware features ratings?

The statistical and content analyses found that main effects on the preferences of hardware aspects of the cell phone were driven by disability groups. The differences indicated that the control group preferences differed significantly from the legally blind group. The cell phone hardware features preferences were driven by disability, indicating that the presence of a disability was overridden by nationality for the hardware ratings dependent variable.

The research question that followed was:

- What are the differences in cell phone usability ratings?

The data analysis on usability ratings found that the significant differences were driven by disability as well as nationality groups. Indicating that on certain cell phone functions there were differences in usability ratings, based on the disability groups, for some based on nationality groups and for some tasks, disability specific nationality groups. This finding reinstates the issue of *Culturabilty* (Barber & Badre, 1998), which emphasizes the need to consider usability in a cultural context.

The next research question was as follows:

- What are the differences in design preferences? (of certain cell phone interface features)

Certain cell phone features and their relationships between cultural dimensions were identified based on previous studies. The data analysis found that when a group level analysis was adopted, as compared to an individual level of analysis, the differences in the cell phone interface features were reflected on the underlying cultural dimensions of the groups.

The question that proposed the integration of the quantitative data analysis findings with the content analysis of the qualitative data was as follows:

- What are the bases of these differences in design preferences of cell phone interfaces?

The significant differences that were found from the statistical data analysis were explained by some of the findings of content analysis. Some of the quantitative results have been validated with the findings from the qualitative data analysis. For example it was found that the usability ratings of the task sending an SMS were significantly greater in India as compared to the United States. From the focus group discussion sessions it was found that the use of SMS was more prevalent in India and they considered it as an essential cell phone feature. Some of the ratings of the cell phone interface features, such as Essential screen space utilization were rated significantly different by the control and the legally blind group. From the qualitative analysis it was found that some of the legally blind participants could not view the cell phone screen (due to their visual disability), therefore this feature was rated of higher preference by the control group. The quantitative data analysis results were tied in with qualitative interpretations (that have been explained in the results section).

The next section highlights some of the significant differences found between the groups that were under analysis for this research study.

6.2 Differences across the Legally Blind Disability Groups

In India the legally blind users emphasized the fact that they are unable to complete tasks since they were not familiar with the phone that used as the test model. However legally blind users in the United States emphasized the fact that the phone had usability and accessibility issues and therefore they had more suggestions on the different aspects of designing the user interface. This could be explained with the differences in disability legislation. In the US the Telecommunications Act 1996 has increased the focus on consumers with disabilities (henceforth referred to as 36 CFR 1193). 36 CFR 1193 specifically addressed accessibility, and assigned regulatory authority of the Federal Communications Commission (FCC) to ensure that all users have access to

communications products, regardless of disability, to the extent that access is achievable without undue expense. This Act was designed to ensure that the 20% of Americans affected by a disability have equal access to telecommunications products such as cell phones and portable computers (Smith- Jackson *et al.,* 2003). No such legislation exists or is enforced in India for people with disabilities. Most of the accessibility user requirements of these two user groups overlapped, however the participants from United States disability group identified more issues concerned with the usability of the interface.

However users with disabilities in India currently used and desired to use more advanced features as compared to the US. This complies with the cross-cultural differences of cell phone adoption in the two countries, with India advancing at a faster pace.

6.3 Differences between India and United States

Privacy issues regarding information sharing through cell phones were brought up in discussions in the US focus group sessions. The participants were concerned about their privacy being violated due to the features such as the camera, voice call and storing personal information on the cell phone. No such privacy issues were raised in India. The importance and familiarity of using Text messaging (SMS) was found to be higher in India as compared to the United States. This complies with findings of the study of French and American mobile phone users by Issac, Nikerson & Tarasewich (2004), where differences were found in text messaging usage which was attributed the relative newness of this feature in United States. The other study by Kim *et al.* (2003) supports these findings, states that text messaging is more frequently used in collectivist cultures such as India. The concept of calling tunes where the caller can listen to a song instead of the regular calling sound has gained popularity in India over the past few years. The popularity of songs from Bollywood (The movie industry in India) penetrates the mobile phone culture and the service providers have the latest songs available for purchase, in the ringing tone and calling tone formats. Therefore the importance of ringing tones and usability ratings of the task, was rated higher in India

as compared to the United States. The users in India were more familiar with the concept of profiles. The current test phone model was developed by Toshiba an Asian cell phone manufacturer, which explains some of the higher usability ratings in India as compared to the United States.

Statistically significant relationships however were not found between the cell phone interface elements and cultural dimensions that were identified by Choi *et. al* (2005).

6.4 Disability Culture Revisited

Some of the differences that were found in some of the index scores of the cultural dimensions, as calculated by the VSM 94 formulae. As discussed before, different cultures perceive things differently. It is the influence of childhood experiences, upbringing, education, social aspects that affects interaction with the environment (Yeo, 1996). Since people born with disabilities (or those that have acquired a disability in their childhood) have had a different childhood, upbringing, education, social interaction and other experiences than those without disabilities, therefore, they will share a common attitude and a set of values different from the population without disabilities. The values and behavior of a population with disabilities differs in some aspects if not all aspects from the national culture. However, if the person has developed a disability in adulthood, s/he may or may not share the values of those that were born with a disability. Most of the participants in this study acquired the disability congenitally. The differences in cultures are also explained by the presence of emic and etic variables. The emic approach is based on the assumption that at least some cultural dimensions are culture-specific and cannot be used to analyze cultures of various entities. Unlike the etic approach of universal cultural dimensions that are used to describe cultures relative to each other. Emic variables are cultural metaphors that are unique to specific cultures and are used to describe each culture independently which can be explored mainly through a qualitative approach (Gannon, 2004). Therefore the presence of a disability culture must be investigated further by purely qualitative methods such as ethnographic studies. However, since this research is

exploratory in nature, the current findings of the cultural dimensions provide an insight to further studying the presence of a disability culture.

6.5 Limitations of the Current Study

The shortcoming of this study is that there is a potential for a sampling bias due to convenient sampling, therefore if a complete random sampling method were employed the validity of the results would be increased. The education level, work experience, gender and age of participants in one group could not be perfectly matched at the time of recruitment which therefore may be a potential bias the findings. Specifically the United States legally blind group had a greater mean age as compared to the other groups. To justify that the effects of age did not bias the scores obtained on the cultural dimension index, an age group independent variable was included in addition to the disability and nationality variables in the ANOVA model for the VSM 94. No significant effects were found for the variable age group, (which considered age>35 high and age<35 low) for the 5 cultural dimensions as the dependent variables.

According to Hofstede's (1994) manual, the minimum number of respondents per country or region to be used in comparisons is 20, since below that number, the influence of individuals is strong. In this study the sample size for each cultural group varied between 16-19 participants. Another limitation is that the VSM 94 questionnaire mainly revolves around work related questions. Therefore it is essential to justify the obtained scores with another robust instrument. For example a questionnaire developed by Bierbrauer *et al.* (1994) called the Cultural Orientation Scale (COS) measures the individualism and collectivism dimensions defined by Hofstede (1991). This scale has been used and validated in various studies (Ferreira, 2002). Ferreira (2002) used this scale in a study that compared the type of information Anglo-American and Hispanic-American people prefer in an e-commerce environment. Further research is needed to deepen the value of Hofstede's cultural specific variables to cross-national and cross-cultural design of interfaces. Also the

possibility of construct bias due to different rating schemes on Likert-type questionnaires adopted by different cultures must considered while interpreting the quantitative data (Cliff & Keats, 2003).

6.6 Guidelines for Cross-National Studies

A set of guidelines were developed from the research experience of this study to address the issues in cross national studies. These guidelines are categorized as technical issues and recruitment issues and are described as follows.

6.6.1 Technical Issues

Video Formats: Video cameras come in two formats: PAL and NTSC. A recording in a PAL format will not play in a NTSC player and vice versa. The PAL format is used in Europe and Asia, and the NTSC format is used in the United States. It is important to ensure that the digital copies of the video recordings are prepared in the country where the research was conducted to avoid video format compatibility issues.

Voltage range: Europe and Asian countries have different voltage as compared to the US. It is important to ensure all equipment is compatible and can be used in the target countries. The researcher must purchase voltage converters to ensure their equipment works in the country they are planning to conduct the research.

Import/Export duty: Some cross-national studies will require the transportation of electronic equipment. It is important to learn the permissible limits on electronic equipment to avoid the payment of import/export duty during shipment of equipment across national borders.

Language: It is important for the moderator of the focus group to be familiar with the national language and the lingo used in the country where localization research is being conducted. Familiarity with their language allows the participants to be more participative in the discussions and interview sessions.

