Flinders University, Adelaide

ACCESSIBLE MOBILE COMMUNICATION FOR PEOPLE WITH DISABILITIES

A Thesis submitted to Flinders University in fulfilment of the requirements for the degree of

MASTER OF ENGINEERING

by

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Summary

Accessible Mobile Communication for People with Disabilities

People with disabilities are both functionally and socially disadvantaged and the lack of access to mobile communication technology adds to their disadvantage. Changes and benefits we have seen in our society with the advent of mobile phones and associated electronic communication for people without disabilities have not migrated to people with disabilities. The comprehensive communication capability of a mobile phone can enable users anywhere to independently access a very wide range of communication, information and control systems and services. This research has addressed the key accessibility issues faced by people with disabilities who need or want to use the mobile phone for voice and data communication.

The research revealed that:

- there exist accessible features on mobile phones that can better assist people with disabilities in using the phone;
- through education and training, people with disabilities can develop or be provided with effective and efficient ways to access and use the phone;
- current, off-the-shelf telecommunications equipment such as car kits, speakerphone, voice recognition technology, wireless connectivity capability on mobile phones can enable people with disabilities, even severe physical disabilities, to access the telecommunications network and services; and
- with a suitable interfacing system in place, Augmentative and Alternative Communication (AAC) device users can operate the phone for voice and data communication, which previously had not been possible.

Trials established that people with a range of physical disabilities can use and should have equal access to telecommunications equipment and services. This research has shown that, with the right policies, processes and support through equipment matching, education, training and delivery, current off-the-shelf solutions can help people with disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community.

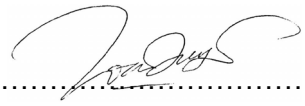
An interfacing system has been developed to provide users of AAC technology with the ability to use a mobile phone for voice calls and text messaging (SMS). It is confidently predicted that other features and services on the phone such as speakerphone, digital camera and FM radio, email and internet-based applications, and local or remote appliances and devices, can be controlled via the AAC device.

Outcomes and findings have confirmed the main hypothesis of the thesis that, despite very limited mobility, speed, accuracy and vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bidirectional communication with systems to which they choose to connect.

The overall outcomes of the research have established that the benefits and usefulness of the mobile phone are so significant that they should become a necessity for people with a disability. It has been successfully demonstrated that, with the proper mechanisms and educational programs in place, the provision of accessible mobile phones for people with disabilities can significantly improve their quality of life through increased range of accessible activities, and will improve their independence, engagement with their peers, safety, security and self-esteem.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature……  ……

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Chapter 1

ACCESSIBLE MOBILE COMMUNICATION FOR PEOPLE WITH DISABILITIES

1.1 Introduction

The provision of Assistive Technology to enhance the lives of people with disabilities is now an established applied science. While modern technology has provided many new options which have made a significant impact on the lifestyle of people with disabilities, particularly in their home, work and school environments, there has been very little application of modern technology to the needs of a person with a disability who is mobile. Changes we have seen in our society with the advent of mobile phones and associated electronic communication for people without disabilities have not migrated to people with disabilities. This project seeks to overcome this barrier.

The comprehensive communication capability of a mobile phone could enable users anywhere to independently access a very wide range of communication, information and control systems and services. The number of mobile phones currently utilised in Australia is clear evidence of their significance and potential. Jolley (2003) indicated that following the introduction of digital mobile (cellular) telephony around 1993, by June 2002 there were 12.67 million mobile telephone subscribers – 11.7 million GSM and 900 thousand CDMA subscribers.

The Short Message Service (SMS) for text messaging has also grown in popularity, spreading from the original take-up by young people to become popular across most significant market segments. There are more companies using SMS as a business medium to advertise their businesses or carry out daily business activities. For example, in the Banking sector, the Commonwealth Securities arm of the Commonwealth Bank of Australia uses SMS to update clients with share prices (Commonwealth Bank, 2001).

Messages of up to 160 characters can be exchanged between mobile phones for a cost equivalent to a local call. Similar to an email service, messages are stored and forwarded at an SMS centre. “Currently 300 million SMS messages are sent each month in Australia, approaching almost one message per cell phone subscriber per day, and generating around one billion dollars of revenue annually” (Jolley, 2003).

The integration of Wireless Application Protocol (WAP) for Internet connection, FM radio for entertainment, digital camera for capturing those ‘unforgettable moments’, Bluetooth technology for wireless connection with other Bluetooth-enabled devices and many more interesting features have made the mobile phone an even more popular and powerful tool for communication. This is further enhanced with the rollout of Third Generation (3G) mobile phone technology, which permits the transmission of voice, data, and video at up to 2 megabits per second across the network carrier.

This chapter gives an overview of the communication difficulties and barriers people with disabilities faced when accessing mainstream telecommunications technology. A brief outline of the telecommunications industry and what disability organisations are doing in providing accessible telecommunications for people with disabilities is also highlighted. The project’s context, scope and the main hypothesis are also defined with clear approaches, methodologies and intended outcomes for the thesis. An overview of succeeding work of the thesis is also given.

1.2 Communication difficulties and barriers faced by people with disabilities

People with disabilities are both functionally and socially disadvantaged and the lack of access to mobile communication technology adds to their disadvantage.

The small size and portability of the mobile phone are contributing factors that have made it a successful communication device for the general population. However, for people with disabilities, some disadvantages stem from the small size of the mobile phone. The small keypads, buttons and screens are obstacles for many people with disabilities and not very attractive for visually or mobility impaired users.

A person with restricted mobility and confined to a powered wheelchair may well have to depend on limited movement to just control the wheelchair. For people in this situation, it is rare that they would be able to pick up a mobile phone and then manipulate the small buttons that are commonplace on the phone keypad. These people may also lack the critical eye-hand coordination, fine motor control and timing required to navigate through the menus and to compose messages or text by selecting characters on the phone keypad.

For people with cerebral palsy, and others who have limited mobility and speech abilities, the tasks of communication and control are especially demanding. Many of these people have a personalised communication device or Augmentative and Alternative Communication (AAC[1]) technology, which they must have with them at all times, wherever they go. Even so, their communication capability is usually limited to direct one-on-one conversational situations. Increased functionality and direct or remote access to other technologies at home, work, or in the community would normally require the provision of additional interface devices. These systems are very expensive, due to the low production volumes and the high degree of customisation and training, and are often beyond the financial means of the users.

For people who use an AAC technology, the lack of a suitable interface system between their AAC device and the mobile phone, which would allow them to access and/or operate the phone, is the largest impediment. This is a need and an opportunity that has been addressed in this thesis.

With the current rapid market trend geared toward smaller phone models with an ever-increasing number of features, the telecommunications technology gap between people with and without disabilities has grown. At present, there are no standards in the mobile telecommunication industry that stipulate how a phone should be developed and what features should be incorporated on phones to support access by all people. Different manufacturers are implementing their own set design standards, as well as proprietary communication protocols, making it difficult to develop uniform standards. Any standards developed by the mobile telecommunications industry are more likely to be voluntary, and do not become mandatory unless national regulators adopt them. Given that telecommunications technology is changing rapidly; driven by competitive pressures, the development and adoption of national and international standards may be a long and challenging process.

The present disability standards for telecommunications equipment for customer with disabilities in Australia are very limited. Section 380 of the Telecommunications Act 1997 (Disability standards) lists just two features: an induction loop to assist people using hearing

[1] This is any system a person uses to communicate in addition to or instead of speech, including pointing to pictures and symbols, using gestures, eye gaze, or electronic devices.

aids, and a raised dot on the number 5 on the telephone keypad to help blind people. They have not kept pace with the rapid developments in communications technology.

Jolley (2003) indicated that experts differ on the preferred scope, list of features and legal/regulatory basis of any future standard. However, in order to achieve full compliance in accessible telecommunications access for people with disabilities, national and international standards need to be developed and implemented by the telecommunications industry and parties involved The inclusion of standardised mobile phone features suitable people with disabilities would allow better access to telecommunications equipment by people with disabilities as well as meet universal design principles.

The research carried out in this project endeavours to explore and make recommendations on the features to be incorporated on mobile phone technologies that will be of benefit for people with disabilities.

Legislative acts and regulatory bodies within Australia are gradually ensuring equitable and accessible telecommunications services and equipment for people with disabilities. In addition, peak consumer disability organisations encourage universal access for all by setting out principles and best practice guidelines in telecommunications access for people with a disability in Australia.

Recently, further effort has also been made to promote the implementation of the Principles of Universal Design by developers and manufacturers of mobile phone technologies, rendering them accessible by people with disabilities as well as by the wider community. The Center for Universal Design (1997) stated that “Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." One example of universal design in relation to deaf and hard of hearing people is the inclusion of closed-caption decoder circuitry in all television sets. Another example is the work from the Trace Research and Development Center of the College of Engineering, University of Wisconsin-Madison that endeavours to standardise a mobile phone design for all people to access. The Trace Center has released the first of a series of "Reference Designs" to illustrate how a single phone can be designed so that it would be cross-disability accessible as well as usable and attractive to mass market consumers (Trace Center, 2002).

1.3 Project’s context and scope

To provide the most effective communication possible for people with disabilities using telecommunications technology such as the mobile phone, the preferred approach is to utilise the person’s existing method(s) of operating their current systems. For many people with severe speech and/or physical disability, the provision of Augmentative and Alternative Communication (AAC) through speech output assistive technology offers powerful and appropriate solutions. An estimated one to two million Americans with severe speech disability can benefit from the application of AAC technology (Williams, 2002). At Novita Children Services Inc. (formerly The Crippled Children’s Association (CCA) Inc. of South Australia), it is estimated that 20% of its 1,300 clients use AAC technology.

A survey carried out in the US by the United Cerebral Palsy Association (UCPA) found that users of AAC technology (augmented communicators) have a critical need to have full access to voice communication technology such as cordless phones, cell phones, and pagers. It also established that, despite difficulties of access and use, telephones are still the preferred method of communication because they are readily available (UCPA, 1999).

People who rely on AAC technology have typically identified a successful method of operating their systems, and the same method may be useful for controlling the mobile phone as well. The development of a configurable interface to the mobile phone that works in conjunction with existing AAC technology such as the Pathfinder[2] from the Prentke Romich Company, could provide *multiple* accessing opportunities. It would also enable persons with severe disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community. This was an opportunity that has been identified and undertaken in this thesis.

While this project addressed the specific needs of people with impaired communication and mobility (physical ability), the outcomes of the overall program could also lead to benefits for all people with disabilities. Potential beneficiaries of this research are people of *all* ages who:

- have adequate speech but poor mobility (eg people with a spinal cord injury or muscular dystrophy). The major innovation area would be the need for control of the phone while in a powered wheelchair; or
- are ambulant and who have difficulty accessing the phone keypad due to reduced strength and dexterity (eg people with arthritis); or
- are not able to speak, who often have limited mobility, and who use personal voice output communication aids (eg people with cerebral palsy). In addition to the features catering for the needs of this group, there is the requirement to interface their personal communication device to the mobile phone communication system for message input and output.

The main hypothesis of this research is *that, despite very limited mobility, speed, accuracy or vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bi-directional communication with systems to which they choose to connect*.

1.4 Project's approaches, methodologies and intended outcomes

The provision of accessible mobile phones for people with disabilities can significantly improve their quality of life through an increased range of accessible activities, and will improve their independence, safety, security and self-esteem.

This research seeks to overcome the obstacles faced by people with disabilities, who need or want to use a mobile phone and its services (eg SMS), by identifying features that are accessible by people with disabilities and investigating/developing new solutions through the integration of existing mobile phone technologies. In addition, the researcher has initiated and evaluated the development of an interfacing system to a mobile phone for people who use an AAC device to communicate.

The work carried out to achieve this objective involved:

- A review of the literature and other available information on the telecommunications industry, technologies, services and current solutions suitable for people with disabilities (Chapter 2);

[2] A communication device featuring a static keyboard and built-in dynamic display touch screen, the Pathfinder comes with a choice of vocabulary programmes for spelling or symbol users. Direct access is via the keyboard and touch screen display, infrared head pointing or switch activated scanning (single, double or joystick options).

- A Focus Group session and survey questionnaire to identify difficulties or barriers faced by people with disabilities and their needs while accessing the mobile phone (Chapters 3 and 4);
- A trial of new mobile telecommunications technologies that could potentially alleviate the problems or barriers faced by people with disabilities when accessing the mobile phone (Chapter 5) as identified in Chapters 3 and 4, as well as the literature review of Chapter 2; and
- The development and validation of a suitable interfacing system between a mobile phone and an AAC device for people who use an AAC device to communicate or to access telecommunications technology and services. (Chapter 6).

This project is the first phase of a long-term collaboration between Flinders University and Novita Children's Services Inc. (industry partner for this project) to develop communication technologies and systems that promote the principles of Universal Design to ensure that future products and services take into account the needs and abilities of all people. This project was supported through the Strategic Partnerships with Industry Research and Training (SPIRT) Scheme, funded by the Australian Research Council / Department of Education, Training and Youth Affairs (DETYA).

The project is also of significance to the Novita Children Services Inc., as it will be able to provide a wider range and quality of cost effective communication and control services to its clients, as well as exploit the commercial opportunity to market the technology to users of all ages, nationally and internationally. The researcher of this thesis is currently employed at Novita Children's Services as a Rehabilitation Engineer to explore and fulfil some of these extended objectives.

1.5 Overview of the succeeding chapters of the thesis

Review of the Literature on the Telecommunications industry, Technologies, Services and Current Solutions for People with Disabilities (Chapter 2)

This section involves a review of the literature and other relevant information sources on:
- People with disabilities and the telecommunications industry, technologies and services in Australia;
- The mobile phone – its present and future technology;
- Current telecommunications solutions and options for people with disabilities.

It also includes an investigation of features on current mobile phone models used by the wider community that are also suitable for people with disabilities. A list of currently available mobile phones with these features will also be presented as a result of this investigation. This list is not comprehensive due to the continuous and rapid change in telecommunications technology, driven by competitive pressures to reduce costs, and by market demand for new services.

Focus Group session and Survey on Accessible Mobile Communications for People with Disabilities (Chapter 3, 4)

These chapters will present the focus group discussion, and a mobile and home phone needs analysis survey questionnaire with people with disabilities, that was carried out at Novita to establish the characteristics or barriers that make it difficult for people with disabilities to use a mobile phone or prevent them from accessing a mobile phone efficiently and effectively. The purpose of the survey questionnaire is also to identify what mobile phone technology people are using and what still needs developing to meet their access

needs. This work is also carried out to verify and reinforce the main hypothesis of this research.

A Trial of New Technological Options for People With Disabilities Through the Use of Telecommunications Equipment (Chapter 5)

This chapter summarises the trials and evaluations that were conducted to determine the suitability for people with disabilities of currently available hardware mobile phone technologies. This was an outcome from the review of the literature, focus group session and survey questionnaire of accessible mobile communications for people with disabilities. The trials included various alternative solutions/options (such as mobile phone car kits, voice recognition and hands-free technology, and network features such as voice mail) to improve the awareness and the telecommunications experience of people with physical disabilities. The aims of this research are to trial and evaluate new technological options that can improve the lifestyle, independence, and social interaction and inclusion of people with physical disabilities through the use of telecommunications, and also to verify the main hypothesis of this thesis.

Mobile phone access for Augmentative and Alternative Communication device Users (Chapter 6)

The ability to carry out essential tasks on a mobile phone such as dialling a number, answering an incoming call, terminating a call, and text messaging on a mobile phone via the client's existing AAC device, presented an opportunity for the development of an interfacing system to make this possible. The interfacing system acts as a link for the exchanges between an AAC device and the mobile phone's built-in modem. The implementation of such an interfacing system required the identification and utilisation of a standard Global System for Mobile communication (GSM) AT[3] command set that is available on most mobile phone modems.

This chapter describes the work undertaken to develop, test and validate an interfacing system between an AAC device and a mobile phone for voice calls and text messaging for the first time.

Overall Conclusions and Recommendations (Chapter 7)

This chapter summarises the overall findings of the thesis that supported and verified the main hypothesis of the study. Recommendations to improve the gap or shortcomings that currently exist between people with disabilities and mobile telecommunications technology are also presented.

[3] AT stands for ATtention, and is the first word to attract the attention of devices during communication between the two devices.

Chapter 2

REVIEW OF THE LITERATURE ON THE TELECOMMUNICATIONS INDUSTRY, TECHNOLOGIES, SERVICES AND CURRENT SOLUTIONS FOR PEOPLE WITH DISABILITIES

2.1 Introduction

Chapter 1 identified the problems that people with disabilities are facing with telecommunications technology and described how the project seeks to overcome them through various approaches and methodologies to obtain feasible and effective outcomes.

This chapter looks at the telecommunications industry, its current trends and directions, and how legislative and regulatory bodies and peak consumer disability organisations are promoting and ensuring equitable and accessible telecommunications equipment and services for people with disabilities in Australia, the UK and the US.

The concept of *Principles of Universal Design* or *Design for All* (Center for Universal Design, 1997) and its implication for people with disabilities and how it could be implemented onto mobile phones to make them more accessible is further discussed in this chapter.

In addition, a review of the literature and other available information sources is also carried out on the mobile phone's present and future technology as well as identifying the features on mobile phones used by the wider community that are also suitable for people with disabilities. This will build the case for supporting the thesis' main hypothesis as investigated in Chapters 3, 4 and 5.

Finally, this chapter presents current telecommunications solutions/options and accessible information for people with disabilities. A conclusion and recommendation on the nature of the telecommunications industry and its relationship with people with disabilities is also presented.

2.2 People with disabilities and the telecommunications industry, technologies and services in Australia

2.2.1 Disability statistics

People with disabilities and the elderly (pre Baby boomers' era (1931 – 1946)) form a significant proportion of the telecommunications market, yet this has been largely ignored. In Europe alone, there are about 100 million elderly people and 50 million people with disabilities (Gill, 1994). This represents about 15% of Europe's population. This does not include those suffering from other cognitive and intellectual impairments or hospitalised due to illnesses or accidents. It is also estimated that, by 2020, about a quarter of Europe will be over 60 and there will be an increase in the number of people with disabilities, who no doubt will encounter some degree of difficulty in using conventional telecommunication equipment (Gill, 1994).

The Australian Bureau of Statistics 2003 Survey on Disability, Ageing and Carers indicated that about 4 million Australians reported a disability of some kind and 5.9% reported a profound or severe limitation of a core activity. In 2003, there were 3.35 million people aged

60 years and over (17% of the population), which compares to 3.0 million people (16%) in 1998. In 2003, just over half (51%) of people aged 60 years and over had a reported disability and 19% had a profound or severe core-activity limitation (ABS, 2003). Functional limitation due to 'age-related disability' is something that most older Australians will have to deal with at some point in their life – a fact that telecommunications equipment designers have not embraced given the growing trend towards smaller devices that are harder to use and interact with.

Unfortunately, the ABS figures give little insight into the actual difficulties experienced by people with disabilities in using telecommunications services and products.

Phoneability[4] (Gill & Shipley, 1999) gives a breakdown of the disability types in relation to phone usage, whilst having regard to the classical diagnostic categories. The figures are based on a population of 385 million persons in the European Union, thus to derive estimates for Australia's population of 19 million people the European figures have been divided by 20. This is shown in Table 2-1 below. The categories of disability used in the table are similar to those commonly used in Australia. Nonetheless, the various governing bodies and organisations within Australia have dissimilar views on the actual figures on the types of disability shown. The Department of Communications, Information Technology and Arts (DCITA[5]) believes that the figures in the table might be misleading, since the figures from the ABS (1998 & 2003) are lower. The Deafness Forum believes that the figures in Table 2-1 for deafness are too low. The table does not give figures for mild hearing impairment - just for moderate, severe and profound (Jolley, 2003).

Table 2-1 also only specifically categorizes the type of impairments. However, there are broader classifications such as those with cerebral palsy, spinal cord injury or muscular dystrophy as well as those with multiple disabilities who have a combination of the disabilities listed.

It is envisaged that the majority of people in these disability groups will benefit from improvement in the design and development of newer mobile phone technology. Manufacturers and consumer advocates will no doubt play an important role in the provision of accessible mobile telecommunications for people with disabilities. Astbrink (2002) outlines eight best practice principles in telecommunications for people with a disability in Australia. These best practice principles are for government, industry and the community sector to follow in order to achieve access to, and equity in, telecommunications products and services by people with disabilities. One of these principles states that "providers of telecommunications equipment and services and regulatory authorities consult regularly with people with disabilities about their access requirements and take appropriate action" and "Equally, organisations representing people with disabilities contribute their knowledge and expertise". This strongly reinforces the value of the work undertaken in this thesis. As an industry partner of this project, Novita aims to develop communication technologies and systems that promote the principles of 'Universal Design' or 'Design for All' to ensure that future products and services take into account the needs and abilities of all people.

[4] PhoneAbility is the independent UK focal point for telecommunications and the needs of disabled and elderly people. The group acts as a catalyst in this area by organising conferences and seminars on telecommunications and disability. It also acts as the UK reference group to the European project COST 219bis on telecommunications: Access by Disabled and Elderly People.

[5] The Department provides strategic advice and professional support to the Australian Government on a wide range of significant and rapidly changing policy areas including: arts and culture, information and communications technology and telecommunications.

Disability type	Estimates for European Union (millions)	Estimates for Australia (thousands)
Hearing impairment (moderate)	16	800
Hearing impairment (severe)	4	200
Deaf	2	100
Vision impairment (moderate)	3	150
Vision impairment (severe)	2	100
Blind	1	50
Deaf-blind	0.2	10
Speech impairment (moderate)	3	150
Speech impairment (severe)	2	100
Limited dexterity	7	350
Limited use of hands/arms	5	250
Weak grip	7	350
Hand tremor	7	350
Cognitive impairment	9	450
Restricted mobility (lower limb)	22	1,100

Table 2-1 Estimated numbers of persons in Australia with a phone-related handicap (interpolated from the European data). (Jolley, 2003)

2.2.2 Telecommunications for people with disabilities in Australia

The provision of accessible telecommunications can benefit all people with disabilities, regardless of the type of disability involved. In particular, it could improve their independence, mobility and quality of life. In Australia, the main focus of telecommunications service providers in recent years has been the emphasis on providing solutions for people with hearing, visual and speech impairments, and has included work such as SMS for deaf people, access for people who are blind, the reduction of hearing aid interference, and access to emergency services (Jolley, 2003). However, insufficient work has been done in the area of physical access for people with disabilities. As mobile telecommunications technology rapidly changes and shrinks in size, this issue is more problematic. People who were already experiencing difficulty with conventional technology can actually be further excluded (Gill, 1994).

At present, there are no universal standards in the telecommunications industry that stipulate how a phone should be developed and what features are to be incorporated on phones to facilitate access by all people. Different manufacturers are implementing their own design standards, as well as proprietary communications protocols, thus making it hard to standardise any new development. Any standards developed by the mobile telecommunications industry are more likely to be voluntary, and do not become mandatory unless they are adopted by national regulatory bodies. Experts differ on the preferred scope, list of features and legal/regulatory basis of any future standard.

To further complicate the situation, due to the varying disabilities and telecommunications needs of each individual, the requirements for the telecommunications products and services differ. An individual's sensory (seeing, hearing, touch and balance), physical (speech, dexterity, manipulation, mobility, strength and endurance) and cognitive (intellect, memory, language and literacy) abilities significantly and directly affect the telecommunications products and services that they can access and successfully use (ETSI TR 102 068, 2002). A solution with certain features that are accessible for one individual or a group of individuals with similar functional limitation, might not meet the needs of another. Similarly, a person with visual impairment has a different requirement from that of a person with speech impairment.

2.2.3 Legislative and Regulatory environment for equal access

Apart from the technical difficulties, affordability (cost) and the lack of awareness have probably been major factors in the poor provision of mobile phone technologies made for people with disabilities (Gill, 1994). Fortunately, in the last few years, this has changed in many parts of the world. There is a growing awareness that older persons and people with disabilities deserve and expect the same standard of telecommunications services and access. Governments are legislating for equal access (Gill, 1994). Examples in Australia include:

- The Disability Discrimination Act 1992 (DDA, 1992), which prohibits discrimination in the provision of goods, services and facilities against people with disabilities and their associates. This includes telecommunications.
- Both the Telecommunications Act 1997 (TA, 1997) and the Telecommunications Consumer Protection and Service Standards Act 1999 (TCPSS, 1999), recognise the inherent right of persons with disabilities to equitable access to telecommunications products and services, and they both refer back to the DDA.
- Telecommunications (Equipment for the Disabled) Regulations 1998 (TR, 1998), specifies that under the Universal Service Obligation, a Universal Service Provider (currently Telstra) is obliged to supply equipment and services that are also accessible to customers with disabilities.
- The Human Rights and Equal Opportunity Commission (HREOC[6], 2001) has endorsed the DDA and noted the importance of telecommunications issues for people with disabilities, and confirms the complexity of access issues for telecommunications products and services in the midst of rapidly changing access technologies.

Since telecommunications technology is continually changing, driven by competitive pressures to reduce costs, and by market demand for new services, the situation for people with disabilities is also continually changing. The telecommunications laws in Australia refer to the DDA as the benchmark for telecommunications accessibility for people with disabilities. With the establishment by HREOC of a high-level accessible telecommunications forum, the scene is set for accelerated improvement in telecommunications access for people with disabilities throughout Australia.

2.2.4 Consumer Representation and Consultation in Australia

In addition to legislative and regulatory steps, peak consumer disability organisations are working on specific projects, services and critical issues facing people with disabilities in using telecommunications services and equipment. An outline of the work and progress of these organisations is described under their respective sections below.

Section 593 of the Telecommunications Act 1997 provides for funding of consumer representation and research. The Commonwealth has allocated $3.4 million over the four years 2002-2006 for Section 593 grants. For the year 2003-2004 up to $700,000 had been allocated for consumer representation, and up to $100,000 had been allocated for research. The Consumers' Telecommunications Network (CTN) receives funding, as do TEDICORE (Telecommunications and Disability Consumer Representation) and DTAN (Deaf Telecommunications Access and Networking). TEDICORE and DTAN are projects supported by Blind Citizens Australia and the Australian Association of the Deaf.

[6] The Human Rights and Equal Opportunity Commission is a national independent statutory government body, established in 1986 by an Act of the federal Parliament, the *Human Rights and Equal Opportunity Commission Act*.

Other organisations that provide support for people with disabilities include: Australian Consumer Industry Forum Disability Advisory Body (ACIF DAB), and major Telecommunications Service Providers such as Telstra and Optus. Telstra, Optus, and ACIF all maintain their own community consultative mechanisms. These include direct consultation with representatives of people with disabilities, and the participation of consumer advocates in telecommunications industry forums and seminars.

There are many projects undertaken by these organisations that have wider implications for people with disabilities. However, the work that is of most significance to the context of this thesis is closely related to that of TEDICORE and ACIF DAB. They have created specific guidelines, principles and forums that seek to promote equity and accessibility and represent the interests of Australian telecommunications consumers with disability. Sections 2.2.4.2 and 2.2.4.4 outline some important principles and guidelines made by these two groups, and the opportunities to further contribute by work undertaken in this research.

2.2.4.1 The Consumers' Telecommunications Network

The Consumers' Telecommunications Network (CTN) is a national coalition of community organizations, which represents community interests on national telecommunications issues. CTN is an important voice promoting better access, quality of service and affordability of telecommunications services for residential consumers. Its members include national and state organisations representing consumers from non-English speaking backgrounds, deaf consumers, indigenous people, low-income consumers, people with disabilities, pensioners and superannuants, rural and remote consumers, and women.

CTN acts as a forum for community organisations to exchange opinions and become informed about telecommunications issues, enabling CTN to advocate on behalf of residential consumers in discussions with other sectors of the telecommunications industry.

CTN is an important voice promoting better access, quality of service and affordability of telecommunications services for residential consumers. CTN is also a member of the Australian Communications Authority (ACA) Consumer Consultative Forum and ACIF Consumer Advisory Council. In addition CTN holds positions on the Standards Australia Council and the Telecommunications Industry Ombudsman Council.

2.2.4.2 Telecommunications and Disability Consumer Representation (TEDICORE)

The TEDICORE project commenced in 1998 when Blind Citizens Australia received a grant of $100,000 under Section 593 of the Telecommunications Act 1997 to carry out a one-year project to represent the interests of consumers with disabilities. The project is resourced by a specialist project officer and supported by a cross-disability advisory body. The TEDICORE partner organisations are:

- Australian Association of the Deaf;
- Blind Citizens Australia;
- Communication Aid Users Society;
- Deafness Forum Limited;
- Physical Disability Council of Australia; and
- Women with Disabilities Australia.

Appendix 2-1 summarises the work of these organisations.

The TEDICORE objectives are to:

- Provide a forum for the discussion of telecommunications matters that are of common interest to telecommunications consumers with a disability;
- Represent disabled consumer interests in the development of government and industry policy in relation to telecommunications; and
- Focus the attention of consumer bodies, the public, government and industry on telecommunications issues affecting disabled consumers (Astbrink, 2000).

For people with disabilities to effectively use telecommunications products, these products need to be accessible, usable and compatible. Astbrink (2002b) drafted the work done by the Australia Communications Authority (ACA) Working Group on the proposed extension of a Disability Standard in late 2002. This outlines the overarching principles to be followed when applying the specific technical Disability Standards, which list quantifiable features for telecommunications customer equipment. These principles include:

1. Telecommunications products to be accessible to all;
2. Interoperability;
3. Stakeholder involvement;
4. Regular review of Disability Standards;
5. Accommodation of future technologies;
6. Reference to the Disability Discrimination Act 1992;
7. Principles of social justice and quality;
8. Compliance with the Disability Standards, and
9. Availability of Complaints-handling process administered by the ACA.

Principles 1, 2, 3, and 5 are of most importance to the context of the research undertaken and are the areas in which this thesis has made a contribution.

Principle 1 states that, “to achieve accessibility, the principles of inclusive design will be taken into account when developing or importing any new product. This will ensure that the product is able to be used by a broader range of the population including people with disabilities”. The mobile phone features that have been identified by people with disabilities to be suitable for them in Section 2.3.1, and work carried out in Chapters 3, 4, and 5, have addressed this principle.

Principle 2 states that, “people with disabilities prefer mainstream products but some may need to use specialised products. Mainstream products will have a compatible connection for specialised products, which are intended to interwork with or through them. Specialised products will also need to be compatible with future networks”.

The section of this thesis that involves the design and development of an interfacing system between an AAC device and a mobile phone adheres closely to this principle. As highlighted in Chapter 1, for people who use an AAC technology, the lack of a suitable interface system between their AAC device and the mobile phone, which would allow them to access and/or operate the phone, is the largest impediment. People who rely on AAC technology have typically identified successful method(s) of operating their systems, and the same method(s) may be useful for controlling the mobile phone as well. The development of a configurable interface to the mobile phone that works in conjunction with an existing AAC technology such as a Pathfinder could provide *multiple* accessing opportunities including voice, text (SMS), email, a wide range of internet services, and the local or remote control of appliances and devices. It would therefore enable persons with severe disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community. The work undertaken in Chapter 6 has addressed this principle.

Principle 3 states that "Industry and disability consumer representatives will be an integral part of any development of Disability Standards and be consulted when reviews of the Disability Standards take place. The experience of consumers with a disability will form the basis of the development of accessible features in the Disability Standards. In order to avoid discrimination, the Disability Standard needs to ensure that people with disabilities can achieve the equivalent functionality as those without a disability". This project has been undertaken in close collaboration with Novita Children's Services, an organisation that provides services to approximately 1,300 clients and their families. End users have contributed to the quality of the outcomes through their participation in focus groups, surveys and trials. Several participants have implemented the solutions recommended for them. The project work addressing this principle has been described in Chapters 3, 4, and 5 of this thesis.

Principle 5 states that "The Disability Standards will cover future technologies such as new types of wireless devices which could include mobile phones, cordless phones and combined products such as mobile phones and organisers. Provision in the Disability Standards will be made to accommodate future technologies". The work undertaken in Chapter 6 has addressed this principle. The interfacing system developed in this section is limited by the set of GSM commands available with the mobile phones. As a wider set of GSM commands becomes available, it is anticipated that the AAC device can be extended to include other ASCII character strings for performing other functions that are available on the mobile phone.

2.2.4.3 Deaf Telecommunications Access and Networking (DTAN)

DTAN has been a project of the Australian Association of the Deaf (AAD) since October 2001 with funding under Section 593 of the Telecommunications Act 1997. DTAN builds on the work done by AAD's Telecommunications Access Sub-committee since 1986. Its activities for 2003 – 2004 (AAD, 2002) are:

- National community consultation with the deaf community
- Publish 2 articles/research reports aimed at Government, industry and regulators
- Disseminate 3 discussion papers aimed at the deaf community
- AAD representation at various telecommunications committees and forums
- Collaborate with other peak disability groups to increase telecommunications access
- Lobby for equitable access to telecommunications products and services for the deaf community

AAD employs a part time DTAN project officer, and already the project has had a major impact: to raise the profile of telecommunications access issues for the deaf community, and to enable AAD to produce research and discussion papers (AAD, 2002). DTAN has recently addressed many issues, including the following:

- Disability Equipment Programs;
- National Relay Service;
- Mobile phones;
- Any-to-any text connectivity;
- Video telephony;
- Accessible payphones; and
- Emergency services;

Section 2.4 gives a description of the first three of these programs and services.
DTAN research and discussion papers are available from the AAD website[7] as PDF files.

[7] http://www.aad.org.au/publication/publish.htm

2.2.4.4 ACIF Disability Advisory Body (DAB)

ACIF is an industry owned, operated and resourced company established in 1997 by the telecommunications industry to implement and manage communications self-regulation within Australia. Its primary role is to develop and administer technical Standards and Industry Codes and provide Industry Facilitation services that promote both the long-term interests of end-users and the efficiency and international competitiveness of the Australian communications industry.

The ACIF Disability Advisory Body (DAB) provides professional advice to ACIF regarding the implications of ACIF's proposed Codes and Standards for telecommunications consumers with disabilities. The guideline produced by ACIF DAB (2001) that is of interest in the context of this research is the *ACIF G586: Industry guideline: Access to telecommunications for people with disabilities*. This document aims to:

- assist ACIF and its Reference Panels and Working Committees to meet their responsibilities under the Disability Discrimination Act 1992 and the Telecommunications (Consumer Protection and Service Standards) Act 1999; and
- assist ACIF and its Reference Panels and Working Committees to provide equity in access to telecommunications for people with disabilities.

A significant guideline from this document makes reference to the principles of universal design that should be taken into account, where relevant, in the development of Codes and Standards by ACIF. This supports the first principle of *Expansion of Telecommunications Disability Standard* outlined by Astbrink (2002b). The opportunity for contributions to this field of work in this thesis arose from the mobile phone features that have been identified by people with disabilities to be suitable for them (in Section 2.3.1) and the work carried out in Chapters 3, 4, and 5. The inclusion of these features as standards on a mobile phone would allow better access to telecommunications equipment by people with disabilities as well as meeting universal design principles.

2.2.4.5 Telecommunications service providers, Telstra and Optus

Telstra (2002) stated that “Telstra is committed to making communication accessible and affordable for all our customers” and “A key component of achieving this is recognising that people have different needs”. Part of this commitment is a *Disability Catalogue* which outlines products and services for older people and people with a disability. It also provides information about Telstra’s Disability Equipment Program and other products and services that may provide solutions for the telecommunications needs of people with disabilities. Solutions cater for categories of hearing, speech, vision, mobility and dexterity impairments. Optus also has a Disability Equipment Program, but not as extensive as Telstra’s.

2.2.5 Overseas trends and activities toward accessible telecommunications for people with disabilities

2.2.5.1 In Europe and particularly the United Kingdom

Europe, particularly the United Kingdom and the United States are the areas of major activity for developments in mobile telecommunications that may have implications for people with disabilities in Australia.

A valuable source of information for Europe and particularly the UK is provided by COST219bis. COST is a framework for European Co-operation in the field Of Scientific and Technical (COST) research, emphasising co-ordination of national research throughout Europe. The main objective of COST219bis is to increase the availability of

telecommunications services and equipment so that they are accessible to all people, including disabled and older people (COST, 1997). This is aligned with the UK's Disability Discrimination Act (DDA[8]) 1995 which prohibits discrimination in the provision of goods, facilities and services against people with disabilities and their associates.

COST219bis provides possibly the best source of information about developments and outstanding challenges for people with disabilities to access telecommunications services and equipment in Europe and particularly the UK. Ekberg (2001) describes COSTbis' objective as "*to increase the availability of accessible telecommunication services and equipment for elderly and disabled people*" and "*to try to get industry interested in the accessibility guidelines*".

Many papers and reports on issues of accessible telecommunications for people with disabilities and the elderly are available from its website[9]. This work is summarised in the publications, "*Telecommunications for all*" (Roe, 1995) and "*Bridging the gap? Access to telecommunications for a*ll" (Roe, 2001) by COST219, which review progress over the past fifteen years. It is a collaborative effort with contributions from more than twenty experts from all over the world. It gives a snapshot of the latest situation concerning the development of telecommunications products and services for older people and people with disabilities and discusses many related issues.

Roe (2001) states that "*the overall telecommunications environment has undergone massive change over the last decade with the erstwhile state-run monopolies having to adapt to the liberalised free-market. Despite the recent downturn in telecommunication and technology shares on the world stock markets, the intensive development has continued relentlessly with the launching of new products onto the market with ever shorter production cycles from concept to marketplace*". Studies carried out by COST219bis confirm that these changes have had a negative impact on the development of standards. Equipment standards for people with disabilities, and other special needs groups, take second place in standards development to work on protocols that ensure connectivity and enhance service expansion and product development. Any standards developed by the telecommunications industry are more likely to be voluntary, and do not become mandatory unless national regulatory bodies adopt them. This worrying situation reinforces the value of the research undertaken for this thesis.

PhoneAbility[10] is another independent UK focal point for telecommunications and the needs of disabled and elderly people.
The group acts as a catalyst in this area by:

- Interacting with a range of relevant organisations,
- Publishing both practical guidelines and policy documents,
- Organising conferences and seminars on telecommunications and disability.

It also acts as the UK reference group to COST 219.

INCLUDE[11] (INCLUsion of Disabled and Elderly) is another main European project that is concerned with designing information and communication technology systems so that they are accessible to everybody including disabled and elderly people. INCLUDE provides information and tools for telematics designers and marketing. The INCLUDE website forms

[8] The Act states that "*The Disability Discrimination Act makes it unlawful for a service provider to discriminate against a disabled person by refusing to provide any service which provides to members of the public*". The *Code of Practice* of Section III of the DDA (1995) also states that "*From 1st October 1999 a service provider has to take reasonable steps to change a practice which makes it unreasonably difficult for disabled people to make use of its services.*" The services affected by the Act include telecommunications.
[9] http://www.stakes.fi/cost219
[10] http://www.tiresias.org/phoneability/
[11] http://www.stakes.fi/include/

the main information dissemination channel and contact point of INCLUDE project for Telematics designers about issues of importance concerning telematics applications and elderly/disabled people. In addition, INCLUDE offers updated information for researchers, people working with elderly and disabled people and also elderly and disabled people themselves.

In recent years there have been numerous developments in the European telecommunications industry from the end user perspective performed by the European Telecommunications Standards Institute's (ETSI) Technical Committee Human Factors (TC HF) under the European Commission's (EC) eEurope Initiative[12] (von Niman & Nordy, 2003). The EC provided funding to set up thirteen teams of experts, known as Specialist Task Forces (STFs), to work under ETSI TC HF sponsorships. Through this collaborative approach the groups were responsible for the ease of use and accessibility of telecommunication equipment and services for all users, including the requirements of groups such as children, older people and people with disabilities. It focused on user interfaces, specifically for mobile communications, multimedia, text telephones and user identification. Their philosophy is that, by adopting the "Design for All" approach and ensuring that Assistive Technologies are considered as part of the design process, it will be possible to improve access to the Information Society by people who might otherwise be excluded from its benefits.

The resulting efforts from the STFs have been the development of standards, technical reports, recommendations, guidelines and principles that address the needs of children, older persons and people with disabilities for access to Information and Communication Technologies (ICT). Outcomes[13] significant to older persons and people with disabilities included:

- **STF 181**'s ETSI Technical Report (TR 102 068) giving guidance as to how Assistive Technology devices such as special displays, special keypads and text entry devices can be interfaced with ICT systems via wired or wireless transmission technologies to aid older and disabled people to be able to utilise mainstream ICT technology such as mobile phones, Personal Data Assistants (PDAs), and lap-tops computer.
- **STF 182**'s ETSI Standard (ES 202 076) on the generic spoken command vocabulary for basic telephone services and ICT devices. This opens up the possibility for disabled people to access electronic devices and services using speech.
- **STF 184**'s ETSI Guide (EG 202 116) with 'Design for All' guidelines for ICT products and services aimed at the working design engineer. It sets out the characteristics of users and their disabilities and describes the human-centred design process.
- **STF 204**'s ETSI Guide (EG 202 191) on the design of multimodal interaction, communication and navigation at the user interface of ICT systems and terminals. This should aid disabled users, as well as all other users under adverse conditions, to interact with ICT systems and devices.