6.6.2 Recruitment of Participants

For recruiting participants for a cross cultural study is necessary to designate a local resident for this task. The budget for a cross-cultural study must include the expenses to hire a consultant to

be in-charge of the recruitment located in the countries where the research will be conducted. Remote recruitment using phone calls and emails was not found effective.

6.7 Guidelines for Studies including People with Disabilities

In this section some guidelines are provided for design studies involving users with disabilities. Some of issues that must be considered have been addressed in User Sensitive Inclusive Design. (Newell & Gregor, 2001). These guidelines are categorized as accommodations and recruitment are as follows:

Accommodations: While conducting a study to improve usability and accessibility issues in designing products for users with disabilities, it is important that these issues must be reflected by the research methods during data collection. One method is by providing questionnaires in accessible formats suitable for the target population. Large print questionnaires for users with low vision and Braille prints for the users that are totally blind must be provided. It is important to keep in mind that different disability types have different accommodation needs. It also is important to consider questionnaire usability in mind while designing the survey questions.

Recruitment: Recruiting users with disabilities is one of the biggest challenges in studies for users with disabilities. This challenge becomes three fold when the recruitment involves scheduling participants at a common location and time for a focus group. The most effective way for this was found to recruit through disability service providers and agencies. These organizations have a direct contact with the target population and therefore a larger number can be recruited through them.

6.8 Future Work

For future cross-cultural quantitative studies it is proposed to consider the influence of cultural dimensions on the responses of ratings questionnaires. Previous studies on response styles have showed that there are major differences in response styles between countries. In one such study by (Harzing, 2006) it was found that country-level characteristics such as power distance, collectivism and uncertainty avoidance significantly influence response styles. This study also

found that, English-language questionnaires are shown to elicit a higher level of middle responses, while questionnaires in a respondent's native language result in more extreme response styles. Therefore for results to truly reflect cultural differences, it is important to adopt certain methods to mitigate the effects of response bias. The qualitative data analysis will render more reliable results when more than one analyst and coder is responsible for the content analysis of a cross-cultural research study. This would lead to a higher inter-rater reliability and therefore lead to more valid results.

For a holistic understanding of cross-cultural aspects of cell phone design the following model was proposed for future work.

6.9 Proposed Research Model

The importance of designing cell phone interfaces by considering differences based on disability and nationality is explained by using Jordon (2002)'s pleasurability framework . This framework can be used to assess the specific needs of users with disabilities to provide insight for the design process. The framework consists of four pleasures: sociological (relationships with others), ideological (people's values and beliefs), psychological (cognitive and emotional characteristics) and physiological (anthropometrics). It is important to realize that needs of the user group with disabilities differs somewhat from mainstream users. Designing products for people with disabilities makes certain tasks possible for them, which would otherwise not be possible. For example the speech based interface which made word processing, web browsing and other activities possible for the blind. Jordon (2002)'s pleasurability framework was studied and its application in designing for users with disabilities has been explained by Harrison (2004). The findings of this thesis have been integrated with Jordon (2002) and Harrison (2004)'s theories, and a model has been developed for a holistic view of designing cell phones for users with disabilities, explained as follows in Figure 22:

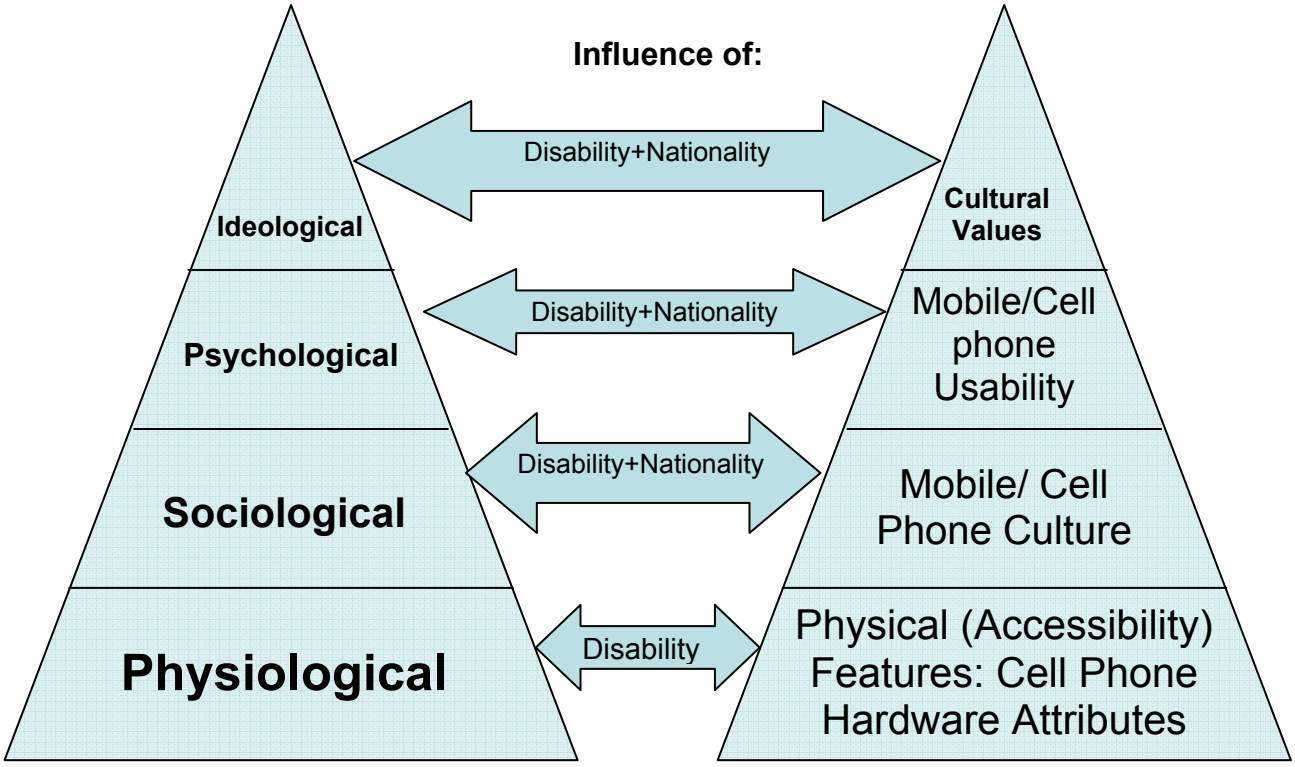

Figure 22: Pyramid Model for Cell phone Design adopted from Jordon (2000)

Physiological

Physiological characteristics are related to the size and appearance of the body. The population with disabilities is at a physiological disadvantage than the main stream population. The user's anthropometrics must be considered in the design of a product. For example a cell phone for a person with limited upper extremity use must be designed such that the keys have minimal force requirements and eliminate any tasks that require the press and hold operation. Physiological characteristics depend mainly on the physical limitations of the users and therefore the accessibility issues for a particular type of disability may not differ to a large extent. As found in this paper significant differences were mainly found between disability and control groups on the physical features and hardware attributes of cell phones.

Sociological

Sociological characteristics deal with a person's relationship with others. This includes the country and culture the user belongs to and the values and customs associated with these. A sense of normalcy is important for people with disabilities as they do not want to be a burden. Due to social isolation, products that can increase interaction with other people are important. Designing cell phone for users with disabilities will enable them to interact socially with their community. Also by reducing the clinical look of the product, users' feelings of social isolation due to negative stigma could be reduced. Therefore it is important that an in-depth analysis of the mobile phone culture in a country is undertaken understand and design implications of mobile phones for the population with disabilities. In this paper the content analysis results of the focus group discussions revealed the differences in the mobile/cell phone cultures, which helped in a enhanced interpretation of the quantitative data collected.

Psychological

Psychological characteristics are related to cognitive and emotional characteristics of people or a group of people. It includes characteristics of intelligence, skill and creativity. It includes the ability to learn, memorize, and tolerate errors, the perceived ease of use. The usability of a product can be perceived by understanding the psychological characteristics of the users. A design implication of this for a person with a deteriorated short term memory having difficulties with memorizing, would be a menu that is wide as opposed to a deep menu structure will be preferred for such an individual. Most people with disabilities may experience some degree of negative emotion (frustration, avoidance, anxiety) when faced with new or complex technology. As many of these users are already suffering from emotional difficulties, they may be more susceptible to frustration. Therefore, it is important to lower the occurrence of frustration by reducing the number of possible errors and ensuring a short learning time. Studying existing technology used by people with disabilities and adapting certain features in the design of cell phones is important and must be

considered for future work. In this paper was found that the perceived usability of the interface was rated differently by different groups based on nationality and disability. For example one finding in this research was that using popular terminology on cell phones such as profiles or modes (or visa versa) reduced the frustration experience and increased the usability ratings when adapting to new cell phone models.