Successful implementation of some of these guidelines and standards are evident in current mobile phone models that implement features and technology that are accessible to people with disabilities as well as embracing the "Design for All" concept. This include speakerphone, predictive text, speed dialing and voice recognition technology such as voice dialing, answering and commands, as outlined in Section 2.3.1. These features are useful to the wider community but provide much better accessibility to people with disabilities.

[12] In 2000, the European Commission (EC) launched a new initiative – eEurope Action Plan 2002 An Information Society For All. Its intention is to accelerate positive change in the European Union (EU). The aims of eEurope are to secure equal access to digital systems and services for all of Europe's citizens, to promote computer literacy and, crucially, to create a partnership environment between the users and providers of Information and Communication (ICT) solutions, based on trust and enterprise. Its ultimate objective is to bring everyone in Europe – every citizen, every school and every company – on-line as quickly as possible.

[13] All written reports, standards and guides developed by ETSI related to human factors aspects of telecommunications are available at http://www.etsi.org.

2.2.5.2 In the United States

There are three important pieces of legislation in the United States, each of which has a role to play in achieving accessible telecommunications for people with disabilities. These are:

- The Americans with Disabilities Act (ADA) 1990;
- Section 255 of the Telecommunications Act 1934 (as revised in 1996); and
- Section 508 of the Rehabilitation Act 1973 (as amended in 1998).

The ADA prohibits discrimination on the basis of disability in various areas including telecommunications.

Section 255 of the Telecommunications Act 1996 specifies that, provided that it is readily achievable to do so, telecommunications equipment and services must be accessible to and usable by persons with disabilities, or they must at least be compatible with their commonly used assistive technology.

Section 508 of the Rehabilitation Act 1998 requires access to the Federal government's electronic and information technology (EIT) for people with disabilities. The law covers all types of mainstream EIT: office equipment, desktop computers, telecommunications equipment, software, etc.

The Section 508 law promises to be extremely important, with far-reaching consequences for information and communications technology worldwide. It will benefit people with sensory and physical disabilities in many facets of their daily lives: employment, education, leisure, personal computing and telecommunications.

Kaplan's (2001) organisation, the World Institute on Disability[14] recognises the need to promote Universal Design as the primary public policy objective to make information technology accessible and acknowledges that Section 508 of the Rehabilitation Act and section 255 of the Telecom Act are two very important laws with which industry must comply in order develop and provide accessible products and services.

Similar to COST219bis in the UK, the Trace Center is the main American website containing information on designing telecommunication services for people with disabilities. Section 2.2.6 describes Trace Center's Reference Design 1 for a mobile phone that meets all the access guidelines proposed by the Federal Communications Commission (FCC).

Wireless Rehabilitation Engineering Research Center (RERC[15]) is another core research centre on universal access to mobile wireless technologies for people with disabilities in the US. Its mission is to promote universal access to mobile wireless technologies and explore their innovative applications in addressing the needs of people with disabilities.

2.2.6 Universal Design Obligations

Recently, further effort has been made to promote the implementation of the "Principles of Universal Design" or "Design for All" by developers and manufacturers of mobile phone technologies accessible by people with disabilities as well as to the wider community. The Center for Universal Design, (1997) states that "Universal design is the design of products

[14] Is a research and public policy institute that works to bring together disability leaders to promote access to technology and strives at establishing partnership with the Industry to establish collaborative ways to make information technology accessible.
[15] http://www.wirelessrerc.gatech.edu/

and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." (*The Center for Universal Design* website[16])

One example of universal design in relation to deaf and hard of hearing people is the inclusion of closed-caption decoder circuitry in all television sets. Universal design is not just for one group or another, however; the goal and philosophy are to meet as many accessibility and usability needs as possible. More "universal" examples are the access features in the Windows operating system, originally implemented in Windows 95, which make the system more accessible to people with a variety of user needs.

In terms of mobile phone technology, the Trace Center (2002) has developed a mobile phone specification that meets all the access requirements proposed by the Federal Communications Commission (FCC). The FCC is the government agency responsible for regulating telecommunications in the United States, located in Washington, D.C. Their responsibilities include public radio communications such as cellular, the allocation of frequencies, the development of regulations that govern their use and monitoring to ensure that regulations are followed.

Figure 2-1 shows the Reference Design 1 which incorporates features such as a volume control that enables the phone to be used in noisy environments, Speakerphone function for hands-free use, Infrared port for wireless connection to computer or modem, Ezbutton that allows the user to have the label for any key read to them as well as the contents of the menus and features of the phone. Other features include easy-to-feel keys, headset jack, a matrix display that allows the use of graphics and multi-line text messages including TTY conversations, and voice dialling. It is important to note that some of these features are readily available, but are scattered throughout different mobile phone manufacturers and models. It would be difficult for a person with disability to find a single phone on the current market that includes all of the above-mentioned features.

Figure 2-1 Trace Centre Reference Design 1 of a mobile phone that incorporates accessibility features (Trace Center, 2002)

Table 2-2 shows the FCC guidelines were met by the Trace Center Reference Design 1. Details of these guidelines and how they are met can be found at the Trace Center website[17].

[16] http://www.design.ncsu.edu/cud/univ_design/princ_overview.htm
[17] http://trace.wisc.edu/docs/phones/tcrd1/tcrd1.htm

FCC Guidelines met by Trace Center Reference Design 1		
Accessibility and Usability		**Compatibility**
Input, control, and mechanical functions	***Output, display, and control functions***	
• Operable without vision. • Operable with low vision. and limited or no hearing. • Operable with little or no colour perception. • Operable without hearing. • Operable with limited manual dexterity. • Operable with limited reach and strength. • Operable without time-dependent controls. • Operable without speech. • Operable with limited cognitive skills.	• Availability of visual information. • Availability of visual information for low vision users. • Access to moving text. • Availability of auditory information. • Availability of auditory information for people who are hard of hearing. • Prevention of visually-induced seizures. • Availability of audio cut-off. • Non-interference with hearing technologies. • Hearing aid coupling.	• External electronic access to all information and control mechanisms. • Connection point for external audio processing devices. • Compatibility of controls with prosthetics. • TTY connectability. • TTY signal compatibility.

Table 2-2 FCC guidelines met by the Trace Center Reference Design 1 (Trace Center, 2002)

Motivated by the trend towards regulatory requirements, the European ICT industry is gearing up for developing solutions for making their products usable for all users, inclusive of older people and users with a disability (ETSI TR 102 068, 2002). Where a "Design for All" solution is unable to provide an acceptable solution, appropriate “technical” interfaces are required to enable the use of so-called “assistive technology” or “assistive devices” to bridge the gap between the user interface of the device/technology and the abilities of the user.
For people with complex communication needs having to use AAC devices, the lack of a suitable interface system, which would allow them to access and/or operate a mobile phone, is the last impediment. This problem has provided an opportunity for further research in this thesis and was subsequently implemented in Chapter 6.

2.3 The Mobile Phone – its present and future technology

The telecommunications industry is modern and competitive. In Australia, there are three major telecommunications service providers namely, Telstra, Optus and Vodafone, which were licensed following the passing of the Telecommunications Act 1991. Digital cellular telephony was introduced around 1993 and the number of brands and models available has increased since then. The major brands include Nokia, Sony Ericsson and Motorola, extending to other brands such as Kyocera, Panasonic, Philips, Siemens, Sagem and many more.

The comprehensive communication capability of a mobile phone can enable users anywhere to independently access a very wide range of communication, information and control systems and services. The number of mobile phones currently utilised in Australia is clear evidence of their significance and potential. By June 2002 there were 12.67 million mobile telephone subscribers, a 13% increase from the previous year. There were 11.7 million GSM and 900 thousand CDMA subscribers (Jolley, 2003).

The following sections discuss the features, network, future technology and uses of the mobile phone.

2.3.1 Mobile phone features

The mobile phone is getting smaller in size, but its features are ever-increasing. These features commonly include:

- Voice:
  - Control (commands),
  - dialling & answering;
- Speed or hotkey dialling;
- Any key or automatic answer of calls;
- Vibrate/visual alert;
- Predictive text;
- Built-in speakerphone;
- Smart[18] Button;
- Contrast control;
- Integrated FM radio, digital camera and video recorder;
- Built-in Modem (voice/data/fax);
- Data Transmission via serial, Infrared ports and Bluetooth[19]; and
- Productivity tools including:
  - text/voice memos
  - alarm clocks
  - organiser/calendar
  - calculator
  - Stopwatch/timer.

Network related features (depending on the service provider) include:

- Enhanced Messaging Service (EMS);
- Short Message Service (SMS);
- Multimedia Service (MMS);
- Calling Line Identification (CLI);
- High Speed data (HSCSD) transfer;
- Voice mail;
- Wireless Application Protocol (WAP);
- General Packet Radio Service (GPRS); and
- Call Management (waiting/forwarding/diverting).

Refer to the *Glossary of Acronyms* in Appendix 1 for an explanation of these.

For features that could not be incorporated onto the phone itself due to size limitations, there are accessories/interfaces available. These include:

- Headset (cordless)
- MP3 Music (hands-free)
- Portable/personal hands-free kit
- Snap-on/attachable:
  - Keypad and keyboard (standard size) for easy SMS and email
  - Digital camera/flash, and
  - FM radio module etc.

[18] A button that allows menu control of the phone.

[19] A specification for short-range radio links (10m) between mobile computers, mobile phones, digital cameras, and other portable devices.

With the advent of WAP and GPRS, on the current GSM (Global Systems for Mobile communication) system, one can surf the mobile Internet with a WAP-enabled mobile phone:

- Download & display text and images from certain web pages;
- Capture and send images and video;
- Engage in e-commerce;
- Email (with attachments); and
- Information searches such as:
    - Entertainment,
    - sports & weather,
    - stock quote,
    - news (local & world),

Appendix 2-2 refers to phone models (2003 – 2004) with features that are considered suitable[20] for people with disabilities. Features include:

- Speed dialling;
- Voice dialling;
- Voice answering (with car kit or personal hands-free);
- Any key answering;
- Vibrate alert;
- Predictive text;
- Speaker phone; and
- Enhancements or accessories such as hands-free (cordless/Bluetooth) headsets, car hands-free kits, wireless connectivity (Bluetooth & infrared) technology and built-in modems.

Williams (2003) and the Trace Center (2002) also list some of these features that are important for accessibility reasons and enhancing the usability of the mobile phone. Telstra's Disability Services *Disability Catalogue* also confirms the majority of the listed features as being desirable for people with disabilities (Telstra, 2002). In addition, it lists features such as QWERTY keypad and visual flashing alert as suitable for people with disabilities. Findings from Chapters 3, 4 and 5 confirmed that these features could also alleviate problems for people with disabilities.

Speed dialling sometimes referred to as "one-touch dialling" or "one-button control" enables a user to program the phone so that it will automatically dial just one number (or a small list of numbers) when any button on the keypad is pushed. Speed dialling usually allows the user to program up to 9 numbers into the phone's memory. The Trace Center (2002) indicated that this feature is useful for people for whom a standard mobile (cell) phone is too complicated, or for an emergency phone for anyone in the family, young or old and that it also has mass-market appeal for this group.

Voice dialling or "voice recognition technology" is available on selected mobile phone models and is based on the phone's ability to record up to 10 voice tags or commands (more for advanced models with in-built memory). This enables the user to dial by pressing a single button and saying the name of the person to be called – the pre-programmed voice tags. Voice commands are not language dependent but are dependent on the speaker's voice.

Voice answering is available with selected mobile phone models and associated car kits. This typically allows a user to have a pre-programmed voice command (eg., *answer*) such that when there is an incoming call, the user only has to say *answer* and the phone would

[20] Derived from researches in the UK (COST219, PhoneAbility), US (Wireless RERC, Trace Center) etc (provide links) in accessibility features, Telstra's Disability Services – Disability Catalogue and end user feedback and recommendations from subsequent focus groups, survey questionnaire and trials of off-the-shelf telecommunications equipment as described in Chapters 3, 4 and 5.

acknowledge it as the “Yes” button having been pressed and accept the call. This feature is used in conjunction with a personal hands-free or a car kit system.

Selected Sony Ericsson phone models also have a *magic word* function that once programmed onto the phone would enable the user total hands-free control of the phone for voice calls or dialling instead of pressing a single button to activate voice dialling. The technology only works in conjunction with a compatible car kit.

Any key answering is another feature than enables user to set the phone such that when there is an incoming call, the user can press any button on the phone and the call would be received. This feature is most suitable for people who find it difficult to press a particular single button.

Vibrate alert informs the user that there is an incoming text message or voice call by shaking the phone. This feature is widely used by people while in a meeting or at a conference presentation. However, this mass-market feature has particular relevance for those with hearing impairment. The user can opt to have this feature on all the time or when the phone has been switch to *silent*.

Predictive text or word prediction is based on a built-in dictionary that is used for comparison with the written word in progress. This feature facilitates the quick entry of text messages.

Speakerphone function facilitates use by people who have difficulty handling the phone. This feature is also available on selected phone models and the user has the option to turn it on or off during a call.

Enhancements or accessories such as hands-free (cordless/Bluetooth) headsets, car hands-free kits, and wireless connectivity (Bluetooth & infrared) technology facilitate voice recognition technology (i.e., voice commands), hands-free control and use of the phone as mentioned above. Wireless connectivity such as Bluetooth and infrared can enable users to synchronise with a personal computer (PC) or other compatible devices such as a PDA to transfer or update data on the phone.

A built-in modem enables a user to connect the phone to the Internet on a compatible PC or to send and receive faxes. Another important feature of the built-in modem, as discussed in Section 2.4.8 of this Chapter and Section 6.2 of Chapter 6 is the GSM AT commands set incorporated on the modem that enables the mobile phone to be controlled via an external compatible device. This is especially relevant for AAC device users who want to access and control the phone for voice calls and text messaging. This was an opportunity that was explored and undertaken in this thesis.

2.3.2 Mobile phone network

There are three generations of cellular mobile communications:

- First Generation (1G) systems were analogue. The Analogue Mobile Phone Service (AMPS[21]) system was developed in the United States and was used in some other countries including Australia. The AMPS system was completely phased out in Australia by the end of 2003. It is still widely used in the United States and in some parts of the world such as New Zealand (NZ), although NZ Telecom customers are migrating to the new CDMA[22] service.
- The Second Generation (2G) technologies include GSM and CDMA (Coded Division Multiple Access).
- Third Generation (3G) technologies are deployed by Hutchinson (Australia), but when they will be fully deployed (by other carriers) and widely used, and what services they will support, is still a matter of conjecture.

The 2G – 2.5G standards currently used in Australia are GSM and CDMA. They both support: voice telephony, slow-speed data communication, and SMS. The transition from the second to the third generation of mobile communication technologies will be gradual as new networks are opened up, new data-rate capacity is realised by content providers and consumers, new content services are developed, new terminals are released, and consumer interest increases.

Currently, WAP-enabled GSM systems coupled with GPRS, provides most of the intended function of a 3G network. Phones with these features provide faster connection speeds, bigger bandwidth and quicker web and email access than conventional mobile phones. Refer to Appendix 2-2 for phone models with these capabilities and other features that are suitable for people with disabilities.

Network features such SMS and MMS have made the mobile phone more versatile and mobile. Text messaging has provided an alternative solution for people to communicate via text while MMS allows sound and images to be transferred across the network in addition to normal text.

On 15th April 2003, Hutchison Telecommunications (Australia) Ltd began releasing its $3billion investment in building a 3G network in Australia called “3” (The Age, 2003). This 3G network in Australia offers the usual 2G – 2.5G services at a much faster speed. It enables Mobile Internet[23] with data speeds up to six times faster than the typical landline dial up speeds (56k) and allows Videotalk[24] to compatible 3G handsets.

Competing carriers Optus and Vodafone are expected to release their 3G network in 2005. Instead of rolling out its own 3G network, Telstra announced in August 2004 that it has established a 50/50 partnership to jointly own and operate Hutchison’s existing 3G network, which currently has 2000 base stations covering Sydney, Melbourne, Brisbane, Adelaide and Perth. Telstra and Hutchison expect to significantly increase the size of the network over the next three years, expanding into Canberra and other regional centres.

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[21] The standard for analogue cellular telephones, which uses a frequency-modulated transmission and frequency spacing to separate user transmission. AMPS operates in the 800 MHz band.

[22] Code Division Multiple Access is a spread spectrum approach for the digital transmission of data/voice over radio frequencies.

[23] Mobile Internet allows high-speed Internet access for 3G compatible handsets when there are no fixed landline connection available.

[24] Videotalk on “3” is the first and only services in Australia that lets you see and hear the person you are talking to - whether you are in Australia, UK, Italy, Austria or Hong Kong.

In Europe, the 3G network is well established through the UMTS (Universal Mobile Telecommunications System) network, which has seamless operation between terrestrial and satellite links, and provides high speed access to the Internet with data rates of up to 2 Mbit/s for stationary terminals and less for mobile. The special services it offers include:

- remote interpretation for deaf people, by Sign Language or Lip-speaking; (which is improving as appropriate visual displays technology is made available).
- remote location and guidance (giving enquirers personal information on how to reach their destinations, with the service centre pin-pointing their immediate location automatically).

2.3.3 Bluetooth technology in mobile phones

The incorporation of Bluetooth technology has improved mobile phone performance and extended its uses. Bluetooth technology is a wireless connectivity technology used for short-range (10 metres, extendable to 100 metres) communications of data and voice between mobile and stationary devices such as mobile phones, handheld PCs and other peripheral devices.

Accessories such as Bluetooth headsets have made accessibility to the mobile phone much simpler. It is envisaged that future development of Bluetooth technology in the mobile phone could eventually turn the mobile phone into a "walking" control unit that can potentially access and control almost any devices or appliances within homes, offices and public venues. The many possibilities of Bluetooth are visually illustrated at the Bluetooth official website[25]. Apart from the benefits to the wider community, these possibilities will also be significant for people with disabilities who are restricted to a wheelchair and have very limited mobility. The ability to use a mobile phone interface to control consumer and domestic products or systems would greatly increase the independence of a person with disabilities as well as increase the quality of life and security.

2.3.4 Mobile phone use and interface

A mobile phone is a portable, powerful and useful tool that could enable people to:

- maintain contact with family members and friends;
- manage transportation issues (e.g., contacting a taxi);
- provide safety and security (e.g., in the event of a breakdown or a dangerous situation);
- access information via WAP services or mobile Internet;
- control environmental equipment;
- communicate with employers/employees (e.g., job related issues);
- operate a business (e.g., using SMS for advertising); and
- run interactive TV shows such as Australian Idol or PopStars.

As will be mentioned in Chapter 3, a mobile phone could also be used as an Augmentative and Alternative Communication (AAC[26]) device by a person with disabilities to convey a key word or idea when carrying out a conversation.

As a mobile phone interface or control unit, the applications are countless. It can function as an extended range remote control, and can be operable from anywhere in the world. In industry, it can monitor if a machine is running, or if some threshold is surpassed. Technical staffs are alerted automatically and can remotely operate an immediate countermeasure.

[25] http://www.bluetooth.com/help/

[26] This is any system a person uses to communicate in addition to or instead of speech, including pointing to pictures and symbols, using gestures, eye gaze, or electronic devices.

An example of this, is a project carried out by Ricci Bitti (2002), entitled "*Tiny Planet: A planet-wide, wireless I/O port for GSM phones"* which demonstrates how SMS can be used through a microcontroller (control unit) to operate domestic and industrial systems using two mobile phones. Control is provided via input and an output port (serial) of the mobile phone through SMS text messages. When the mobile receives a predefined text message from another mobile phone (Figure 2-2), like *"Activate burglar alarm"* or *"Start backup pump"*, the control unit automatically recognizes it as a command, and switches the output accordingly. Besides switching the port on or off, the user can ***pulse*** *it* for a short period (e.g. *"Reboot remote server"*).

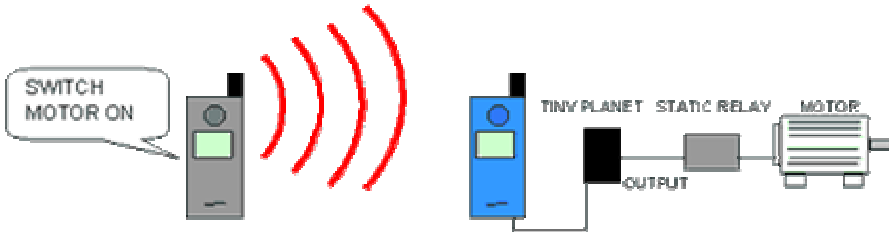

Figure 2-2 An external mobile phone sending a SMS message to the mobile phone that controls a device (from Ricci Bitti, A, 2002)

The control unit (Figure 2-3) can also be used to *notify the status* of the input port by automatically sending a message every time the *input changes* (e.g. *"Insufficient level in Tank #1"*). To know input status at any time, the device can *send back a SMS* describing the status of the input, as a response to a request message.

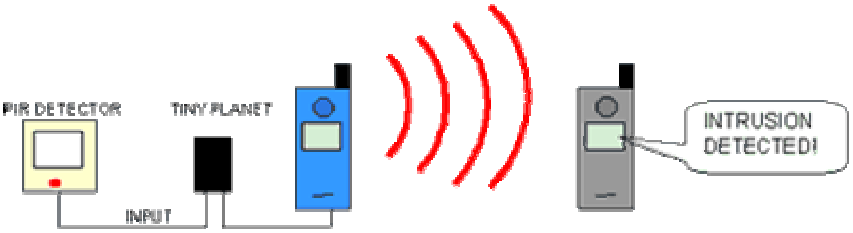

Figure 2-3 The mobile phone that controls a device sends a status message back to an external mobile phone (from Ricci Bitti, 2002).

Commercial applications of a mobile phone interface are numerous as well. As previously mentioned, with the invention of Bluetooth technology and its incorporation into the mobile phone, the phone could eventually turn the mobile phone into a "walking" control unit that potentially controls almost any Bluetooth-equipped devices or appliances within homes, offices and public venues remotely. Tan's (2002) work in the development of a wireless home network system for controlling home electrical appliances over the Internet implemented this concept. In Tan's system the need for a physical connection to the Internet was removed by using Bluetooth wireless technology to provide a link from the appliance to the Internet and the Wireless Application Protocol (WAP) to provide a data link between the Internet and a mobile phone. It is essentially made up of two subsystems, the front end graphical user interface on the mobile phone and the back end Bluetooth powered automation system, interacting with each other through WAP.

A mobile phone interface could also be used to download and upload information from networks and public venues. For example, the Kodak Picture Maker Kiosk (Figure 2-4) and FujiFilm Digital Photo Centre (Figure 2-5) available at selected Nokia retailer outlets, pharmacies and at airports allow a user with a Bluetooth, infrared and MMC (MultiMedia Card) enabled phone such as the Nokia 6600 to transfer picture files and print off high quality pictures within minutes.

Figure 2.4 Photo-teller (from Kodak website)

Figure 2-5 FujiFilm Digital Photo Centre (from FujiFilm website)

The concept of all the components of an environment control system such as an environmental control unit (ECU), or a *home automation* system to be controlled and monitored from a mobile phone, is also possible. An ECU is a piece of technology that allows a person to control aspects of their environment (e.g. temperature, humidity, lighting, window blinds) and provide access to electronic media technology (e.g. radio, CD player, television). ECUs can assist some persons with functional limitations to independently control their daily living space, and can increase their ability to participate in school, work and leisure activities. Incorporation of Bluetooth technology onto mobile phones to function as an ECU controller is an issue for the developers to consider.

The Official Bluetooth Website (Bluetooth, 2001) sketches out a number of interesting applications that include (in their words):

- *"The three-in-one phone* - At home, your phone functions as a portable phone (fixed line charge). When you're on the move, it functions as a mobile phone (cellular charge). And when your phone comes within range of another mobile phone with built-in Bluetooth wireless technology it functions as a walkie-talkie (no telephony charge)."
- *"The Internet bridge* - Use your mobile computer to surf the Internet wherever your are, and regardless if you're cordlessly connected through a mobile phone (cellular) or through a wire-bound connection to the mobile phone."
- "*The interactive conference* - In meetings and conferences you can transfer selected documents instantly with selected participants, and exchange electronic business cards automatically, without any wired connections."
- *"The ultimate headset* - Connect your wireless headset to your mobile phone, mobile computer or any wired connection to keep your hands free for more important tasks when you're at the office or in your car."
- *"The automatic synchronizer* -Automatic synchronization of your desktop, mobile computer, notebook (personal digital assistant (PC-PDA) and hand-held personal computer (PC-HPC) and your mobile phone. For instance, when you enter your office the address list and calendar in your notebook will automatically be updated to agree with the one in your desktop, or vice versa."

The home automation system such as the *Smart House Concept* which controls, monitors and optimises building services such as lighting; heating; security, and alarm systems; access control; audio-visual and entertainment systems; ventilation, filtration and climate control, etc, is another example where the mobile phone could be used to carry out these tasks.

For example, the *Clipsal Smart Home* developed by Adelaide-based Clipsal Integrated Systems use a combination of Clipsal's C-Bus Energy Management and Minder Home Automation Systems to give homeowners security and convenience and contribute to energy

savings (Kaufman, 2003). The company is currently concentrating on ways to make the automation process even more accessible through telephony, the Internet, and other wireless links (Clipsal, 2002).

2.4 Current solutions and options

With the provision of any new technology, it is important to know that an off-the-shelf item, or a single solution that is suitable for one individual, might not meet the needs of another. Often, there is a need to tailor-make equipment to suit the particular needs and interfacing requirements of individual users. This is especially important for people with disabilities wanting to use a mobile phone. A person with speech impairment has a different requirement from that of a person with physical impairment such as mobility and dexterity. Therefore a mobile phone that works well for a speech-impaired person might not be suitable for a person with physical disabilities. Ultimately, it comes down to the needs and ability of the person who wants to use a mobile phone and what technologies are available.

Fortunately, there is an extensive range of mobile phone models, with features and accessories that can be selected to best meet the needs of people with a disability. Appendix 2-2 lists mobile phones with features that are suitable for people with disabilities.

Solutions such as predictive text and snap-on or built-in standard QWERTY keypad to overcome the small keypad for faster text messaging; voice recognition technology and built-in speakerphone, and accessories such cord/cordless headsets and Bluetooth car kits installed on wheelchairs are available to overcome the problems associated with mobile phone access for people with disabilities. These solutions have been identified by Telstra (2002), Williams (2003) and the Trace Center (2002) as being suitable for people with disabilities, as highlighted in Section 2.3.1. Chapters 3, 4 and 5 of the thesis have also identified, confirmed and evaluated some of these features as suitable for people with disabilities.

In addition, there are other products and services currently available to assist people with disabilities in telecommunications access. These include:

- Disability Equipment Program
- National Relay Service – Australian Communications Exchange.
- SMS for deaf people and mobile phones for people who are blind;
- Talking Text Messages Service;
- CDMA phones for Hearing Aid Users;
- Telecommunication websites and online guidelines for people with disabilities; and
- Other miscellaneous solutions, e.g. PDAs, car kits and software such as mobile PhoneTools, MobileSpeak etc.

The following sections discuss these options in detail.

2.4.1 Disability Equipment Programs

Each of Telstra and Optus operates a Disability Equipment Program (DEP) to provide customers with disabilities with specialised or modified customer equipment to enable them to use the fixed-line telephone network, but there is little emphasis on the mobile phone service. Telstra has a substantially wider variety of equipment available, catering much better to the needs of people with disabilities other than deafness. Telstra's *Disability Catalogue* outlines equipment including teletypewriter (TTY) machines, modems, handsets with hearing aid couplers, hands-free telephones, adaptors for people with cochlear implants and telephones with adjustable ring tones and voice amplifiers.

While other carrier service providers, such as Vodafone (UK owned), AAPT (owned by Telecom New Zealand) and Primus (Australian owned), do not have their own programs, Telstra wholesale announced, in January 2003, arrangements whereby other companies can also access their disability equipment (Jolley, 2003). The requirement for TTYs to be issued by telecommunications companies was a legislative result through the Telecommunications Act 1997 and Regulations 1998. Since becoming the Universal Service Provider, Telstra has taken management responsibility for the DEP.

Opinion is divided on whether Disability Equipment Programs should be extended to cover mobile phones and accessories that might be required by persons with disabilities. Extension to the program is the expressed wish of people with disabilities and their consumer advocates. However, stakeholders are concerned about the cost of extending the range of products in the absence of a clearly established legal obligation to do so. The legal basis for such extension would seem to be supported by advice contained in HREOC (2001).

Bytheway (2001), CEO of ACE argues that the current equipment programs are an historic remnant of legislative and regulatory changes that have not adequately predicted the impact of deregulation for people with a disability. The benefits of choice and cost savings resulting from the deregulation of the telecommunications industry which are enjoyed by many Australians are not being shared by people with a disability. Existing equipment program/s is not flexible enough to deal with the increasing complexity of the telecommunications environment. ACE propose a Disability Telecommunication Equipment Program (DTEP) which offers a comprehensive range of equipment, and at the same time provides quality services and support to customers in metropolitan, as well as rural and remote areas.

Jolley (2003) stated that “Telstra claims that extension of its DEP to include mobile phones and accessories required by people with disabilities would need a legal basis. If such provision was to be mandated a legal basis would seem to be needed; but otherwise a voluntary expansion to the program would not cause any formal detriment. While program expansion could have financial implications for the user, it would also bring benefits by making mobile telecommunications more accessible to many people with disabilities”. It would be interesting to observe the outcome of this issue in the near future as people with disabilities and their advocates (eg TEDICORE, ACE, ACIF DAB, Deafness Forum and CTN etc) push strongly to expand the program to include mobile phones with features and accessories for people with disabilities.

2.4.2 National Relay Service (NRS)

For hearing and speech impaired people, other services such as the National Relay Service (NRS) of the Australian Communication Exchange (ACE) could provide a possible solution that would meet their needs. The services offered are generally available for fixed line phone users, but some of these services are beginning to integrate mobile phone users as well.

The NRS offers services (24 hours a day, every day of the year) with the following call configurations:

- *Text to Speech Relay (TSR)*: Enables a person who is deaf or who has a speech / hearing impairment, and who uses a TTY or modem, to communicate directly by text to the relay service for communication with someone who speaks and hears normally.
- *Voice Carry Over (VCO):* Enables people with hearing impairment to use their natural speech to communicate with a hearing person over the telephone and read the responses on a TTY.
- *VCO to VCO relay:* Enables two people with a hearing impairment to both use natural speech to communicate with each other and read the responses from the other person on a TTY.

- *Hearing Carry Over (HCO):* Enables people with speech impairment to listen to the telephone conversation of another person and type their responses on a TTY.
- *Speech-to-Speech Relay (SSR):* Enables people with speech impairment to have a two-way conversation over the telephone.
- *Text Emergency Call Service:* Enables access to police, fire and ambulance via TTY or a computer with modem.

2.4.3 SMS and mobile phones for people with sensory disabilities

In the late 1990s mobile phone networks introduced SMS but it was only limited to use within the same network/carrier service. Lobbying efforts by the Australian Association of the Deaf and other organisations fast-forwarded cross-networking accessibility for SMS use in April 2002 (ADD, 2002a). SMS has been a great development for the deaf community, but for heavy users SMS becomes expensive. AAD (2002a) reports anecdotal evidence that many deaf people make an average of ten SMS calls each day – ten times the national average. Some Deaf people were making 300+ SMS calls a month while others may only be using it infrequently (15 - 25 times per month). The charge for SMS calls is very high, having regard to the volume of data, which is transferred through the network. A deaf person sending ten text messages each day could face a monthly bill of more than $60, even though only 50 kilobytes of data has been transferred. Deaf people pay approximately $50 - $200 per month on access and SMS charges (AAD, 2002b). For most people, with voice communication as their natural communication medium, 'texting' each other is not generally used for conversation. However, people with a hearing loss, and who must rely on text communication, may wish to use text messaging for conversation in the absence of their TTY.

Blind people cannot use SMS, nor most of the other features of mobile phones that others take for granted, but recently released software gives synthetic speech access to high-end mobile phones. Two companies, one in Germany and the other in Spain, have released software that gives access through synthetic speech output from mobile phones using the Symbian[27] operating system.

The German software, known as TALX[28] (or TALKS), uses the Eloquence text-to-speech engine. With TALKS, vision impaired users can:
- Write and read SMS and e-mail
- Send out fax messages
- Manage contact information and dial phone numbers from the phone book
- Use the appointment calendar
- Customize the phone settings according to their personal preferences.

The Spanish software[29] is called Mobile Accessibility[30], and operates under the Symbian Series-60 as well as the Microsoft Smartphone 2002 operating systems. This software is

[27] Symbian is a software licensing company owned by wireless industry leaders Ericsson, Nokia, Panasonic, Motorola, Psion, Samsung Electronics, Siemens and Sony Ericsson. It describes itself as the supplier of the advanced, open, standard operating system for data-enabled mobile phones.

[28] Developed by Brand & Gröber. The Nokia Communicators such as the Nokia 9210 and 9210i (or 9290 for the U.S.) is a combination of a mobile phone and a Personal Digital Assistant (PDA) that are compatible with TALX and operate on a Symbian Series 80 operating system. In Australia, the TALKS software costs around $695 (October 2004 prices) from Quantum Technology, an Australian distributor for the software. As of 2004 TALKS is also compatible with mobile phones that use the Symbian Series 60 platform. This includes the Nokia 3620, 3650. 3660, N-Gage, and the Nokia 6600 model.
http://www.talx.de/index_e.htm

[29] The software is platform independent, and is expected to work on all new generation mobile phones regardless of their individual operating system. An audio demonstration of software is available at the company's website (http://codfact.com). The Mobile Accessibility software works with the Nokia 3620, 3650, 3660, 6600, 6620, 7610, 7650, Nokia N Gage, Nokia N Gage Q, and Siemens SX1 mobile phones. It is planned that it will also support the Samsung SGH-D700, Sony-Ericsson P800,

described as a computer application which makes many features of mobile phones accessible to people who are blind. Features of the Mobile Accessibility software include:

- SMS and MMS messages may be sent, received and read;
- Entries on the list of contacts may be added, removed and updated;
- Gives access to the list of calls received, and one-button dialling to return any of them;
- Identification of incoming calls;
- Operation of alarms;
- Personalisation of voice synthesiser;
- Access to list of calls (missed calls, numbers dialled,)
- Automatic start-up when phone is switched on;
- Call tunes to be associated with contacts;
- Reading of battery strength and signal strength; and
- Availability in several languages: English, French, German, Italian, Spanish, Portuguese and Japanese.

2.4.4 Telstra's Text Messages

In March 2004, Telstra introduced a Talking Text[31] Messages service that is applicable to people with hearing, visual and speech impairments. This facility enables SMS to be sent from a Telstra mobile to most of Telstra's fixed phones (i.e. phones with Telstra's Home Message 101 Service[32] activated).

To send an SMS to a Telstra fixed line phone, the user:

1. Types the SMS text message onto the Telstra mobile phone.
2. Keys in the full ten digit fixed phone number including the STD area code (without spaces) eg 0882557351.
3. Presses send.

The text message is converted into speech and the receiver's phone will ring in the normal manner. The message is then read out to the person who answers the phone using the latest text-to-speech technology. This is illustrated in Figure 2-6.

After listening to the message, the user can:

- Re-play or listen to the message again,
- Send an SMS reply from the user's compatible service by choosing from seven pre-defined responses,
- Save the message to the user's compatible Telstra MessageBank or Telstra Home Messages 101 service. The message is automatically deleted unless the user chooses to save it.

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and the SPV Smartphone. In Australia, the Mobile Accessibility software costs around $350 (September 2004 prices) from VisTech Solutions, an Australian distributor for the software.

[30] http://www.mobileaccessibility.com

[31] http://www.telstra.com.au/talkingtext/index.htm

[32] Telstra Home Messages 101 is a free, easy-to-use home message solution that allows messages to be left for you when you are away from the phone, on another call or dialled up to the Internet. By dialling 101 from their Telstra home phone, a user may retrieve up to 10 stored messages.

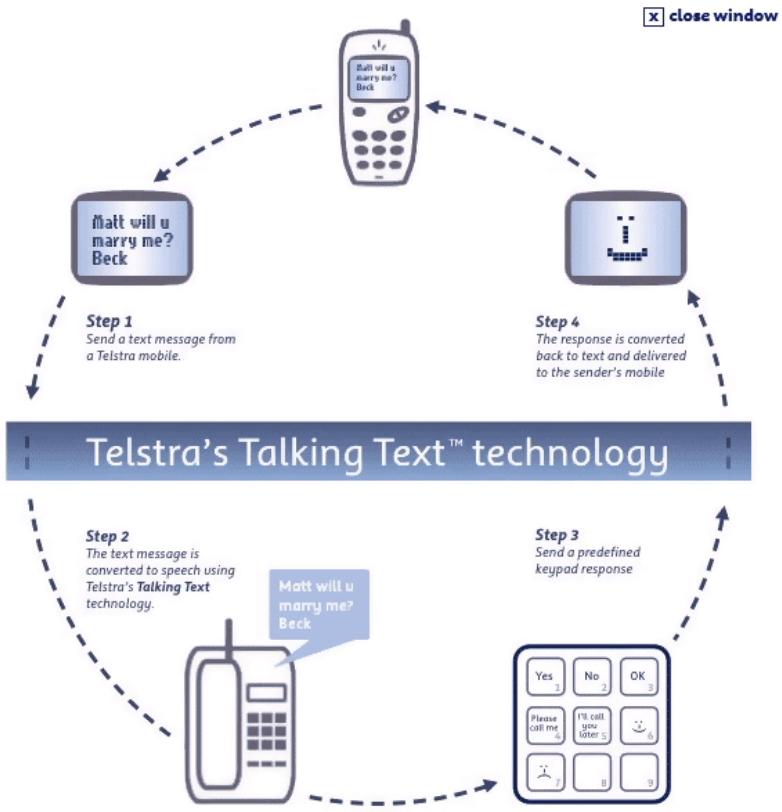

Figure 2-6 Telstra's Talking Text Service (from Telstra, 2004)

Although this new service have benefits for people with hearing, visual and speech impairments, its effectiveness has yet to be critically appraised by consumers and peak consumer disability organisations.

2.4.5 CDMA phones for Hearing Aid Users

The GSM mobile telephony technology was introduced into Australia in 1992, without regard to the extent of the interference caused to many people using hearing aids. The size of the problem was not recognised until some years later, when the GSM system grew rapidly and cases of interference became widely recorded, both in Australia and overseas.

In July 1999 a group of people with hearing impairments lodged a DDA complaint, alleging unlawful discrimination in that the complainants had great difficulty in using GSM digital mobile phone services (HREOC, 2000). Electromagnetic fields generated by many digital mobile phones interfere with hearing aids to such an extent that hearing aid wearers cannot use those mobile phones. Hearing impaired users of mobile phones faced restrictions on their capacity to access the same mobile telephone service that the community as a whole was using. In 1999 the AMPS network was being closed, and the CDMA network was just being established, thus mobile phone users had little choice but GSM. This forced Telstra, Optus and Vodafone to develop and introduce a scheme for making GSM mobile phones compatible for Hearing Aid Users. For example, Telstra will now provide, to persons eligible for the scheme, one of the following offers:

- Hands-free accessories to suit their existing GSM phone;
- Transfer from their existing Telstra MobileNet GSM Digital plan to a nominated 12 month Telstra MobileNet CDMA (Code Division Multiple Access) Freedom plan.
- Inductive loop for those customers who have a compatible handset

More recently, CDMA phones are being used by most hearing aid users as a result of the findings of an Australian Hearing research project (HREOC, 2000), which found that most hearing aid users, who can use a normal telephone or analogue mobile phone, can use a CDMA digital mobile phone. Consequently, hearing aid users do not need to use accessories, such as hands free kits, or inductive neck loops under most situations encountered in day-to-day activities.