Ideological

Ideological characteristics deal with a person's values, morals, tastes and aspirations. During the study of these characteristics it is important to consider the emic and etic variables used to define cultural dimensions. A careful consideration of the boundaries of culture is essential as well, where cultural values may be defined by disability as well as nationality. An in depth analysis of the cultural differences and similarities between the target population provides holistic perspective to the design of cell phones for a population with disabilities. The findings of cultural variables must be further studied to understand their design implications. For example, it has been observed that the user population with disabilities does not want to waste money on useless or unusable products. They often refuse to buy equipment that cannot be of benefit to other people as well. It is important to ensure that the product look and feel aesthetically satisfies the user with disability as well. It is imperative that in designing a product that is usable and accessibility, the aesthetic appeal aspect is not overlooked, to ensure that the product experience is pleasurable for the user.

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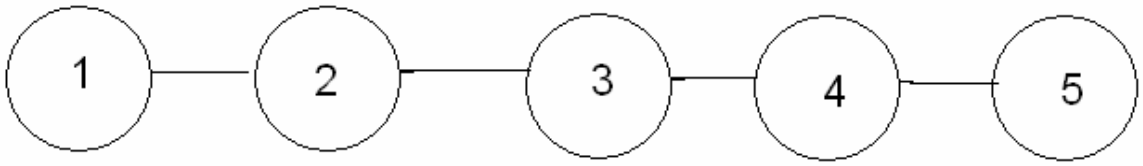
Appendix A: **Value Survey Module 94 Questionnaire**

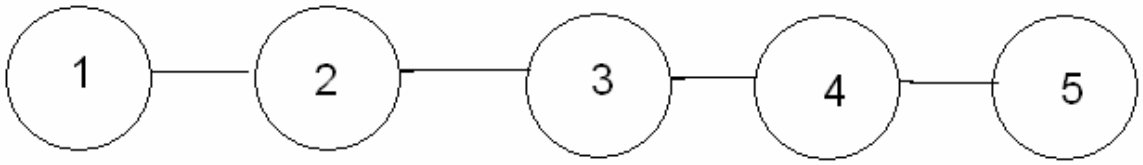
Please think of an ideal work situation, (you can disregard your present work situation, if it is not ideal). The work situation could be an employment or a student position at a university/school/college or any other. In choosing an ideal work situation, how important would it be to you ...
(please choose one answer in each line across):

1 = of utmost importance
2 = very important
3 = of moderate importance
4 = of little importance
5 = of very little or no importance

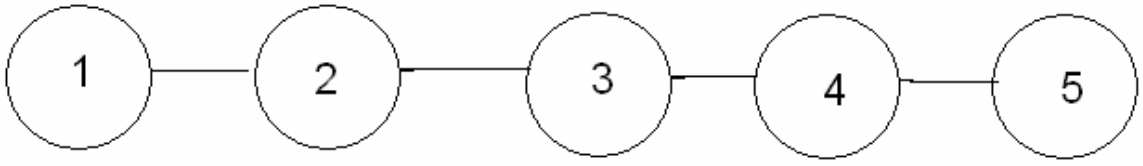
1) To have sufficient time for your personal or family life



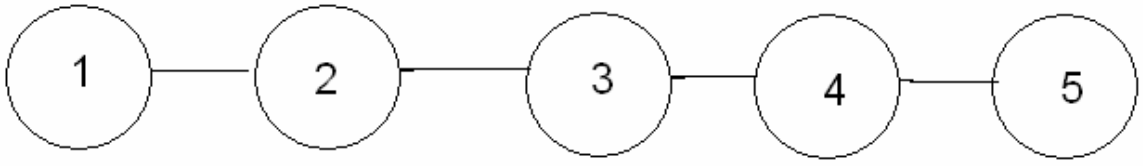
2) To have good physical working conditions (good ventilation and lighting, adequate workspace, etc.)



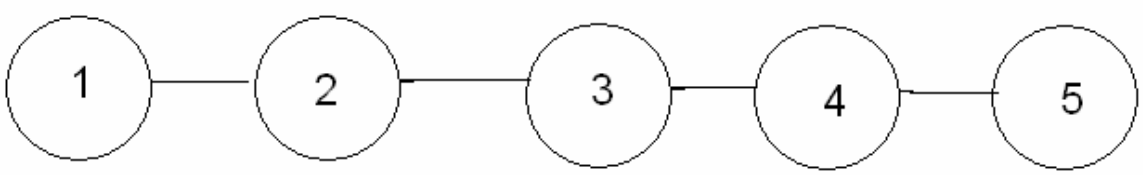
3) To have a good working relationship with your direct superior



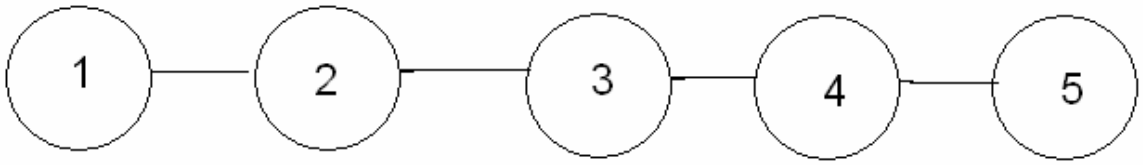
4) To have security of employment



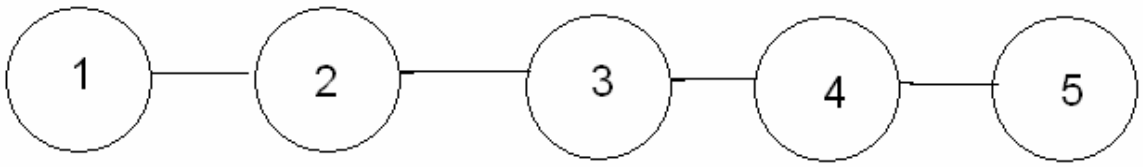
5) To work with people who cooperate well with one another



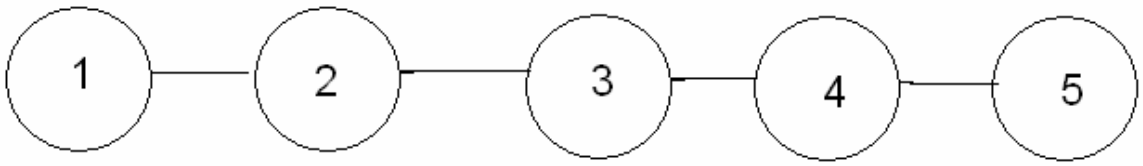
6) To be consulted by your direct superior in his/her decisions



7) To have an opportunity for advancement to higher level positions



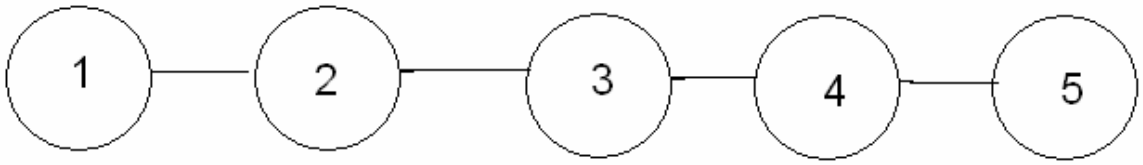
8) To have an element of variety and adventure at work



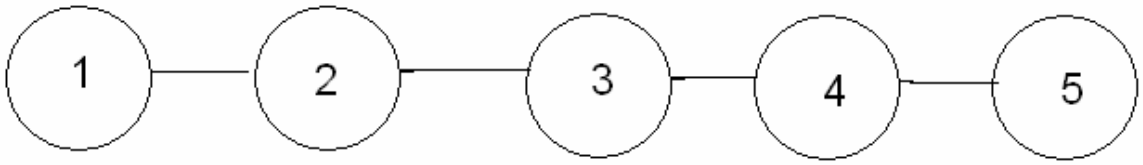
In your private life, how important is each of the following to you? (Please choose one answer in each line across):

1 = of utmost importance
2 = very important
3 = of moderate importance
4 = of little importance
5 = of very little or no importance