2.4.6 Telecommunication guidelines for people with disabilities

Choosing a mobile phone that serves the needs of people with disabilities is an extremely difficult task. It requires a "telecommunications officer" or a salesperson to have explicit knowledge or expertise of both the mobile phone features suitable for people with disabilities and also the ability of the persons involved. Often this requires the involvement of therapists and carers. The process of "*Matching people with disabilities with the available mobile phone technology*" as discussed in Chapter 5 refers to such expertise.

Published documents that give guidance to disabled people when choosing a mobile phone, similar to those from the Danish Centre for technical aids and education entitled "*Mobile Telephones: The disabled persons' guide to choosing a mobile telephone*" (Brandt, 1996), can be an invaluable resource. However, resources such as this can quickly be outdated due to the rapid changes in new technology, especially mobile phone technologies whose lifecycle on the market is usually about a year. COST 219 publish guidelines on user-friendly design of a mobile phone and requirements of new telecommunications equipment that are relevant from the perspective of manufacturers of mobile phones, and the regulatory and standardisation bodies. These include:

- "Guidelines- Booklet on Mobile Phones" (Gjoderum et al, 1999); and
- "*Guidebooks: Accessibility requirements for new telecommunication equipment"* (Roe, 1999).

The websites of various mobile phone researchers (Wireless RERC[33] and PhoneChoice[34]), retailers (eg, Telstra[35] and Optus[36]) and phone manufacturers (eg, Nokia[37,38], Sony Ericsson[39] and Motorola[40]) provide online guidelines and phone selector programs that guide people through the process of choosing an appropriate phone that meets their needs. However, these websites are generally for the wider community use and only include some features that are accessible for people with disabilities. Nevertheless, the concept of providing an online phone selector that guides people with disabilities in choosing the right phone for them is a valuable one and needs to be considered by regulators, service providers and peak consumer disability organisations.

Appendix 2-2 also lists the phones with the features that are useful for people with disabilities.

[33] http://www.wirelessrerc.gatech.edu/projects/research/r1_chooseCellPhone.html
[34] http://www.phonechoice.com.au/
[35] http://www.telstra.com.au/mobile/mobiles/phones/select_search.cfm
[36] http://www.optus.com.au/shop/browsephone
[37] http://www.nokiaaccessibility.com/
[38] http://www.whatsbestforme.com/selector/create.asp?TemplateID=10000110
[39] https://www.hitec.com/cgi-bin/sonyericssonmobile-snc.storefront/4155304401d12b822740417456740658/Catalog
[40] http://commerce.motorola.com/consumer/QWhtml/accessibility/default.html

2.4.7 Other miscellaneous solutions

In addition to the solutions discussed above, other solutions such as Personal Data Assistants (PDAs), voice recognition technology and mobile phone software, and Car Hands-free kits can also assist people with disabilities with mobile phone access.

2.4.7.1 Personal Digital Assistants (PDAs) with mobile phone capabilities

A PDA is a portable computing device capable of transmitting data. These devices make possible services such as paging, data messaging, electronic mail, computing, facsimile, date book and other information handling capabilities. A PDA coupled with a mobile phone and its associated features can be a very powerful communication device. It provides a larger screen and user interface for people with a disability. Voice recognition technology such as voice dialling, and hands-free capability such as speakerphone, provide a user with a hands-free device with a larger screen (eg for an O_2XDA, 55mm x 73mm) touch screen and user interface. Coupled with Bluetooth technology, it is a very powerful communication device for someone with a disability. An example of this is the O_2XDA (used in the trial described in Chapter 5) or its newer version i-mate™ Pocket PC. The website[41] has more information on its features.

2.4.7.2 Voice recognition technology and car hands-free kit

Voice recognition technology such as voice dialling, answering and car hands-free kits, gives a mobile phone user the flexibility of minimal or no interaction with the mobile phone's keypad to enable voice calls. These technologies are particularly useful for people with disabilities who might be restricted to a wheelchair, could have reduced strength and mobility, and who may be unable to lift the phone up to the shoulder level to engage in a conversation. For persons in this situation, voice recognition technology and speakerphone incorporated onto mobile phones can eliminate their problems. Pressing a single button on the phone can allow the person to call up to ten pre-programmed numbers on their mobile phone.

These technologies are similarly implemented onto car hands-free kits. Instead of being installed onto a car, the same car hands-free kit (with speakerphone capability) can be installed onto a wheelchair. A person with a disability has the same option for voice calls as an able-bodied person would use the kit on a car. This includes the voice dialling option mentioned above through a single control button or through voice only control (as used in the trial discussed in Chapter 5). For people with severe physical disabilities, these options significantly reduce the telecommunications access problems they would otherwise experience. However, the trade-off with these solutions is the issue of privacy of the conversation.

2.4.7.3 Mobile phone software

For people with disabilities who cannot interact with the mobile phone, but are able to use a computer or laptop computer, there are software options that would enable them to still use a mobile phone for data and voice communication. For example, BVRP Software[42] provide a software called "*mobile PhoneTools*" (Figure 2-7) that enables a user with a compatible mobile phone to:

- Send and receive emails, text messages (SMS) and faxes;
- Surf the wireless Web; and
- Make and receive voice calls.

[41] http://www.mphone.co.uk/PDA/i-mate-pocket-pc-2003.htm
[42] http://www.bvrp.com/eng/products/mobilephonetools/

Figure 2-7 *Mobile PhoneTools* (BVRP, 2002)

This can be done via serial connection between the mobile phone and the computer or though Infrared and Bluetooth.

Major mobile phone manufacturers such as Nokia, Sony Ericsson and Motorola all have their own computer software that emulates the mobile phone function. However, this software mostly allows the user to send and receive SMS, synchronise data (images, sound, contacts etc) between a phone and the PC, but does not have voice calls capability. For example Nokia has *PC Suites*, Sony Ericsson has *Communications Suite*, Motorola has *Motorola Genuine Mobile PhoneTools* or *Genuine Fone Data Suite* and Panasonic has *Mobile Action Data Suite*.

2.4.8 Research direction for the thesis

The previous sections of this Chapter outlined the approaches and philosophies identified by the telecommunications industry, disability organisations, legislative and regulatory bodies as the directions for providing accessible telecommunications products and services for people with disabilities. Nonetheless, the outcomes have more emphasis on fulfilling universal obligations and little emphasis on meeting actual end-users needs. Various features and solutions/options presented have been identified as suitable for people with disabilities but nonetheless there have not been any research or studies undertaken to verify their effectiveness by the end users.

To provide the most effective mobile telecommunications access possible, an appropriate course of action is to identify the needs and telecommunications requirements of people with disabilities prior to recommending a solution or solutions. As highlighted in section 2.2.2, due to the varying disabilities and telecommunications needs of each individual, the requirements for the telecommunications products and services differ. A solution with certain features that are accessible for one individual or a group of individuals with similar functional limitation, might not meet the needs of another. This identification is generally carried out through assessment or evaluation methods. Identified solutions can be further verified by trials of the possible solutions for people with disabilities. Chapters 3 and 4 of this thesis discuss Focus Group session and Survey Questionnaire work carried out to identify the problems and needs of people with disabilities. Chapter 5 of this thesis discusses a trial of new technological options for people with disabilities through the use of telecommunication equipment.

Another method of providing effective and efficient mobile telecommunications access is to utilise the person's existing method(s) of communication. For many people with severe speech and/or physical disability, the provision of Augmentative and Alternative Communication (AAC) through speech output assistive technology (i.e., AAC technology or device) offers powerful and appropriate solutions.

An example of an AAC device is a Pathfinder[43] (Figure 2-8) from the Prentke Romich Company (PRC[44]).

Figure 2-8 The Prentke Romich Pathfinder

The Pathfinder consists of three components: a method of representing language, a method of selection, and an output system.

Component 1: A method of representing language.

Three methods are used in AAC systems: single meaning pictures, alphabet-based methods, and semantic compaction. The *single meaning pictures* method is a simple concept where a picture is used to represent a word. However it becomes problematic when a vocabulary grows to above one hundred words. *Alphabet-based* methods include spelling, word prediction, letter coding, and whole word selection. These methods require spelling and reading skills. The *sematic compaction* method uses multiple meaning icons in sequence to indicate vocabulary items. These methods vary in performance and are often used in combination by various levels of comprehension of the user.

Component 2: A method of use

For many people this can be a keyboard used with traditional manual pointing. However, for those with a physical disability, other methods include pointing with a headstick or other heading pointing system. Switches to control scanning methods or switches to input codes such as Morse code can also be used.

[43] A communication device featuring a static keyboard and built in dynamic display touch screen, the Pathfinder comes with a choice of vocabulary programmes for spelling or symbol users. Direct access is via the keyboard and touch screen display, infrared head pointing or switch activated scanning (single, double or joystick options).

[44] www.prentrom.com

Component 3: Output of the system.

For most people who rely on an AAC, the primary output is speech. This can be synthetic speech or digitised speech. Synthetic speech is produced by an algorithm that converts text to speech, allowing any word that can be spelled to be spoken. Digitised speech uses a vocabulary produced by the recording of spoken utterances. This limits the user to only what has been recorded.

Other outputs include the dynamic visual display touch screen, infrared (for control of environmental control units (ECU) such as TV, VCR etc as well as for data transfer) and data outputs (via serial port, USB) etc. This component of the AAC technology is most significant for the use of a mobile phone as it provides the output/input medium between the AAC technology and external technologies such as the mobile phone. This was an opportunity that was explored and undertaken to reinforce the main hypothesis of this thesis.

As discussed in Chapter 1, for people who use an AAC technology, the lack of a suitable interface system between their AAC device and the mobile phone, which would allow them to access and/or operate the phone, is the largest impediment. People who rely on AAC technology have typically identified successful method(s) of operating their systems, and the same method(s) may be useful for controlling the mobile phone as well. A development of a configurable interface to the mobile phone that works in conjunction with an existing AAC technology such as a Pathfinder could provide *multiple* accessing opportunities. It would also enable persons with severe disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community.

This interface system between an AAC device and a mobile phone is made possible with an in-built modem on high-end mobile phone models that have serial and wireless connectivity (e.g. Bluetooth and Infrared). The in-built modem enabled the mobile phone to be controlled via appropriate ASCII[45] string Global Systems for Mobile Communication (GSM[46]) AT commands. GSM AT commands are extended AT commands of the standard modem for controlling the mobile phone functions such as voice calls and GSM network services such as text messaging (or SMS) by an external device (eg computer terminal).

Most AAC technology such as the Pathfinder has a serial and/or infrared (IrDA[47]) port, which readily outputs strings of ASCII characters. An opportunity exists to design and implement an interfacing system that acts as a translating medium between the mobile phone and an AAC device that accepts ASCII string commands from an AAC device to control the mobile phone for voice and data communication. Commands for other similar devices and control signals from switches could also be translated to ASCII string commands to control the mobile phone. Chapter 6 of this thesis discusses the development of this system in greater detail.

2.4. Conclusion and Recommendation

Due to the continuous and rapid change in telecommunications technology, driven by competitive pressures to reduce costs, and by market demand for new services, the situation for people with disabilities is also continually changing. Advances in and availability of new technologies are helping people with disabilities to have better access to

[45] American Standard Code for Information Exchange – world-wide standard for the code numbers used by computers to represent all the upper and lower-case Latin letters, numbers, punctuation, etc.

[46] A standard for digital cellular phone service in over 85 countries, which operates at 900/1800/1900 MHz.

[47] Infrared Data Association - which sets standards for using infrared transmission to transfer data between electronic devices (eg computers and other peripherals and devices) through the air, with no cables or wires.

telecommunications. Legislative acts and regulatory environment within Australia are also ensuring that people with disabilities have equal and accessible telecommunications equipment and services. In addition, peak consumer disability organisations are working on projects, services and critical issues facing people with disabilities in using telecommunications services and equipment. TEDICORE and ACIF DAB are two disability consumer representation bodies that provide guidelines, principles and best practice that represent people with disabilities in telecommunications access.

Further efforts are being made both nationally and internationally to promote the implementation of the principles of universal design by developers and manufacturers of mobile phone technologies accessible by people with disabilities as well as to the wider community.

This chapter has examined the current legislative, technical and consumer issues related to the provision of communication products and services for people with disabilities. It has identified that there is a significant need, and a practical opportunity, to increase the access, range, effectiveness and quality of these communication services, and identified the design principles and product development directions to be followed.

Most of the mobile phone solutions/options presented in this chapter suggests that is there is an awareness of the telecommunications needs for people with disabilities. Nonetheless, much more research and studies need to be done to verify their effectiveness for people with disabilities. There is a need for end-users, designers, manufacturers, service providers and regulators to work together to develop and implement new telecommunications products and services of practical benefit to people with disabilities. One step forward is the inclusion of a standard set of mobile phone features identified in this chapter and demonstrated later in this thesis as suitable for people with disabilities. This would allow better access to telecommunications equipment by people with disabilities as well as meet universal design principles.

Chapter 3

FOCUS GROUP SESSION ON ACCESSIBLE MOBILE COMMUNICATIONS FOR PEOPLE WITH DISABILITIES

3.1 Introduction

The review of the literature in Chapter 2 has revealed numerous solutions and alternative access methods for people with disabilities regarding the use of a mobile phone. However, some of these solutions or access methods are tailor-made to suit people with specific disabilities and, in most cases, are not suitable or do not reflect the needs of the wider disability community.

In general, sections 2.2.2 and 2.4 of Chapter 2 highlighted that different people have different needs when it comes to using or accessing a mobile phone, and therefore it is difficult to provide a single solution to suit everyone. It is especially difficult where the person has a disability and/or has more complex communication needs. For this reason, a focus group discussion was conducted to collect the views that people with disabilities have with regards to mobile phone use and access.

The focus group took the form of a group discussion carried out in a carefully planned structure, where the focus was to gather information on mobile phone use and access for people with disabilities. The purpose of the focus group was to gather information on the needs as well as the difficulties or barriers that people with disabilities experience when using or accessing standard off-the-shelf mobile phones.

A focus group discussion was chosen over the other methods of evaluation or design for this research since it provided a form of direct contact and feedback with end users. The face-to-face format enhanced the outcomes of the research as the participants and researchers could interact and exchange actual problems and experiences as they arose.

The focus group was carried out at the premises of Novita Children's Services with Novita clients, and clients of Adult Therapy Services (ATS[48]) of the Independent Living Centre[49] (formerly Communication Therapy Services clients of Novita, until 2003). Four independent participants, with a range of age (between 16 to 33), disabilities, gender, and experiences with mobile phone use, took part in the group discussion. An experienced facilitator from Barkuma Inc.[50] who had worked with people with disabilities, and had previous experience in steering focus group discussion, conducted the focus group session.

The scope of the focus group session involved an informal discussion about the issues that participants were having, or had experienced in the past, when using mobile phone and home phones. It was an opportunity for participants to express their opinions and experiences, which included views on assistive technology that had been tried or experienced with operating mobile phones via electronic communication devices. It also allowed participants to gain a better understanding of existing technology that was designed to aid access to mobile phones. The group also included some discussions on the use of landline-connected phones in the participants' homes.

[48] ATS clients were formerly clients of Communication Therapy Services of The Crippled Children's Association. The mission of ATS is to provide therapy, training and equipment prescription for, and together with, adults with disabilities in the community.
[49] The Independent Living Centre's (www.ilc.asn.au) mission is to enhance the power of clients to be independent and make their own informed choices, through increasing access to information and life opportunities.
[50] A registered, not-for-profit community organisation that provides services to people with an intellectual disability. http://www.barkuma.com.au/

3.2 Objective of the Focus Group discussion

The overall objective of the Focus Group was to ascertain the mobile and fixed telecommunication needs of the Novita clients and, from the identified needs, develop and pilot new service alternatives and product concepts in telecommunications within the wider Novita community. The information gathered from the Focus Group was also used to fine-tune a *Mobile and Home Phone Needs Analysis Survey Questionnaire* (Chapter 4) later distributed to clients of both Novita Children's Services' and the Independent Living Centre. This was to support and confirm the findings from the focus group as well as to determine the appropriate actions that need to be carried out to overcome some of the difficulties or barriers that participants face when using mobile phones.

3.3 Methodology

As describe by Kreuger (1994), a focus group is a "carefully planned discussion designed to obtain perceptions in a defined area of interest in a permissive, non-threatening environment". Therefore the administration of the focus group discussion needed to be well planned and organised. Figure 3-1 shows the processes carried out prior to the focus group discussion.

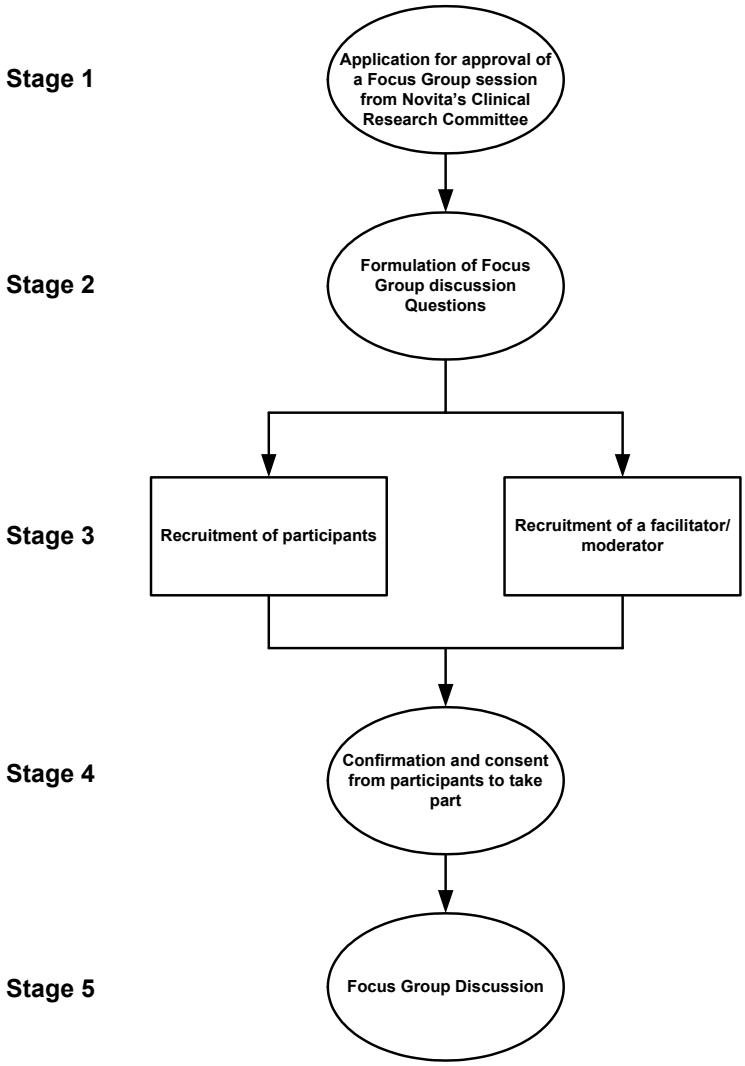

Figure 3-1 The five-stage process the Focus Group discussion implemented.

Stage 1: Application for approval of a Focus Group from Novita's Clinical Research Committee.

Envisaging the need for a focus group discussion to obtain further views, ideas and reconfirmation about a topic of interest, a formal application for approval for such activity was lodged with the Novita's Clinical Research Committee. Since Novita clients were participants of the research, a formal application to protect clients' confidentiality in accordance with Novita's rules and code of conduct was also lodged.

Stage 2: Formulation of Focus Group discussion questions

Upon receiving approval from the Clinical Research Committee of Novita, the formulation of the discussion questions to collect the necessary information for the research was drafted. Kreuger (1988) suggests that a focused interview should include less than ten questions and often around five or six open-ended questions. Stewart and Shamdasani (1990) propose that most interview guides consist of fewer than a dozen questions. The focus group in this research implemented nine questions - 7 open and 2 closed-type questions. Question topics included:

- How are people currently using mobile and home phones?
- What difficulties or barriers are people having when using phones?
- What needs to be changed or improving?

For the actual questions used during the Focus Groups discussion refer to (Appendix 3-1).

A small questionnaire (Appendix 3-2) was also created for use during the Focus Group discussion. This addressed

(a) the use of current mobile phone technology that could provide better access to mobile phones and
(b) features incorporated on later phone models that could also be beneficial to a user.

The focus group discussion also provided an opportunity to demonstrate the available technology, both hardware and software that may solve some of the problems that people with disabilities have when using a mobile phone. This included the Motorola Smart CELLect software (that can be installed on a Laptop) to give access to SMS, and various mobile phone features on the Ericsson and Nokia phone models.

Stage 3: Recruitment of participants and a facilitator/moderator for the Focus Group

Most focus groups typically run between one to two hours, with 2 hours being the physical and psychological limit for most people (Kreuger, 1998). Because of the nature of the participants involved, the questions and discussion were designed to be completed within 90 minutes.

The next step in the process involved the selection of the participants for the focus group. At the same time, an experienced facilitator/moderator to conduct the focus group discussion was selected and appointed.

The process to select participants involved three steps:

1. Generating a list of potential clients.
2. Telephoning nominated individuals and/or their carers to invite them participate.
3. Following up with those who had expressed interest in the focus group by sending out a formal information that:
   - Introduced them to the project and invited them to participate (Introduction);
   - Provided Information sheets for participants, and
   - Provided a "Consent" form (Appendix 3-3).

The time constraint on the project didn't allow for any formal advertisement (for example, through Novita's internal newsletter, NEXUS[51]) to invite people to participate in the Focus Group discussion. A hand-selected list of 12 potential participants was provided by a speech pathologist who had extensive knowledge of the clients at Novita. The selection of the clients was based on the criteria that:

- The client uses or has expressed a desire to use a mobile phone.
- The client is experiencing difficulties in using their mobile phone(s).

A staff member from the Research and Development, NovitaTech[52], contacted these clients individually to invite them to participate.

Stewart and Shamdasani (1990) state that "moderators have the difficult task of dealing with dynamics that constantly evolve", and "must handle the problems by constantly checking behaviour against attitudes, challenging and drawing out respondents with opposite views and looking for the emotional component of the response". Since most of the participants have a disability of some sort, the task was more difficult. The appointment of an experienced facilitator/moderator to conduct the focus group discussion was done through several phone conversations with prospective people and a meeting with the person selected for the job.

Stage 4: Confirmation and consent from participants to take part

Consequent to accepting the initial invitation, an information sheet and a consent form were sent to the individual clients to confirm their willingness, as well as gaining their consent, to participate.

Stage 5: Focus Group Discussion

The Focus Group discussion was scheduled on the 1st March 2002 at Novita, at 10 am for one-and-a-half hours. Ruth Davey*, (Coordinator, Quality Assurance & Evaluation at Barkuma Inc*.) who had worked with people with disability, was invited to steer the focus group discussion.

Analysis and Evaluation of the Focus Group results

Analysis and evaluation of the Focus Group results was carried out after the focus group session by the researcher (author of thesis) and the outcomes were used for fine-tuning the written Survey Questionnaire mentioned above and for future planning telecommunications provision to the wider Novita community.

3.4 Results from the Focus Group discussion

Four independent participants (three females and one male) took part in the Focus Group discussion. Two of the female participants were university students, while the third was still at school. The male participant was self-employed. All participants of the Focus Group discussion were mobile phone users and were restricted to a powered wheelchair. Table 3-1 illustrates the profile and mobile phone use of each of the participants involved in the Focus Group discussion.

[51] Nexus is a monthly newsletter sent to the parents/carers of all active Novita Children's Services clients. It contains valuable information relevant to families including: general interest stories from clients and families; latest news about what is happening in Novita, and information about upcoming events.

[52] A technology division of Novita Children's Services Inc.

PARTICIPANT	AGE	DIAGNOSIS AND CIRCUMSTANCES	MOBILE PHONE MODEL AND FEATURES USED
1	23	**Impaired Mobility** Restricted to wheelchairs (limited movement) and reduced strength	**Motorola T300** • Vibrate alert • Text messaging
2	21	**Impaired Mobility** Restricted to wheelchairs (limited movement) and reduced strength	**Nokia 3310** • Text messaging • Speed dialling • Predictive text (word prediction) • Vibrate alert
3	33	**Cerebral Palsy** Restricted to a wheelchair and has reduced strength and speech problems.	**Nokia 3210** • Text messaging • Predictive text • Vibrate alert
4	16	**Cerebral Palsy** Participant has limited mobility and uses a walking aid while at home & a wheelchair when out and about. Experiences hand tremors occasionally.	**Nokia 5110** • Text messaging • Speed dialling • Personal hands free kit (an earpiece)

Table 3-1 Details of the participants taking part in the Focus Group discussion.

Following the Focus Group discussion, a transcript was created and forwarded to the participants for checking and acceptance. The following summarises the responses collected during the Focus Group discussion.

3.4.1 Mobile Phone Section

3.4.1.1 Reasons for using a mobile phone

The purposes for which the phone was used or available for use included:

- a method of keeping in contact with friends and family (by 4 participants):
- a means of ringing for a taxi and checking on the taxi's location (by 3 participants); and
- a safety device in telephoning for an ambulance or the police (by 3 participants).

The phone was used when "out and about" (by one participant). Apart from using the phone for all the purposes aforementioned one participant described, "*I use it as an AAC (augmentative and alternative communication) device to convey a key word or idea when carrying out a conversation*".

3.4.1.2 Favourite features of the mobile phone

The vibrate alert feature on the mobile phone was popular, especially when at University or in a meeting. "*Vibrating is good. At Uni, you're not allowed to have your phones on. You can put it on silent, and you can still feel the vibration*" described one participant. SMS text messages were perceived as an excellent way to communicate, and they were also cheaper than the regular phone call. One member of the group listed features such as the calculator, the reminder function (for appointments), the memo pad and the way of storing telephone numbers as particularly useful. The Motorola phone used by one participant was reported as confusing, and it did not have the predictive text (word prediction) function.

3.4.1.3 Mobile phone features, which were disliked by users.

One participant pointed out a dilemma, where the newer phones are smaller, much lighter, but harder to use due to the buttons being too close together. The older phones were bigger and heavier, but the buttons were more discrete and easier to press. In moving a smaller phone from waist level to shoulder level, it was difficult to avoid pressing a vital button that immediately terminated the conversation. Text messaging was seen as a preferred method of communication in order to avoid the problems with oral communication associated with these newer models. A speaker type phone, with a microphone at the collar level would solve this problem, except for the lack of privacy in using such a function. However, it was seen as a preferred trade-off. Another member of the group suggested a speaker could be mounted in the chair's headrest to get around the problem of being unable to hold the phone at the ear level.

The volume level of the Motorola phone was reported as "too low", especially near a busy road. It was unclear how the volume level could be changed.

"*Sometimes when I put the phone on my ear, I have very bad tremors, and I start to shake, and when I'm talking to people, it gets very frustrating, and I have to put it down, and I can't hear what people are saying*" commented one participant. A speakerphone attached to the wheelchair would not solve this problem all the time, as the participant sometimes used a wheelchair and at other times used a walking aid. A comment was made regarding the sound quality, which could become unclear, depending on the distance of the phone from the speaker's mouth. This could be a problem for the person on the other end of the telephone. "*At home, I do have an earpiece, but you can't always wear it*" described the same participant.

The "on-off" button on top of the phone was reported as quite difficult to press, hence the decision to resort to the vibrate alert option, in preference to turning the telephone off in a meeting.

3.4.1.4 Problems or difficulties associated with mobile phones

Problems associated with dialling buttons were mentioned earlier in this document. One member of the group had overcome this problem to some extent with speed dialling. When the speed dialling number is pressed, there is no need to press another button to send the call. "*Hands free, speaker phone would be better for me, and then I wouldn't have to lift it up. I wouldn't be pressing extra buttons*" described the participant. There were no problems in using the phone at the waist level. It would be an advantage if one could switch the phone over from speaker (public) to private, if necessary, and ask the person to call back.

One member of the group mentioned the difficulty in getting the phone from its storage location (eg a side pocket on a wheelchair); lifting the phone and answering an incoming call in time before the caller had hung up. Another group member said to get around this "time delay", selected friends who knew the person well, and communicated with the person often, were asked to not hang up straight away. Organisations and social workers were also asked to record this request in their files.

One suggestion was for a mobile phone that had the same answering facilities built into it as an answering machine, such that when the phone was unanswered, a recorded message would be heard. If wanted, a button could be pressed to answer the caller. Otherwise their message could be recorded. Another suggestion arising from the discussion was that voice activated answering could be useful for people in the above situation.

Costs and affordability were identified as a problem, with the extra time used during calls becoming significant over the year. This is especially important for people with severe speech impairment such as participant 3, where a longer time is needed to convey a message across and for the receiver to correctly understand the message. Thus, participant 3 might take up to five minutes to complete a call, where it would normally take a person with no significant impairment 2-3 minutes to convey the message across. It was estimated that, if participant 3 usually made 5 calls week on average, they would be paying about $480 extra for the extra 2 minutes accumulated over the whole year. This is similar to the text messaging problem faced by the deaf community who are heavy users of SMS as outlined in Section 2.4.3. Extensive use of SMS becomes expensive for these people.

3.4.1.5 Other solutions / options discussed

A few features available on some modern mobile phones at the time of the research were shown and demonstrated during the Focus Group discussion. These features included speed dialling, voice dialling, and speakerphone function that were originally thought to make access to the mobile phone easier and had been mentioned by participants. Computer software such as *Motorola Smart CELLect*, which can be installed on a laptop computer for sending and receiving text messages (SMS) messages, was also demonstrated. The software provides an option for people with speech impairment, who cannot use the small keypad on the phone, to communicate via text. In addition, this option offers a larger screen and standard QWERTY keyboard interface.

3.4.2 Home Phone Section

3.4.2.1 Difficulties associated with use of the home phone

Every member of the Focus Group also used a home phone. Nonetheless, each participant reported some difficulties with its use. A tangled cord was reported as one difficulty. When operating a cordless phone, the buttons on the handset were found to be a problem in that it took too long to enter a pin number, and then return the handset to ear level to wait for the next instruction. Another participant complained that her arm became tired. However, the answer to the problem, a headset, was prohibitive in cost for her.

One group member reported that, because of her tremors, the cordless phone was not the answer and she ended up dropping the phone. The remaining member of the group would like a headset and a hands free phone with large buttons.

A few suggestions from the researcher were put forward after this discussion to overcome some problems experienced by the participants. These included:

- Telstra Products and Services Catalogue and the Disability Equipment Program (refer to Section 2.4.1);
- The Australian Communication Exchange's (ACE) National Relay Service (refer to Section 2.4.2); and
- Telstra's Call Connect or Sensis®1234

The *Telstra Products and Services Catalogue* is a catalogue that outlines the equipment provided for older people and people with a disability through the Disability Equipment Program, which Telstra manages. As a national Universal Service Provider, Telstra has an obligation to ensure that standard telephone services are reasonably accessible to all people in Australia on an equitable basis.

The catalogue includes information about equipment and services for the elderly and people with hearing, speech, vision, mobility and dexterity. This includes information about the following phone products:

- Hands-free phone.
- A special add-on to a regular phone, which holds the handset so that you can bring your head over to the handset.
- A lever, which will take the phone off the hook and replace it with a "Holdaphone".
- Big Button phones; and
- Cordless phones etc.

Refer to Section 2.4.1 for further details of the Disability Equipment Program.

The Australian Communication Exchange's (ACE) National Relay Service (NRS) is a speech-to-speech relay service, where a facilitator can assist a conversation between two people. Its features and function has been discussed in Section 2.4.2 of Chapter 2. One participant used this facility every day.

Telstra Call Connect (or Sensis®1234, as of May 2004)) is another option available at additional charges to the caller. By dialling 12456, the operator will connect a person to the requested number, or else the operator finds a number for the caller and makes the connection. In addition, if a Call Connect call is made from a Telstra mobile phone, Telstra Call Connect also sends the requested number to the mobile phone via SMS whether the call is connected, busy or left unanswered.

Other home phone features that are useful for people with disabilities include:

- *Delayed Hotline*; and
- *Abbreviated Dialling*.

Delayed Hotline allows the caller to call the most frequently dialled number without actually dialling. When the phone is taken off the hook for a period of 4 seconds, a number will be automatically dialled, e.g. 12456 to *CallConnect*. This most frequently dialled number needs to be initially set by the operator and costs are added to the monthly rental charges. The *Abbreviated Dialling* feature allows up to 60 pre-stored of the most frequently used numbers in the telephone memory. The user only needs to dial one or two digit code to make calls – similar to speed dialling on a mobile phone. Again this service incurs costs that are added to the monthly rental charges.

3.5 Discussion

The versatility of the mobile phone as a communication tool was illustrated during the focus group. Apart from being used as a communication device for text messaging (data), maintaining contact with friends and family (voice) and as a safety device for emergency situations, a mobile phone is also used as an Augmentative and Alternative Communication (AAC) device to convey a key word or idea when carrying out a conversation.

There were many problems associated with mobile phone use, features and design discussed:

- Later mobile phone models have dialling button problems associated with them due to the smaller buttons being too close together. As the newer phone models shrink in size and increase in complexity, this problem will become more profound for people with disabilities.
- Lifting the phone from the waist level to the ear level and maintaining it there during mobile phone use was the biggest issue raised from the Focus Group discussion. For many people with severe weakness and reduced strength in their arms and hands, there is a dilemma between smaller mobile phone models that are lighter to lift but harder to use in contrast to larger models which are easier to use but harder to lift to the shoulder. A solution that was discussed that might solve the problem was to have a user interface to control the phone at waist level and to mount the phone at ear level. Alternatively, having a speaker mounted on the wheelchair's headrest and the phone at waist level. Other solutions such as personal headsets (both cord and cordless) were also mentioned that would solve this problem. However, putting these headsets on can present more problems for the user with a disability. Another solution that would alleviate this problem would be built-in speakerphone on the phone, but again at the cost of privacy. Quite often, text messaging was seen as the preferred method of communication in order to avoid many problems with oral communication associated with new phone models.
- The delayed time in getting a phone from its storage position (eg a side pocket on a wheelchair), lifting the phone and answering an incoming call in time before the caller had hung up, were also very difficult for participants. Some participants do not mind accepting the privacy trade-off associated with using speakerphone. Other participants opted to have a *profile* set up to overcome this problem. This included setting a longer ring time or by having the same answering facilities built into the mobile phone as an answering machine such that, when the phone is unanswered, a recorded message would be heard telling the "caller" not to hang up straight away. Alternatively, a recorded message could be heard – the concept of the *voicemail* or *Telstra's Message 101* service discussed in Section 2.3.1 of Chapter 2.

There was also the cost problem associated with newer models, as well as the extra time used during calls, which can accumulate to a significant extent. For a person with disability who is independent, this can be a big issue. Phones with hands-free features such as voice recognition and speakerphone are appropriate solutions but are quite expensive and sometimes beyond the reach of their budget. For a person with severe speech impairment, the time it takes to convey a message across the network is much longer than an ordinary person. The extra time accumulated over the whole year could be costly, which was illustrated by one participant in the Focus Group.

Another problem that was faced by all participants was their need to see the solutions that could help reduce or eliminate their problems (both hardware and software) demonstrated to them or to trial the solutions available to them. This was the only way they could confirm whether the solutions are actually suitable to their needs.

Altogether, participants favoured hands-free solutions such as speed dialling, voice activation/recognition and speakerphone functions of the mobile phone, as they would eliminate the need to lift the phone up to the ear or press any extra buttons. This fits well with the features identified as being suitable for people with disabilities in section 2.3.1 of Chapter 2.

3.6 Conclusion and Recommendations

All members participating in the Focus Group were current users of mobile phones, which resulted in the smooth running of the focus group, whereby every participant had the

opportunity to participate in the discussion. Most of the intended discussion questions were covered during the focus group, with the participants expressing their concerns where they had difficulties and suggesting ways that could alleviate their problems as well as meeting their needs.

There was a strong need expressed for hands-free operation of the phone through the use of speakerphone function and/or voice recognition since all the participants had reduced strength in their arms and hands and were restricted to a powered wheelchair. Lifting the mobile phone to shoulder level and maintaining it there for the duration of the call was the biggest problem experienced by all participants. In relation to the disability community, this is a *very important* finding that needs careful consideration in any future product design and development.

The type of disability that participants have often limits the way they can use the mobile phone. Some have adapted ways to overcome their shortcomings when using their mobile phone, while others preferred advanced technologies to solve their problems although there are some trade-offs involved such as privacy. There were also participants who had *little* or *no knowledge* of available mobile phone technologies, both hardware and software that can be used in conjunction with their mobile phone or AAC device that could help reduce or eliminate their problems. *Education* about the mobile phone solutions or options available for people with disabilities would benefit many people who experienced situations similar to the participants in the Focus Group discussion. This is in line with one of Astbrink's (2002) principles of best practice in telecommunications for people with a disability, that "*Telecommunications products and services that improve and increase access for people with disabilities are actively advertised and promoted, with information also available in accessible formats".*

Participants had stressed that it was very hard to know what was available and what technology could help them. For this reason, there was a need for workshops or information sessions to demonstrate and educate the wider disability community on the available mobile phone solutions or options to make mobile phone access simpler. A trial of possible mobile phone solutions or options for people with disabilities was another opportunity to explore. The idea for the trial on "New technological options for people with physical disabilities through the use of telecommunications equipment" (Chapter 5) originated from this Focus Group discussion.

Overall, the outcomes of the focus group have further strengthened the main hypothesis of this thesis, *that, despite very limited mobility, speed, accuracy or vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bi-directional communication with systems to which they choose to connect*. This is provided that there are suitable solutions or options available to make access to the mobile phone possible in the first place.

The focus group discussion helped clear some issues on the topic of mobile phone access by people with disabilities. However, it brought up new issues that need to be considered in the "Mobile and Home Phone Needs Analysis Questionnaire" (Chapter 4) to develop a "clearer picture" of how people with disabilities access mobile phones, identify the problems that prevent them from accessing them efficiently, and determine what still needs developing. These issues include:

- how a person with disabilities uses or accesses a mobile phone;
- what other access methods or aids do they use to overcome problems, if any;
- the context in which they use the mobile phone; and
- their awareness of current and future mobile phone technologies.

For example, whether a person is restricted to a powered wheelchair or not affects the way he or she accesses the mobile phone and deals with the problems associated with it.

Therefore, in addition to incorporation of the questions asked during the focus group session, the following should also be included in the questionnaire to develop a “clearer picture” that is representative of the wider Novita community:

- A list of mobile phone technologies available.
- A list of future mobile phone technology.
- Other electronic devices (eg computers, PDAs etc) that people with disabilities are using.

By addressing the interfacing problems confronting people with disabilities, and determining which of the activities necessary to use a phone could be achieved and which activities could not, practical solutions as well as alternative method or approaches can be developed to provide easier access for specific individuals or groups of individuals with disabilities.

Chapter 4

SURVEY OF ACCESSIBLE MOBILE COMMUNICATIONS FOR PEOPLE WITH DISABILITIES

4.1 Introduction

The Focus Group discussion carried out in the previous chapter had helped clear some of the issues relating to mobile phone access by people with disabilities. The Focus Group discussion's outcomes have further strengthened the main hypothesis by providing more concrete evidence from the end-user's perspective that access to mobile phones is possible by people with disabilities, as long as the phone is designed with accessible features or can be accessed by other methods and options.

However, the Focus Group has brought up new issues that need to be considered to get a "clearer picture" including: how people with disabilities access mobile phones, what are the problems that prevent them from accessing mobile phones efficiently, what methods or aids do they use to over the problems and what still needs developing. This Mobile and Home Phone Needs Analysis Survey Questionnaire is a follow-up work to the Focus Group discussion.

The survey questionnaire targets a larger and more diverse group of clients of Novita Children's Services Inc. and clients of the Independent Living Centre of South Australia, and is designed to look at the access issues in greater detail.

4.2 Objective of the Survey Questionnaire

The purpose of this Survey Questionnaire was to identify the issues relating to mobile and home phone use and access, as well as the difficulties or barriers that people with disabilities are confronted with, when attempting to use a mobile or home phone for both voice and data communication.

The focus group carried out prior to this survey provided information that was used to further develop the survey questionnaire that was distributed to the wider Novita community to:

- gather *general information* on the use of mobile and home phones;
- determine what currently available *add-on technologies* people are using, including other electronic devices;
- identify the characteristics or barriers that make it difficult for people to use a mobile phone or prevent users of mobile phones from accessing them efficiently; and
- establish what still needs to be developed to *enhance/improve accessibility* to phones, eg future mobile phone technology.

In Section A, it sought to identify the characteristics or barriers that may hinder or prevent people with disabilities from using a mobile phone, or prevent users of mobile phones from accessing them efficiently. Furthermore, it aimed to identify the currently available mobile phone technology that people were using and what still needed developing.

In Section B, it sought information on the accessibility of home phones to determine the home phone access needs that are currently unmet, the number of clients that wished to use their home phone independently but currently could not do so, and which of the activities necessary to use a phone could be achieved and which could not.

By addressing the interfacing problems confronting people with disabilities, and determining which of the activities necessary to use a phone could be achieved and which activities could not, practical solutions as well as alternative methods or approaches can be developed to provide easier access for specific groups of individuals with disabilities.

4.3 Methodology

The six stages as depicted in Figure 4-1, were carried out before and after the distribution of *the Mobile and Home Phone Needs Analysis Survey Questionnaire* to analyse the responses from the participants. The main drive of this work was the need of the researcher to collect the views of end users of mobile telecommunications equipment and understand their problems and needs. The following sections discuss the six stages carried out in this research.

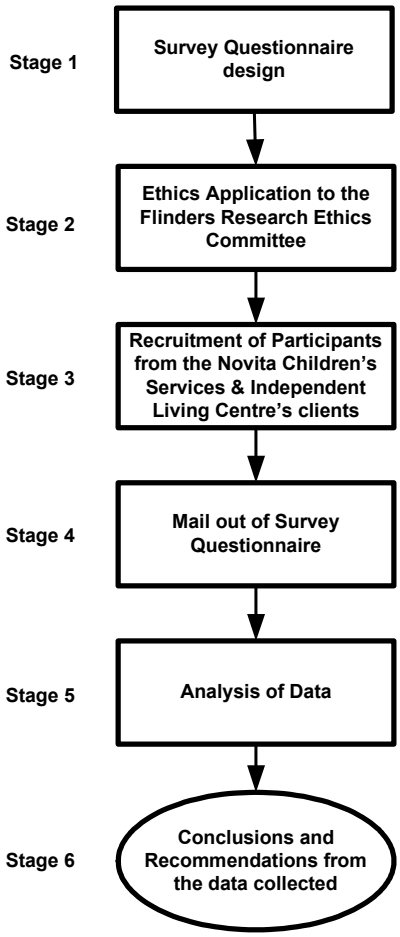

Figure 4-1 The six-stage Survey Questionnaire process.

4.3.1 Survey Questionnaire design

Following the focus group session carried out in Chapter 3, the survey questionnaire was fine-tuned with a specific purpose of extracting as much information from clients as possible regarding their uses, problems and needs. The final survey questionnaire was divided into two sections:

- A *Mobile Phone Needs Analysis* section; and
- A *Home Phone Needs Analysis* section.

The majority of the focus of the research was based on the mobile phone section, which involved five parts:

A. General information – clients and the technology?
B. Use of the mobile phone – purpose?
C. Accessibility of mobile phone users – ease in performing essential tasks?
D. Available mobile phone technology – who is using what?
E. Future mobile phone technology – what needs developing to enhance/improve accessibility?

A copy of the Survey Questionnaire implemented in this research is provided in Appendix 4-1.

Part A was designed to acquire a better understanding of each respondent's status, the types of technology that people with a disability are using and where they would be likely to use it. This information enabled the researcher to model a solution that involves the technologies that respondents are using and the context in which they are used.

Part B was designed to identify the purposes for which respondents would likely use the mobile phone. Depending on the intended use, some tasks are easy to perform while others are not. Sometimes, however, only a simple modification to a mobile phone or access method can enable other tasks to be performed.

Part C was designed to study the ease with which the respondents perform the essential tasks on the mobile phone. Essential tasks include: dialling, lifting the phone, holding the phone, answering a call, and terminating a call. This part enabled obstacles or difficulties in performing task(s) to be identified, and facilitated the development of solutions to alleviate the problems.

Part D was designed to identify the available technologies that could make access to the mobile phone easier

Part E identified what still needed developing to enhance accessibility to the mobile phone.

The *Home Phone Needs Analysis* section specifically identified which of the tasks required to use the phone were the most difficult to perform and the problems that caused it. Solutions were then identified to alleviate these problems.

4.3.2 Recruitment of potential participants for the Survey

For the purpose of gathering information across the spectrum of age, disability, gender and experience with telecommunications equipment, two groups of participants were chosen for the survey. Through discussions with senior speech therapists, a list of potential participants (aged 13 - 18) from Novita that met the selection criteria was identified and the invited participants were randomly selected from this list. The selection of potential participants (age 19 and above) from Adult Therapy Services (ATS) clients of the Independent Living Centre (formerly Communication Therapy Services clients of Novita, until 2003) was done manually and involved the assistance of a senior speech therapist with extensive knowledge of the clients.

The selection criteria for both groups of clients were:

- The client uses or would like to use a mobile phone; and
- The client is experiencing difficulties in using their mobile phone.

4.3.3 Ethics Approval

A formal "*application for approval of social behavioural research involving human subjects*" was submitted to Flinders University's Social and Behavioural Research Ethics Committee. Following the approval of the ethics application for the project (see Appendix 4-2), documents including an introduction letter, information sheet, consent forms and other relevant documentation (Appendix 4-3), were sent along with the Survey Questionnaire to the clients identified in Section 4.3.2 above.

4.3.4 Distribution of survey via mail

Distribution of the survey was carried out via mail on the 2nd of May 2002. All documentations mentioned in the previous section were sent to clients with a reply-paid envelope enclosed. In total, 342 copies of the survey questionnaire were sent out by mail. 275 of the questionnaires were distributed to *Children's Services* clients of the Novita Children's Services Inc. in the age range of 13 to 18 years old (inclusive). 67 questionnaires were distributed to ATS clients of the Independent Living Centre (ILC) who are living independently or in shared homes.

47 respondents, comprising 35 clients from Novita and 12 clients from ILC, completed the survey questionnaire. This represented a total return rate of 13.7%. The responses from the survey were analysed together to obtain a clearer picture of the use, problems and telecommunications access needs from the broad range of participants involved.

4.3.5 Analysis with SPSS software

Responses obtained from clients were recorded and analysed using the Statistical Packages for the Social Sciences (SPSS) data analysis software. SPSS is a data management and analysis product produced by SPSS, Inc. in Chicago, Illinois and is particularly well-suited to survey research. Among its features are modules for statistical data analysis, including descriptive statistics such as plots, frequencies, charts, and lists, as well as sophisticated inferential and multivariate statistical procedures like analysis of variance (ANOVA), factor analysis, cluster analysis, and categorical data analysis.

4.4 Results and Discussion

The survey responses collected were recorded and analysed as a total group using the descriptive statistics of frequencies and cross-tabulation analysis tools of SPSS. Actual responses collected from the respondents were recorded and the tabulated data are shown in Appendix 4-4. It should be noted that the survey responses were provided anonymously, and therefore individual follow-up was not possible.

The following sections summarise and discuss the findings from the survey.

Section A Mobile phone Needs Analysis

4.4.1 Part A: Information about the participant and the technology

(1) The use of Alternative and Augmentative Communication (AAC) device(s) by clients

Question 1: Do you use an Alternative and Augmentative Communication (AAC) device?

35 (74%) of the 47 respondents stated that they did not use an AAC device, while 6 (13%) reported that they did. Information was not provided by 6 respondents (13%). 31 respondents (66%) reported that they had access to or used a mobile phone.

4 (8.5%) of the respondents used both an AAC device and a mobile phone. These respondents were restricted to a wheelchair; two used both a powered and manual wheelchair, one used a powered wheelchair, and one used a manual wheelchair.

A closer analysis of the results showed that one of these 4 respondents had only minor physical impairment and, as a result, found all tasks required to operate the mobile phone very easy to perform. On the other hand, the remaining 3 respondents all had a speech impairment and moderate to severe physical disabilities and therefore found operating the phone either *very difficult, can not be done, or can only be achieved with help from others*. For these respondents, using their existing AAC device to interface and/or access the mobile phone was not currently possible.

As discussed in Chapter 2, AAC device users would normally have developed a proficient way of operating their AAC device. Therefore, if there existed an interfacing system between their AAC device and a mobile phone, access problems to a mobile phone for these respondents could be alleviated. With the involvement of therapists, technologists, engineers and the AAC device users, a complete system could be set up to enable AAC device users to interact and control the mobile phone for voice and data communication. This opportunity was explored and undertaken to reinforce the hypothesis of the thesis. This work was carried out as described in Chapter 6.

(2) The use of a wheelchair

Question 2: Do you use a wheelchair? If yes, please indicate powered or manual.

Of the total respondents:

- 13 (28%) used a powered wheelchair only;
- 8 (17%) used a manual wheelchair only;
- 8 (17%) used both powered and manual wheelchairs;
- 15 (32%) were not restricted to a wheelchair;
- 3 (6%) respondents did not give a response.

In total 29 (62%) of the 47 respondents from the survey were wheelchair users. Respondents who were manual wheelchair users generally required the assistance of a carer to push the wheelchair.

A cross-tabulation of the results revealed that 22 (71%) of the 31 mobile phone users were restricted to a wheelchair. Of these 22:

- 8 (36%) used a powered wheelchair only;
- 9 (41%) used a manual wheelchair only;
- 5 (23%) used both powered and manual wheelchairs.

The high number of wheelchair users, especially respondents using powered wheelchairs or users of both powered and manual wheelchairs, indicated that these clients had some degree of physical and mobility impairment that might adversely affect their ability to use a phone. A comparison was made between powered wheelchair users and manual wheelchair users carrying out essential tasks such as answering an incoming call, dialling a number, lifting the phone, holding the phone and terminating a phone call. The results are shown in Table 4-1.

	No. of respondents who found the task very difficult, can not be done, or can only be achieved with help	
Task(s)	**Powered wheelchair users, or users of both powered and manual chairs (13 respondents)**	**Manual wheelchair only users (9 respondents)**
Answering an incoming call	8	4
Dialling a number	2	2
Lifting the phone	9	3
Holding the phone for the duration of the call	9	4
Terminating a call	9	2

Table 4-1 Number of respondents who experienced difficulties performing telephone communication tasks while in a wheelchair.

Apart from dialling a number, more participants in powered wheelchairs experienced greater difficulty performing all other essential tasks required to operate a mobile phone efficiently than participants using manual wheelchairs only. Given that 22 (71%) of the 31 mobile phone users were restricted to a wheelchair and that 13 (59%) of these respondents were powered wheelchair users or users of both powered and manual wheelchairs, this was a very significant result.

This suggests that, if powered wheelchair participants were to use a mobile phone independently, it would have to be specially adapted or securely mounted to the wheelchair for ease of use. For these people, securely *mounting* the mobile phone at an appropriate position on the wheelchair so that they could engage and use it effectively and efficiently would be the first priority. In terms of adaptation of the mobile phone for ease of use, other forms of telecommunication devices or solutions such as those discussed in Chapter 2 and the Focus Group discussion (Chapter 3) would be also appropriate for these participants. These include voice recognition technology such as voice dialling or commands, and hands-free speakerphone.

(3) The use of Computers

Question 3: Which of the following portable electronic devices do you use? Desktop computer, PDA, Laptop/portable PC or other?. If yes, please indicate where you use it? Home, school, work or other?

Of the total respondents:

- 22 (47%) were desktop computer users;
- 5 (11%) were Laptop / Portable PC users;
- 11 (23%) respondents used both desktop and portable computers;
- 4 (9%) were not computer users;
- 5 (10%) respondents did not give a response.

In total, 38 (81%) of the 47 respondents from the survey stated that they were computer users.

There was no use of Personal Digital Assistant (PDA) devices of any kind by the respondents. This was understandable due to the fact that the PDA was a relatively new piece of technology at the time this research was carried out, as well as being high cost. The ability of clients to use Portable Electronic Devices (computers) would be significant in determining future developments for making mobile phones more accessible for people with disabilities. This was especially important for people who rely on a larger screen and

interface as well as text messaging to communicate, for Internet access, and for web-based monitoring and control.

A person with Cerebral Palsy, who has reasonable use of their voice but with reduced strength of their upper arms and hands, would find it hard to either initiate a call, lift the mobile phone to their ear, or maintain it there for the duration of the call (referred to in Chapter 3). People who cannot access the keys of the keypad of a mobile phone could potentially access the mobile phone for communication via other means. Apart from those solutions mentioned in the previous section, external interfaces such as computers or PDAs could be used instead. Computers and PDAs offer a larger screen and a standard QWERTY keying option for the standard mobile phone. Mobile phone access via computer software, and PDAs with mobile phone and speakerphone incorporated in them, are now becoming more common.

The environment in which the respondents used their portable electronic devices was also an important factor in determining an appropriate solution that better services their telecommunication needs. The survey revealed that respondents mainly used their PED in their homes (81%) or at school (55%).

(4) Internet use at home

Question 4: Do you have access to the Internet at home?

36 (77%) of the 47 respondents reported accessing the Internet at home. A cross-tabulation of the survey results showed that 26 of the 31 mobile phone users also used the Internet at home. Although this fact does not relate to the physical access issues of mobile phone use, it does however, give an indication that there was a high level of Internet usage amongst Novita's and the Independent Living Centre's client population.

The important implication is that, apart from using a mobile phone for voice and text communication, people with disabilities may wish to exploit its use, at any place and time, for Internet access and web-based monitoring and control of surrounding devices and environment control units (ECUs).

The concept of a person dialling from their mobile phone to an Internet-connected server at their home, work or any other location, and using the phone to monitor and control home appliances or devices that are connected to the server, is relatively new. The use of the Internet and the mobile phone to control and monitor external devices are only limited by the software applications developed and the services that each individual technology can provide.

A similar concept known as *Smart Home Technology* was introduced by Clipsal Integrated Systems (Clipsal, 2002), whereby all the appliances and ECUs in the home are controlled via a touch-sensitive LCD panel via C-BUS system or remotely controlled with a mobile phone or using the internet via the *Thinkboxx* system (SmartWorld, 2004).

With the development of Bluetooth technology, a Bluetooth-enabled mobile phone could be use as a remote control unit to control and monitor surrounding devices that incorporate Bluetooth technology, as discussed in Chapter 2. This would have significant impact on the general community as well as the disability community. This conforms to the principles of universal design, which state that "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design" (Center for UD, 1997).

(5) Access to or use of mobile phones

Question 5: Do you have access to or use a mobile phone? If yes, please specify brand and model.

31 (66%) of the 47 respondents to the survey have access to or use a mobile phone. Figure 4-2 below illustrates the usage of mobile phone models used by these respondents.

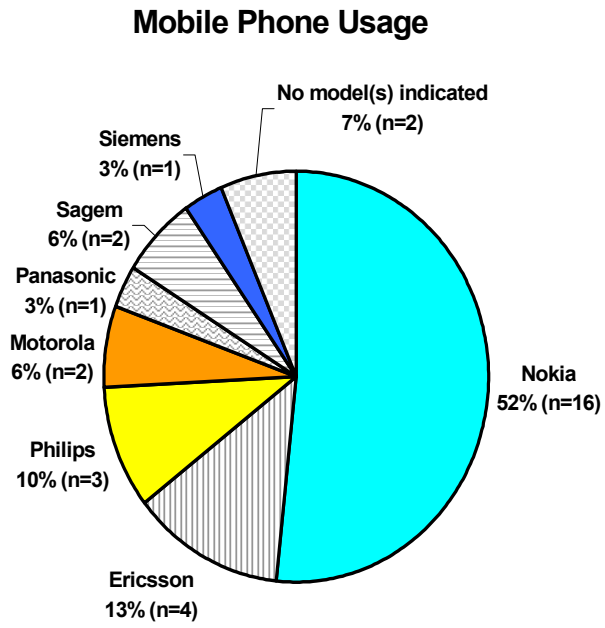

Figure 4-2 Respondents' usage of mobile phones from selected manufacturers (total n=31).

For the minority of the respondents in this research who do not use or have access to mobiles, the issue of accessibility still needs consideration. Accessible features identified in Section 2.3.1 of Chapter 2 could help alleviate problems confronted by people with disabilities who are non-mobile phone users.

Currently, no formal standards exist for mobile phones to include features appropriate for use by people with disabilities. Although there exist guidelines, such as *Guidelines-Booklet on Mobile Phones* by Gjoderum J and et al. (1999) and *Guidebooks: Accessibility requirements for new telecommunication equipment*, by Roe (1999), that outline accessibility features for people with disabilities, individual mobile phone manufacturers decide for themselves what features are appropriate (and what are not) to incorporate in their newer models. The main reason for this is that telecommunications technology is continually changing, driven by competitive pressures to reduce costs, and by market demand for new services. Thus, a solution or feature that is appropriate for people with disabilities may be available on one mobile phone brand or model, but not on another. At present, knowledge of accessibility features of the most commonly used mobile phone brands and models is very important in determining the appropriate solutions that can be provided to the wider disability community. The majority of these solutions were mentioned and discussed in Chapter 2.

It is anticipated that a formal standard may be developed which clearly defines what mobile phone manufacturers should include on future mobile phones models if they are to be accessible to all people, including people with disabilities. Astbrink (2002b) drafted a document for the Australian Communications Authority (ACA) Working Group on the

proposed extension of a Disability Standard in late 2002. This work outlined the over-arching principles to be followed when applying the specific technical Disability Standards that list quantifiable features for telecommunications customer equipment. Two principles from this document are particularly significant in the context of this thesis – inter-operability and stakeholder involvement. These principles hold that specialised products need to be compatible with mainstream and future telecommunication products and networks, and that industry and disability consumer representatives should be an integral part of any development of Disability Standards.

Work carried out in Chapter 6, and the recommendations of features that are particularly suited to people with disabilities Section 2.2.1 of Chapter 2 and Chapter 7 of this thesis, have addressed these issues.

4.4.2 Part B: Use of the Mobile Phone

(1) The purpose for which a mobile phone is used

The purposes for which the respondents used the mobile phone varied according to individual needs. Figure 4-3 below, depicts the levels of importance of use for particular purposes by the mobile phone. Voice-to-voice communication (77%), security/emergencies (81%), and sending and receiving text messages (SMS) (47%), were considered as either *very important* or *quite important* reasons for mobile phone use.

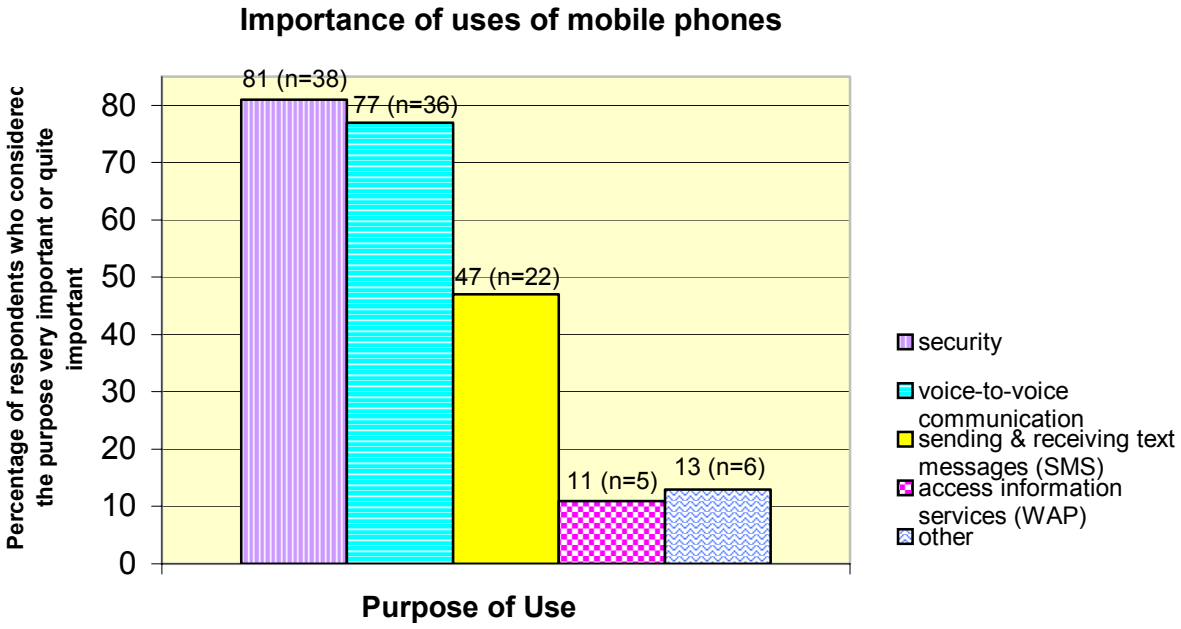

Figure 4-3 Importance of uses of the mobile phone (total n=47).

14 respondents (30%) regarded SMS as a non-essential use. This was unexpected, since SMS use has increase dramatically in the public and private sector of the community, especially for commercial businesses (see Chapter 1). A main reason for this could be that a message takes quite a long time to create and the text generation process is more difficult for someone who has an impairment such as tremor, low coordination, reduced strength or limited movement. This was evident in the response to Part C of the survey where 6 (19%) of the 31 respondents who used the mobile phone, found it *very difficult, cannot be done,* or *can only be achieved with help from others* due to these restrictions. New technology such as predictive text has the potential to speed up the process considerably. This is supported

by the results of a trial on the use of off-the-shelf telecommunications equipment detailed in Appendix 5-7 of Chapter 5 of this thesis.

28 respondents (60%) regarded access to the information services available on mobile phone networks as unnecessary as well as expensive to access. Most believed that the information could be more easily obtained elsewhere, such as newspapers, radio or television. This was consistent with earlier findings from the focus group discussion described in Chapter 3.

4.4.3 Part C: Accessibility for Mobile Phone Users

(1) The ease with which a person can perform common tasks on a mobile phone

The majority of the respondents who had access to or used a mobile phone found most of the tasks required to use a mobile phone to be *very easy* or *achievable.* There were exceptions where respondents found it *very difficult*, *cannot be done* or *can only be achieved with help from others* for tasks illustrated in Figure 4-4.

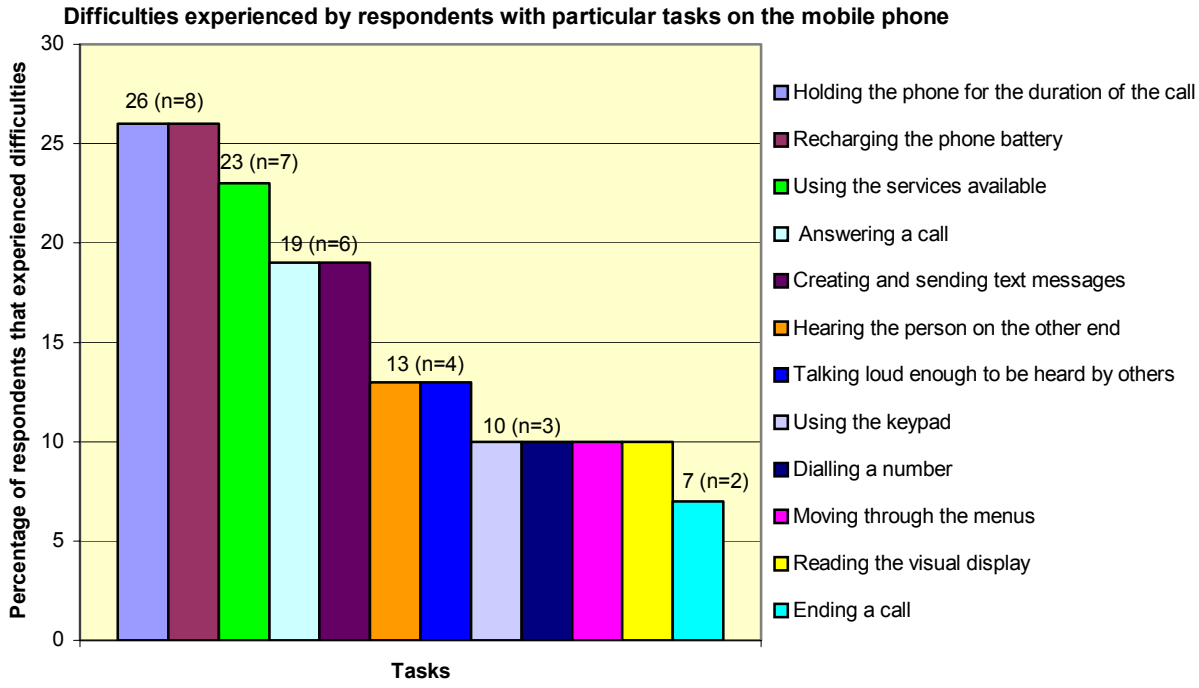

Figure 4-4 Percentage of respondents who experienced difficulty performing specific tasks on a mobile phone (total n=31).

The five tasks that had been identified by the respondents (≥ 19%) who had access to or used a mobile phone to be *very difficult, cannot be done* or *can only be achieved by the help of others* included:

- Holding the phone for the duration of the call (26%);
- Recharging the phone battery (26%);
- Using the services available (via WAP) (23%);
- Answer an incoming call (19%); and
- Creating and sending text messages (19%).

The main reasons for these difficulties were that the respondents had very limited movement and strength in their fingers, hands and arms. A small number had coordination, vocal and speed problems that prevented them from using the mobile phone efficiently. Overall, the

responses support the hypothesis *that despite very limited mobility, speed, accuracy and vocal communication ability, if an appropriate interfacing solution exists, users will be able to successfully operate the mobile phone itself, and use it for various modes of bidirectional communication with systems to which they choose to connect*.

The suggestions provided by respondents to overcome the obstacles or difficulties that people with disabilities have when accessing a mobile phone, have been incorporated in current research being undertaken at Novita to make access to mobile phones easier. These included:

- Speakerphone functionality;
- A custom-made holder that will not move around during use;
- A tool/device to assist in pressing keys;
- Longer time to answer calls before diversion;
- Inclusion of a mobile phone as a standard option with a wheelchair for security and for the carer's benefit.
- Larger keypads and screens; and
- Improved overall usability/accessibility of the phone for all.

The most notable suggestions were to lengthen the time available for responses and to allow a longer ringing time to answer calls before a diversion. These relate to the services that the network carriers provide and hopefully can be addressed by service providers in the near future. At present, the ringing time before the phone diverts to voicemail or "times out" is pre-defined, or adjusted on request, by individual telecommunications service providers. For example, Telstra sets this time in five-second intervals between 15 and 30 seconds. If a voicemail box is set up on a particular phone number then the calls get diverted to the voicemail box, otherwise the call "times out" and the caller has to redial the number. A possibility suggested by a client is that users register a 'profile' with their service provider, similar to voice mail, which would activate an auto voice answering message, or extend the ringing time for incoming calls, to enable the user to answer the phone in time.

Other useful suggestions included a custom-made mobile phone holder on a wheelchair, or a speakerphone function instead of earpiece/headsets. The latter mainly comes down to choice since each individual has different needs. If a user accepts the trade-off of reduced privacy, a speakerphone-enabled phone may be the most appropriate choice. This is important for users with reduced strength or mobility as it eliminates the need for the user to lift and hold the phone for the duration of the call. Using a headset is another alternative if privacy of a conversation is an issue. The suggestion of a custom-made mobile phone holder on a wheelchair reinforces the need to securely mount the mobile phone at an appropriate position on the wheelchair so that the user could engage and use the phone effectively and efficiently, as discussed in 4.4.1. This is especially important for users, such as those with muscular dystrophy, who have significantly reduced strength and mobility.

Other factors that adversely affected the ability to use a mobile phone included:

- Limited mobility and physical movement due lack of fine motor control problems;
- Very limited communication skills (e g. uses an AAC device or communication board to communicate);
- Severe multiple disabilities;
- Involuntary movements;
- Tremors;
- Reduced strength; and
- Small physical keypad and button sizes.

Finding available interfacing solutions to overcome the difficulties faced by people with disabilities would be a first step towards providing access to mobile phones. Education of

users about the available solutions would also play an important role in mobile phone access since it was found through the focus group discussion that people with disabilities are *not fully aware* of available options and that, even when they are aware of them, they *do not use them to the fullest extent*. Education through demonstrational workshops, trials of potential solutions, and seminars of available solutions would be important ways of improving the manner in which people access the mobile phone. All of these issues have been addressed in the course this research through the work carried out in Chapters 5 and 6. This involved a trial of off-the-shelf telecommunications equipment with end users and a pre-conference workshop and a paper presentation seminar at the Australian Rehabilitation & Assistive Technology Association (ARATA) 2004 Conference held in Melbourne as outlined in Section 6.3.4 of Chapter 6.

4.4.4 Part D: Available Mobile Phone Technology

(1) The use of available mobile phone technology

Figure 4-5 shows the mobile phone features that were used by the 31 (66%) of the 47 respondents who had access to or used a mobile phone. The figure suggests that few respondents (≤15%) were actually using the available or add-on mobile phone technologies such as vibrate alert, speakerphone, personal hands-free kit, voice recognition (voice dialling), cordless headset (Figure 4-6), attachable QWERTY keypad (Figure 4-7), predictive text, mobile phone software, and portable computer or PDA for SMS. On the other hand, the features that were most used by respondents (≥ 19%) included text messaging (30%), speed dialling (23%), and voice mail (19%).

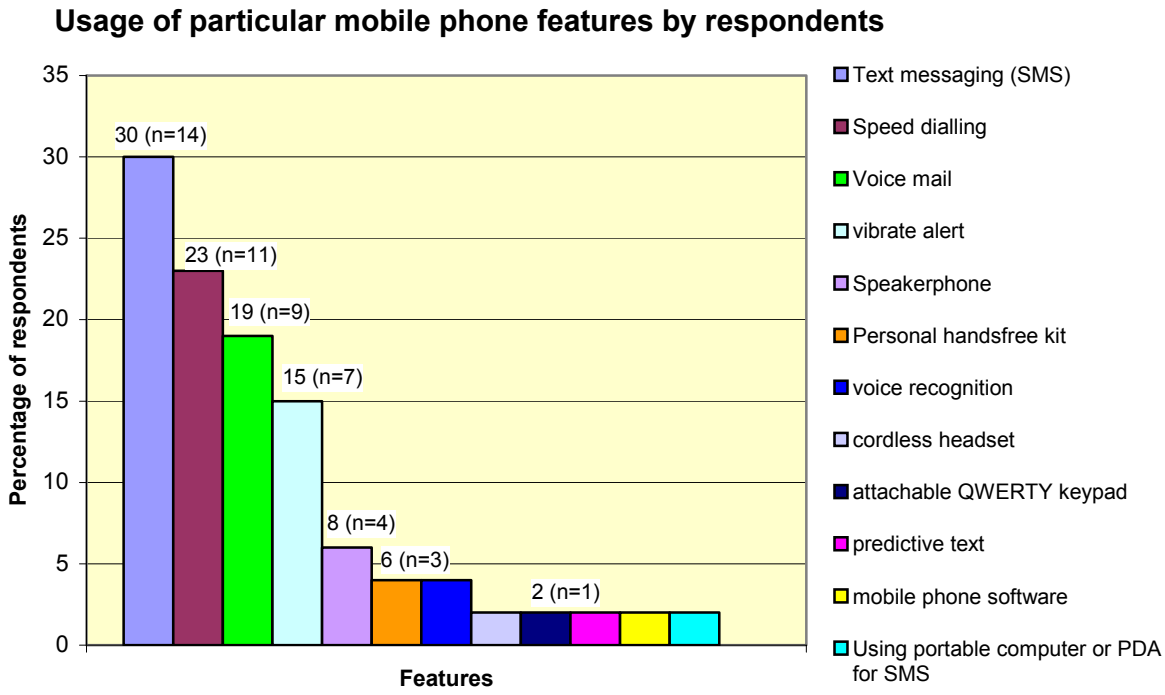

Figure 4-5 Respondents' usage of particular features on the mobile phone (total n=31).

Very few clients were using email (9%) and information searches (4%) available from their network service providers. The reasons that these two features were not popular choices could be that email was only available with more advanced mobile phone models at the time of the research, and that an information search incurred a cost for the respondent each time it was used. This reinforced the findings from the focus group discussion in Chapter 3.

However, 13 respondents (28%) and 9 respondents (19%) indicated that they would use email and information searches respectively, if available to them.

Figure 4-6 Cordless Bluetooth Headset

Figure 4-7 Ericsson T28 and an attachable QWERTY keypad

Respondents' levels of interest in the use of available add-on technologies are shown in Figure 4-8.

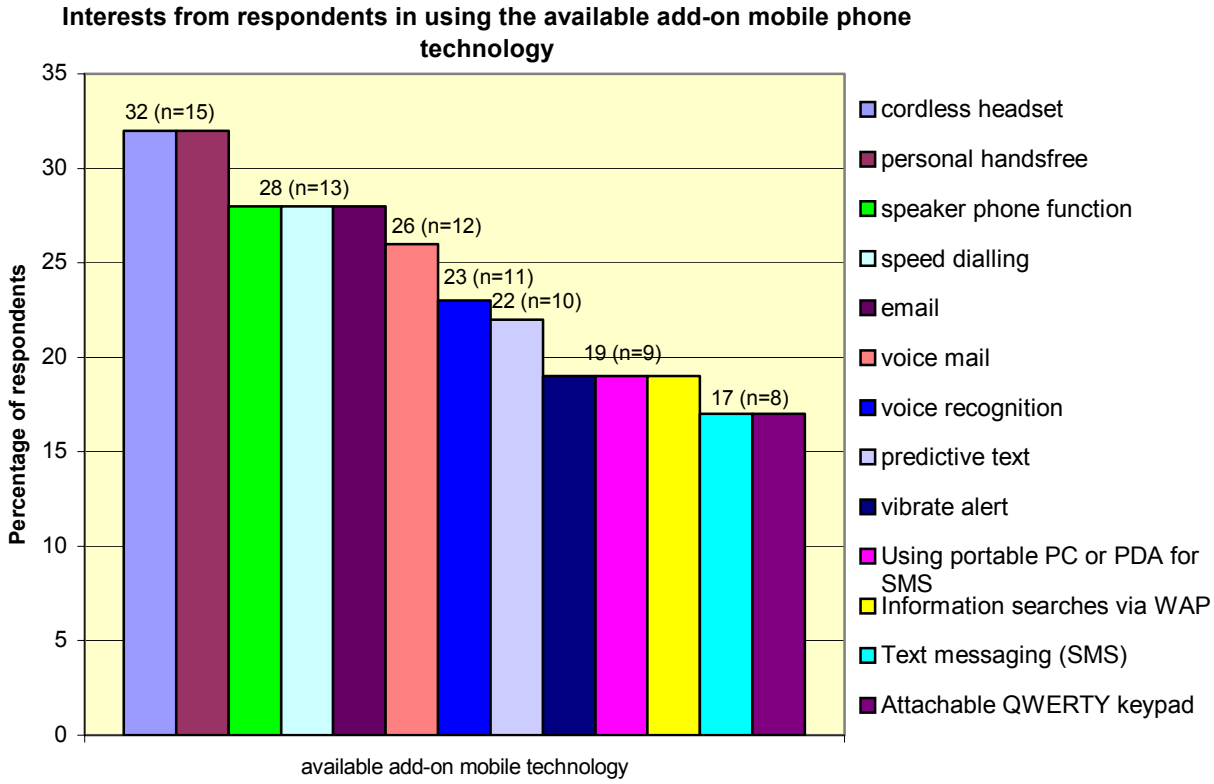

Figure 4-8 Respondents' interest in using available add-on mobile phone technology (total n=47)

The available add-on technology that some respondents indicated they *would not* use included:

- *Predictive text* (19%);
- *Voice recognition* (21%);
- *Attachable QWERTY keypad* (26%);
- using a *portable computer or PDA with a mobile phone to send and receive text messages (SMS) and faxes* (30%).

Refer to Appendix 4-5 for actual values for other add-on technologies not listed.

The results above showed some willingness of participants to use the available add-on technology. However, for some add-on technologies there were similar numbers of participants who were unwilling to use the technologies at the time of the research. There was no appropriate explanation as to why a client would not use an existing technology, and the anonymity of respondents prevented any follow-up. It is surmised that the lack of knowledge about the options available and how the technology actually works, or concerns that the technology might be too difficult to use, are the main factors contributing to the slow uptake of technologies. This is consistent with a recent study carried out by the Yankee Group[53] in the US which showed that 50% of customers postponed a purchase because they thought a product might be too difficult to operate (Crosasmum, 2004). However, such perceptions could be overcome by education and training through workshops.

It is also important to note that, due to the diversity within the group of people with disabilities involved in the survey, a solution that is suitable for a particular client might not be appropriate for another. Another plausible factor is that the add-on technology could itself present more problems than the user was already experiencing. The anonymity of the respondents prevented any follow up on these issues. For these reasons, it was considered necessary that further workshops or trials of the available technology (Chapter 5) be conducted within this project to introduce possible and alternative solutions for people with disabilities. This reinforced the same conclusion made from the findings from the focus group discussion of Chapter 3.

4.4.5 Part E: Future Mobile Phone Technology

(1) The use of possible future mobile phone technology

When the 47 respondents were asked to rate the importance of use of possible future mobile phone technology:

- 13 respondents (28%) found controlling the mobile phone via an AAC device to be *important* to *very important*;
- 26 respondents (53%) stated that a large mobile screen was *important* to *very important* as a future technology; and
- 18 of the respondents (38%) said that a large/computer keyboard connected to a mobile phone was *important* to *very important*

Respondents rated several other future mobile technologies as being *important* to *very important*:

- 2 respondents (4%) indicated accessible/larger buttons, but not as big as those on a computer keyboard;
- 1 respondent (2%) stated better accessibility to menus;
- 1 respondent (2%) mentioned speakerphone; and
- 1 respondent (2%) said a phone holder while typing SMS or numbers (2%);

[53] http://www.yankeegroup.com/.

The above results suggest that the participants were willing to use technologies that were in the process of development or available on the market and which could alleviate their telecommunications access problems. For participants who wanted to control the mobile phone via an AAC device (28%), when compared with the actual number of respondents who actually were AAC device users (13%) at the time of the survey, this was a significant increase. This was an unexpected result, but due to anonymity of the survey it was not possible follow up on this issue. A possible explanation is that respondents who weren't using an AAC device at the time of the survey could be in the process of transition to the use of an AAC device. Another possibility could be that non-users would want to use an AAC device if it had mobile phone access capability.

This outcome reinforces the value of the work undertaken in this thesis in Chapter 6 to develop a configurable interface to the mobile phone that works in conjunction with an existing AAC technology. This interface could provide *multiple* accessing opportunities for people with disabilities. Apart from being able to use the system for voice and text messaging, other features and services on the mobile phone could also be accessible to people with disabilities, include:

- internet access;
- information search via WAP;
- upload and download information from the phone to a computer; and
- control of environmental control units as discussed in Section 2.3.3 of Chapter 2.

Section B Home Phone Needs Analysis

4.4.6 Home phone use

19 (40%) of the 47 respondents to the survey had a standard home phone. The largest proportion of these (53%) had a portable/cordless phone, of which 36% included speakerphone-enabled phones. None had an adaptable phone of any sort.

An important point to note is that portable/cordless phones have surpassed standard phones as the popular choice for household phone use. The absence of cords makes the use of these phones more convenient for everyone.

4.4.7 The ease with which a person can perform common tasks on a home phone

The tasks required to use a home phone efficient were found to be *very easy* or *achievable* by respondents. These included:

- Moving to the phone in time to answer an incoming call (64%);
- Lifting the handset to take the phone 'off the hook' (70%);
- Holding the handset to their ear and mouth for the duration of call (68%);
- Using a regular phone keypad to dial a phone number (72%);
- Dialling the full required phone number before the telephone "times out" (66%); and
- Hanging the phone up after a conversation is over (72%).

There were a few exceptions where respondents (≥ 17%) found the following tasks either v*ery difficult*, c*an not be done,* or c*an only be achieved with help from others*:

- Moving to the phone in time to answer an incoming call (29%)
- Lifting the handset to take the phone 'off the hook' (17%)
- Holding the handset to their ear and mouth for the duration of call (21%)
- Dialling the full required phone number before the telephone "times out" (26%)

Unlike for mobile phones, where a relatively higher numbers of respondents found it more difficult to perform similar tasks, most of the respondents to the ***Home Phone Section*** could perform most tasks with ease. Those who found the tasks difficult, or unable to be performed without the help from others, experienced problems similar to those of mobile phone users. The problems experienced by respondents included: restricted mobility, reduced strength limited coordination, and fine motor control. There were respondents with the inability to do anything physically without the help from their carers. Limited communications skill was also a factor that led to difficulty in using the phone.

There were respondents who were restricted to a wheelchair (powered or manual) that found it most difficult in answering an incoming call in time. One respondent commented, "*By the time I get to the phone and get my hands in position to answer it the caller sometimes hangs up".* This remained so even when the number of rings on an incoming call had been set to maximum. Most of the respondents who fall in the category of restricted movement/control or reduced strength/dexterity found the most difficulty was in dialing the full required phone number. "*Reduced dexterity makes it difficult and sometimes, use nose to make it easier*", noted another respondent. The extreme case occurs when the person is physically unable to do anything other than instruct people non-verbally by using eye and head movements to communicate or when the person has very severe multiple disabilities. For these people the use of a telephone can only be achieved with the help of their care-giver and their care-giver acting as their voice or mediator to convey their messages across the network.