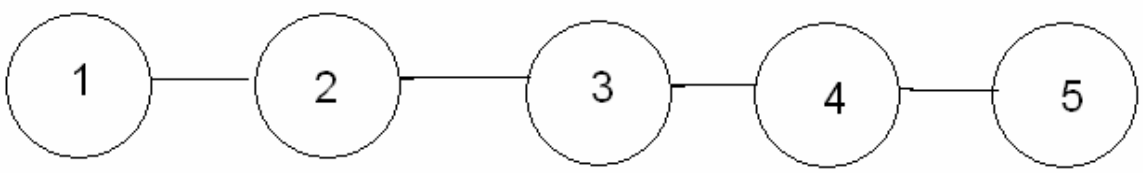
9) Personal steadiness and stability



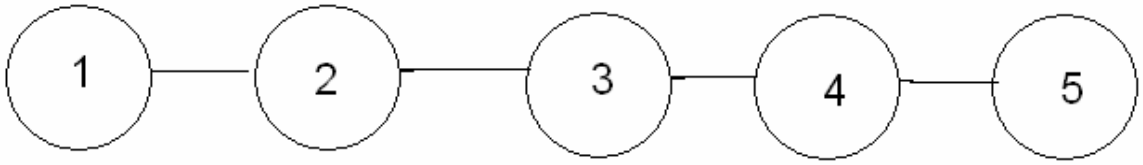
10) Thrift



11) Persistence (perseverance)

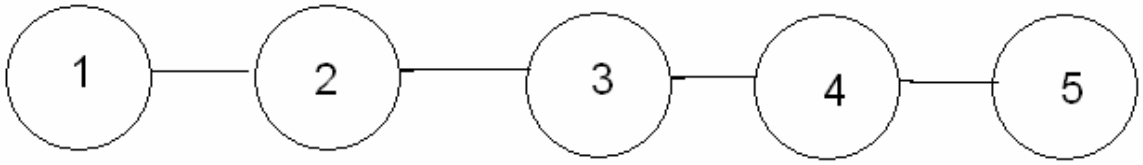


12) Respect for tradition



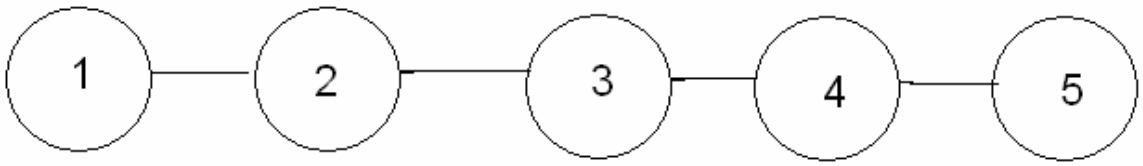
13) How often do you feel nervous or tense at work?

1=never
2=seldom
3=sometimes
4=usually
5=always



14) In your experience, how frequently, are subordinates afraid to express disagreement with their superiors?

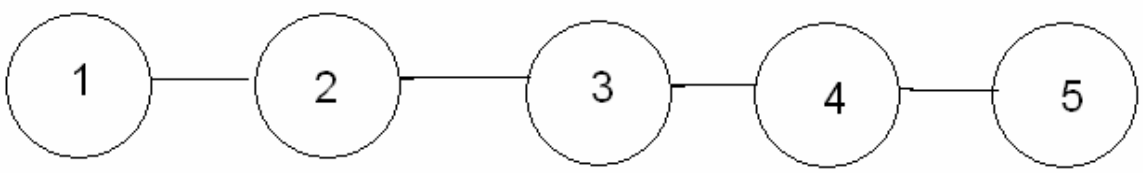
1= very seldom
2= seldom
3= sometimes
4= frequently
5= very frequently



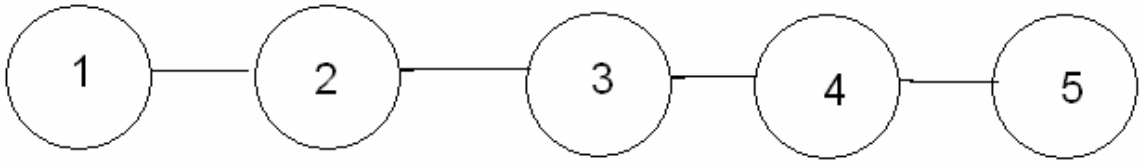
To what extent do you agree or disagree with each of the following statements? (Please choose one answer in each line across):

1 = strongly agree
2 = agree
3 = undecided
4 = disagree
5 = strongly disagree

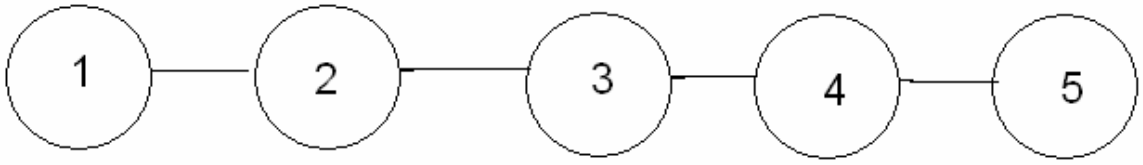
15) Most people can be trusted



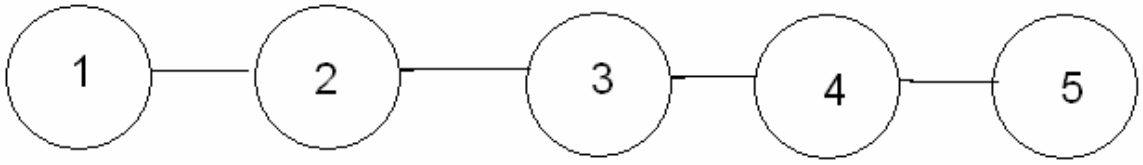
16) One can be a good manager/supervisor without having precise answers to most questions that subordinates may raise about their work



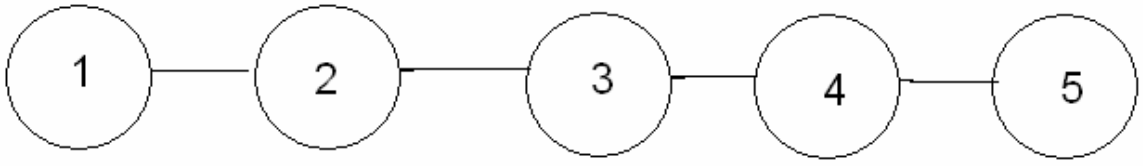
17) An organization structure in which certain subordinates have two supervisors should be avoided at all costs



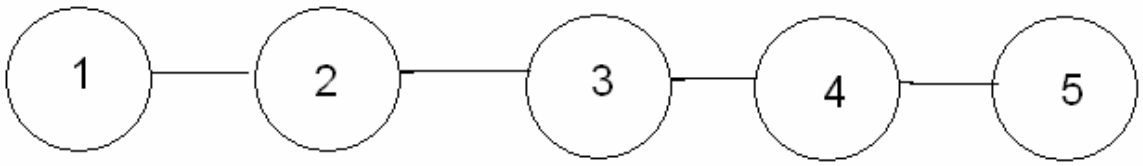
18) Competition between peers usually does more harm than good



19) An organization's rules should not be broken-not even when the member thinks it is in the organization’s best interest



20) When people have failed in life it is often their own fault



VSM 94 Formulae for Index Calculation

Power Distance Index (PDI)

The index formula is **PDI = –35m(03) +35m(06) +25m(14) –20m(17) –20**

in which m(03) is the mean score for question 03, etc.

The index normally has a value between 0 (small Power Distance) and 100 (large Power Distance), but values below 0 and above 100 are technically possible.

Individualism Index (IDV)

The index formula is **IDV = –50m(01) +30m(02) +20m(04) –25m(08) +130**

in which m(01) is the mean score for question 01, etc.

The index normally has a value between 0 (strongly collectivist) and 100 (strongly individualist), but values below 0 and above 100 are technically possible.

Masculinity Index (MAS)

The index formula is **MAS = +60m(05) –20m(07) +20m(15) –70m(20) +100**

in which m(05) is the mean score for question 05, etc.

The index normally has a value between 0 (strongly feminine) and 100 (strongly masculine), but values below 0 and above 100 are technically possible.

Uncertainty Avoidance Index (UAI)

The index formula is **UAI = +25m(13) +20m(16) –50m(18) –15m(19) +120**

in which m(13) is the mean score for question 13, etc.

Long-term Orientation Index (LTO)

The index formula is **LTO = -20m(10) +20m(12) +40**

(revised version 1999)

in which m(10 is the mean score for question 10, etc.

The index normally has a value between 0 (very short-term oriented) and 100 (very long-term oriented), but values below 0 and above 100 are technically possible.

Appendix B: Demographic Questionnaire

1) Are you:
1. Male
2. female

2) How old are you?

1. Under 20
2. 20-24
3. 25-29
4. 30-34
5. 35-39
6. 40-49
7. 50-59
8. 60 or over

3) How many years of formal school education (or their equivalent) did you complete (starting with primary school)?

1. 10 years or less
2. 11 years
3. 12 years
4. 13 years
5. 14 years
6. 15 years
7. 16 years
8. 17 years
9. 18 years or over

4) If you have or have had a paid job, what kind of job is it / was it?

1. No paid job (includes full-time students)
2. Unskilled or semi-skilled manual worker
3. Generally trained office worker or secretary
4. Vocationally trained craftsperson, technician, nurse, artist or equivalent
5. Academically trained professional or equivalent (but not a manager of people)
6. Manager of one or more subordinates (non-managers)
7. Manager of one or more managers

5) What is your nationality? _____

6) What was your nationality at birth (if different)?_____

7) Do you have a disability?

1. Yes
2. No

If yes please answer the following 8) 9) and 10):

8) What is your type of disability?
1. Upper Extremity Limitations
2. Full Blindness
3. Legal Blindness
4. Low Vision

9) When did you acquire this disability?
1. at birth
2. age 0- 6 years
3. age 6-12 years
4. age 12-18 years
5. after the age of 18

10) How did you acquire the disability?
1. it was congenital
2. through an illness or disease
3. because of an accident
4. any other cause_____

11) Were you born in India?
1. Yes
2. No

12) Are your parents of Indian Origin?
1. Yes
2. No

13) Have you ever traveled/lived overseas?
1. Yes
2. No

14) Have you used a cell phone before?
1. Yes
2. No

If Yes then

15) For how many years have you used a cell phone?_____

16) What cell phone model have you been using?_____

Appendix C: Contact Information of Institutes/Agencies for the Visually Impaired

(Locations of Focus Groups Conducted)

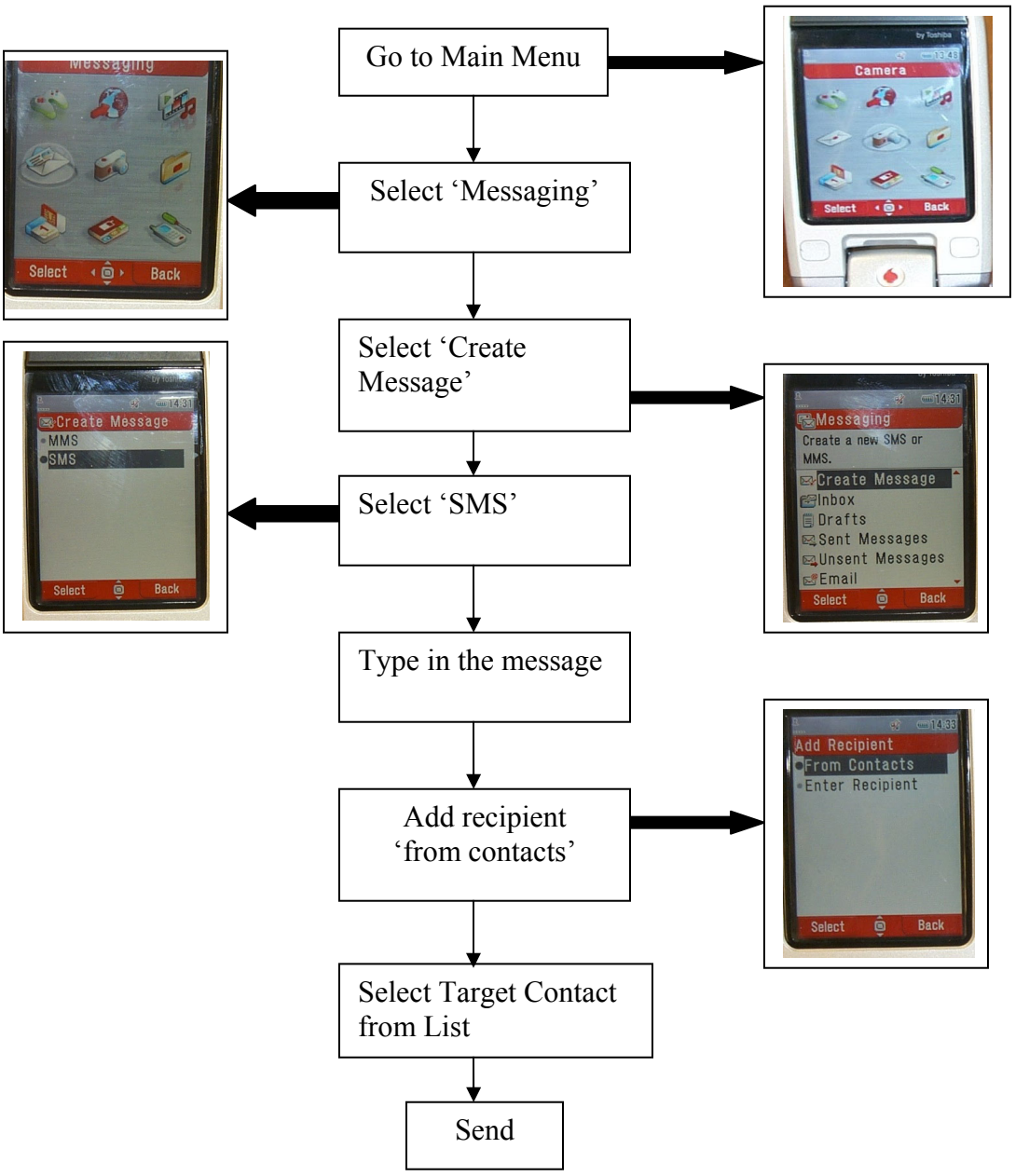
National Association for the Blind
11 Khan Abdul Gaffar Khan Road
Worli Seaface
Mumbai 400 025.

Tel. +9122 2493 8511

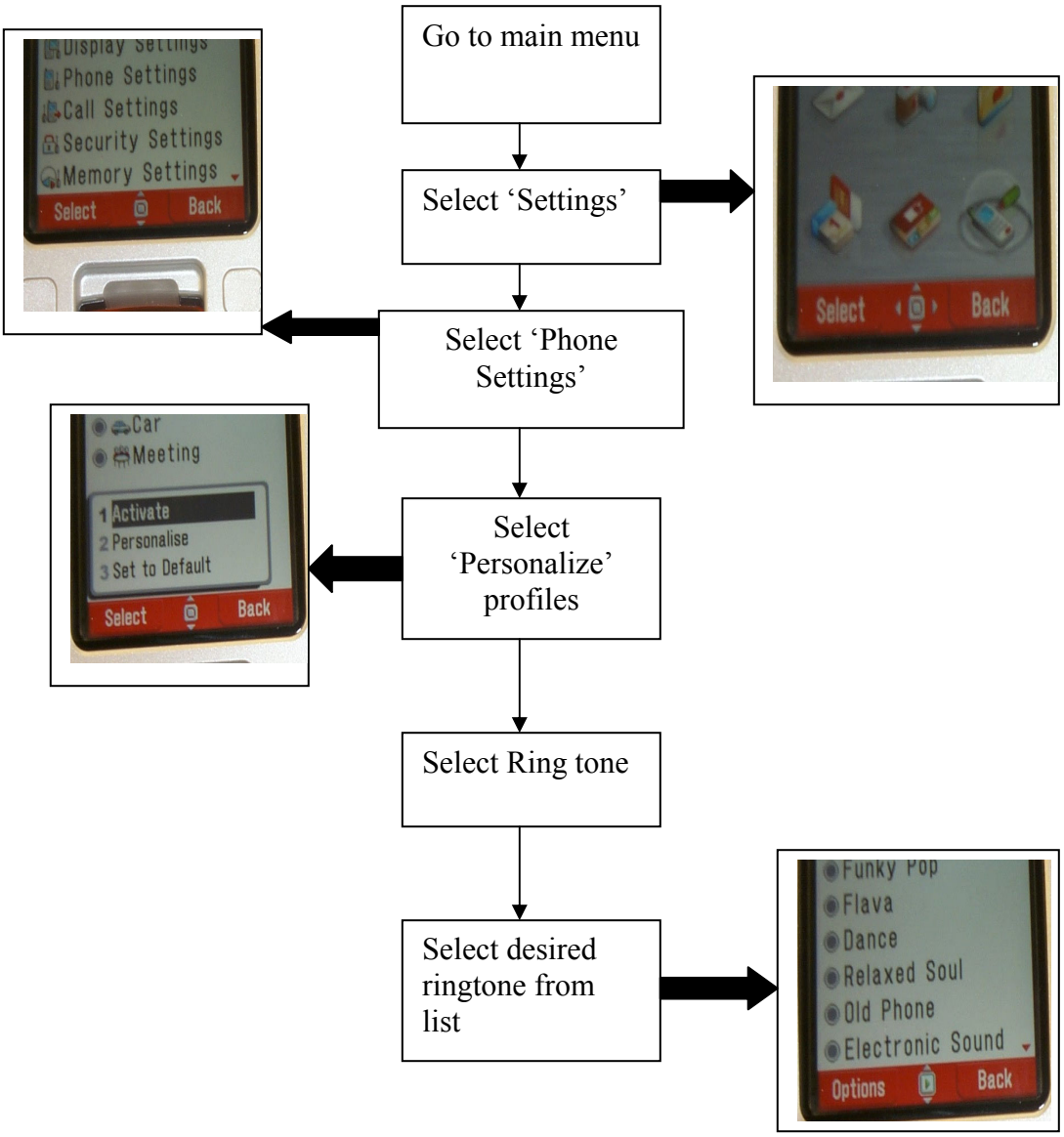
United States Access Board
1331 F Street, NW, Suite 1000
Washington, DC 20004-1111
Phone (voice): (202) 272-0080 toll free: (800) 872-2253
Phone (TTY): (202) 272-0082 toll free: (800) 993-2822
Fax: (202) 272-0081