Based on the finding from this research, further work was carried out to identify existing solutions to overcome each obstacle. Hobbs (2002) has produced *The Home Phone Solutions Guide*[54] as the result of this further investigation. The guide is a compilation of readily available solutions that would overcome hurdles such as getting to the phone in time to answer a call, and holding the phone mouthpiece for the duration of a call.

The outcomes of the *Mobile and Home Phone Needs Analysis Survey Questionnaire* research have been widely published through:

- Novita's internal newsletter, NEXUS[55]; and
- The Australian Rehabilitation Assistive Technology Association (ARATA[56]) newsletter.

4.5 Conclusion and Recommendations

This survey has established that there are significant numbers of Novita and Independent Living Centre clients who experience difficulties in performing some of the essential tasks required to operate a mobile or home phone efficiently and effectively. The main causes for the difficulties were impairments such as tremors, low coordination, reduced strength (as occurs with muscular dystrophy), limited mobility and severe multiple disabilities such as cerebral palsy.

31 (66%) of the 47 respondents to the survey had access to or used a mobile phone. Of the 31 mobile phone users, 22 respondents (71%) were normally seated in a wheelchair. This fact suggests that people restricted to a wheelchair experience significant difficulty in using a mobile phone. The survey results showed that people restricted to a powered wheelchair (who generally have severe disabilities) experienced greater difficulties than manual

[54] http://www.novitatech.org.au/library/The%20Home%20Phone%20Solutions%20Guide.pdf

[55] Nexus is a monthly newsletter sent to the parents/carers of all active Novita Children's Services clients. It contains valuable information relevant to families including: general interest stories from clients and families; latest news about what is happening in Novita, and information about forthcoming events.
http://www.novitatech.org.au/library/Nexus%20newsletter-_survey%20results%20summary_participants_fina..pdf

[56] The ARATA is an Association whose purpose is to serve as a forum for information sharing and liaison between people who are involved with assistive technology and maintains a newsletter which is published quarterly.
http://www.novitatech.org.au/library/ARATA_newsletter.pdf

wheelchair users in carrying out essential tasks such as answering an incoming call, dialling a number, lifting the phone, holding the phone and terminating a phone call. This suggests that, if powered wheelchair participants were attempting to use a mobile phone independently, it would have to be specially adapted or securely mounted to the wheelchair for ease of use. For these people, securely *mounting* the mobile phone on the wheelchair, at an appropriate position at which they could engage and use it effectively and efficiently, would be the first priority. In terms of adaptation of the mobile phone for ease of use, other forms of telecommunication devices or solutions including voice recognition technology such as voice dialling or commands, hands-free speakerphone, and one-touch (or speed) dialling would be also appropriate for these participants.

In general, the majority of the respondents were ***not aware*** of the available mobile phone technology that could assist them and, if they were, ***did not use*** it to its ***fullest extent***. This further confirmed the results obtained from Chapter 3, whereby participants had *little* or *no* knowledge of available mobile phone technologies, both hardware and software, that could be used in conjunction with their mobile phone or AAC device to alleviate or eliminate their access problems with mobile phones.

The results of the survey also confirmed the view that there is a need to make access to mobile phones easier as first identified in Chapter 3. The need to explore existing solutions, and/or development of an interfacing system to make easier access to mobile and home phones, was consistent with the directions that are currently being taken by researchers of the Research and Development Department of NovitaTech, and other organisations such as PhoneAbility and the Trace Center, as mentioned in Chapter 2.

Similar to the conclusion reached following the Focus Group discussion, education will play an important role in making people with disabilities aware of existing solutions as well as helping people with disabilities obtain better access to mobile telecommunications technology. Implementation of workshops and/or trials to educate people with disabilities, and their therapists and carers, on the available mobile technology (discussed in Chapter 5) through the introduction of possible and alternative solutions is an illustration of a step in the right direction for future development in this field. Furthermore, this work would strengthen and support the thesis' hypothesis.

Similar work is being undertaken by other organisations such as TEDICORE and ACIF to promote equity and accessibility and to represent the interests of Australian telecommunications consumers with disability as outlined in Chapter 2. The involvement of end users in the process of defining the telecommunications access requirements of people with disabilities was one of the principles that Astbrink (2002) had outlined as the best practice in telecommunications access for people with disabilities in Australia. This principle has been addressed and adhered to in this thesis.

Overall, the information obtained from the survey provided a valuable guide for researchers, therapists and other departments of Novita on the current issues that confront people with disabilities when using a mobile or home phone.

The outcomes of this survey have contributed a significant body of information, not previously available, on some of the access issues and needs of people with disabilities, from the end users' perspective, relating to mobile and home phone use. It has steered the succeeding work carried out in Chapters 5 and 6 to develop solutions that can support the communication needs of people with disabilities.

Chapter 5

A TRIAL OF NEW TECHNOLOGICAL OPTIONS FOR PEOPLE WITH DISABILITIES THROUGH THE USE OF TELECOMMUNICATIONS EQUIPMENT

5.1 Introduction

The availability of mobile phones has changed the way we communicate and interact with one another. Surveys indicated that, by 2002, 12.7 million (65%) of the Australian population use a mobile phone, an increase of 13% from the previous year (Jolley,2003). Apart from being used primarily for voice communication, technology such as Small Message Service (SMS) on mobile phones has provided more communication options. The ability to create and send a quick text message, instead of talking to people on the phone, has become a popular option. Research conducted by *mobileYouth* found that there were 103 million mobile phone users in western cultures (such as the USA, Canada, UK, Australia, and Germany) aged 5 to 24 in Jan 2002. Members of this cohort are the "heavyweight" text users of the world, sending 3 billion text messages between them (Brown, 2002). People with disabilities, however, are generally NOT experienced in the use of mobile phones and SMS.

Accessing telecommunication technology, and the broad range of services behind it, has always been an ongoing challenge for people with disabilities. Typical problems faced by people with disabilities are those of a physical nature such as access to the phone through the use of the keypad, and lifting and holding the phone for the duration of the call (as identified in Chapter 3 and 4). People with other disabilities experience further difficulties linked to the impairment such as hearing, visual, speech, language and cognitive impairment. In addition, the lack of knowledge of existing solutions or available options has deterred or prevented people with disabilities from using telecommunications equipment. This was evident through the research carried out in Chapters 3 and 4. Survey results from Chapter 4 have shown that the reason most people own a mobile phone is for the security it provides. Parents buy them for their teenage children, comfortable in the knowledge that if anything happens when they are out, they are only a phone call away. It is likely that having access to a mobile phone is more important and more critical for someone with a disability, compared with an able-bodied person, for this reason alone. It could mean the difference between an independent and a dependent lifestyle.

This chapter discusses the processes and results obtained from research carried out to trial and evaluate new configurable 'off-the-shelf' technological options that could significantly improve the quality of life of people with physical disabilities. The options would achieve this through an increased range of accessible activities and can improve their independence, safety, security, and self-esteem. Thus, reinforcing and supporting the main hypothesis of the thesis. This trial is a direct result of the work carried in Chapters 3 and 4 which identified that generally people with disabilities were either not aware of the available mobile phone technology that could provide them better access or, if they were of the available technology, did not use it to the fullest extent.

5.2 Objective of the Telecommunications Trial

Preliminary research through a focus group session (Chapter 3) and "*Mobile and Home Needs Analysis Survey*" questionnaires (Chapter 4), carried out by NovitaTech and Flinders University, in March and May 2002, respectively, has shown that people with disabilities

within the community are able to use, and want to have access to, mobile telecommunications. It has also highlighted that most people with a disability are not ***aware*** of the available technology and, if they are, ***do not use it*** to its ***fullest*** extent. Few respondents were actually using the available or add-on mobile phone technology. Of the forty-seven respondents, modest numbers have expressed interest in using available add-on technology or mobile phone features available on more advanced (high-end) models. These features include cordless headset (32%), personal hands-free (32%), speakerphone function (28%), speed dialling (27%) and voice recognition (23%).

The aim of this part of the investigation was to trial and evaluate new technological options that can improve the lifestyle, independence, and social interaction of people with physical disabilities through the use of telecommunications. This work has followed on from the research results, findings and recommendations from the Focus Group session and "*Mobile and Home Needs Analysis Survey*" questionnaires.

This investigation looked at alternative solutions (such as car kits, voice recognition and hands-free technology, and network features such as voice mail) that might improve the awareness and the telecommunications experience of people with physical disabilities. It aimed to enable these members of the community to participate and experience telecommunications technology to the same extent as able-bodied people currently do. Appendix 5-1, describes the details of the technology used during the trial.

In addition to the main hypothesis outlined in Section 1.3 of Chapter 1, a supporting hypothesis was also developed for this particular part of the research, *"**that through the use of wireless mobile phone technology, people with disabilities will become more active and participating members of the community, leading to an increased sense of social inclusion, independence, and security**"*.

5.3 Methodology

Clearly defined ethical approval processes, trials protocol, procedures and assessment methods were implemented throughout the trial period. The research began with the application for ethics approval for the project as it includes human involvements. Participants for the trial were then selected. Once each participant's problems and needs were identified and matched with the required solution, the training and trial of the equipment began. The trial itself followed defined procedures and protocols that were kept consistent for all participants.

5.3.1 Participants

A broad range of participants representing a spectrum of age, disability, gender, and experience with telecommunications equipment was sourced for the trial from the 1300 children and adults for whom The Novita Children's Services of South Australia Inc. (formerly, CCA) provides a service. Ethics approval for the trial shown in Appendix 5-2 was obtained from the Women's and Children's Hospital's (WCH) Research Ethics Committee (REC) of South Australia. Supporting documents that were subsequently sent to the participants are shown in Appendix 5-3. These included an introduction letter to the participant, information sheet about the trial, and a letter seeking the participant's consent.

Participants were chosen for the trial based on their needs and the off-the-shelf telecommunications equipment available at the time of the trial. This was carried out through an initial assessment of "*matching the participant with the available technology*" (Appendix 5-4). This assessment identified the participants' communication needs and accessibility problems. A priority scale was implemented to measure the *Importance* and

Needs of the participants, while a rating scale was used to measure the *"Performance"* and *"Frustration"* when accessing telecommunications equipment. The outcome from this exercise was a list of the highest priorities in terms of each participant's communication needs and accessibility problems, which were consequently used to match with the available solutions required to overcome the barriers faced by the individuals. If a solution was not found in the first instance, a process of re-rating the feature's priorities would be carried out. For example, instead of having several features to overcome the participant's difficulties, only some of the features would be available in the new solution. Thus, the participant's accessibility was not compromised in anyway, although access and choice were not fully achieved. This process is shown in Figure 5-1.

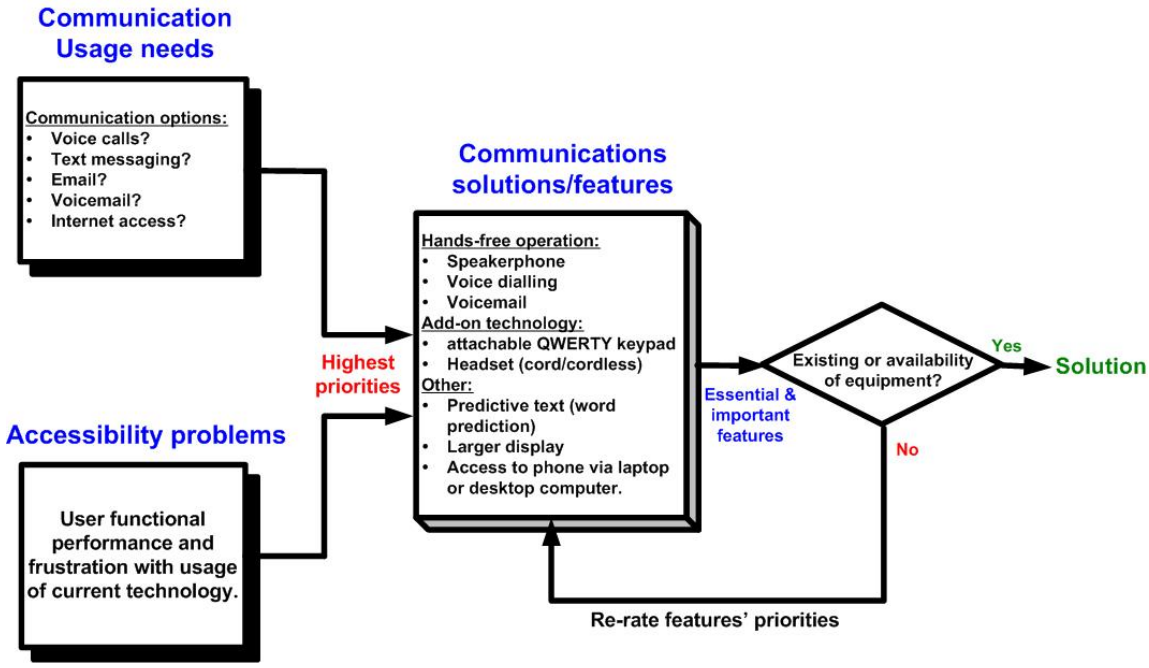

Figure 5-1 Matching participants to available technology

5.3.2 Trial's Protocol, Procedures, Assessment Methods, Performance Indicators and Monitoring

Trial's protocol and Procedures

From the initial assessment, ten participants were selected to trial the technology that best fitted their needs for a period of three weeks. Prior to the trial, each participant received training in the use of the provided technology, whereby all the features and associated applications of the technology were explained in detail. The training of the participant in the use of the equipment was carried out after a workable solution was found. This generally occupied a 1 to 2 hour session, with further sessions repeated as required. The training covered the necessary skills required to perform various tasks that were needed by the participant. Tasks were demonstrated to the participant and the participant was asked to repeat the process to ensure that they were understood. A quick user guide and short-cut tips sheet were also given to the participant during the trial. A contact number was also given to the participant in the case where the participant needed to contact the researcher during the trial when they encountered problems. This was a standard protocol for all participants.

Re-training was an ongoing process throughout the trial when required by the participants. Due to the nature of the participants involved, and some of the possible problems that occurred due to the technology, some trials ran in parallel depending on the uniqueness of

the individual's needs. Other trials were conducted sequentially, for those with similar solutions.

The whole process of clinical trial protocol and procedures for this trial is illustrated in Figure 5-2.

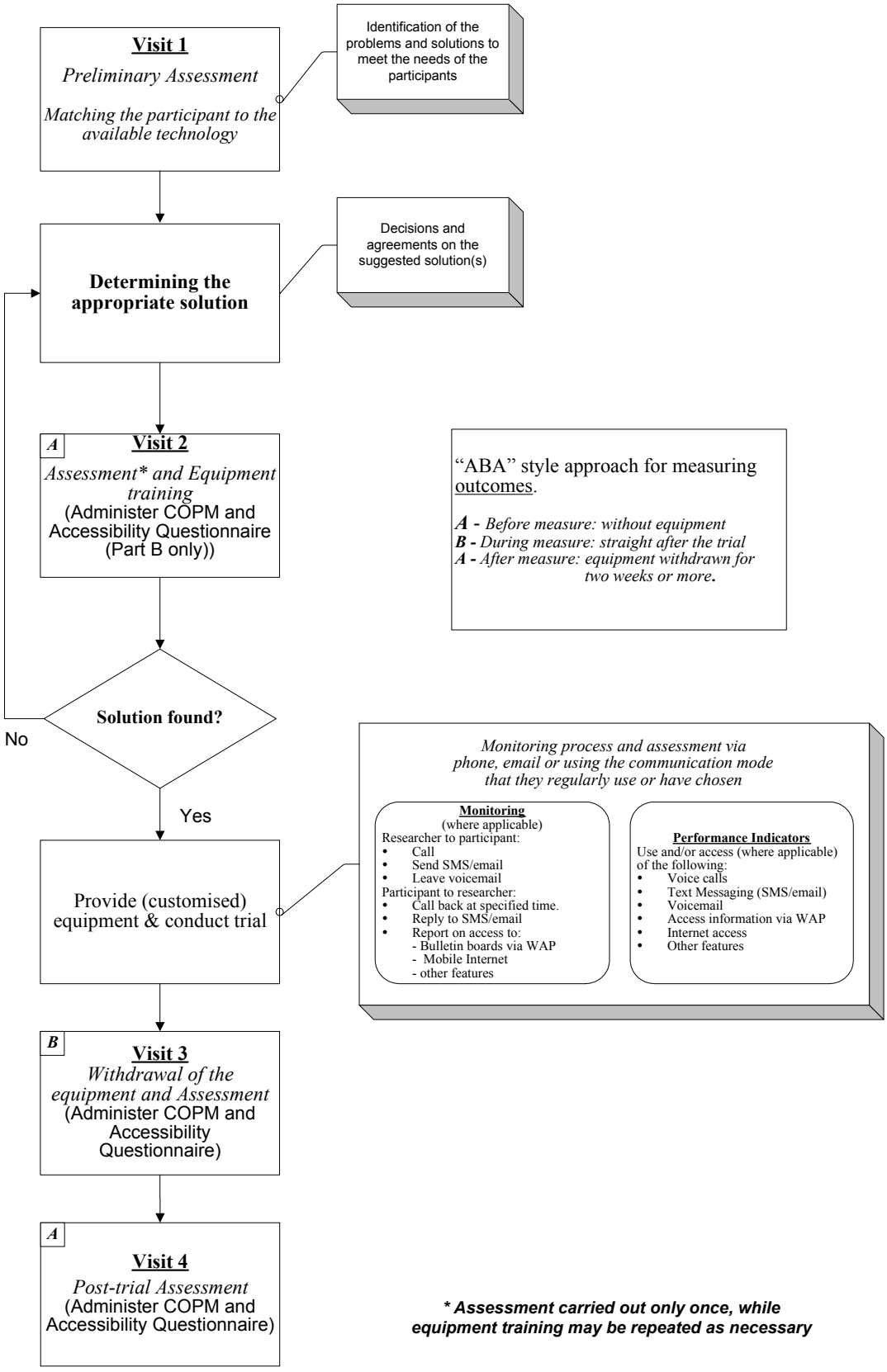

Figure 5-2 Clinical trial protocol and procedures

Assessment methods

An "ABA" style assessment approach[57] was implemented throughout each trial period:

A – *Before intervention*: without equipment (prior to the trial);
B – *During intervention*: with equipment (at the end of the trial);
A – *After intervention*: without equipment (after equipment had been withdrawn for two weeks).

This process involved a measure of the participant's performance and satisfaction relating to the problem areas identified by the participant. At each stage during the trial, represented by the visit numbers (i.e. visit 2, 3. etc), an assessment was carried out, through the use of a customised Canadian Occupational Performance Measure (COPM) questionnaire (Mary, et al., 1999) and an Accessibility Questionnaire shown in Appendix 5-5 and 5-6, respectively. Table 5-1 shows the rating scales used for COPM during the trial.

COPM is a valid and reliable standardised outcome measure tool designed to detect change in a participant's self-perception of occupational performance over time (Mary, et al., 1999). Its validity and reliability as an effective outcome measure tool has been widely published across all disciplines including health or client-centred in clinical rehabilitation and assistive technology. A study carried out by Dedding et al (2004) on the convergent and divergent validity of the COPM found that there is supportive evidence for the convergent and divergent validity of the COPM. The results of Dedding et al supported the assumption that the COPM can provide information that cannot be obtained with current standardised instruments to measure health. Petty et al. (1998), through research on the applicability of implementing the COPM in *Vision Technology*[58] at the University of Toronto's Adaptive Technology Resource Centre, found COPM to be an effective outcome measure for monitoring the impact that assistive technology has on clients' occupational performance and on their satisfaction. It was also noted that the COPM was particularly suited to assistive technology because it focused on changes in occupational performance before and after equipment intervention, identified adequacies or failures in both support performance and intervention performance and documented the need for further equipment intervention, support training, environmental changes or re-assessment. Petty et al. (1998) also noted that COPM was relatively easy to administer by a trained clinician and could be readily incorporated into a typical clinical assessment. In the context of this trial, the COPM was considered to be the most appropriate outcome measurement tool to use.

Outcomes measure	Scales
Performance (standardised)	**1** not able to do at all **2 3 4 5 6 7 8 9 10** able to do it extremely well
Satisfaction	**1** not satisfied at all **2 3 4 5 6 7 8 9 10** extremely satisfied

Table 5-1 COPM rating scales used throughout the trial (Mary et al., 1999)

[57] First used in "*Effectiveness of electronic aids to daily living: Increased independence and decreased frustration*" (Croser R, 2001).
[58] Technology used in the enhancement and substitution of sight.

The Accessibility Questionnaire was specifically designed to evaluate the performance, frustration and satisfaction as well as the time responses when performing the common tasks on the telecommunications equipment provided. The rating scales used for the assessment of these performance measures were based on the philosophy and methods employed in the COPM. This is shown in Table 5-2.

Outcomes measure (designed in-house)	Scales
Performance	1 very easy 2 3 4 5 achievable but with difficulty 6 7 8 9 10 not possible
Frustration	1 not frustrated at all 2 3 4 5 6 7 8 9 extremely frustrated 10
Satisfaction	1 not satisfied at all 2 3 4 5 6 7 8 9 extremely satisfied 10

Table 5-2 Accessibility Questionnaire rating scales used throughout the trial (adapted from COPM's rating scales) (Mary et al., 1999).

Time response is the time taken (perceived by the participant) to carry out a task when using the telecommunications equipment. COPM was used throughout the trial to measure the performance and satisfaction of the broader issues, concerns and problems that a participant had with phone technologies to evaluate the research aim and hypothesis, while the Accessibility Questionnaire handled the technical aspects of telecommunication use. It is important to note that, although the Accessibility Questionnaire results are important, it was the COPM results that were significant in substantiating the hypothesis of this thesis.

Performance indicators and monitoring

The performance indicators used for the trial (where applicable) involved the use of, and/or access to, the following features:

- Voice calls *(through various methods such as speed dialling, voice dialling or other methods);*
- Text messaging or Short Message Service (SMS) and/or email[59] *(opening, creating & sending);*
- Voicemail *(retrieving a message);*
- Access to the information services (e.g., weather, news, sports, lotto numbers etc…) via WAP;
- Browsing the Internet (website specified); and
- Other features on the phone (e.g., the extras features such as voice memo or commands plus any other features, depending on the product).

[59] Dependent on the provided technology.

In addition, the following monitoring procedure was carried out to ascertain the performance indicators (where applicable):

1. The researcher:
   - Calling the client on the provided technology to check on the trial's progress (which was pre-arranged between the researcher and client);
   - Sending an SMS to the client and asking the client to respond to the message; and/or
   - Leaving a voicemail message (if applicable) in the participant's INBOX asking the participant to reply back using the voicemail feature.
2. The participant:
   - Calling the researcher back using the provided technology at a specified time to report on progress;
   - Replying or sending an SMS back to the researcher; and
   - Accessing the information service (similar to the *teletext* service or bulletin boards) via WAP to get information such as:
     - News;
     - Weather; and
     - Sports information etc.

     This was done by the participant accessing the Service provider's bulletin board through a series of button selections and following the menu presented. The information provided is secured by the service provider's wireless security protocols.

Due to the ethics imposed on the trials, a participant was not obligated to carry out a task in the research if they did not wish to. However, the client was strongly encouraged to carry out essential tasks such as initiating or replying to call and initiating or replying to a text message during the trial. Other tasks that would not affect the trial's outcomes were not enforced but only encouraged by the researcher.

5.4 Results

5.4.1 Participants

Participants who took part in this trial included those with mild physical disability with limited mobility and restricted movement, reduced strength or muscular dystrophy, and even those with severe Athetoid Cerebral Palsy. Their ages ranged from fourteen to eighty (median age was 33), with some having no previous exposure to telecommunication technology and others currently using them. This is illustrated in Table 5-3.

A review of the initial assessment results concluded that the ten participants could be classified into three distinct groups:

GROUP 1: Participants with ***mild*** physical disabilities that prevented them from using standard telecommunications equipment effectively and efficiently. Typical problems were associated with small keys and displays and difficulties related to lifting or holding the phone for the duration of the call. **Three** participants belonged to this group – Participants 2, 7, and 8.

GROUP 2: Participants with ***moderate*** physical disabilities (eg. Cerebral Palsy or mobility) that typically restricted them to the use of one mode of communication such as text or voice and/or limited use of both. **Four** participants belonged to this group – Participants 1, 3, 4, and 5.

GROUP 3: Participants with ***severe*** physical disabilities (eg. severe Cerebral Palsy) who used a switch scanning method to operate an Augmentative and Alternative Communication (AAC) device to communicate with people. For these

participants, independent use of conventional telecommunications equipment was not possible. A carer normally operated or used the phone on behalf of the participants to convey messages across the network. **Three** participants belonged to this group – Participants 6, 9, 10.

Finding an off-the-shelf solution for these participants proved difficult at first. It required a combination of technologies, innovative thinking and various trials to find the right technologies to operate the mobile phone. Significant time and effort was spent addressing the needs of this group.

Identifying and classifying the participants into the three groups allowed the researcher to allocate the appropriate time and resources to find the suitable solutions that met the needs of each group. For example, Group 1 required less time and resources than Groups 2 and 3, due to the Group 1 participants' "mild" physical disabilities classification. Finding a solution for this group of participants was less demanding and took on average about 2 hours in total per person. For Groups 2 and 3, the time increased to approximately 3 to 4 hours in total respectively. Understanding the participant's telecommunications needs, and knowledge of the telecommunications solutions and options available, were the two key factors for the process to be successful. This was addressed by the researcher of this thesis, in consultation with the participants, carers and therapists.

The above strategy proved very successful, and could be implemented to classify any future clients of Novita who wanted to have access to mobile phones into the specific groups and allocate the appropriate amount of time and resources for finding the appropriate solution for them.

GROUP	PARTICIPANTS	AGE	DIAGNOSIS AND CIRCUMSTANCES	PREVIOUS TELECOMMUNICATIONS EXPOSURE TO MOBILE PHONES	SOLUTION PROVIDED (FEATURES AVAILABLE & USED)
1	2	80	**Restricted Mobility** A hearing aid user, is restricted to wheelchair (mobility) and experiences tremors.	**Minimal exposure** Some exposure, from a family member's handset. Only purpose was to make voice calls. No particular features were used. Difficulties included operating the small keypad and seeing the small screen.	**Kyocera QCP 3035** • Speakerphone • Speed dialling • Voicemail (Message 101)
	7	18	**Muscular Dystrophy** Restricted to a wheelchair and has mild reduced strength. No speech problems.	**Motorola Talkabout** **Features used:** • Text messaging • Speed dialling **Features not used:** • Voice dialling • WAP (rarely used)	**Kyocera QCP 3035** • Speakerphone • Voice dialling • Speed dialling • Voicemail • Bluetooth headset (rarely used) • Email
	8	14	**Cerebral Palsy (CP)** Cognitively more than physically (eg the participant tends to forget how to use features on the phone).	**Philips Savvy** **Features used:** • Text messaging • Speed dialling **Features not used:** • Voice dialling • WAP (rarely used)	**Panasonic GD95** • Speakerphone • Predictive text for faster text messaging • Voice dialling • Speed dialling • Larger Screen

Table 5-3 Details of Group 1 participants of the trial.

GROUP	PARTICIPANTS	AGE	DIAGNOSIS AND CIRCUMSTANCES	PREVIOUS TELECOMMUNICATIONS EXPOSURE WITH MOBILE PHONES	SOLUTION PROVIDED (FEATURES PROVIDED & USED)
2	1	17	**Cerebral Palsy** Participant has limited mobility and uses a walking aid while at home & a wheelchair when out and about. Experiences hand tremors occasionally.	**Nokia 5110** **Features used:** • Text messaging • Speed dialling	**Panasonic GD95** • Speakerphone • Predictive text for faster text messaging • Voice dialling • Speed dialling • Larger Screen
	3	18	**Duchenne's Muscular Dystrophy** Participant is restricted to a wheelchair and is unable to lift anything above waist level.	**Panasonic GD75** **Features used:** • Text messaging • Speed dialling **Features not used:** • Voice dialling • WAP (rarely)	**O_2XDA** • Speakerphone • Attachable computer keyboard • Speed dialling • Mobile Internet
	4	53	**Cerebral Palsy mild** Participant has mild speech problem and tremors and reduced strength in the arms and hands.	**Ericsson A2618** **Features used:** • Text messaging **Features not used:** • Speed dialling • WAP	**Panasonic GD95** • Speakerphone • Predictive text for faster text messaging • Voice dialling & speed dialling • Larger Screen • WAP (occasionally used)
	5	23	**Restricted Mobility** Restricted to wheelchairs (limited movement) and reduced strength	**None** *(both mobile phone and car kit systems)*	**Nokia Wireless (Bluetooth) Car Kit** • Speakerphone • Voice dialling (not often) • Speed dialling • Voicemail (never used) *(A Nokia 6310i phone was used as it provided with the features needed)*

Table 5-3 cont'd Details of Group 2 participants of the trial

GROUP	PARTICIPANTS	AGE	DIAGNOSIS AND CIRCUMSTANCES	PREVIOUS TELECOMMUNICATIONS EXPOSURE WITH MOBILE PHONES	SOLUTION PROVIDED (FEATURES PROVIDED & USED)
3	6	39	**Restricted Mobility** Limited mobility and restricted movement as well reduced strength	**None**	**Ericsson Advanced Car kit** • Speakerphone • Voice dialling
	9	16	**Athetoid CP (severe)** Participant communicates via an AAC device (Pathfinder) using single switch scanning method.	**None**	**RehaPhone** (Infrared controlled home phone) • Speakerphone • Speed dialling
	10	50	**CP (severe)** Participant communicates via an AAC device (Deltatalker) using joystick controlled by the foot.	**Nokia 3310** Carer uses the phone on behalf of the participant.	**Ericsson Advanced Car kit** • Speakerphone • Speed dialling *(Sony Ericsson T68i phone was used as it provided with the features needed)*

Table 5-3 cont'd Details of Group 3 participants of the trial

5.4.2 Initial Assessment – "Matching participant to available technology"

The "matching of equipment to participant" procedure discussed in Section 5.3.1 was implemented to find an off-the-shelf solution for all participants identified in each group. Each participant was assessed and matched to an appropriate solution. Initial interviews with the ten participants revealed that voice calls and text messaging were the most important communication needs. Results are summarized in Table 5-4.

Communication media	Priority 1	Priority 2
Voice calls	8	2
Text messaging (SMS)	2	7
Email	0	0
Voicemail	0	1
Internet access	0	0
Information via WAP	0	0

Table 5-4 Mobile communication needs of the 10 participants

Mobile communication solutions that the majority of participants identified to be essential and/or important included:

- Speakerphone capability;
- Voice dialling and speed dialling;
- Predictive text (word prediction) for faster text messaging;
- Voicemail; and
- Larger display.

Other mobile phone solutions that were considered useful by participants included:

- The control of mobile phone via a computer; and
- An attachable computer keyboard for the phone.

Those mobile phone technologies that were considered "not required" by many participants included:

- Headsets (cord and cordless); and
- Attachable keypad for a mobile phone.

The summary of the results is depicted in Table 5-5. The number of respondents in each row is 10.

Mobile communication solutions	Essential	Important	Useful to have	Not required
Speakerphone	5	3	2	0
Voice dialling	5	3	2	0
Speed dialling	5	1	3	1
Voicemail	3	2	3	1
Predictive text	3	1	2	4
Larger display	2	1	3	4
Access via computer	0	1	5	4
Attachable keypad	0	1	4	5
Attachable keyboard	0	1	5	4
Headset (cordless)	0	2	2	6
Headset (with cord)	1	1	0	8

Table 5-5 Mobile communication solutions rated by the 10 participants.

5.4.3 Canadian Occupational Performance Measure (COPM) Outcomes

A direct interview was undertaken with participants to identify the occupational performance problems, issues and concerns that they had with the use of telecommunications equipment.

Analysis of the COPM results showed that 9 out of 10 participants reported high to very high performance and satisfaction with their trial solutions. For some, the performance and satisfaction two weeks after the trial also increased compared with when they first began the trial. This is illustrated below in Figure 5-3 and Figure 5-4 respectively.

Only participant 6 explicitly showed limited improvement in performance and a slight decrease in satisfaction with the solution provided.

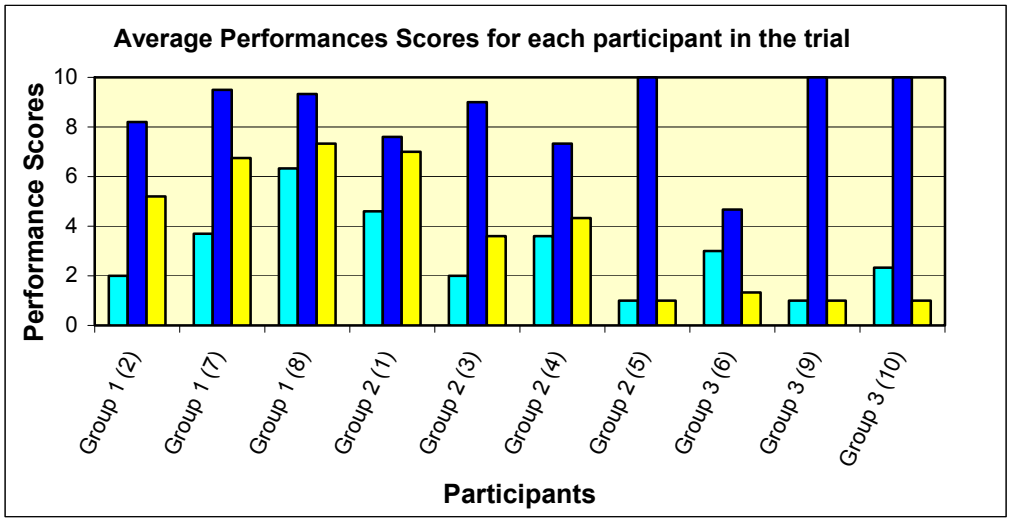

Figure 5-3 Average performance of the 10 participants throughout the trial

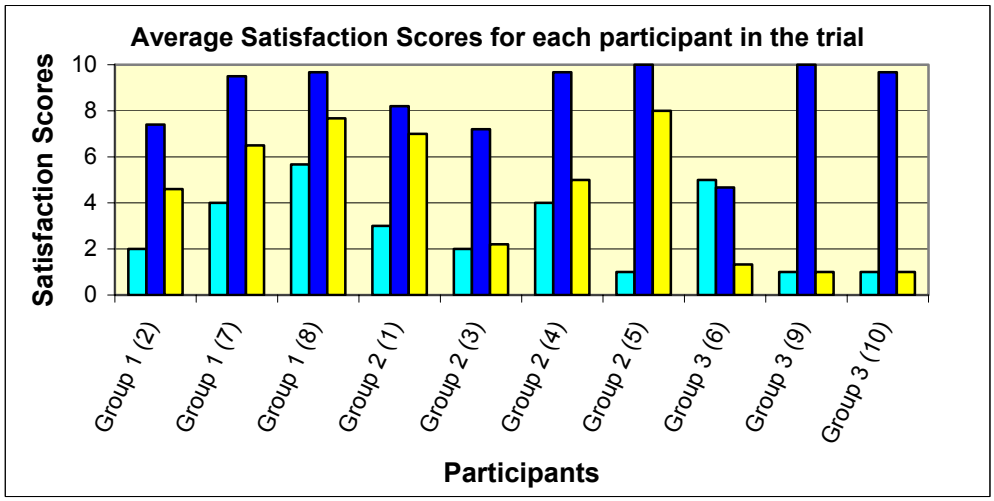

Figure 5-4 Average satisfaction of the 10 participants throughout the trial

***Note**: Group 1, 2, 3 (x) – where x is the actual participant*
The COPM scores range from 1(minimum) to 10 (maximum).

Appendix 5-7 describes the detailed results of each individual – showing their individual problems, needs, and outcomes from both assessments as well as their feedback.

5.5 Discussion and Findings

The overall performances and satisfaction of all of the participants that took part in the trial increased significantly during the trial. Nine out of ten participants showed high to very high outcomes. Participant 6 from Group 3 explicitly showed only slight improvement in performance and reduced satisfaction with the solution provided. This was due to a technical problem experienced with the telecommunications equipment during the trial period. The problem was caused by the erratic behaviour of the mobile phone voice control system[60], which did not function as technically specified. This prevented an effective evaluation of the participant. Efforts were made to correct this malfunction through software upgrades and hardware replacement. Although this particular trial was not as successful as anticipated, the indications were that a "total" hands-free solution would have led to significantly improved performance and satisfaction for this participant. Total hands-free solutions could potentially alleviate problems for individuals in Groups 2 and 3 who simply want to make and receive calls.

Figures 5-3 and 5-4 of the results showed that the increases in the performance and satisfaction of Group 3 were greater than those of Group 1 and 2 (with the exception of the Participant 6 in Group 3). Groups 1 and 2 had low performance and satisfaction prior to the trial due to a lack of awareness of the full capabilities of their current phone. Once educated and trained by the researcher, their performance and satisfaction increased and remained high. Hence **education** played a big factor in improving the way they now use their phone. For participants who had not been previously exposed to telecommunications technology prior to the trial, satisfaction improved significantly because of their realisation of the availability of a solution for them.

Features that were considered essential and important by participants prior to the trial included speakerphone, voice and speed dialling, voicemail and predictive text. Table 5-6 shows the number of participants in each group who considered particular features to be essential or important prior to the trial.

Features	Group 1 (n=3)	Group 2 (n=4)	Group 3 (n=3)
Voice dialling	3	4	3
Speakerphone	3	3	3
Speed dialling	1	2	2
Voicemail	1	3	0
Predictive text	1	1	1

Table 5-6 Available features that the 10 participants considered "essential" or "important" needs.

Generally, hands-free solutions such as voice dialling and speakerphone were features considered to be most important and equally required by all participants. These available features of mobile phone technology made up for the inadequacies that the participants experienced prior to the trial.

The installation on the wheelchair of car kits that incorporated speakerphone, with voice and speed dialling, such as that from Sony Ericsson and Nokia, proved successful for three participants (5, 6, and 10) of the trial. The concept of installing a car kit onto a wheelchair was previously ***unknown*** to them. For these participants, the privacy of a conversation was stated to be not an issue. For two of these participants (5 and 10), the increase in performance and satisfaction was significant. Therefore having speakerphone capability and

[60] A mobile phone used with a car kit installed on a powered wheelchair. The system implemented voice recognition technology via the use of a "magic word" to activate the voice dialling feature of the phone.

reduced effort to control the phone through voice and/or speed dialling with the car kit was a very effective solution. The provision of the car kit, and elimination of any effort required to control the phone, benefited one participant from Group 3 immensely, since prior to the trial the participant had ***no*** form of independent access to the mobile telecommunications network. The car kit system also has great potential for improving the telecommunications needs of any people with disabilities who would fit into the Group 2 and 3 categories of the trial. This very positive outcome requires promotion by telecommunications providers and therapists to further publicise the availability and value of these options.

Participant 9 who was an Augmentative and Alternative (AAC) device user also found the speakerphone capability very useful and effective solution as the participant can listen and join in a conversation at any time. Although the rate[61] at which the participant produced synthesised speech messages from the AAC device was very slow (i.e., about 2 – 3 words per minute), however, the outcome in using the solution provided was significant for the participant and the trial. Access to phones by this participant had never been possible prior to the trial. It was found that, for the participant to effectively engage in a phone conversation, pre-defined greetings or conversational messages have to be created. In addition, the persons involved in the conversation have to be made aware that the participant is an AAC device user and allows time for the person to communicate.

Six of the ten participants reported that, when using the trialled equipment, the time required to carry out essential tasks such as answering incoming calls and making calls improved dramatically. Refer to Appendix 5-7 for actual results. This was an important factor in measuring the success of the solution provided to each participant. For 4 participants the task of making calls was reduced from minutes to seconds. Similarly improvements occurred for answering incoming calls. Whereas 4 participants could not answer to a call in time before the trial, all could do so with the provided technology.

Text messaging improved significantly for 4 participants as a direct result from the use of predictive text. For participant 1 this meant a reduction from approximately 8 minutes for message generation to around 5 minutes with the solution provided. For participant 3, the time was reduced from 5 minutes to 2 minutes. For participant 4 it was an improvement from 30 minutes down to 15 minutes. Finally, for participant 7 it was an improvement from 3 minutes to approximately 40 seconds. Three out of the ten participants (1, 3 and 4), however, displayed no improvement or, in some cases, an increase in the time required to carry out the essential tasks. This outcome was mainly attributed to the fact that it took some participants more time to get used to using the provided technology.