Raleigh Lions Clinic For the Blind
315 Hubert Street
Raleigh, NC 27603
Phone: 919-833-8611
Fax: 919-833-5664

Appendix D: Action Sequences of Tasks



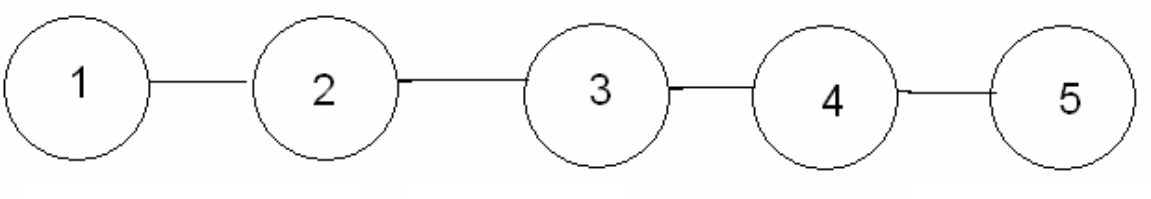
Action Sequence for Sending a message



Appendix E: Interface Rating Questionnaire

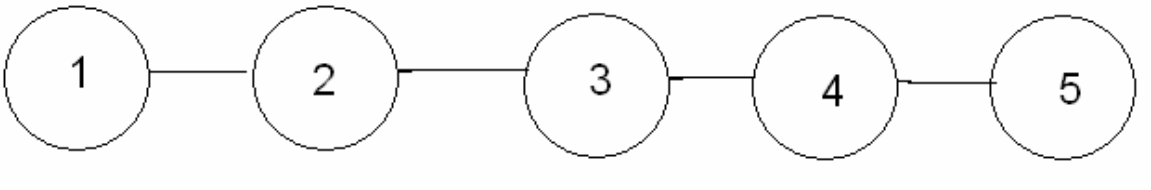
The following features must be rated in a scale from 1-5, according to whether you would prefer this feature or not.

1) **Minimal Steps or Keystrokes**



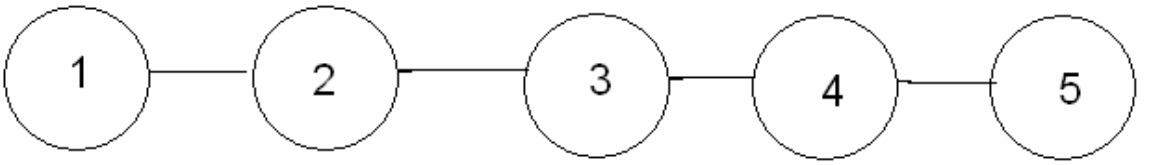
Not necessary at all Very important

2) **Secondary information**



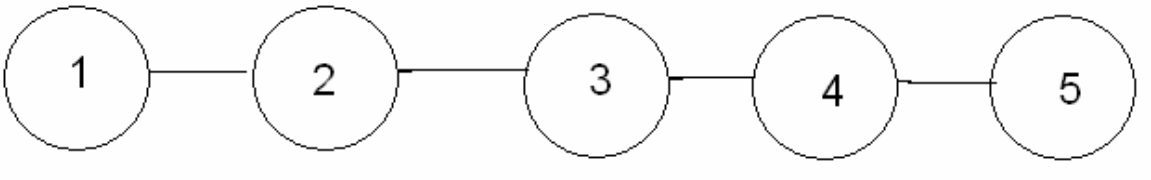
Not necessary at all Very important

3) **Variety of Contents**



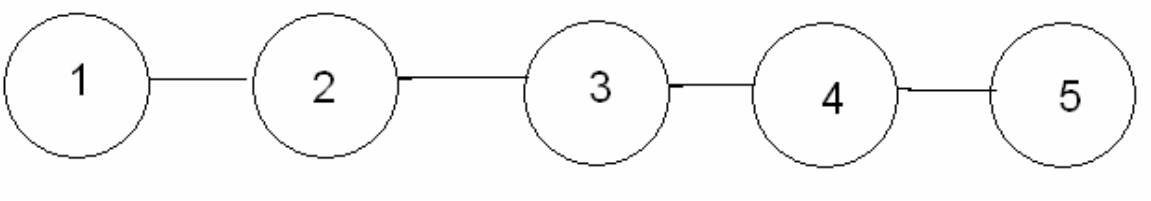
Not necessary at all Very important

4) **Menu Labeling**



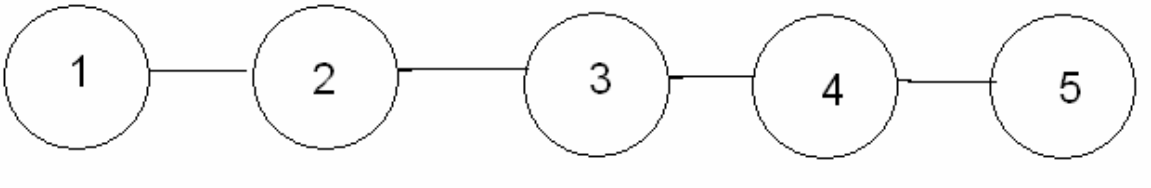
Not necessary at all Very important

5) **Efficient screen space utilization**



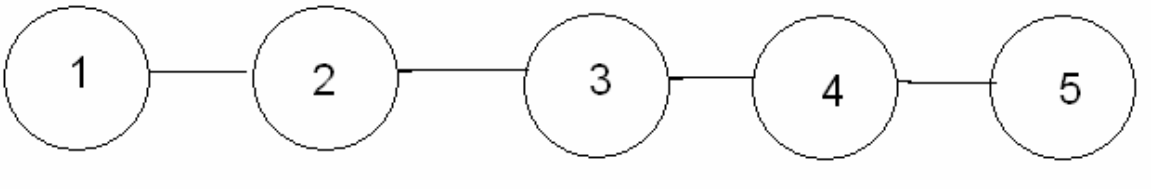
Not necessary at all Very important

6) Large amount of information within a screen



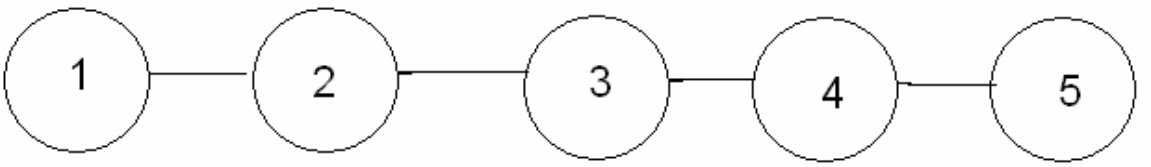
Not necessary at all Very important

7) Personalizable interface (concept of Profiles)