Two of the four participants who considered voicemail (answering machine) as essential and important actually used the features provided to them. One participant used it everyday after school to check for messages while the other participant used it on occasions where the need arose. The other two participants didn't need to use it during the trial period.

The initial training for each participant, as well as the three-week trial period, were considered insufficient or too short for those participants who were slightly more intellectually challenged. This included participants 1, 4 and 8. The general consensus amongst participants was that a minimum trial length of 1 month was required. This factor was equally important for participants 1, 2, 4 and 9 who had not previously used a mobile phone or had little exposure to it. However, to maintain consistency of the trial's protocol, the three-week trial period was maintained for all participants, except for participant 1 who was recovering from surgery and had minor brain damage, and who was given a 1-week extension.

[61] Cornish and Higginbotham (2000), and Higginbotham (2004) indicated that estimates of the average rate at which augmented communicators can produce messages are on the order of 10 words per minute and varies considerably across individuals, communication, contexts and technologies.

Text messaging was regarded as an important mode of communication by participants, and the majority who used it showed substantial improvement in the response time. For some participants this meant saving minutes and, as a direct result, led to significantly increased satisfaction. The development of predictive text technology on mobile phones has proven to be enormously beneficial for people with disabilities. This concept was a relatively new feature for many of the participants. However, with proper training, this technology proved extremely helpful and very successful for those participants that used it in the trial. This included participants 1, 3, 4, and 7 as mentioned earlier (also refer to Appendix 5-7 for full details).

Although the trials implemented were an overall success, some problems were experienced. Participants 3 and 6 had abandoned use of the initial equipment provided to them. This was not due to a failure of the "Matching of participants to available technology" process, but due to technical problems that arose with the initial equipment provided.

For participant 3, the solution provided was inadequate for the participant's needs. The features on the equipment specified by the manufacturer did not meet the expectation of the participants. The solution provided to the participant had all the features needed, however, the size of the text on the screen was too small and the volume of the speakerphone was inadequate for the participant's needs. For participant 6, the problem was due to a technical problem. The technology was replaced, but the problem still persisted during the trial. One participant withdrew prematurely due to personal circumstances/commitments. Efforts to find another suitable time for the trial were not successful. The total withdrawal of this participant from the trial prevented a software solution (as initially intended) from being trialled. A reserve participant was engaged to ensure a total of 10 trials. Participant 1 was given a one-week extension because of recent experiences (recovering from surgery) that affected the intellectual ability of the participant. Although the assessment process involved was slow, the data collected for this participant were not affected in any way. The participant had signified that everything presented was fully understood, and this had been reconfirmed with a carer present at the time.

There were technical issues related to short-term access to the GSM and CDMA networks while maintaining one participant's current phone number. It was also found that the installation of mobile phone car kits on wheelchairs was difficult due to a lack of competent installers.

The outcomes of this trial have been presented to:

- the Department of Communications, Information Technology and Arts (DCITA) – the funding body for this project), a report of this research is also available online[62];
- Telstra's Disability Services – supported additional funding for equipment purchasing and access to network and services;
- ACIF DAB – mentioned in Chapter 2;
- the ARATA conference, available online[63]; and
- the International Conference On Smart Homes and health Telematic (ICOST) 2004 conference and published in the ICOST 2004 proceedings (Zhang and Mokhtari, 2004)

The general feedback received from the organisations as well as people present at the conferences was that there were great interest and discussion from the significant results obtained from the trial – nine out of the ten participants achieving high to very results in performance and satisfaction. For therapists, carers, and people with disabilities the outcomes of the trial (the first of its kind funded by the Australian federal government) was

[62] http://www.novitatech.org.au/library/NewTelecomOpShortReport.pdf
[63] http://www.e-bility.com/arataconf/abstracts/nguyen2.html

very significant in that they were assured that there could be a solution to their telecommunication needs provided that they ask the right questions of the right people. This was evident with the presenter being approached by attendees after the presentation asking specific questions relating to their personal telecommunication needs as well as those that they know would benefit from the research.

DCITA were impressed with the report that was submitted to them and commented, "…*the report is professional in its approach, with a strong methodology and processes that are focussed on meeting the requirements of the project…*". Telstra's Disabilities Services were equally satisfied with the outcomes of the trials. Both organisations pledged to support future projects whenever they could.

5.6 Conclusion and Recommendations

The outcome of the trial showed that nine out of ten participants experienced high to very high levels of overall performance and satisfaction with the use of the telecommunication equipment provided. (A technical difficulty prevented an effective evaluation of the 10th participant).

The implications of this are that:

- Participants who previously had an ***inadequate*** solution, had an ***adequate*** solution during the trial that enabled them to access telecommunication equipment and services. The provision of hands-free features such as speakerphone and voice and speed dialling on phones proved to be ***essential*** for participants with limited physical abilities to use the mobile phone more effectively and efficiently. Mobile phone car kits also proved to be of ***practical*** value for participants restricted to wheelchairs. Voicemail and text messaging were also important forms of communication that could be performed with the technology.
- Participants who had ***no prior independent access*** to telecommunication equipment were able to ***access*** the network and its services successfully; and
- Mobile telephone technologies have been shown to provide improved access, functionality, social interaction, independence, safety and security. These are all areas of high priority for people with a disability, as highlighted by the participants.

This research and clinical trial was also able to demonstrate that current, off-the-shelf telecommunications equipment **can** enable people with disabilities, even severe physical disabilities, to access the telecommunications network.

Prior to the trial, the researchers were confident that off-the-shelf solutions did exist for people with mild to moderate physical disabilities, and were satisfied with the results from the trial. However, even the therapists and technologists who have extensive experience in the disability sector were surprised when off-the-shelf solutions were found for the participants with severe physical limitations. It was expected that it would be very difficult to find a satisfactory match for these clients, yet solutions were found, and they can now have access to the telecommunications network. This is a profound outcome of these trials.

Pivotal to the success of these trials were an in-depth knowledge of existing mobile phone technology options and features, a clear understanding of the client's telecommunication needs and abilities, and the appropriate matching of the technology to an individual. This matching of appropriate technology to an individual has led to 4 of the 10 participants purchasing the solution that was tailored for them. This is a sign of increased confidence and independence leading to an improved lifestyle and social interaction.

Another important outcome from this research was the discovery that most trial participants were not aware of the full capabilities of their current mobile phone (if they had one), and hence **education** of the participants by the researcher played a big factor in improving the way they now use their phone.

The provision of an effective telecommunications solution for a person with a disability can be achieved within an overall total of half a working day, even for the more challenging situations. Of particular significance is the substantially increased independence each participant gained through an appropriate equipment match, and hence the decreased reliance on a third party to perform a previously impossible task.

With the right policies, processes and support (appropriate user skill and equipment matching, education, training and delivery) in place, solutions can be found. This research and trial was successful in validating the research aim and hypothesis and was also able to demonstrate that current off-the-shelf solutions ***can*** help alleviate problems and improve the lifestyle, social interaction, security and independence of many people with physical disabilities. Thus:

People with a range of physical disabilities <u>can</u> use and <u>should</u> have equal access to telecommunication equipment and services.

This outcome has also reinforced and supported the main hypothesis of the overall research, *that, despite very limited mobility, speed, accuracy or vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bi-directional communication with systems to which they choose to connect*.

Recognising the significant social, health and security benefits that will be derived, it is recommended that:

1. Telecommunication solutions and services such as hands-free technology and mobile phone car kits (and their installation onto wheelchairs) be made available to people with physical disabilities by telecommunication providers to ensure that they have equitable access to the network.

2. Trained professionals with the necessary skills and knowledge of the telecommunications industry accept responsibility, in conjunction with the relevant organisations and telecommunication providers, for providing appropriate telecommunications solutions for people with disabilities. This could be achieved through:
   a) Each organization having a trained person (e.g. a Telecommunications Officer) who has the knowledge to educate people with disabilities about the applications, access and use of appropriate telecommunications equipment;
   b) A dedicated accessible website that guides people through the whole process of selecting an appropriate solution for their individual needs;
   c) A ‘freecall’ hotline number that assists people through the process of selecting and obtaining the appropriate solution;
   d) Educational programs such as workshops or training sessions to educate the disability community (therapists, clients and carers) on how to effectively use and access current telecommunications equipment.
3. Acknowledging the longer times that some people, such as Augmentative and Alternative Communication users, and those who are intellectually challenged, will take to convey the same message across a communications network, there be concessional charging rates for use of the network.

Chapter 6

MOBILE PHONE ACCESS FOR AUGMENTATIVE AND ALTERNATIVE COMMUNICATION DEVICE USERS

6.1 Introduction

People with severe disabilities are both functionally and socially disadvantaged and usually require Augmentative and Alternative Communication (AAC) devices, with expensive customised hardware and software interfaces, to support their educational, vocational, social and recreational activities. According to Williams & Romich (2002), an estimated one to two million Americans with severe speech disability can benefit from the application of AAC technology. Novita Children's Services Incorporated of South Australia has estimated that 20% of its 1300 clients use AAC technology.

For these people, the lack of a suitable interface system, which would allow them to access and/or operate the phone, is the largest impediment. This was evident from the results of the Focus Group and Survey Questionnaire results in Chapters 3 and 4, respectively, where clients were not utilizing the available technology to its fullest extent. Furthermore, there was a genuine need to make mobile phone access easier, either through an AAC device, a larger keypad, or a larger display.

As discovered in the previous chapter, modern telecommunications technology can provide many new options for people with disabilities, and *people with a range of physical disabilities can use, and should have equal access to, telecommunication equipment and services*. Given that the telecommunications technology is continually and rapidly changing, driven by competitive pressures to reduce costs, and by market demand for new services, the situation for people with disabilities is also continually changing. The telecommunications laws in Australia refer to the Disability Discrimination Act as the benchmark for telecommunications accessibility for people with disabilities. In addition to legislative and regulatory steps, peak consumer disability organisations are working on specific projects to improve services and critical issues facing people with disabilities, as outlined in Chapter 2.

The concept of someone using their existing AAC device to interface with the mobile phone to independently dial a number, answer a call and/or terminate a call, as well as text messaging, has provided an avenue for exploration in this research. Existing AAC devices have incorporated some elements of Universal Design principles, and device users and their therapists usually would have identified successful methods of operating their AAC system for face-to-face communication, yet these steps do not deliver the full potential for direct access to, or control of, a standard mobile phone this is in common use by the general public. The mobile phone forms part of modern communication. Access to a mobile phone via an AAC device would enable persons with severe disabilities to communicate effectively with a wider range of people and to access the same range of information systems and services enjoyed by able-bodied members of the community.

The following sections of this chapter describe the investigation and design work, carried out to develop, test and validate an interfacing system that would allow people with a physical disability who use an augmentative and alternative communication device to independently use a mobile phone. The system enables AAC device users to make voice calls and send and receive text messages through the use of a standard mobile phone.

Prior to this research, mobile phone access by people with disabilities using their existing AAC device had not been possible due to the lack of a communication interface between the two devices. A key link in the interfacing system investigated and implemented in this research is the set of Global Systems for Mobile Communications (GSM[64]) AT commands (Activexpert Software, 1999 and Nokia, 2003) which enables the gap between the two devices to be bridged. Details are described in the following sections.

6.2 An Interfacing System Between an AAC Device and a Mobile Phone

Most AAC technology, such as the Pathfinder discussed in Chapter 2, has a serial and/or infrared (IrDA[65]) port that outputs strings of ASCII[66] characters. It is therefore feasible to design and implement an interfacing system to act as a translating medium by accepting ASCII string commands from an AAC device, or control signals from switches or other devices, and translating them to appropriate GSM AT commands that the phone's modem readily accepts and acts upon.

6.2.1 Global Systems for Mobile Communication (GSM) AT Commands

GSM AT commands are commands for controlling Mobile Equipment (ME) functions (eg, mobile phone) and GSM network services (eg, text messaging (SMS)) from a Terminal Equipment (TE) item (eg, computer, an AAC device or similar devices) through a Terminal Adaptor (TA) (eg, interfacing hardware/software system) as shown in Figure 6-1.

AT stands for ATtention and is the two-character abbreviation that is always used to start a command line to be sent from a TE to a TA. GSM AT commands follow several digital cellular standards including:

- International Telecommunications Union – Telecommunications Standard Sector (ITU-T[67]) Recommendation V.25ter (ITU-T V.25ter, 1999);
- European Telecommunications Standards Institute (ESTI[68]) GSM 07.07 (also known as ETSI Technical Specification (TS) 100 916) (ETSI GSM 07.07, 1998);
- ESTI GSM 07.05 (also known as ETSI TS 100 585) (ETSI GSM 07.05, 1998);
- ETSI Third-Generation Partnership Project[69] (3GPP) Technical Specification (TS) 27.007 (3GPP TS 27.007, 2002-2003);
- ETSI 3GPP TS 27.005 (3GPP TS 27.005, 2001-2009);
- Telecommunications Industry Association International Standard (TIA[70] IS-99) (TIA IS-99, 1995);
- TIA IS-135 (TIA IS-135, 1995);
- ITU-T T.31 (ITU-T T.31, 1995); and
- ITU-T T.32 (ITU-T T.32, 1995).

Detailed descriptions of each standard are not discussed within this thesis, but may be found in the cited references. Appendix 6-1 also outlines the purpose of these standards. The

[64] A standard for digital cellular phone service in over 85 countries, which operates at 900/1800/1900 MHz.

[65] Infrared Data Association - which sets standards for using infrared transmission to transfer data between electronic devices (eg computers and other peripherals and devices) through the air, with no cables or wires.

[66] American Standard Code for Information Exchange – world-wide standard for the code numbers used by computers to represent all the upper and lower-case Latin letters, numbers, punctuation, etc

[67] ITU-T is an international body of member countries whose task is to define recommendations and standards relating to the international telecommunications industry

[68] The European standardization body for telecommunications.

[69] Set up to expedite the development of open globally-accepted technical specifications for 3G.

[70] The United States' telecommunications standards making body.

particular standards that were relevant to this research include the ITU-T Recommendation V.25ter and all the ETSI specifications mentioned above. Furthermore, only a relevant subset of the AT commands from these standards was implemented within this work.

GSM AT commands require eight bits of data and therefore it is necessary for the TE - TA link to be set to eight bits/ byte mode. The interface between TA and ME is dependent on the interface in the ME. Often TA and ME function as a single entity such as in mobile phones that have an in-built modem. AT commands may be observed passing in either direction on the link between the TE and the TA. However, most of the commands retrieve information from the ME, and not from the TA.

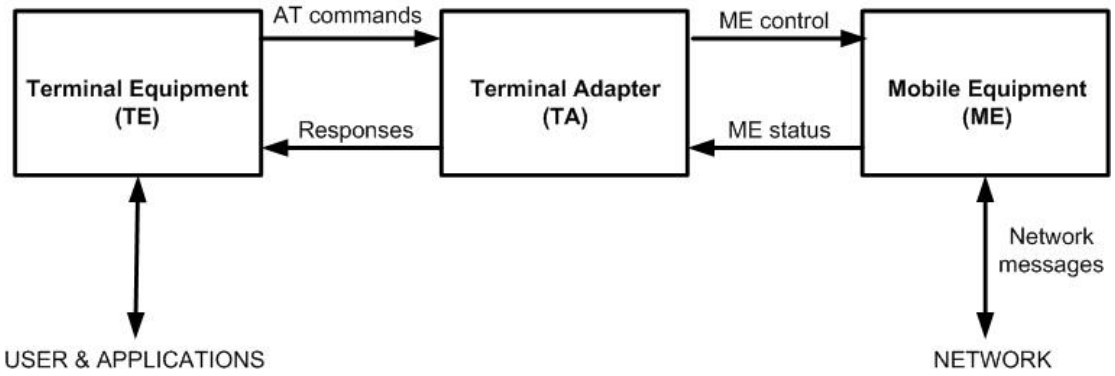

Figure 6-1 Terminal Equipment, Terminal Adapter and Mobile Equipment set-up (ETSI GSM 07.07, 1998)

AT commands are incorporated and function within any of the following physical implementations:

- TA, ME and TE as three separate entities;
- TA integrated under the ME cover, and the TE implemented as a separate entity;
- TA integrated under the TE cover, and the ME implemented as a separate entity;
- TA and ME integrated under the TE cover as a single entity.

Depending on the capabilities of each device (TE, TA and ME), various set-up arrangements could be implemented. This will become apparent when the interfacing system is discussed in Section 6.3.

Table 6-1 shows the essential GSM AT commands used in the emulation of voice calls and SMS and their corresponding functionality. Appendix 6-2 shows the more detailed GSM AT commands implemented on Nokia mobile phones. For any mobile phone to enable voice calls, SMS and other control functions to be invoked by an external device, the appropriate GSM AT commands must be capable of being implemented on that phone.

GSM AT commands	Function
AT	ATtention – establish connection with modem
ATDn;	Initiate a voice call to phone number n. (*n is the multidigit mobile or fixed phone number (including digits that permit international roaming)*) (";" – semi colon delimiter for voice calls, without this it is a data call, e.g. a fax dial up)
ATA	Answer an incoming call
ATH	End a call
AT+CMGF = m	Message Format (m = 1 = text, m = 0 = PDU[71] (default setting on all phones))
AT+CSCA	Service Centre Address
AT+CMGS	Send Message
AT+CMGR	Read Message
AT+CMGL	List Message

Table 6-1 A small set of essential GSM AT commands for voice calls and text messaging.

It is important to note, however, that ***not all*** GSM AT commands are implemented on all mobile phones, as most commands are optional, as described in the ETSI GSM 0.7.07 standard. Each mobile phone manufacturer decides which commands are appropriate to be implemented onto a particular mobile phone and which are not. Commands that are implemented usually give responses such as "OK", while those that are not implemented or cannot be interpreted give an "ERROR" or "CME ERROR = operation not supported" response, respectively. This is demonstrated in Appendix 6-3, GSM test results for Motorola V3688, and in Appendix 6-4, GSM AT command line, information responses and result codes. The implementation of the required GSM AT commands is described in Section 6.2.2 and Section 6.2.3.

6.2.2 Implementation of the required GSM AT commands onto the Interfacing System

Conventionally, electronic devices are connected together by a serial cable or an infrared link. A third option is Bluetooth[72].A serial cable is commonly used and is less susceptible to external interference than infrared. Infrared (IrDA) has the advantage of being wireless but can be easily interrupted by outside interference and has a limited range (approximately 1 metre) and limited misalignment angle (±15°) between the axes of the infrared transmitter and receiver. At present, connection to most mobile phones can be achieved via a serial cable, IrDA (infrared) or Bluetooth. A Bluetooth connection avoids the need for a cable connection and largely overcomes the external interference, or the need for correct alignment, that are associated with infrared links. Most advanced GSM mobile phones include an internal hardware modem. The modem allows the use for data, fax, SMS and voice to be controlled by standardised GSM AT commands via an external device such as a portable computer. Currently, phone manufacturers have their own sets of extended GSM AT-commands that could be used with the modem to allow modification of logos, ring tones and calendar entries etc. For mobile phones that do not have an internal modem, a software modem (e.g. Nokia Data Suite[73]) which supports ESTI GSM 07.07 and ETSI 3GPP 27.007

[71] Portable Data Unit (PDU) is encoded data transferred to/from a handset over the telecommunications network. Data transferred are not direct ASCII strings (text).

[72] Bluetooth is an open standard for short range (10 m extendable to 100m) wireless transmission of voice and data between mobile devices (PCs, handheld computers, telephone and printers.)

[73] Software that allows synchronisation and exchange of data (contacts, profiles and phone settings) between a mobile phone and the computer.

standards (for overall control of the phone) or ESTI GSM 07.05 and ETSI 3GPP 27.005 standards (for SMS control) is needed.

AAC technology such as the Pathfinder (TE) (PRC, 2004), as discussed in Chapter 2, has a serial or infrared (IrDA) port, which readily outputs strings of ASCII characters. It is therefore *feasible* to design and implement an interfacing system (TA), which acts as a translating unit that accepts ASCII string commands from an AAC device and translates them to appropriate GSM AT commands that the phone (ME) readily accepts and acts upon. Commands from other similar devices and control signals from switches could also be translated to ASCII string commands to control the mobile phone for voice and data communication. This is illustrated in Figure 6-2 below. Depending on the capabilities of each device, (TE, TA and ME) various implementations as discussed in Section 6.2.1 could be implemented.

AT commands for essential tasks such as making a call (ATD), answering a call (ATA) or terminating a call (ATH) can be achieved by an AAC device or switch with which a person with a disability is familiar, and for which a successful method of operation has been identified. An AAC device such as a Pathfinder can send ASCII string GSM AT commands directly to the phone via a serial cable (at an appropriate baud rate[74]) or by an infrared connection. Alternatively, a serial-to-Bluetooth adapter such as the "Free2move[75] Bluetooth Serial Port Plug", once connected to the serial port of an AAC device, can enable it to establish a wireless connection with a mobile phone[76] at a range of up to 100m. For other input devices, such as a switch-controlled scanning device, sequences of control signals could be translated to appropriate GSM AT commands via a microcontroller-based interfacing unit or system to manage voice calls. More complex functions such as modifying or adding new numbers to the phonebook, dialling numbers from the phonebook, turning on the speakerphone (if the phone has one) or operating the digital camera to take and store pictures as well as sending and receiving text messages, can also be implemented using the interfacing system.

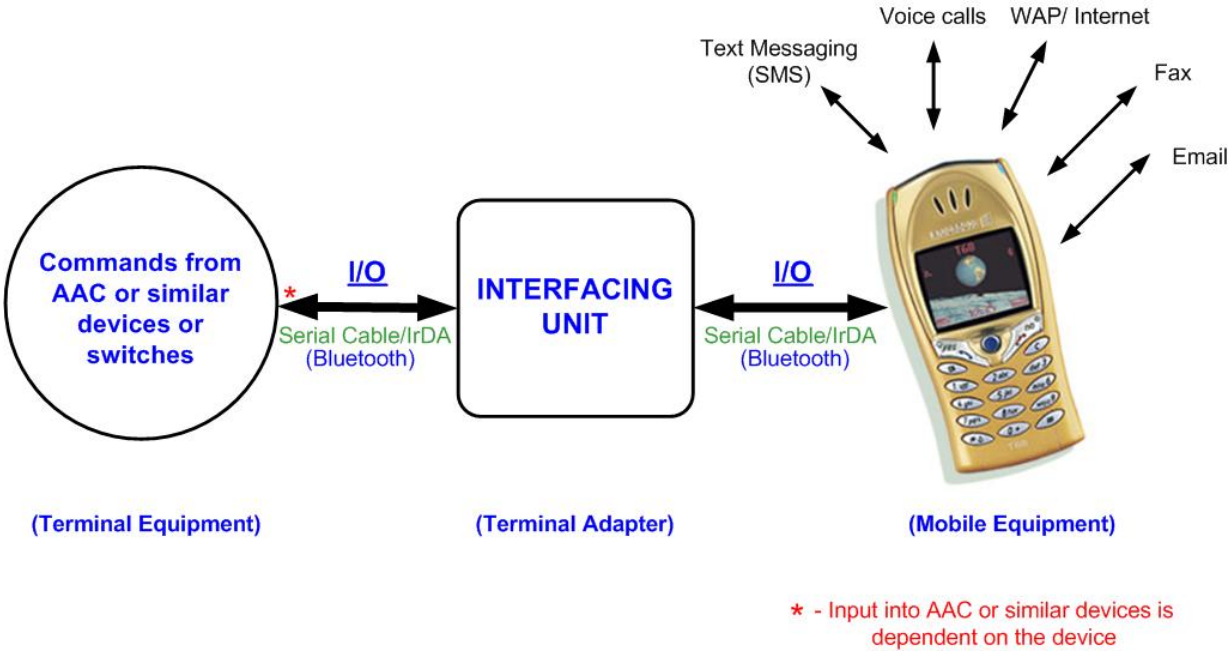

Figure 6-2 An Interfacing System between an AAC device and the mobile phone.

[74] The speed of information being transmitted across a serial interface between two modems, expressed in units of bits per second (bps).

[75] Available from Expansys Australia (www.expansys.com.au).

[76] Pairing of the Bluetooth adapter to the mobile phone is a one-off process done via the Free2move configuration software. The Bluetooth adapter is set to automatically connect to the mobile phone whenever its Bluetooth feature is activated.

6.2.2.1 Testing the availability of GSM AT commands on mobile phones

Testing of mobile phones for the types of GSM AT commands that are implemented on the phone was carried out using various software applications including those that are available commercially. These included:

- mobile PhoneTools (available from BVRP Software) (discussed in Chapter 2) (BVRP Software,2003);
- Motorola SmartCellect software for Motorola phones;
- software that was free to download from the Internet such as AT-command Scanner from Hummel Software (Hummel Software, 2002); and
- HyperTerminal (which is readily available with the PC's operating system).

HyperTerminal is a communications program found in the *Accessories* folder of Windows that allows a user to call a remote computer or modem, via a modem, and transfer data or files. In the HyperTerminal application, the user can also change the port settings for modem connections and adjust the settings to make a call. This is demonstrated in Section 6.2.3.

The Motorola SmartCellect software enables text messaging to be undertaken via a PC. This software also incorporates "PhoneTools" from BVRP software that allows testing of GSM AT commands. Typical results from the Motorola SmartCellect software that tested all the GSM AT commands on a Motorola V3688 using the ESTI GSM 07.05/07.07 standard showed that the phone implemented the basic GSM AT commands for voice calls and text messaging in PDU[77] mode. A response apart from "ERROR" or "CME ERROR = operation not supported" indicates that the phone has not implemented the GSM AT command or an error related to the phone. Full results from the test of this phone are shown in Appendix 6-3.

The "*mobile PhoneTools"* software discussed in Chapter 2 emulates voice calls and text messages through a graphical user interface displayed on a Laptop or Desktop PC. It also has other features and capabilities such as phonebook management and the creation of ring tones. Another useful feature is the capability of testing GSM AT commands. The software is compatible with many mobile phone models. The BVRP Software website[78] provides a more detailed description of this software.

AT-Command Scanner is another software program that can be installed onto a PC to test all the GSM AT command sets from the ESTI GSM 07.05/07.07 standards with any mobile phone. The phone can be connected to the serial port of the PC for testing or it can be performed via infrared (IrDA). The AT Command Scanner automatically steps through each AT command in the standard and produces a set of results similar to that from Motorola SmartCellect software as shown in Appendix 6-3.

GSM AT commands test results carried out for other phone models are also published on the Internet by Gabor (2001). Results include those for Nokia, Samsung, Siemens, Ericsson and Motorola phone models. Truad (1996), has a useful website which gives an overview of GSM AT commands, how they are used and links to various mobile phone manufacturers GSM AT command sets.

From the testing of various mobile phone models and research on the Internet it was found that Nokia and Sony Ericsson phones tend to implement the majority of the AT commands, and more of the "optional" AT commands as listed in the ESTI GSM 07.05/07.07 standards, than those of other manufacturers.

[77] Portable Data Unit (PDU) is encoded data transferred to/from a handset over the telecommunications network. Data transferred are not direct ASCII strings (text).

[78] www.bvrp.com.

6.2.2.2 Mobile phone characteristics required for the interfacing system development

As mentioned in Section 6.2.1, not all GSM AT commands are implemented on all mobile phones and most are optionally implemented under the jurisdiction of the manufacturers. Therefore to implement an interfacing system as indicated in Figure 6-2, a full investigation of the type of GSM AT commands that the mobile phone has, and other essential characteristics, was required.

An initial phase of the development of the *Interfacing System* was to determine the appropriate mobile phone available for the system. A suitable phone must include the following characteristics:

1. An inbuilt voice/data/fax modem on the mobile phone;

   The inbuilt modem acts as a (hardware) terminal adapter that accepts and responds to AT commands.

2. The required GSM AT commands for carrying out voice calls and text messaging (SMS) as outlined in Table 6-1.

   Commands for voice calls include those for: making a call, answering an incoming call and terminating a call. SMS commands must have the message format as ASCII text and not as Portable Data Unit (PDU), which is encoded. This is because AAC technology usually outputs ASCII strings (text). The use of PDU mode requires additional software to convert the PDU data into standard ASCII text format.

3. Connection to the mobile phone must be achievable via a serial cable, IrDA (infrared) and/or Bluetooth.

   For the set-up shown in Figure 6-2, a serial cable or Bluetooth connection would be preferable over infrared (IrDA) since infrared has limitations as discussed. A serial cable, although non-cordless, allows the phone to be securely mounted at the desired location on a person's wheelchair tray. Bluetooth technology provides cordless connection between two devices within a range of 10 metres (Class 2), which can be extended up to 100m (Class 1), and is not interrupted by any physical interference. The cost of implementing a Bluetooth medium is considerably higher than infrared and serial, with infrared costing more than serial. Nevertheless, the costs of implementing these connections are regarded as small (~$50 to ~$200) compared with the cost of a Pathfinder which is approximately AUD$20,000[79].

6.2.2.3 Mobile phones suitable for the interfacing system

Selection of mobile phones considered suitable for the interfacing system was based on the following criteria:

Versatile access

The phone must support serial, infrared and/or Bluetooth access. It was preferable to have all three types of access modes, as it would mean that access to the phone was not restricted to any one mode.

[79] Approximate prices as indicated by NovitaTech (June 2004).

Compatibility with existing software solutions

The chosen phone must be compatible with the *mobile PhoneTools* software. This software could potentially provide an alternative solution for people with a disability who use a laptop PC as an AAC device, as described in Chapter 2.

Essential implementable AT commands

The phone must have implemented the essential AT commands sets as specified in Table 6-1 of Section 6.2.1. Voice control requires the basic AT commands. Text messages (SMS) can be sent from a *terminal equipment* (eg. AAC device) to a *terminal adapter* (eg inbuilt modem) by AT commands if the phone supports the AT+CGMF (Message format), AT+CSCA (Service Center Address), and AT+CMGS (Send Message)) commands. For devices such as the Pathfinder that output ASCII string characters, the selected mobile phone must be able to implement the AT+CGMF = 1 (text mode) command.

Table 6-2 shows a selection of mobile phones suitable for the interfacing system at the time of the research. Later models, and those in the pipeline from various manufacturers, would require testing to confirm their suitability. Due to the limitation of resources, individual testing for GSM AT commands implementation in all the listed phones was not possible. Information for some of these phones was gathered from the Internet (I) and/or the manufacturers (M).

Model	Compatible with *mobile PhoneTools*	Accepts AT+: Basic commands & CGMF	Access via Serial, IrDA & Bluetooth	Cable type	Source
Ericsson T39m/s	✓	✓(Basic command) CGMF = 0	✓ In-built Infrared & Bluetooth	RS232 cable (DRS-10)	I
Sony Ericsson T68i	✓	✓(Basic command) CGMF = 0	✓ In-built Infrared & Bluetooth	RS232 cable (DRS-11)	I & M
Sony Ericsson T610	✓	✓(Basic command) CGMF = 0 – 1	✓ In-built Infrared & Bluetooth	RS232 cable (DRS-11)	Self-testing
Nokia 6210	✓	✓(Basic command) CGMF = 0 – 1	✓ In-built Infrared & Bluetooth connection with Nokia Connectivity Pack DTL-1	Data cable (DLR-3P)	I
Nokia 6310i	✓	✓(Basic command) CGMF = 0-1	✓ In-built Infrared & Bluetooth	Data cable (DLR-3P)	I & M

Table 6-2 Phones suitable for the interfacing system.

The Nokia 6310i and Sony Ericsson T610 phones met all the selection criteria and subsequently were used for testing, verification of the design concept, and implementation.

6.2.3 Proof of Concept via HyperTerminal Application

Having understood how GSM AT commands were implemented at various levels of TE, TA and ME, as well as identifying the mobile phone characteristics required for the interfacing system, the next phase of the development of the system was to prove the concept of sending ASCII string GSM AT commands from an AAC device to control the mobile phone to make voice calls and to send and receive text messages. This was achieved by using a Laptop/desktop computer as the TE and the HyperTerminal Application software, together

with the phone's modem as the TA and the phone as the ME in the set-up similar to Figure 6-1 in Section 6.2.1.

6.2.3.1 Emulation of calling/answering/ending of voice calls using GSM AT commands

Figure 6-3 demonstrates the process by which a HyperTerminal application was used to emulate voice calls such as initiating a call, answering an incoming call and terminating a call, as well as sending and receiving text messages (SMS) using AT commands. The first step was to send an AT (ATtention) command to the mobile phone's modem to establish a connection. The usual responses from the modem are "OK" for success or "ERROR" for failure of the commands.

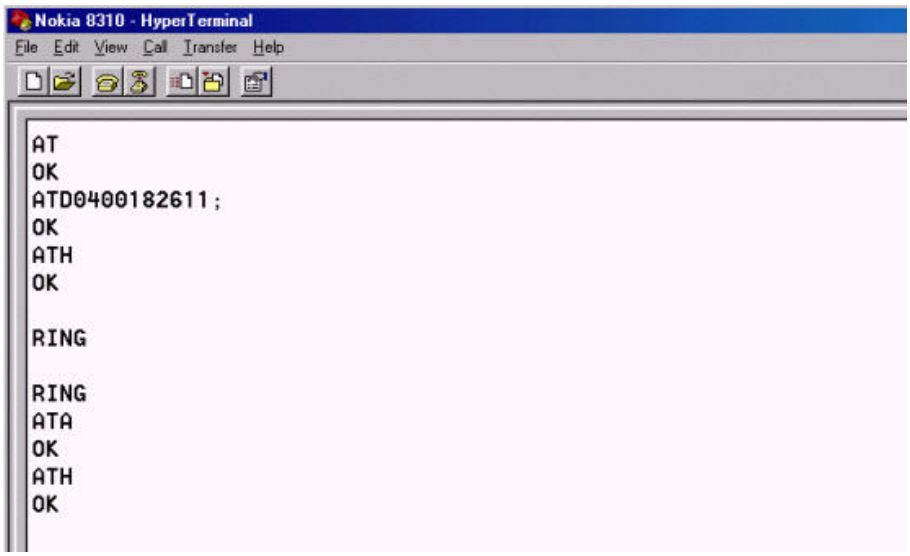

Figure 6-3 HyperTerminal application used to emulate call/answer/end of voice calls using GSM AT commands.

To initiate a voice call, an "ATD" (*Dial*) command followed by the phone number, and a semicolon (terminated by a Carriage Return, <CR>) was sent to the modem. An "OK" response indicates that the command is acceptable and the phone dials the specified number. Alternatively, if the user knows the location at which a person's number is stored within the phone, an *ATD>location number;* command can be used to call that person directly from the phone's phonebook. For example, if Toan's number is stored at memory location "53", then the command ***ATD>53;*** can be used to call Toan. Furthermore, the person's name that is stored in the phone's phonebook can also be used to call the person directly. For example, the command ***ATD> "Toan";*** can be used to call Toan. A call can be terminated at any time during a conversation by sending an "ATH" (*Hang-up*) command to the modem. An incoming call (indicated by a "*RING RING*" response – an *unsolicited result code*) can be answered by an "ATA" (*Answer*) command.

Another method is to use the *Keypad Control*[80] (AT+CKPD) AT command to emulate the key presses required to activate the voice dialling capability of the mobile phone. This would enable a person to use their voice to call up to ten pre-stored numbers on the phone. For example, the phone could have Toan's number tagged with a voice command saying "Call Toan". Sending the command ***AT+CKPD="S", 5,1***, to the phone's modem would activate

[80] Keypad Control (+CKPD) command is used to operate the keypad of the ME. The key presses are sent to the ME as a string type subparameter and each character in the string represents a key which will be pressed. For example, the command *AT+CKPD="S", 5,1* will emulate the "Send" key on the keypad. The number "5" represent the time to strike each key (in tenths of a second), and the number "1" represents the pause to wait between keystrokes (in tenths of a second). It is important to note that there are different keypad types between different manufacturers and between ME models, therefore different keypad control commands.

the voice dialling feature of the phone and would return the prompt "*After the tone, say the command*". The person would then use their voice to say "Call Toan" to ring Toan's phone.

Similarly, other keypad AT commands (if implemented on the modem) could be used by AAC device users to open incoming messages on the phone's display, turn on/off features on the phone such as speakerphone, operate a digital camera or FM radio etc. These commands varied for different mobile phone manufacturers and different keypad layouts.

For further information on how to emulate the keypad on the phone is available in Appendix 6-4, which outlines the character codes for the key presses on a Mobile Equipment (ME) keypad.

Appendix 6-5 shows how to set-up the HyperTerminal application on the computer to connect with a mobile phone so that GSM AT commands can be used to control the mobile phone for voice calls and text messaging.

Appendix 6-6 shows how text messages (SMS) can be stored, sent, and received using HyperTerminal application.

6.3 Implementation – Converting concept to reality!

6.3.1 System's set up

Having successfully proved by software-based tests that voice calls and text messaging are achievable via GSM AT commands, the subsequent phase of the development of the system was to implement this physically as shown in Figure 6-6 below. The hardware of this system included:

- the Pathfinder AAC device manufactured by Prentke Romich Company[81] (Terminal Equipment);
- the Interfacing system (voice/data/fax modem – Terminal Adapter); and
- the mobile phone (Mobile Equipment).

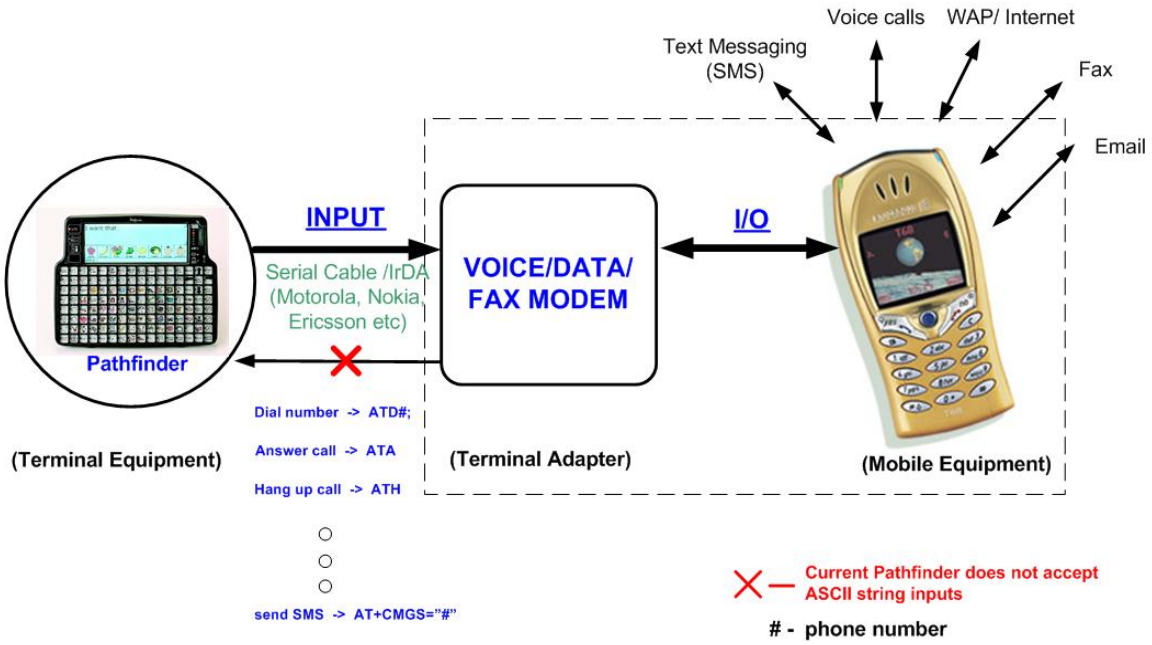

Figure 6-6 Mobile phone access via an AAC device (eg a Pathfinder)

[81] Other PRC products such as the Vantage and Vanguard can be used to implement the same system. The Pathfinder was chosen as a representative from the product range.

This particular set-up corresponds to “TA integrated under the ME cover, and the TE implemented as a separate entity” physical implementation model as discussed in Section 6.2.1. The TA in this set up is an in-built voice/data/fax modem of the mobile phone (ME). The TE is the Pathfinder itself. Another set-up that corresponds to the “TA integrated under the TE cover, and the ME implemented as a separate entity”, is shown in Figure 6-16, Section 6.3.5, and described in Section 6.2.1. The terminal adapter of the system is the in-built voice/data/fax modem of the mobile phone, which functions as a translating unit that accepts and interprets incoming tasks as specified by the GSM AT commands, and instructs the phone what to do. The mobile phone or mobile equipment carries out the instructed task received from the TA and interrogates the network services.