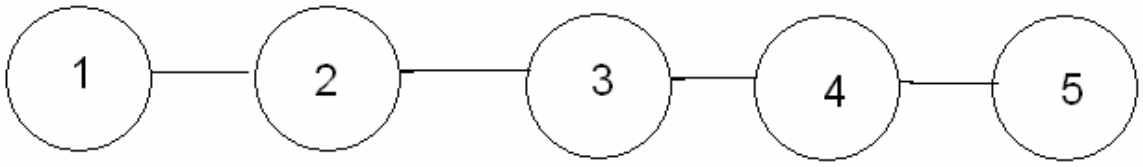
Not necessary at all Very important

8) Familiar interface



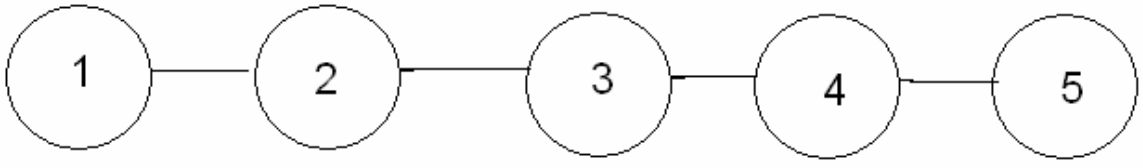
Not necessary at all Very important

9) Using default folders/personalizable folders



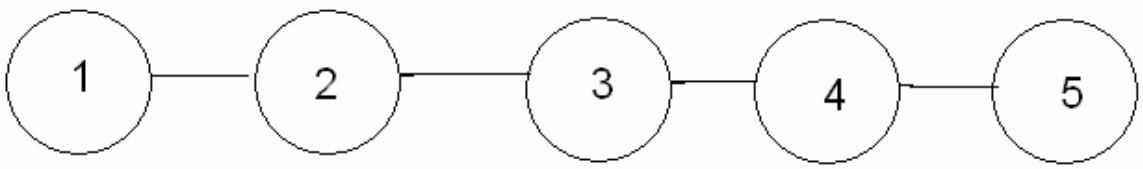
Not necessary at all Very important

10) Hotkey, softkey, shortcut functions



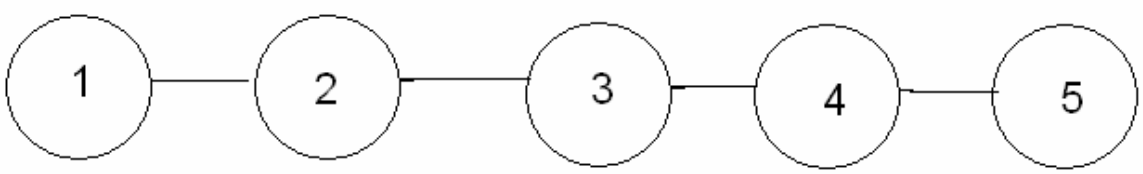
Not necessary at all Very important

11) Programmable softkeys



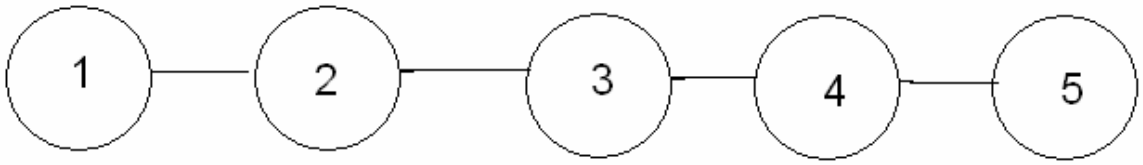
Not necessary at all Very important

12) Group SMS



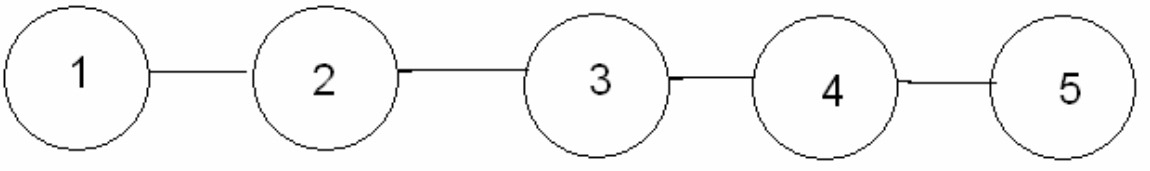
Not necessary at all Very important

13) Variety of fonts and font sizes



Not necessary at all Very important

14) Cell phone body aesthetic appeal (look and feel)



Not necessary at all Very important

Appendix F: INFORMED CONSENT FORM

Title of Project: Cross cultural comparison of cell phone interface design preferences and performance among users with (and without) visual disabilities
Principal Investigators: Tonya L. Smith-Jackson, Ph.D. and Ira Jhangiani (Graduate Student)

PURPOSE OF PROJECT
This project will acquire and analyze the preliminary information gathered from UK and German users with disabilities to develop questionnaires and tasks for the final study in the US and India.

INFORMATION
In this project, you will be instructed to perform tasks on the cell phone and then will be told to fill out questionnaires related to the task and design preferences of the interface. You will also be told to perform card sorting. A cultural questionnaire would have to be filled out at the end of the session.
All sessions will be videotaped to support data collection

RISKS
Participation in this project does not place you at more than minimal risk of harm.

BENEFITS
You will be compensated for your participation, and you will be given information to contact the principal investigator to get information about the outcomes of the study. You will also benefit from knowing that you have participated in worthwhile research that has immediate and positive applications.

CONFIDENTIALITY
The information gained in this research project will be kept strictly confidential. At no time will the researchers release the results of the study to anyone other than individuals working on the project without your written consent.

You will be identified only by a 3 digit study code. Data will be stored securely and will be made available only in the context of research publications and discussion. No reference will be made in oral or written reports that could link you to the data nor will you ever be identified as a participant in the project.

We will use digitized portions of the videos of the focus group and experimental sessions. However, faces will be blurred or obscured so that you cannot be identified. However, your voice as well as your hands may be used to present specific issues requiring design attention. If you feel uncomfortable with the display of your hands and voice to other groups, please indicate on the second page.

COMPENSATION
You will be compensated at the rate of the equivalent of $10 US per hour (in pounds or deutschmarks) for participation in this research. Also, you will be reimbursed for travel to and from the focus group site up to the equivalent of $20 US.

FREEDOM TO WITHDRAW
You are free to withdraw from this study at any time without penalty.

APPROVAL
This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University and by the Department of Industrial and Systems Engineering.

PARTICIPANT'S RESPONSIBILITIES
It is very important that you keep the activities and information discussed confidential, since others will be participating in this research.

QUESTIONS
If you have questions, or do not understand information on this form, please feel free to ask them now.

PARTICIPANT'S PERMISSION
I have read and understand the Informed Consent and conditions of this project. I have had all questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without penalty.

Signature _____

Date _____

PARTICIPANT'S PERMISSION TO USE EXCERPTS FROM VIDEOTAPED SESSIONS (FACES WILL BE OBSCURED OR BLOCKED)

I have read and understand the manner in which videos will be used for subsequent presentation of information related to this study. I understand that my face will not be identifiable because it will be obscured or blocked. I understand that my hands and voice will be presented as relevant to the operation of cell phones. I grant permission to researchers to present this information as necessary in the manner described on this form.

Signature _____

Date _____

I do not grant permission to researchers to present this information as necessary in the manner described on this form. I do not want any digitized images of my hands or recorded voice to be used for presentation purposes.

Signature _____

Date _____

CONTACT
If you have questions at any time about the project or the procedures, you may contact the principal investigator, Tonya Smith-Jackson at 231-4119 or smithjack@vt.edu (519-H Whittemore).

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact Dr. David Moore, Chair of the Institutional Review Board Research Division at 231-4991.

Appendix G: IRB Amendment

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Institutional Review Board

Dr. David M. Moore
IRB (Human Subjects) Chair
Assistant Vice President for Research Compliance
1880 Pratt Drive, Suite 2006(0497), Blacksburg, VA 24061
Office: 540/231-4991; FAX: 540/231-0959
email: moored@vt.edu

DATE: November 15, 2005

MEMORANDUM

TO: Tonya L. Smith-Jackson ISE 0118

FROM: David Moore

SUBJECT: **IRB Amendment Approval**: "Needs Analysis and Requirements Acquisition for Inclusive Design of Cell Phones: United Kingdom and Germany" IRB # 05-348

This memo is regarding the above referenced protocol which was previously granted approval by the IRB on May 17, 2005. You subsequently requested permission to amend your approved protocol to include the addition of the listed changes. Since the requested amendment is nonsubstantive in nature, I, as Chair of the Virginia Tech Institutional Review Board, have granted approval for requested protocol amendment, effective as of November 15, 2005. The anniversary date will remain the same as the original approval date.