6.3.2 System’s Function

The overall objective of the system is to enable a person with a disability, who uses an AAC device such as the Pathfinder, to independently use the mobile phone for voice calls by initiating a voice call, answering any incoming calls, terminating calls anytime, and to use the phone for text messages by independently generating and sending text messages and receiving text messages. To do this, the Pathfinder would need to be programmed to include a “mobile phone” application as shown in Figure 6-7 below. The programming of this application is usually done by a technologist or engineer, in conjunction with a speech therapist and the end user. A quick starter guide to program the “mobile phone” function can be found in Appendix 6-7.

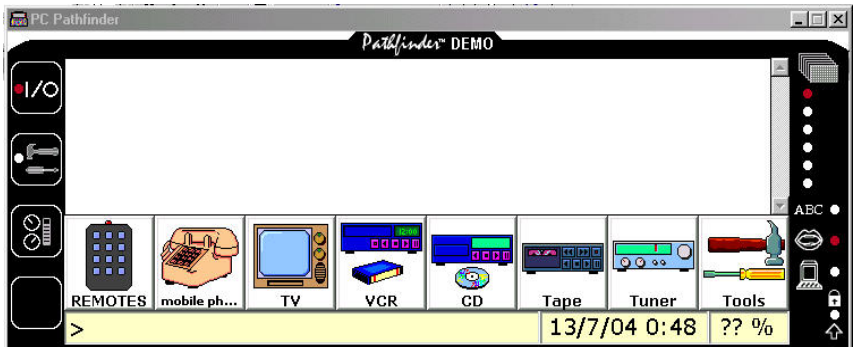

Figure 6-7 Functions on the Pathfinder.

The “Mobile phone” application consists of activity-row ICONS of various layers containing various tasks such as direct dialling of pre-stored numbers, manual dialling, answer and hang up of voice calls, and text messaging. The overall structure of the activity icons layout for mobile phone use on the Pathfinder is as shown in Figure 6-8. The “Mobile phone” application was developed by the author of this thesis using Prentke Romich’s Pathfinder, with assistance and feedback from therapists and clients of Novita Children’s Services.

To use this application, an end user would select the “mobile phone” icon as shown in Figure 6-9. This leads to another set of sub-activity row icons as shown in Figure 6-10. Selecting the activity-row ICONS with already pre-programmed GSM AT commands attached to it can perform the tasks of voice calls and text messaging. All AT commands are hidden from the user. The user can opt to perform direct dialling of pre-stored numbers, or single digit dialling of new numbers. Figure 6-11 depicts the activity-row icons that that would have appeared when “dial numbers” (single digit dialling) was selected. Upon selecting the “dial numbers” icon, the user is prompted to enter the number of person the user wants to call and the call is initiated by selecting the “make call” icon as shown in Figure 6-12. Selection of icons can be done via the dynamic touch-screen of the Pathfinder or other access methods such as a joystick or single switch scanning.

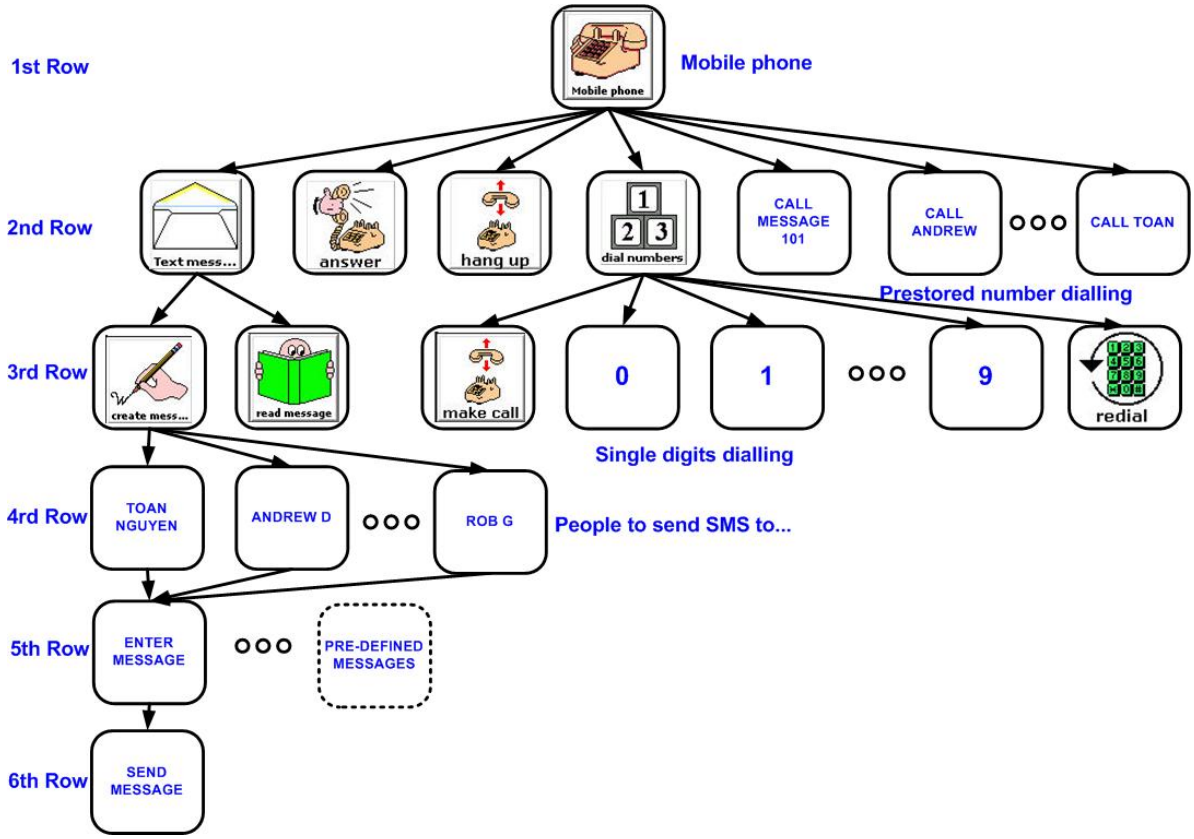

Figure 6-8 Structural layout of activity-row icons programmed on the Pathfinder.

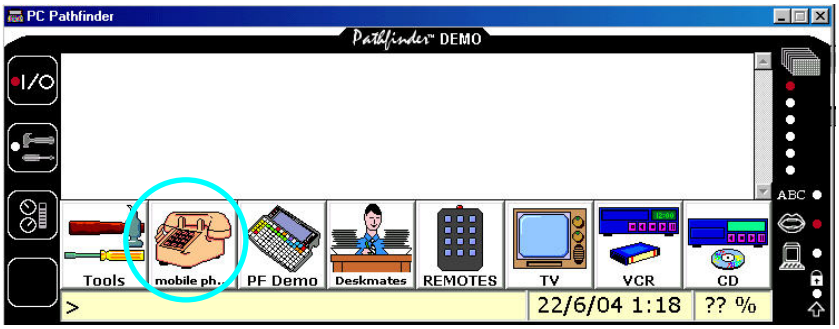

Figure 6-9 First activity-row icons on the Pathfinder.

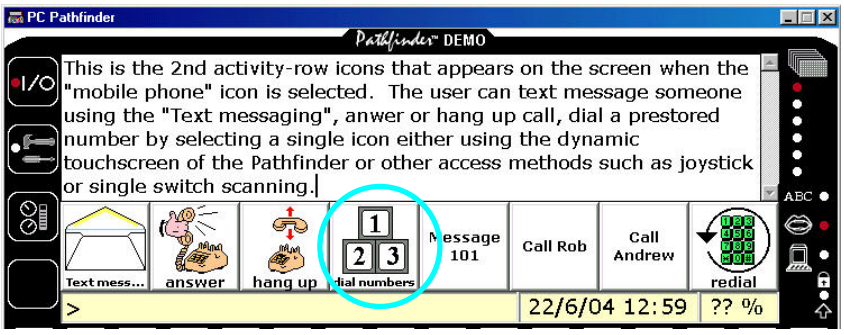

Figure 6-10 Second activity-row icons on the Pathfinder.

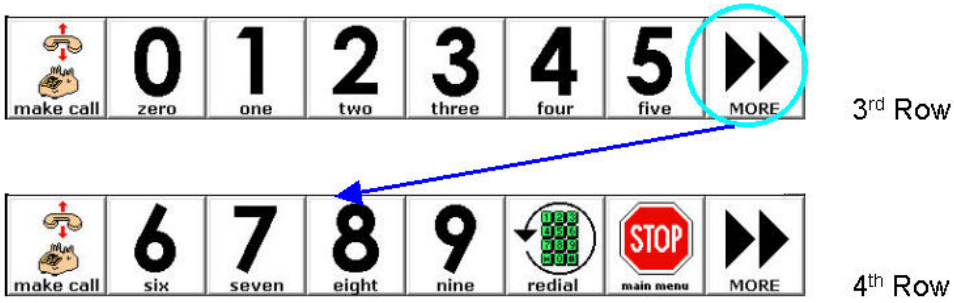

Figure 6-11 Activity-row icons for single-digit dialling.

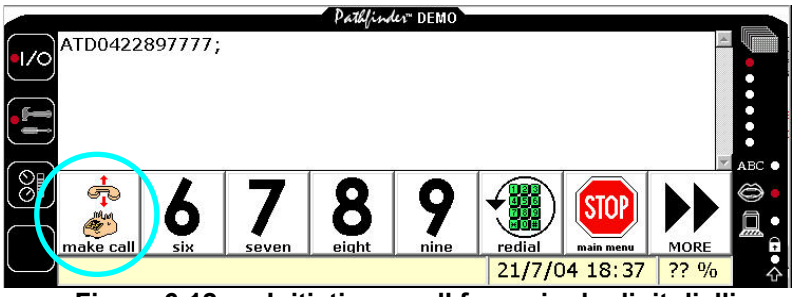

Figure 6-12 Initiating a call from single-digit dialling.

For an end-user who can create conversational sentences using either MinSpeak[82] (Unity[83] or Adult Quick Learning System (AQLS[84])), Icon Prediction or Word Prediction on the Pathfinder adequately, one-to-one conversion should be achievable but may be slow, as indicated by Cornish and Higginbotham (2000). However, for those users who employ single switch scanning methods, one-to-one conversation would not be feasible since creating conversational sentences on the Pathfinder would be extremely slow. For these people, predefined greetings, or common conversational phrases, would be more suitable.

Text messaging follows a sequence of icon selections, which prompts the user to select the person to whom they wish to send an SMS message, to enter the text message, and to then send it as depicted in Figure 6-8. Again, all of the AT commands, as well as the Message Service Centre number, are hidden from the end user. For text messaging, a user can opt to create the text message and link it to the 5th row as shown in Figure 6-8 prior to using the "text message" function. Alternatively, the user can compose it live since time is not as an issue in this situation and it doesn't matter how long the user takes to create the message.

6.3.3 System's limitations

The physical set up in Figure 6-6 is limited to each device's capability. Firstly, the inbuilt modem of the phone can only accept GSM AT commands that have been pre-programmed into it. The particular inbuilt modems for the two test phones, the Nokia 6310i and Sony Ericsson T610, incorporate all the required GSM AT commands necessary for voice calls and text messaging, as confirmed in Section 6.2.2.3. However, this is not the case for all mobile phone brands or models.

Secondly, the Pathfinder used for the project does not accept ASCII string inputs through its serial or infrared port. Therefore, responses from the phone's modem can't be shown on the Pathfinder's dynamic display. The end-user would have to physically press a single button

[82] MinSpeak is a method of accessing language through the use of short sequences of multi-meaning icons.

[83] Unity is a program which includes two integrated versions – "Single-Hit" and "Sequenced" vocabulary. For Single-Hit, one key selection produce a word, while with Sequenced vocabulary, two or more keystrokes generate a word as well as allowing access to expanded vocabulary.

[84] AQLS is a program that allows individuals to start quickly and generate language spontaneously with minimum keystrokes.

on the phone to display any incoming text message on the mobile phone screen or ask a carer to assist them. However, for phones that support the Keypad Control (+CKPD) AT commands mentioned in Section 6.2.3.2, and Table 3 of Appendix 6-4 and which can emulate key presses of the buttons on the keypad, opening an incoming message is achievable from the Pathfinder, as tested and discussed in Section 6.3.4.

Finally, the system may be limited by the physical set-up or mounting of the equipment on a user's wheelchair. The two scenarios that need consideration are the private (closed) conversations, and public (open) conversations, of system users who are restricted to a wheelchair. Private conversations would be more challenging to deal with it. The phone has to be mounted on the wheelchair in such way that it is at ear level so that the person can tilt their head to listen to the person on the other phone while, at the same time, being able to see any text messages on the phone's screen. Although cord/cordless headsets could help alleviate this problem, it may be hard for users to attach the headset themselves and the assistance of another person or carer would often be required. This partially defeats the desire for independence by people in this situation. There is also an issue of "comfort" in having the headsets on the ear at all times.

For public conversions, it is less challenging as solutions such as the car kits identified in Chapter 2 and trialled in Chapter 5, provide the speakerphone (hands-free) function. The outstanding issue for this case is mounting the speakerphone in such way that no echoing effect occurs between the speaker and the microphone of the speakerphone system.

Apart from the limitations mentioned, successful use of the system requires the pre-programming of the Pathfinder in readiness for engaging in a conversation. For a Pathfinder user who can physically create conversational sentences from the Pathfinder's keyboard, this is not an issue. However, for people with severe disabilities who can only access the Pathfinder via a single switch scanning method for creating conventional speech, this can be a problem. In particular, having predefined messages ready prior to using SMS could be beneficial in emergency situations for people who use a single switch scanning method.

6.3.4 Testing and Validation

Testing of the "AAC device to Mobile Phone System" was carried out on a Pathfinder supplied by Novita Children's Services and the two test phones shown in Figures 6-13 and 6-14. Two connection methods were initially tested - serial connection and an infrared connection to the mobile phone. The third connection method, Bluetooth, was also tested as shown in Figure 6-15.

The tests were similar to that carried out using the computer HyperTerminal application as discussed in Section 6.2.3. The testing parameters (tasks) and the validation outcomes for all three connection methods are shown in Table 6-3.

The Bluetooth connection method proved as reliable as the serial and infrared connection. Once the Bluetooth connection is established it was permanent. In addition, Bluetooth connection proved to be a superior option as it replaces the cable and does not have the physical interference limitation associated with the infrared option.

Figure 6-13 Sony Ericsson T610 to the Pathfinder via serial cable.

Figure 6-14 Nokia 6310i to the Pathfinder via Infrared.

The test results proved very successful for all the intended functions to be implemented onto the “AAC device to Mobile Phone System” with the Sony Ericsson T610 but not for the Nokia 6310i, which failed to perform one of the intended functions, namely to read or open a text message received on the phone. This reinforces the fact that not all phones, even those considered advanced at the time of the trial, support the necessary GSM AT commands to control the phone. Since manufacturers do not clearly specify what GSM AT commands are implemented on their phone models, or make the information readily accessible, physical testing of the particular phone may be the only certain way of revealing which GSM AT commands are implemented on it.

Figure 6-15 Free2move Bluetooth adapter connected to the serial port of the Pathfinder to provide wireless connection and control of the Sony Ericsson T610.

For phones that support the Keypad Control (+CKPD) AT commands that can emulate key presses of the buttons on the keypad, opening an incoming message is achievable depending on the keypad layout on the particular phone. For phones that implement +CKPD AT commands for the “soft key 1” (AT+CKPD=“[“,5,1) and “soft key 2” (AT+CKPD=”]”,5,1) it is also possible to open incoming messages. Testing carried out on the Motorola V600 and Sony Ericsson T610 showed that this was possible with the two “select/option” commands. This finding was significant for the interfacing system, as it confirmed that total control of voice calls and text messaging on the phone via an AAC device was possible. In addition, these two commands were successfully used to turn/off the speakerphone available on the Motorola V600, and to turn on the digital camera to take and store pictures. The successful development and demonstration of this capability is regarded as a significant step in opening up new opportunities for persons with a severe disability and complex communication needs.

Tasks	Commands sent		Outcomes (passed/failed)
Making a voice call (to Toan's mobile phone)	***ATD0400182611*** ***ATD"+61400182611";*** ***ATD>53;*** ***ATD> "Toan";***	(direct number dialling) (number string dialling***)*** (memory location dialling) (name saved in memory dialling)	Passed for both phones
Answering an incoming call	***ATA;***	(answer in coming call)	Passed for both phones
Terminating a call	***ATH;***	(terminate call)	Passed for both phones.
Voice calls via "voice dialling" feature	***AT+CKPD="S", 5,1***	(activate voice dialling mode)	Passed for Sony Ericsson T610 Failed for Nokia 6310i
Sending a text message	***AT+CMGF=1*** ***AT+CMGW = "+61400182611"*** (sent message to Toan) **AT+CSCA="+61418706700" (**Message Centre Service no.) ***>I'll be 15 mins. late to the meeting.*** ^{c}c	(set phone to text mode)	Passed for both phones
Receiving and opening a text message	***AT+CKPD= "[", 5,1***	(using keypad control command to open message)	Passed for Sony Ericsson T610 Failed for Nokia 6310i

Table 6-3 Outcomes from testing carried out with the "AAC device to Mobile Phone System" for the Sony Ericsson T610 and Nokia 6310i using serial, infrared and Bluetooth connection.

N.B: "^{c}*c" is the Ctrl+Z buttons to a send message and "[" the character codes for "soft key 1" function for keypad control (Appendix 6-4).*

In addition to testing the two mobile phones in Figures 6-13 and 6-14, the testing of the complete "AAC device to Mobile Phone System" with the inclusion of a car kit system was also carried out. The addition of this component equips the system with the options of hands-free operation, or voice only control, as described in Chapter 5 and in Appendix 5-1. The Hands-free operation system testing was carried out using the Nokia Wireless (Bluetooth) Car Kit as depicted in Figure 6-16. There was an option to operate the system via the Pathfinder or via the car kit's control button for voice dialling. The "voice only control" system consisted of a Sony Ericsson T610 phone and Ericsson's Advanced Car Kit.

Testing of the "voice only control" system via the Pathfinder's synthesised speech output proved very successful for voice calls. Text messaging using the Pathfinder for this system also proved very effective. The commands used for testing are the same to that in Table 6-3. Similar results were obtained for the testing of the "hands-free operation system" in Figure 6-15.

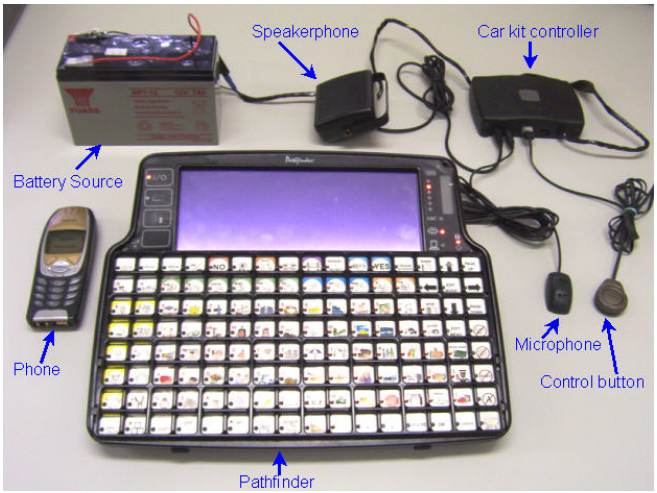

Figure 6-15 Components of "AAC device to Mobile Phone System"

Working models of the above two systems were successfully demonstrated at a pre-conference workshop and in a paper presented at the Australian Rehabilitation & Assistive Technology Association (ARATA) 2004 Conference held in Melbourne on the 1st to the 4th June (ARATA, 2004). Conference delegates included people with an interest in the field of rehabilitation and assistive technology namely, Occupational Therapists, Speech Therapists, Rehabilitation Engineers, Researchers, end-users and carers. The majority of the people present at the workshop and presentation were interested in the two systems and made enquiries regarding the availability of the systems for their clients or people they believed would benefit from them.

A copy of the paper presented at this conference entitled “Mobile phone access via an AAC device”, is published in the ARATA 2004 Conference Proceedings[85].

To date, testing of the systems had only been carried by the researchers involved in this project. Validation of the system with end users is the next step in the development of the system and will be undertaken by Novita Children’s Services Inc of South Australia.

6.3.5 Future work and directions

The current system functions sufficiently well to cater for voice calls and sending text messages. However to produce an ideal system, the ability to display incoming text messages received by the phone on the Pathfinder’s dynamic display has yet to be resolved. This is future work to be taken by researchers at NovitaTech, a division of Novita Children’s Services Inc.

With the current small size screens on most mobile phones, it would also be difficult for some AAC device users to read the text message displayed on it unless the users have the phone mounted in front of them. As an alternative, a Liquid Crystal Display (LCD) unit could be incorporated to display any responses from the phone and text messages sent out and received on the phone. This would be achievable through the use of a microcontroller unit (TA), integrated under the TE cover and the mobile phone (ME) as a separate entity as shown in Figure 6-11.

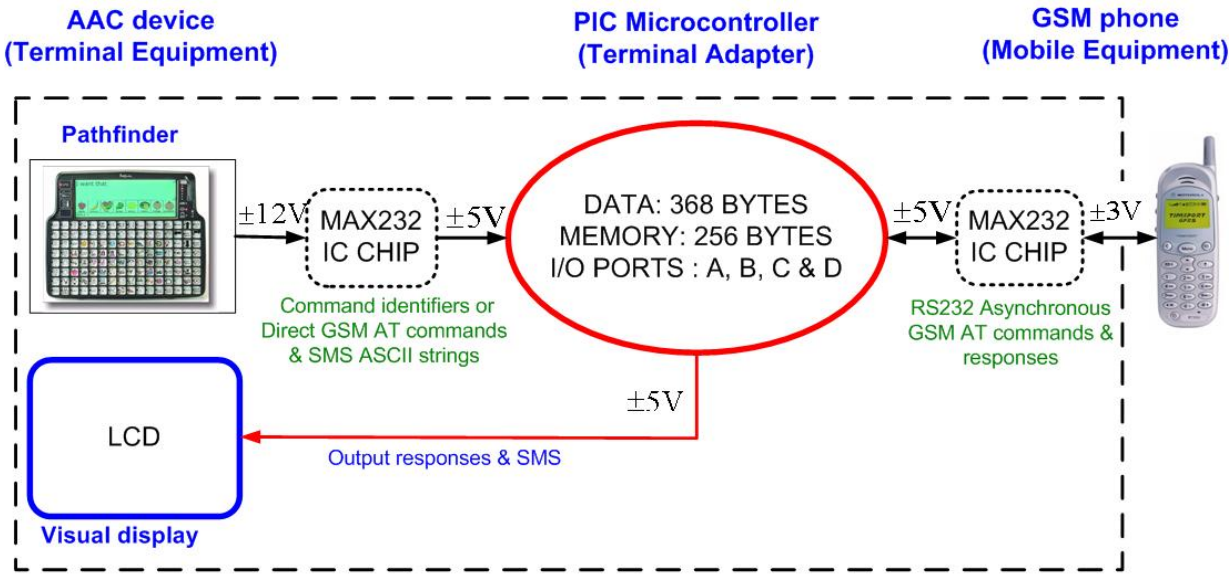

Figure 6-16 Interfacing system between an AAC device and a mobile phone

[85] www.e-bility.com/arataconf/abstracts/nguyen.html

In addition to AAC devices use, the system could also cater for a multi/single switch or keyboard interface that sends out command identifiers or ASCII string AT commands to control the mobile phone. Audible feedback from the system could also be implemented.
Since different devices operate at different input/output voltages, a voltage conversion Integrated Circuit (IC) chip such as the standard MAX232 chip would also required. A full description of the design specification for further development of this system can be found in Appendix 6-8.

6.4 Conclusion and Recommendations

The work undertaken in this chapter has successfully demonstrated that, with an appropriate interfacing system in place, AAC device users could interact with and independently operate a mobile phone via their existing AAC device using different modes (serial, infrared or Bluetooth) to:

- Initiate a voice call;
- Answer an incoming call;
- Terminate a call; and
- Send and receive text messages.

In addition, it is confidently predicted that other features on the phone such as speakerphone, digital camera and FM radio can be controlled via the AAC device. All this was made possible through the use of GSM AT commands implemented on high-end mobile phones with a built-in modem. These commands, once programmed onto an AAC device (eg a Pathfinder from the Prentke Romich Company), replaces the key presses on the keypad that a person would have to carry out to perform a particular function on the mobile phone.

The successful development and demonstration of this capability is regarded as a significant step in opening up new opportunities for persons with a severe disability. It would enable people with disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community through the use of the mobile phone. This further supports the research's hypothesis *that, despite very limited mobility, speed, accuracy or vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bi-directional communication with systems to which they choose to connect*.

The system developed for the research, and any future systems developed, are limited by the GSM AT commands implemented on the mobile phone's modem. ***Not all*** GSM AT commands are implemented on all mobile phones, since most are optional as described in the ETSI GSM 0.7.07 standard. Each mobile phone manufacturer decides which commands are appropriate to be implemented onto a particular mobile phone and which are not.

Therefore, to provide accessible mobile communication for people with disabilities and to meet accessibility obligations specified by the DDA, it is recommended that:

1. Mobile phone manufacturers make mobile phones with built-in modem that are equipped with the necessary GSM AT commands to enable voice calls, text messaging, and keypad control of the phone via an external device.
2. Mobile phone manufacturers clearly define the GSM AT commands implemented on each phone and that this information be made accessible to the general public.
3. Organisations that represent the interests of telecommunications consumers with disability such as the Telecommunications and Disability Consumer Representation (TEDICORE) or the Australian Consumer Industry Forum (ACIF) Disability Advisory Body (DAB) ensure that the necessary GSM AT commands to operate a mobile phone via an external device be made a priority and be communicated to the manufacturers and included in any future telecommunications standards development.

Chapter 7

OVERALL CONCLUSIONS AND RECOMMENDATIONS

Access to telecommunications equipment is of vital importance to people with physical disabilities. Unfortunately, as technology is continually and rapidly advancing, and mobile phones are shrinking in size, the gap between people with disabilities and telecommunication technology has grown. This has been further exacerbated by the lack of knowledge of users and therapists, and the insufficient information available on the features and solutions that are suitable for people with disabilities. For many people with severe physical disabilities or complex communication needs, the lack of a suitable interfacing to a mobile phone is the largest impediment.

Findings from the review of the literature in Chapter 2 indicated that mobile phone solutions existed for people with disabilities in various forms across different mobile phone models and manufacturers. However, there was still a lack of universal telecommunications standards that specified the features that should be implemented on mobile phones to meet the needs of people with disabilities. Although legislators and regulatory bodies within Australia are gradually ensuring equitable and accessible telecommunications services and equipment for people with disabilities, the development of telecommunications standards is an area that is lagging behind. With mobile phone manufacturers continuing to develop their own in-house standards and protocols for the operation of the phone and associated equipment, any future implementation of a universal telecommunications standard is likely to be voluntary. The inclusion of standardised mobile phone features which are particularly suited for people with disabilities would also allow better access to telecommunications equipment by all people through the increased application of universal design principles. In addition, peak disability consumer organisations should encourage universal access for all by setting out principles and best practice guidelines in telecommunications access for people with a disability in Australia.

Through the involvement of clients from Novita Children's Services, and in a focus group session, survey questionnaire, trials of telecommunications options and the development of an interface system to the mobile phone, this project has addressed four of 8 major principles espoused by Astbrink (2002b). The four principles for specific technical Disability Standards which list quantifiable features for telecommunications customer equipment and that were identified in this project as being of particular significance and relevance, were: (1) telecommunications products to be accessible to all, (2) interoperability between mainstream and specialised products, (3) stakeholder involvement in the design of products, and (4) provision of future technologies.

The outcomes of the focus group and survey questionnaire showed that:

- Apart from general difficulties in performing essential tasks on current phones efficiently, most people with a disability are *not aware* of the available technology, and if they are, *do not use it to the fullest extent*;
- There was a strong need for hands-free operation of the phone through the use of speakerphone function and/or voice recognition, especially for people that have reduced strength in their arms and hands and are restricted to a powered wheelchair The survey results showed that people restricted to a powered wheelchair (who generally have severe disabilities) experienced great difficulties in carrying out essential tasks such as answering an incoming call, dialling a number, lifting the phone, holding the phone and terminating a phone call;
- There was a need to make access to mobile phones easier through existing solutions and alternative options or the development of an interfacing system to make the use of mobile phones more accessible for people with disabilities.

These findings have contributed a significant body of information, not previously available, on some of the access issues and needs of people with disabilities, from the end users' perspective, relating to mobile and home phone use. The findings had laid the foundation for the succeeding work carried out in Chapters 5 to trial new technological options with end users and to develop solution(s) that can support the communication needs of people with disabilities in Chapter 6.

Outcomes from the trials of new technological options for people with disabilities of Chapter 5 have demonstrated that:

- Nine out of ten participants experienced high to very high levels of overall performance and satisfaction with the use of the telecommunication equipment provided.
- Current, off-the-shelf telecommunications equipment **can** enable people with disabilities, even severe physical disabilities, to access the telecommunications network.

The success of these trials was due to an in-depth knowledge of existing mobile phone technology options and features, a clear understanding of each participant's telecommunication needs and abilities, and the appropriate matching of the technology and training provided to an individual. This individualized matching, and the users' first hand experience of the benefits that the technology could bring, have led to 4 of the 10 participants purchasing the solution that was tailored for them. This is a sign of increased confidence and independence that will lead to improved lifestyle and social interaction.

The findings were significant and indicated that *people with a range of physical disabilities can use and should have equal access to telecommunication equipment and services.*
With the right policies, processes and support (appropriate user skill and equipment matching, education, training and delivery) in place, solutions can be found. This research and trial was successful in demonstrating that current off-the-shelf solutions *can* help alleviate problems and improve the lifestyle, social interaction, security and independence of many people with physical disabilities.

It was apparent, however, that the disability community must be made much more aware of the technology and the advantages and opportunities it can offer. The current lack of education and awareness by the disability community is the main problem that prevents people with physical disabilities from using and obtaining the maximum benefit from telecommunications. This was demonstrated in the focus group session and survey questionnaire outcomes. Prior to the trials, education and training played a vital role in increasing the performance and satisfaction of ninety percent of the participants during and after the trial. This applied to participants who were both current or non-current telecommunications users, and to their therapists and carers.

It is therefore imperative that organisations and telecommunications providers interact with people with disabilities and put appropriate educational programs in place to demonstrate to people with physical disabilities the solutions that are applicable to them. Additionally, they should also have some form of "assessment of need and matching of available technology" procedure in place when dealing with people with disabilities wanting access to telecommunications equipment.

The work undertaken in the development and implementation of an interfacing system for AAC device users to access the mobile phone and independently operate a mobile phone via their existing AAC device for voice calls and text messaging was successfully demonstrated. In addition, it is confidently predicted that other features on the phone such as speakerphone, digital camera and FM radio can be controlled from the AAC device.

The successful development and demonstration of this capability for the first time is regarded as a significant step in opening up new opportunities for persons with a disability, severe disabilities or those people with complex communication needs. It would enable people with disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community through the use of the mobile phone. This work and other outcomes from the research of this thesis have strongly supported the main hypothesis, ***that, despite very limited mobility, speed, accuracy or vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bi-directional communication with systems to which they choose to connect.***

It is envisaged that through the implementation of the recommendations made throughout the various chapters of this thesis would be a step closer to narrowing the telecommunications access gap that currently exists for people with disabilities. With the proper mechanisms and educational programs including workshops or training sessions in place to educate therapists, clients and carers on how to effectively assess, use and access current telecommunications services and equipment, and the development of tailored interface devices, full access to the telecommunications services and equipment could be achieved. Regulators, manufacturers, designers and consumer advocates will no doubt play an important role in the provision of accessible mobile telecommunications for people with disabilities.

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APPENDICES
Appendix 1 Glossary of Acronyms and Technology

AAC — Augmentative and Alternative Communication is any communication, which supplements or augments speech, including words, sign systems and written symbols. The user indicates the symbols needed from a book, chart or electronic aid. It attempts to provide those with severe expressive disorders with an efficient communication system

AAD — The Australian Association of the Deaf Inc. (AAD) is the national peak organisation for Deaf people in Australia. It represents the views of Deaf people who use Auslan (Australian Sign Language).

ABS — Australian Bureau of Statistics

ACA — The Australian Communications Authority is a regulator of the telecommunications industry. Its role is to help create an environment where industry growth and technological change result in innovation and competition that drives down prices and improves services, but where the interests of consumers are protected. This includes people with disabilities.

ACE — Australian Communication Exchange is a Commonwealth regulatory authority for telecommunications and radio communications established under the Australian Communications Authority Act 1997.

ACMA — The Australian Communications and Media Authority. ACMA will assume the existing responsibilities of the ACA and the Australian Broadcasting Association (ABA) — regulating broadcasting, online content, radiocommunications and telecommunications.

ACIF — Australian Consumer Industry Forum. ACIF is an industry owned, operated and resourced company established in 1997 by the telecommunications industry to implement and manage communications self-regulation within Australia.

ARATA — Australian Rehabilitation & Assistive Technology Association is a national association whose purpose is to serve as a forum for issues in rehabilitation and assistive technology.

ASCII — American Standard Code for Information Exchange – world-wide standard for the code numbers used by computers to represent all the upper and lower-case Latin letters, numbers, punctuation, etc.

AT — AT stands for ATtention, and is the first word a GSM AT command to attract the attention of devices during communication between the two devices.

CAUS — The Communication Aid User Society Inc. defends the right of all people with Communication or speech impairment to express themselves and be listened to.

CCA — The Crippled Children's Association of South Australia Inc. providing therapy, equipment and home support services to South Australian children and young people with physical disabilities. CCA changed its name to Novita Children's Services Inc., in 2004.

CDMA Code Division Multiple Access is a spread spectrum approach for the digital transmission of data/voice over radio frequencies.

CTN The Consumers' Telecommunications Network is a national coalition of community organisations which represents community interests on national telecommunications issues. CTN is an important voice promoting better access, quality of service and affordability of telecommunications services for residential consumers.

CLI Calling Line Identification. Also known as “caller ID”. This is a network feature that once activated can be switched off and on through most handsets. It allows for callers’ numbers to be displayed on the screen of the phone before the call is answered, unless the caller has a silent number or has disabled this feature.

DAB The Disability Advisory Body provides professional advice to ACIF regarding the implications for telecommunications consumers with disabilities of ACIF's proposed Codes and Standards.

DDA The Disability Discrimination Act 1992. Is a law which can be used to stop people with a disability from being treated less fairly than people without a disability. It does not matter what disability you have. Relatives, friends and carers of people with a disability are also protected by this law if they are discriminated against.

DCITA The Department of Communications, Information Technology and Arts The Department provides strategic advice and professional support to the Australian Government on a wide range of significant and rapidly changing policy areas including: arts and culture, broadcasting and online regulation, information and communications technology, information economy, intellectual property, post, sport and telecommunications. The Department also administers legislation, regulations, grants, and incentives to industry and the wider community.

DCE DCE stands for Data Communication Equipment, as defined by the RS-232 specification. The basic function of a DCE is to convert data from one interface, such as a digital signal, to another interface, such as an analogue signal. One example of DCE is a modem.

DTAN The Deaf Telecommunications Access and Networking has been a project of the Australian Association of the Deaf (AAD) since October 2001 with funding under Section 593 of the Telecommunications Act 1997.

DTE DTE stands for Data Terminal Equipment, as defined by the RS-232 specification. Examples of DTE are computers, printers, and terminals.

ECU An environmental control unit (ECU) a piece of technology that allows a person to control aspects of their environment (e.g. temperature, humidity, lighting, window blinds) and provide access to electronic media technology (e.g. radio, CD player, television etc).

EMS Enhanced Messaging Service is an application-level extension of SMS for cellular phones. An EMS-enabled mobile phone can send and receive

messages that have special text formatting (such as bold or italic), animations, pictures, icons sound effects and special ring tones.

ETSI — European Telecommunications Standardization Institute. The European standardization body for telecommunications. It is an independent non-profit organization whose work is carried out by technical working groups consisting of telecommunications companies, manufacturers, regulatory authorities and other parties in the sector.

FCC — Federal Communications Commission is the government agency responsible for regulating telecommunications in the United States, located in Washington, D.C. Their responsibilities include public radio communications, such as cellular, include allocation of frequencies, the development of regulations that govern their use and monitoring to ensure that regulations are followed.

GPRS — General Packet Radio Service a packet-based data transfer technology that provides increased capacity and higher data rates (from 56 up to 114 Kbps) for quick access to the mobile Internet.

GSM — Global Systems for Mobile Communication is a standard for digital cellular phone service in over 85 countries. It is used on the 900 MHz and 1800 MHz frequencies in Europe, Asia and Australia, and the 1900 MHz frequency in North America and Latin America.

HCO — Hearing Carry Over enables people with a speech impairment to listen to the telephone conversation of another person and type their responses on a TTY.

HSCSD — High Speed Circuit Switch Data is an enhancement to GSM networks that enables data speeds to be boosted from 9.6kbps in multiples up to 57.6kbps.

HREOC — The Human Rights and Equal Opportunity Commission is a national independent statutory government body, established in 1986 by an Act of the federal Parliament, the *Human Rights and Equal Opportunity Commission Act*. It endorsed the importance of telecommunications issues for people with disabilities.

IRA — International Reference Alphabet (formerly International Alphabet No. 5) is the standard code used for information interchange among data processing systems, data communications systems, and associated equipment. ASCII is the IRA version in the United States.

IrDA — The Infrared Data Association, which sets standards for using infrared transmission to transfer data between electronic devices (eg computers and other peripherals and devices) through the air, with no cables or wires.

ME — Mobile Equipment (e.g. a mobile phone).

MMC — MultiMedia Card is the latest storage medium (flash memory) for digital cameras, MP3 players and mobile (cell) phones.

MMS — Multimedia Service is a store-and-forward method of transmitting graphics, video clips, sound files and short text messages over wireless networks using the WAP protocol. MMS also supports e-mail addressing, so the device can send e-mails directly to an e-mail address, but MMS does not support attachments as email does.

MP3	MP3 is short for MPEG3, which stands for Motion Picture Experts Group, Audio Layer 3. It is a popular file format for music because it produces CD-quality sound in a highly compressed file. The technology creates sound files a tenth the size of standard CD music files with very little loss of sound quality.
PDA	A Personal Data Assistant is a portable computing device capable of transmitting data. These devices make possible services such as paging, data messaging, electronic mail, computing, facsimile, date book and other information handling capabilities.
SMS	SMS stands for "short message service" - a service provided by mobile phone networks that enables users to send a text message to another mobile user.
SSR	Speech to Speech Relay enables people with speech impairment to have a two-way conversation over the telephone.
TDMA	Time Division Multiple Access is a technology for delivering digital wireless service using time-division multiplexing (TDM). TDMA works by dividing a radio frequency channel into time slots and then allocating slots to multiple calls. In this way, a single frequency can support multiple, simultaneous data channels. TDMA is used by the GSM digital cellular system.
TA	Terminal Adapter is the connecting equipment between the Terminal Equipment (computer) and the mobile or home phone.
TE	Terminal Equipment (e.g. a computer).
TEDICORE	The Telecommunications and Disability Consumer Representation (TEDICORE) project commenced in 1998 when Blind Citizens Australia received a grant under Section 593 of the Telecommunications Act 1997 of $100,000 to carry out a one-year project to represent the interests of consumers with disabilities.
TSR	Text to Speech Relay enables a person who is Deaf or who has a speech/hearing impairment, and who uses a TTY or modem, to communicate directly by text to the relay service for communication with someone who speaks and hears normally.
UMTS	Universal Mobile Telecommunications System is a Third Generation (3G) mobile technology that will deliver broadband information at speeds up to 2Mbits/sec. Besides voice and data, UMTS will deliver audio and video to wireless devices anywhere in the world through fixed, wireless and satellite systems.
VCO	Voice Carry Over enables people with hearing impairment to use their natural speech to communicate with a hearing person over the telephone and read the responses on a TTY.
WAP	Wireless Application Protocol is a secure specification that allows users to access information (from the Internet) instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smartphones and communicators.