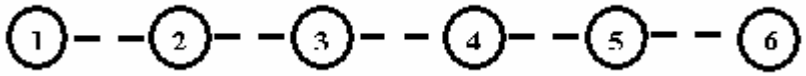
Virginia Tech has an approved Federal Wide Assurance (FWA00000572, exp. 7/20/07) on file with OHRP, and its IRB Registration Number is IRB00000667.

cc: File
OSP 0170
T. Coalson 0118

Appendix H: Hardware Features

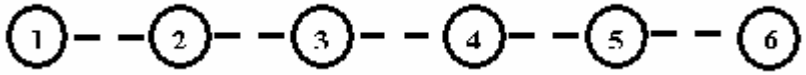
Phone Body

How do you feel about the size of the phone?



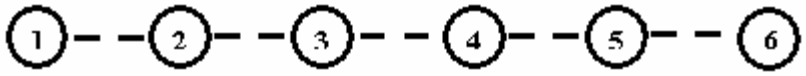
Don't like at all Like very much

How do you feel about the shape of the phone?



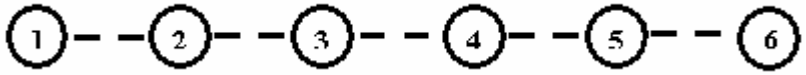
Don't like at all Like very much

How do you feel about the weight of the phone?



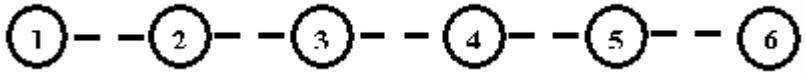
Don't like at all Like very much

When dialing, how does it feel to hold this phone?



Very Bad Very Good

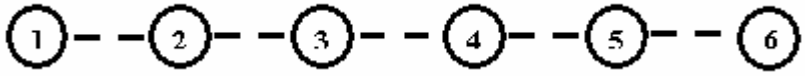
When speaking, how does it feel to hold this phone?



Very Bad Very Good

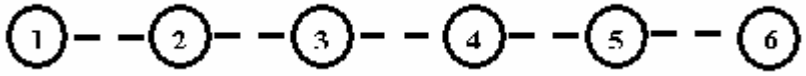
Keys (Buttons)

How do you feel about the size of the buttons on the key pad?



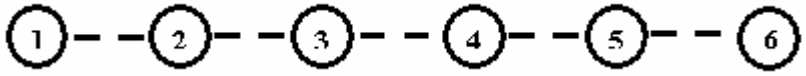
Don't like at all Like very much

How do you feel about the shape of the buttons?



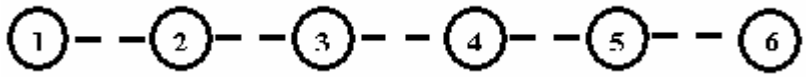
Don't like at all Like very much

Indicate how easy it is to press the buttons?



Don't like at all Like very much

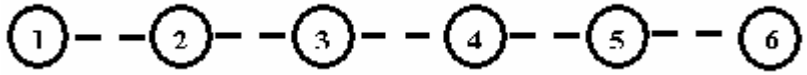
Indicate how easy it is to read labels on the key?



Very Bad Very Good

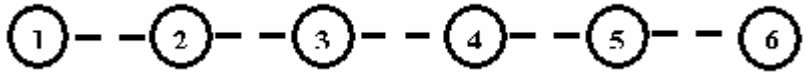
LCD Screen

How do you feel about the size of the LCD screen?



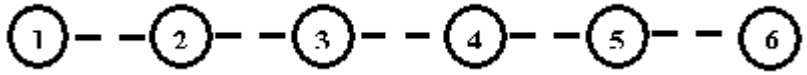
Don't like at all Like very much

Indicate how easy it is to open the LCD screen.



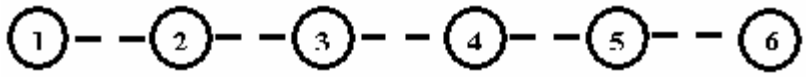
Don't like at all Like very much

How do you feel about rotating the LCD screen?



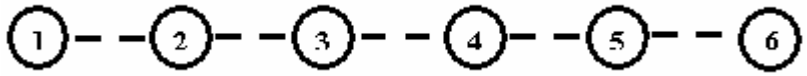
Don't like at all Like very much

How do you feel about the contrast of the LCD screen?



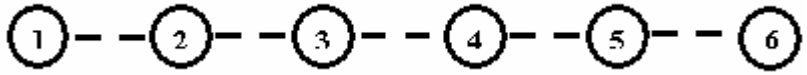
Don't like at all Like very much

How do you feel about the brightness of the LCD screen?



Don't like at all Like very much

How do you feel about the font size in the menu?

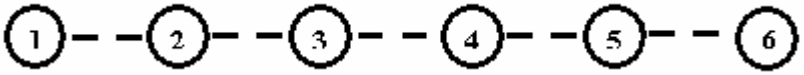


Don't like at all Like very much

15-1. If you don't like the font size, what is the reason?
☐ Too small ☐ Too large ☐ Else:_____

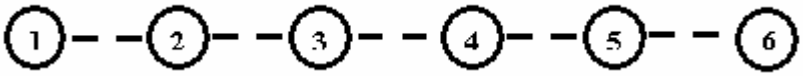
Overall Look and satisfaction

16. How do you feel about the overall look of the phone?



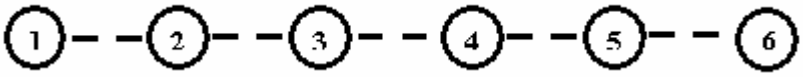
Don’t like at all Like very much

17. Indicate how satisfactory the phone is, overall



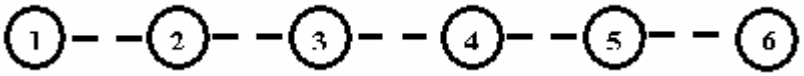
Not satisfactory at all Satisfactory very much

1. Indicate how easy it was to complete this task.



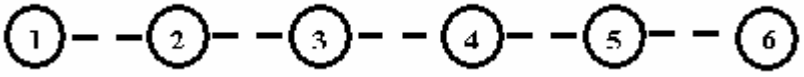
Very Difficult **Very Easy**

2. Indicate how easy it was to locate or find functions in menus.



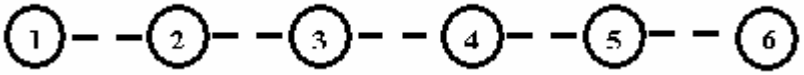
Very Difficult **Very easy**

3. Indicate how easy it was to identify relevant keys on the phone keypad.



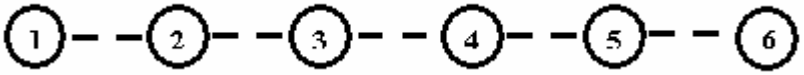
Very Difficult Very easy

4. Indicate how meaningful the icon was to the function/feature?



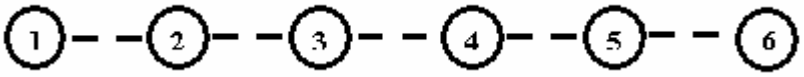
Not meaningful at all Very meaningful

5. Indicate how understandable the menu label was to the function?



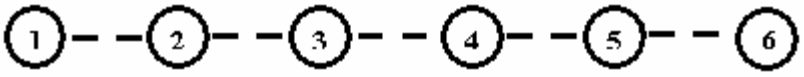
Not understandable at all Very understandable

6. How would you rate feedback or response from the phone on undertaking actions (beeps to indicate when you press a key, text messages to indicate the task completion, etc.)?



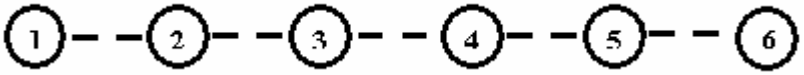
Very Bad Very Good

7. How important do you find this function?



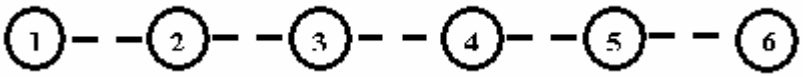
Not at all important very important

8. How often do you use this task?



Not at all very often

9. Is this function essential in a mobile phone?



Not at all essential Very essential

Appendix J: Dimension scores of Combined Country and Disability groups

	Group			
Dimension	**India**	**US**	**LB**	**CG**
PDI	75.6061	23.3824	32.973	47
IDV	86.0606	90.5882	84.1892	93.5
MAS	42.7273	16.1765	38.9189	17.3333
UAI	36.5152	51.4706	64.1892	19.3333
LTO	38.1818	40	38.3784	40

Appendix K: Summary of Overview Grids