Appendix 2 Review of the Literature on Telecommunications Industry, Technologies, Services and Current Solutions

Appendix 2-1 Australian organisations with interest in telecommunications access for people with disabilities

Organisations with interests in telecommunications access for people with disabilities	Objective of the organisation
Australian Association of the Deaf (AAD)	Is the national peak organisation for deaf people in Australia. It represents the views of deaf people who use Auslan (Australian Sign Language). It is a true consumer organisation - only deaf people have the right to vote on AAD business and to be elected to the Board.
Blind Citizens Australia	The united voice of blind and vision-impaired Australians whose mission is to achieve equity and equality by their empowerment, by promoting positive community attitudes, and by striving for high quality and accessible services which meet their needs.
Communication Aid Users Society (CAUS)	Defends the right of all people with Communication or speech impairment to express themselves and be listened to.
Deafness Forum Limited	Is the peak body for deafness in Australia. Established in early 1993 at the instigation of the Federal government, the Deafness Forum now represents all interests and viewpoints of the deaf and hearing impaired communities of Australia (including those people who have a chronic disorder of the ear and those who are deaf-blind).
Physical Disability Council of Australia Ltd (PDCA)	Is a national peak organisation representing people with physical disabilities across Australia. PDCA works on a collective model, and decisions are made using a consensus approach. PDCA is entirely run by people with physical disabilities, for people with physical disabilities, and is the only organisation of its kind in Australia.
Women with Disabilities Australia (WWDA)	Was formed in 1995 by a group of women with disabilities who believed that the needs and issues of women with disabilities in Australia were not being acknowledged or addressed. They were concerned to explore issues of sexuality and sexual identity; to challenge stereotypical images and oppressive mores relating to child-bearing and rearing; to actively promote the participation of women with disabilities in all aspects of social, economic, political and cultural life.

Table 1 Australian organisations with interest in telecommunications access for people with disabilities

Appendix 2-2 Mobile phone with features suitable for people with disabilities

The following lists some mobile phones with features that are considered suitable for people with disabilities. Information was taken from the manufacturer's specification and user guides. This list was current at 1st October 2004.

Features	Nokia	Sony Ericsson	Motorola	Others
Speed dialling	6310i, 3650, 7250i, 6600, 6610, 6820, 7610, 6230	T68i, T105, T610, T630, T600, T230, P800, P900, K700i, K500i	E398, V600, V80	Panasonic X 70 Siemens (SX1, S55, S65), i-mate Pocket PC & SmartPhone 2
Voice dialling	6310i, 3650, 6600, 6610, 6820, 6230, 7610	T68i, T610, T630, P800, P900, K700i, K500i	E398, V80, V600	Siemens (SX1, S55), i-mate Pocket PC, & SmartPhone 2, Panasonic X 70
Voice answering (with Car kit and personal hands-free)	6310i*, 6600*, 6610*, 6820*, 6230*, 3650*, 7610*	T68i, T610,T630, P800, P900, K700i, K500i *(These models are also **magic word**+ compatible)*	-	-
Any key answering	6310i, 6600, 6610, 6820, 6230, 3650, 7610,	T68i, T610, T630, P800, P900	E398, V600, V80	-
Vibrate alert	6310i, 3650, 6600, 6610, 6230, 6820, 7610	T68i, T610, T105, T600, T230, T630, P800, P900, K700i, K500i	E398, V600, V80	Siemens (SX1, S55, S65), i-mate Pocket PC & SmartPhone 2, Panasonic X 70
Predictive text	6310i, 7250i, 6600, 6610, 3650, 6820, 7610, 6230	T68i, T105, T610, T600, T630, T230, P800, P900, K700i, K500i	E398, V600, V80	Siemens SX1, S55, S65, i-mate SmartPhone 2, Panasonic X 70
Speaker phone	6600, 6610, 6820, 7610, 6230	P800, P900, K700i, K500i	V80, V600, E398	Siemens (SX1, S55, S65), i-mate Pocket PC & SmartPhone 2, Panasonic X 70
Enhancements				
Hands-free (Cordless) Headset	6310i, 7250i, 3650, 6600, 6610, 6820, 6230	T68i, T610, T630, P800, P900, K700i	E398, V80, V600	Siemens (SX1, S55, S65), i-mate Pocket PC,
Car Hands-free kits	6310i, 7250i, 3650, 6600, 6610, 6820, 6230	T68i, T610, T630, T230, P800, P900, K700i, K500i	E398, V80, V600	Siemens (SX1, S55, S65), i-mate Pocket PC,
Wireless Connectivity (Bluetooth (BT) & Infrared (I/R))	6310i, 7250i, 6600, 6610, 6230, 3650, 6820, 7610	T68i, T610, T630, P800, P900, K700i, K500i	E398 (BT), V600 (BT), V80 (BT)	Panasonic X 70, Siemens (SX1, S55, S65), i-mate Pocket PC, i-mate SmartPhone 2
Built-in modem (data/fax)	6310i, 3650, 7610, 6610, 6230	T68i, T610, T630, P800, P900 K700i, K500i	E398, V600, V80	Siemens (SX1, S55, S65), i-mate Pocket PC & SmartPhone 2, Panasonic X 70

Table 2 Mobile phones with features suitable for People with Disabilities

* These models have automatic answering option with personal hands-free kit instead of voice answering.

+ A user can program the phone to recognise a distinct word (magic word) that enables the phone's voice recognition mode to be activated without having to press a button on the phone.

Appendix 3 Focus Group session on Accessible Mobile Communications for People with Disabilities

Appendix 3-1 Questions used during the Focus Group Session

MOBILE PHONE SECTION

1. Do you currently use a mobile phone?
   If No, then I hope you will be patient while we ask some questions of the people here who do use a mobile phone
   If Yes,

2. For what purpose do you use a mobile phone?

3. What do you like about the features on your mobile phone?

4. What do you dislike about the features on your mobile phone?

5. What problems/difficulties do you have when using your mobile phone? For example

   - dial a number
   - carry out a conversion
   - terminate a call or hang up.

6. What would you like to be able to do with your mobile phone that you can't do now?

7. What needs to be changed to enable you to do what you want to do with your mobile phone?

HOME PHONE SECTION

8. Do you use a phone at home?
   If YES, do you have any difficulties with using the phone?

9. IF NO - What needs to be improved to enable you to use the home phone?

Appendix 3-2 Mobile Phone Access Survey Questionnaire

Please tick the box(es) that appropriately applies to you.

		Yes	No	Currently using	Don't Know
Technologies	Cordless Headset				
	Attachable QWERTY keypad				
	Personal Hands-free kit				
	Portable Computer or PDA with a mobile phone to SMS				
	Text messaging (SMS)				
	Voice mail				
	Email				
	Information searches via WAP (i.e. weather, news)				
	Other (*please specify*) …….				
Features	Predictive text				
	Voice recognition (e.g. voice dialling)				
	Speed dialling				
	Vibrate alert				
	Speaker phone function				
	Other (*please specify*) ……..				

Table 1 A small survey questionnaire used during the Focus Group discussion.

Appendix 3-3 Introduction letter, Information sheet and Consent form

Introduction letter to potential Focus Group participants

Dear …….. Date

A joint project is under way between Flinders University and NovitaTech (formerly Regency Park Rehabilitation Engineering), a division of Novita Children's Services Inc., to identify what issues exist for people with disabilities when using mobile and home phones. Accessing mobile and home phones can be a problem for people with disabilities. The aim of the project is to identify key problem areas and to establish the need for new technology. The project is being carried out by Mr Toan Nguyen, a postgraduate student of the Flinders University.

If you currently use or would like to use a mobile or home phone, we invite you to participate in a focus group. A focus group is another name for a group discussion, where the focus is to gather information on a particular topic of interest.

During the focus group people will have the opportunity to hear about and view some of the latest technology for using mobile and home phones.

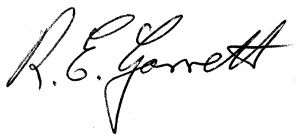
After the focus group, information will be summarised. A survey will be sent to the Novita community and used to support and confirm the findings of the focus group. This will help to determine what actions are required to overcome some of the barriers that clients are having when using mobile and home phones.

More information on this focus group can be found on the Information Sheet attached.

Novita's Clinical Research Committee has approved this focus group.

We encourage you to take part in the focus group to assist this valuable research project. If you would like to take part in the focus group discussion, please sign the consent form and send it in the Reply Paid envelope provided. Whether you decide to participate or not, services provided by Novita will not be affected in any way. Thank you for your consideration.

Regards,



Rob Garrett
Manager, Research and Development

Information Sheet for Focus Group participants

The focus group will involve an informal discussion about the issues that people are currently having or have had in the past when using mobile phone and home phones. It will give people the opportunity to express their opinions and experiences, which may include views on assistive technology that has been tried and/or experiences with operating phones via electronic communication devices. It will also allow people to gain a better understanding of existing technology that is designed to aid access to mobile and home phones.

The focus group discussion will try to find answers to questions such as:

- How are people currently using mobile and home phones?
- What problems are people having when using phones?
- What works? What doesn't?
- What changes have people made to home phones or to mobile phones that are making them easier to use?

Participants' contributions will help guide future planning for mobile and home phones.

Participants will receive $30 for their time. It is estimated that the focus group will run for 1.5 hours. The date for the focus group will fall on a weekday between the 18th of February and 1st of March, 10am at the Regency Park Centre. The date and room will be set once sufficient confirmations have been received. The cost of transportation to and from the Regency Park Centre will be covered by Novita.

All discussions and activities that take place during the focus group will be kept confidential in a secure place and is password protected. The findings may be published, but no names will be connected to the specific results.

Participants can withdraw from the focus group discussion at any stage. Services provided by the Novita Children's Services Inc. and NovitaTech will not be affected in anyway.

If there are any questions, please feel free to contact any of the people below.

Mr. Rob Garrett, Manager, Research & Development,
NovitaTech, PO Box 2438, Regency Park SA 5942. Phone: 08 8243 8263

Mr Toan Nguyen, Postgraduate Student, School of Informatics and Engineering, The Flinders University of South Australia GPO Box 2100, Adelaide SA 5001. Phone: 08 8201 5158 or 8201 3602.

Mr Michael Bebb, Senior Speech Therapist
ATS, Independent Living Centre of South Australia. Phone 08 8243 8357

Consent Form for Focus Group participants

The Novita Children's Services Inc.,
Consent Form for Focus Group participation

I _____

hereby consent to my involvement in the Focus Group discussion entitled: Using Mobile and Home Phones

1. The nature and purpose of the Focus Group discussion described on the attached Information Sheet has been explained to me. I understand it, and agree to taking part.

2. I understand that I may not directly benefit by taking part in this Focus Group discussion.

3. I understand that while information gained in the Focus Group discussion may be published, I will not be identified and information will be confidential.

4. I understand that I can withdraw from the Focus Group discussion at any stage and that this will not affect medical care or any other aspects of my relationship with Novita Children's Services Inc.

5. I understand participants will receive $30 for their time. It is estimated that the focus group will run for 1.5 hours. The cost of transportation to and from the Regency Park Centre will be covered by Novita.

6. I have had the opportunity to discuss taking part in this Focus Group discussion with a family member or friend and/or have had the opportunity to have a family member or friend present whilst the research project was being explained by the researcher.

7. I am aware that I should retain a copy of the Consent Form, when completed, and the Information Sheet.

The names of the contact person(s) are on the information sheet if you have any questions.

Signed: .....

Full name of Participant: .....

Dated:.....

I certify that I have explained the study to the participant and consider that he/she understands what is involved.

Signed: .....

Title: .....Dated: .....

Appendix 4 Survey on Accessible Mobile Communication for People with Disabilities

Appendix 4-1 Mobile and Home Phone Needs Analysis Survey

Section A: Mobile Phone Needs Analysis

Part A – General Information – You and the technology.

1. Do you use an Alternative and Augmentative Communication (AAC) device? Yes ☐ No ☐

If yes, please specify type……..…..

2. Do you use a wheelchair? Yes ☐ No ☐

If yes, please indicate: Powered ☐ Manual ☐

3. Which of the following portable electronic devices do you use?

☐ Desktop computer
☐ Laptop / portable PC
☐ Personal Digital Assistant (PDA)
☐ Other, please specify type
……

3a. If you answered "yes" to any of the above, please indicate where you use it?
(*Please mark* **(☒)** *all that apply*)

☐ Home
☐ School
☐ Work
☐ Other, please specify
……

4. Do you have access to the Internet at home? Yes ☐ No ☐

5. Do you have access to or use a mobile phone? Yes ☐ No ☐

If yes, please specify (*brand and model, for example Nokia 3310)*……..……..

Part B – Use of Mobile Phone

Please rate the importance of the following:

Purpose of use:	**Very important**	**Quite important**	**Not important**	**Don't Know?**
(a) Voice-to-voice communication	☐	☐	☐	☐
(b) Sending and receiving text messages (SMS)	☐	☐	☐	☐
(c) For emergencies or security purposes (for example, to call an ambulance, taxi or the police)	☐	☐	☐	☐
Purpose of use:	**Very important**	**Quite important**	**Not important**	**Don't Know?**
(d) Access to the information services available (for example, sports, weather and news)	☐	☐	☐	☐
(e) Other (please specify), ……	☐	☐	☐	☐

**** If you are not currently using a mobile phone, please skip to PART E.****

Part C – Accessibility for Mobile Phone Users

Please indicate the ***ease*** with which you can perform the following tasks **ON YOUR OWN** by marking (☒) the appropriate box:

Tasks	ON YOUR OWN					Can ONLY be achieved with help from others
	Very Easy	**Achievable**	**Very Difficult**	**Cannot be done**	**Don't know**	
1. Using the keypad	☐	☐	☐	☐	☐	☐
2. Moving through the menus	☐	☐	☐	☐	☐	☐
3. Dialling a number	☐	☐	☐	☐	☐	☐
4. Answering a call	☐	☐	☐	☐	☐	☐
5. Holding the phone for the duration of the call	☐	☐	☐	☐	☐	☐
6. Hearing the person on the other end	☐	☐	☐	☐	☐	☐
7. Talking loud enough to be heard by others	☐	☐	☐	☐	☐	☐
8. Reading the visual display	☐	☐	☐	☐	☐	☐
9. Creating an Email or text messaging (SMS)	☐	☐	☐	☐	☐	☐
10. Using the services available (for example, voicemail, information such as news, weather)	☐	☐	☐	☐	☐	☐
11. Ending a call	☐	☐	☐	☐	☐	☐
12. Recharging the phone battery	☐	☐	☐	☐	☐	☐

If you placed marks in the "**Very Difficult**" or "**Cannot be done**" boxes, could you please explain what are the obstacles or difficulties preventing you from achieving **that** task: (for example, limited movement, strength, mobility…)

_____

_____

What do you think could be done to overcome these obstacles or difficulties?

_____

_____

Part D – Available Mobile Phone Technology

The following mobile phone add-on technologies and extra features are currently available on the market to make access to the mobile phone easier. Please indicate which ones you would use, wouldn't use or are currently using? (mark (☒) where applicable to you)

Add-on Technologies	YES I am currently using	YES I would use	NO I wouldn't use	Don't Know?
1. Cordless Headset	☐	☐	☐	☐
2. Attachable QWERTY keypad	☐	☐	☐	☐
3. Predictive text	☐	☐	☐	☐
4. Voice recognition (*dial & answer)*	☐	☐	☐	☐
5. Personal Hands-free kit	☐	☐	☐	☐
6. Speaker phone function	☐	☐	☐	☐
7. Vibrate alert	☐	☐	☐	☐
8. Using a Portable computer or Portable Digital Assistance (PDA) with a mobile phone to send text messages (SMS) or faxes.	☐	☐	☐	☐

If you answered "YES, I am currently using" at 8 , please indicate the Mobile Phone software (for example, Motorola Smart CELLect with PhoneTools), you are using:

☐ Motorola ……

☐ Nokia ……..……...

☐ Ericsson ……..……...

☐ Others (please specify)……..……..

Mobile Phone Features	**YES I am currently using**	**YES I would use**	**NO I wouldn't use**	**Don't Know?**
1. Text Messaging (SMS)	☐	☐	☐	☐
2. Email	☐	☐	☐	☐
3. Speed dialling	☐	☐	☐	☐
4. Information searches (for example, weather, news)	☐	☐	☐	☐
5. Voice mail	☐	☐	☐	☐
6. Other (please specify); ……	☐	☐	☐	☐

If you placed marks in the "**NO I wouldn't use**" boxes, could you please give a brief explanation.

_____

_____

Part E – Future Mobile Phone Technology

Please rate the ***importance*** of the following future mobile phone technology that is in the process of being developed to enhance accessibility.

Future Technology:	**Very Important**	**Important**	**Unimportant**	**Don't know**
1. Control of the mobile phone via your communication (AAC) device	☐	☐	☐	☐
2. Large mobile phone screen	☐	☐	☐	☐
3. Large/computer keyboard connected to your mobile phone	☐	☐	☐	☐
4. Other (please specify), ……	☐	☐	☐	☐

Section B: Home Phone Needs Analysis

Please tell us about your ***HOME PHONE***.

Tick the response that **best** describes the ***HOME PHONE*** that you use:

1. A standard household phone ☐
2. A phone with a speaker or "hands free" function ☐
3. A portable or cordless phone ☐
4. An adapted or specialised phone ☐

If you placed a tick at 4, please describe the features of this phone: _____

_____

_____

Please indicate the level of difficulty you have when performing the following tasks **ON YOUR OWN** by marking (☒) the appropriate box:

Task	ON YOUR OWN				Can ONLY be achieved with help from others
	Very Easy	Achievable	Very Difficult	Cannot be done	
1. Moving to the phone in time to answer an incoming call	☐	☐	☐	☐	☐
2. Lifting the handset to take the phone to be off the hook	☐	☐	☐	☐	☐
3. Holding the handset to your ear and mouth for the duration of call	☐	☐	☐	☐	☐
4. Using a regular phone keypad to dial a phone number	☐	☐	☐	☐	☐
5. Dialling the required phone number before the telephone "times out"	☐	☐	☐	☐	☐
6. Hanging the phone up after a conversation is over	☐	☐	☐	☐	☐

If you placed marks in any of the "**Very Difficult**" or "**Cannot be done**" boxes, could you please explain why this is so: (eg: limited movement, strength, mobility…)

_____

_____

Thank you for taking the time to fill in this survey for us! ☺

Appendix 4-2 Ethics Approval Confirmation

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

Social and Behavioural Research Ethics Committee
Faculty of Social Sciences

GPO Box 2100
Adelaide 5001 Australia

Telephone: (+61 8) 8201 3513
Fax: (+61 8) 8201 3756
Email: Lesley.Wyndram@flinders.edu.au

SBRE 2476

29 April 2002

Mr Toan Nguyen
19 Winkfield St
Davoren Park SA 5113

Dear Mr Nguyen

Project 2476 Accessible Mobile Communication For People with Disabilities

Further to my letter dated 11 April 2002, I am pleased to inform you that approval of the above project has been confirmed following receipt of the additional information you submitted on 23 April.

May I draw to your attention that, in order to comply with monitoring requirements of the *National Statement on Ethical Conduct in Research Involving Humans* an annual and/or final report must be submitted. A copy of the report pro-forma is available from the SBREC website http://www/ssn/flinders.edu.au/ethics/ethics/

Yours sincerely

Lesley Wyndram
Secretary
SOCIAL AND BEHAVIOURAL RESEARCH ETHICS COMMITTEE

c.c. Simon Macdonald, Office of Research
Prof Andrew Downing, Informatics & Engineering
Mr Rob Garrett, Regency Park Rehabilitation Engineering, PO Box 2438, Regency Park 5942

(esr\letter\2476finapp)

Location: Sturt Road, Bedford Park, South Australia.

Appendix 4-3 Introduction letter, Information Sheet, and Consent form for Survey Questionnaire participants

Introduction letter for Survey Questionnaire Participants

_ March 2002

Dear ……..

A joint project is under way between **Flinders University** and **Regency Park Rehabilitation Engineering**, a division of the Crippled Children's Association of SA Inc (CCA), to identify what issues exist for people with disabilities when using mobile and home phones. The aim of the project is to identify key problem areas and to establish the need for new technology. The project is being carried out by Mr Toan Nguyen, a postgraduate student of the Flinders University, under the supervision of Mr Rob Garrett (CCA) and Prof. Andrew Downing (Flinders University).

If you currently use or would like to use a mobile or home phone, we invite you to participate in this **Mobile and Home Phone Needs Analysis Survey**.

The purpose of this survey is to identify issues relating to phone use, likes, dislikes and the difficulties or barriers that people are facing when using a mobile or standard phone. It will also determine which of the activities necessary to use a phone can be achieved and which activities cannot be achieved. This will help to determine what actions are required to overcome some of the barriers that clients are having when using mobile and home phones.

All information obtained from the Survey Questionnaire will be strictly confidential. More information on this Survey Questionnaire can be found on the Information Sheet ***attached***.

Approval for this research has been given by The Flinders University Social and Behavioural Research Ethics Committee and the Committee Secretary, Lesley Wyndram can be contacted on (08) 8201 3513. We encourage you to take part in this Survey Questionnaire to assist this worthwhile research project. A summary of the results from the survey will be sent to participants.

The Survey Questionnaire will generally take about 15 - 20 minutes of your time. If you would like to take part in this Survey Questionnaire, please sign the consent form and fill out the Survey Questionnaire and send it back to me in the Reply Paid envelope provided. Whether you decide to participate or not, services provided by the CCA will not be affected in any way. Thank you for your consideration.

Yours Sincerely,

Andrew Downing
Professor, School of Informatics and Engineering

N.B: Rehabilitation Engineering department of CCA is NovitaTech of Novita Children's Services Inc., as May 2004.

Information Sheet for Survey Questionnaire Participants

INFORMATION SHEET FOR PARTICIPANTS

Mobile and Home Phone Needs Analysis Survey

Different people have different needs when it comes to using mobile and home phones. For people with disabilities, these needs become increasingly distinct, as accessing these phones can become an issue. More often, specialised or modified phones are needed to make up for these special circumstances.

This Survey Questionnaire is designed to:

- Gather ***general information*** on the use of mobile and home phones.
- Determine what currently available ***add-on technologies*** people are using.
- Determine the ***problems or difficulties*** people are having when using phones.
- Established what needs to be developed to ***enhance/improve accessibility*** to phones.

This survey is divided in two sections:

1. The Mobile Phone Needs Analysis section deals with issues relating to mobile phone use.
2. The Home Phone Needs Analysis deals with accessibility issues relating to home phone use.

The information obtained from each section of this survey will help the researcher to:

- Develop ***practical solutions*** to overcome the difficulties or barriers that users are having when using a mobile or home phone.
- Develop ***alternative methods or approaches*** to using a mobile or home phone.
- Model an ***integrated system*** that will provide easier access to both the mobile and home phones.

We ask that you complete the Survey Questionnaire to help us gain this information. If you are not mobile phone user, then please complete the sections that are relevant to you and return it back to me, by **Friday 17 May**, in the reply paid envelope provided.

Please note that participation in this study is voluntary and that you are under no obligation to complete the questionnaire. Responses to all questions are grouped together and reported only as a total response. You are therefore **not** individually identifiable in the result. You may leave out any questions you do not wish to answer, or you may decline at any time to participate further in the research. All responses will be kept confidential in a secure place and anything stored on a computer is password protected.

If there are any questions, please feel free to contact any of the people below:

Mr. Rob Garrett, Manager, Research & Development, Regency Park Rehabilitation Engineering, PO Box 2438, Regency Park SA 5942. Phone: 08 8243 8263

Mr Toan Nguyen, Postgraduate Student, School of Informatics and Engineering, Flinders University Adelaide Australia GPO Box 2100, Adelaide SA 5001.
Phone: 08 8201 5158 or 8201 3602.

Ms Lesley Wyndram, Ethics Committee Secretary, Room 269, Social Sciences South Building, Flinders University Adelaide Australia. Phone: 08 8201 3513.

Consent form for the Survey Questionnaire Participants

The Crippled Children's Association of South Australia Inc.,
Consent Form for Participation

I _____

being the parent / guardian / carer of

_____

hereby consent to his / her involvement as a participant in this Survey Questionnaire entitled: *Mobile and Home Phone Needs Analysis Survey*.

8. I understand the nature and purpose of the Survey Questionnaire described on the attached Information Sheet and consent to the participant, named above, to take part.

I understand that:

- The participant may not directly benefit by taking part in this Survey Questionnaire.
- While information gained in the Survey Questionnaire may be published, the participant will not be identified and information will be confidential.
- The participant may leave out any questions he/she do not wish to answer and can withdraw at any stage of the research and that this will not affect medical care or any other aspects of their relationship with The Crippled Children's Services of South Australia Inc.
- I can physically assist the participant to fill out the Survey where needed, but cannot influence their decision in any way.

I am aware that I should retain a copy of the Consent Form, when completed, and the Information Sheet.

I certify that I have explained the study to the participant and consider that he/she understands what is involved.

Signed: ..... Dated:.....

Full name of parent/guardian/carer.....

N.B: The names of the contact person are on the information sheet if you have any questions.

Appendix 4-4 Survey Questionnaire Results (Raw data)

SURVEY QUESTIONNAIRE RESULTS

Response rate

Of the **342** surveys sent (275 to CCA clients, 67 to ATS clients), **47** respondents replied to the survey (including the *2* that were unable to complete the questionnaire).

- This represents a total return rate of **13.7%** with:
  - 35 from CCA clients (12.7%)
  - 12 from ATS (17.9%)
  - 5 invalid respondents (**2** unable to answer, 3 wrong addresses)

Section A: Mobile Phone Needs Analysis

1. General Information – respondents and the technology

1.1. Alternative and Augmentative Communication (AAC) device use

*Responses from **total** respondents (47):*

Users of AAC devices	Non-users of AAC devices	No answer
6 (13%)	*35 (74%)*	*6 (13%)*

The type of AAC devices include:

Pathfinder (x2)	Lightwriter	Dynavox
Liberator	Mobile phone	

1.2. Wheelchair use

*In **total** there were **29** (62%)wheelchair users:*

Powered wheelchair	Manual wheelchair	Both	Non-user	No answer
13 (28%)	*8 (17%)*	*8 (17%)*	*15 (32%)*	*3 (6%)*

1.3. Electronic Devices Use

*In **total** there were **38** (81%)wheelchair users:*

Desktop Computer	Laptop/Portable PC	Both	PDA	Non-user	No answer
22 (47%)	*5 (11%)*	*11 (23%)*	*0*	*4 (9%)*	*5 (10%)*

1.4. Where these Portable Electronic Devices are Used

*Responses from the **total** respondents:*

Home	School	Work	Other	No answer
38 (81%)	*26 (55%)*	*3 (6%)*	*6 (13%)*	*7 (15%)*

Other places where Portable Electronic Devices are used:

Shopping, church	On the road	In the community
Around the place (2)	TAFE/University (2)	

1.5. Internet Use at Home

Responses:

Respondent type	Yes	No	No answer
CCA clients	26 (74%)	7 (20%)	2 (6%)
ATS clients	10 (83%)	2 (6%)	0
Total	36 (77%)	9 (19%)	2 (4%)

1.6. Access to or use a mobile phone

Responses:

Respondent type	Yes	No	No answer
CCA clients	24 (69%)	9 (26%)	2 (6%)
ATS clients	7 (58%)	5 (42%)	0
Total	31(66%)	14 (30%)	2 (4%)

Mobile Phone Brand in Use:

Mobile Phone Type	Number of responses
Nokia	*16*
Ericsson	*4*
Motorola	*2*
Philips	*3*
Panasonic	*1*
Sagem	*2*
Siemens	*1*
Did not specify	*2*
Total	*31*

1.7. Purpose of Use of mobile phones

*Responses from the **total** respondents (47):*

Purpose of use:	Very important	Quite important	Not important	Don't Know	No answer
Voice-to-voice	28 (59.6%)	8 (17%)	3 (6.4%)	0	8 (17%)
SMS	10 (21.3%)	12 (25.5%)	14 (29.8%)	4 (8.5%)	7 (14.9%)
emergencies	35 (74.5%)	3 (6.4%)	1 (2.1%)	0	8 (17%)
Access to information	1 (2%)	4 (8.5%)	28 (59.6%)	4 (8.5%)	10 (21.3%)
other	2 (4.3%)	4 (8.5%)	3 (6.4%)	4 (8.5%)	34 (72.3%)

Other uses:

Games	Keep in contacted with family when separated	General communication

1.8. Accessibility for Mobile Phone Users

*Responses from the **total** respondents:*

	ON YOUR OWN					Can ONLY be achieved by the help of others	No answer
Tasks	**Very Easy**	**Achievable**	**Very Difficult**	**Cannot be done**	**Don't know**		
1. Using the keypad	12 (38.7%)	13 (41.9%)	1 (3.2%)	0	1 (3.2%)	2 (6.5%)	2 (6.5%)
2. Moving through the menus	20 (64.5%)	5 (16.1%)	1 (3.2%)	0	1 (3.2%)	2 (6.5%)	2 (6.5%)
3. Dialling a number	18 (58.1%)	7 (22.6%)	1 (3.2%)	0	1 (3.2%)	2 (6.5%)	2 (6.5%)
4. Answering a call	20 (64.5%)	5 (16.1%)	5 (16.1%)	0	1 (3.2%)	1 (3.2%)	2 (6.5%)
5. Holding the phone for the duration of the call	14 (45.2%)	6 (19.4%)	6 (19.4%)	0	1 (3.2%)	2 (6.5%)	2 (6.5%)
6. Hearing the person on the other end	16 (51.6%)	9 (29.0%)	2 (6.5%)	0	1 (3.2%)	2 (6.5%)	2 (6.5%)
7. Talking loud enough to be heard by others	17 (54.8%)	8 (25.8%)	2 (6.5%)	0	0	2 (6.5%)	2 (6.5%)
8. Reading the visual display	15 (48.4%)	10 (32.3%)	2 (6.5%)	0	1 (3.2%)	1 (3.2%)	2 (6.5%)
9. Creating an Email or text messaging (SMS)	10 (32.3%)	8 (25.8%)	2 (6.5%)	2 (6.5%)	5 (16.1%)	2 (6.5%)	2 (6.5%)
10. Using the services available (for example, voicemail, information such as news, weather)	10 (32.3%)	5 (16.1%)	4 (12.9%)	1 (3.2%)0	8 (17.0)	2 (6.5%)	2 (6.5%)
11. Ending a call	20 (64.5%)	5 (16.1%)	0	0	2 (6.5%)	2 (6.5%)	2 (6.5%)
12. Recharging the phone battery	16 (51.6%)	3 (9.7%)	4 (12.9%)	0	2 (6.5%)	4 (8.5%)	2 (6.5%)

1.8.1. Obstacles or Difficulties preventing users from undertaking of a particular task

*Written responses accumulated from the **all** respondents:*

- *Limited movement*, *muscle weakness*
- For longer calls, the arm muscles become tired
- Do not understand how to do it, when shown forget very quickly
- Not speaking loud enough, due to shyness
- *Limited movement*, hearing impairment
- *Muscular restrictions*, *fine motor control* problems; *time limits – cannot perform tasks quickly*; coordination of sight and movement of fingers/hands simultaneously; *difficulty in holding the phone long enough.*
- Rett syndrome
- *Limited movement/physically* cannot hold the phone. Very limited communication skills.
- *Limited movement* without spasms.
- Quality of hands-free output determined by surrounding noise levels. Cannot hold due to *limited finger, hand and arm controls/strength. Button size makes it difficult.*

1.8.2. What could be done overcome the obstacles or difficulties

*Written responses accumulated from the **total** respondents:*

- Speakerphone because don't like or want to wear earphones/headset.
- Unsure *(2)*
- Optus or Telstra needs to alter time restrictions on responses. A holder that is stable enough not to move around during use. A tool/device to assist in pressing keys.
- A mobile phone should be part of a standard with wheelchair for security and for carer's benefits.
- Larger keypads and screens. Longer time to answer calls before diversion.
- Bit hard to get to when it rings - make it more accessible.
- Custom made holder on wheelchair.
- Improve overall usability.

1.9. Available Mobile Phone Technology

*Responses from the **total** respondents:*

Add-on Technologies	YES I am currently using	YES I would use	NO I wouldn't use	Don't Know?	No Answer
1. Cordless Headset	1 (2.1%)	15 (31.9%)	7 (14.9%)	1 (3.2%)	23 (48.9%)
2. Attachable QWERTY keypad	1 (2.1%)	8 (17.0%)	12 (25.5%)	3 (6.4%)	23 (48.9%)
3. Predictive text	2 (4.3%)	10 (21.9%)	9 (19.2%)	4 (8.5%)	22 (62.9%)
4. Voice recognition (*dial & answer)*	2 (4.3%)	11 (23.4%)	10 (21.9%)	1 (3.2%)	23 (48.9%)
5. Personal Hands-free kit	2 (4.3%)	15 (31.9%)	6 (12.8%)	2 (4.3%)	22 (62.9%)
6. Speaker phone function	3 (6.4%)	13 (27.7%)	6 (12.8%)	1 (3.2%)	23 (48.9%)
7. Vibrate alert	7 (14.9%)	9 (19.2%)	7 (14.9%)	3 (6.4%)	21 (44.7%)
8. Using a Portable computer or Portable Digital Assistance (PDA) with a mobile phone to send text messages (SMS) or faxes.	1 (2.1%)	9 (19.2%)	14 (29.8%)	2 (4.3%)	22 (62.9%)

If you answered "YES, I am currently using" at 8 , please indicate the Mobile Phone software you are using:

☐ Motorola …….

☐ Nokia ……..…

☐ Ericsson 1 (2.1%)……

☐ Others (please specify)……..…

Mobile Phone Features	YES I am currently using	YES I would use	NO I wouldn't use	Don't Know?	No answer
1. Text Messaging (SMS)	14 (29.8%)	8 (17.0%)	6 (12.8%)	0	19 (40.4%)
2. Email	4 (8.5%)	13 (27.7%)	10 (21.3%)	0	20 (42.6%)
3. Speed dialling	11 (23.4%)	13 (27.7%)	2 (4.3%)	2 (4.3%)	19 (40.4%)
4. Information searches (for example, weather, news)	2 (4.3%)	9 (19.2%)	14 (29.8%)	3 (6.4%)	19 (40.4%)
5. Voice mail	9 (19.2%)	12 (25.5%)	6 (12.8%)	1 (2.1%)	19 (40.4%)
6. Other (please specify);	0	1 (2.1%)	2 (4.3%)	1 (2.1%)	43 (91.5%)

1.10. Future Mobile Phone Technology

*Responses from the **total** respondents:*

Future Technology	Very Important	Important	Unimportant	Don't know	No answer
1. Control of the mobile phone via your communication (AAC) device	6 (12.8%)	7 (14.9%)	16 (34.0%)	12 (25.5%)	6 (12.8%)
2. Large mobile phone screen	12 (25.5%)	13 (27.7%)	17 (36.2%)	0	5 10.6%)
3. Large/computer keyboard connected to your mobile phone	10 (21.3%)	8 (17.0%)	20 (42.6%)	3 (6.4%)	6 (12.8%)
4. Other (please specify), ……	5 (10.6%)	2 (4.3%)	2 (4.3%)	2 (4.3%)	36 (76.6%)

Other future technology:

- Better accessibility to menus
- Larger buttons but not as big as a computer keyboard or
- Louder ringer
- Phone holder while typing SMS or numbers
- Speakerphone
- Easier button, not too small and to press
- Did not specify (2)

Section B: Home Phone Needs Analysis

2.1 Home Phone Use

*Responses from the **total** respondents:*

Home Phone	Yes		No		No answer	
Standard household	19	(40.4%)	25	(53.2%)	3	(6.4%)
Speakerphone	17	(36.2%)	27	(57.5%)	3	(6.4%)
Portable/cordless	25	(53.2%)	19	(40.4%)	3	(6.4%)
Adapted/specialised	0		44	(93.6%)	3	(6.4%)

2.2 Accessibility in Home Phone Use

*Responses from the **total** respondents:*

	ON YOUR OWN				Can only be achieved with help from others	
Task(s)	Very Easy	Achievable	Very Difficult	Cannot be done		No answer
1. Moving to the phone in time to answer an incoming call	13 (27.7%)	17 (36.2%)	10 (21.3%)	0	3 (6.4%)	4 (8.5%)
2. Lifting the handset to take the phone to be off the hook	26 (55.3%)	7 (14.9%)	2 (4.3%)	4 (8.5%)	4 (8.5%)	4 (8.5%)
3. Holding the handset to your ear and mouth for the duration of call	23 (48.9%)	9 (19.2%)	3 (6.4%)	3 (6.4%)	4 (8.5%)	5 (10.6%)
4. Using a regular phone keypad to dial a phone number	25 (53.2%)	9 (19.2%)	5 (10.6%)	3 (6.4%)	1 (2.1%)	4 (8.5%)
5. Dialling the required phone number before the telephone "times out"	22 (46.8%)	9 (19.2%)	7 (14.9%)	3 (6.4%)	2 (4.3%)	4 (8.5%)
6. Hanging the phone up after a conversation is over	27 (57.5%)	7 (14.9%)	3 (6.4%)	3 (6.4%)	3 (6.4%)	4 (8.5%)

2.2.1 Home Phone Use – why is it difficult to perform tasks:

*Written responses accumulated from the **total** respondents:*

- All depends on his situation in the home. 2 have difficulty with fine motor skills. 4 indicated that pads could be larger. 5 indicated that *there should be a longer "times out" cut out for people having difficulties.*
- I have difficulty reading the phone number then, dialling, lose my place. Looking at the book and then dialling.
- Can only use right hand
- Finds it difficult to find the numbers.
- I don't usually use the receiver as I have hands-free free but when I do I need assistance.
- Lack of voluntary movement. Uses a switch operated by head to drive and access Pathfinder.
- Limited movement due to *lack of fine motor control* and spasms.
- *Limited movement/mobility restrictions*. Tremors. Coordinating two things at once (e.g. holding and talking) a problem. *Speed difficulties*.
- *Limited physical movement* and voice communication.
- *Mobility* -wheelchair
- No use of arms.
- Physically unable to do anything but able to instruct people, not verbally - but uses eye and head to communicate.
- *Restricted movement and strength*
- Task 1. *By the time I get to the phone and get my hands in position to answer it the caller sometimes hangs up*. (I answer it by pushing a button). Task 2. I don't have the strength to lift the handset.
- Unable to fill in survey – intellectually restricted (2).
- Very limited communication skills and would never have the ability to use a standard phone. Severe multiple disability. If a video link up via a computer - maybe able to use skills to speak via a microphone and use mouse and simple computer functions.
- Dexterity makes it difficult and sometimes, use nose to make it easier.

Appendix 5 New Telecommunications Options for People with Disabilities

Appendix 5-1 Technology used during the trial

Trials were conducted with 10 participants. Off-the-shelf solutions used for the trial varied considerably from participant to participant. Although each individual had their specific needs, where there were similar functional capabilities and needs of participants, a single solution was reused during the trial. An illustration and a brief description of each of the technology used during the trial are shown below.

Solution 1: Panasonic GD 95

Figure 1 Panasonic GD 95

The Panasonic GD95 (GSM) has a large screen (30mm x 40mm) and icon-based menus, predictive text for quicker text messaging, voice and speed dialling and speakerphone capabilities for hands-free operation.

Solution 2: Kyocera QCP 3035

Figure 2 Kyocera QCP 3035

The Kyocera QCP 3035 (CDMA) has a larger screen (30mm x 35mm), predictive text for quicker text messaging, voice and speed dialling and speakerphones capabilities for hands-free operation.

CDMA – **C**oded **D**uplex **M**ultiplexing **A**ccess phones provides higher data transfer rate across the telecommunications network and are hearing aid compatible.

Solution 3: O_2XDA (Personal Digital Assistant)

Figure 3 Personal Digital Assistant – O_2XDA

The O_2XDA is a powerful pocket PC, a personal organiser, and a GPRS mobile, all-in-one. With a larger display (55mm x 73mm) and touch sensitive colour screen, it provides a user-friendly interface. It also has an attachable keyboard for fast text entry and easier access.

Solution 4: Nokia Bluetooth Car Kit (installed on wheelchair)

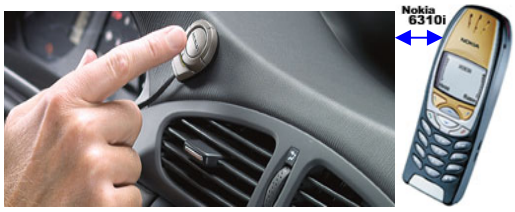


Figure 4 Nokia Bluetooth Car Kit used with Nokia 6310i

The Nokia Bluetooth Car Kit once installed on a wheelchair, and used with a compatible Nokia phone (eg. Nokia 6310i), enables users to control calls via a single remote control located at the desired position. The microphone and speakers enabled hands-free voice calls.

Solution 5: Ericsson Advanced Car Kit (installed on wheelchair)

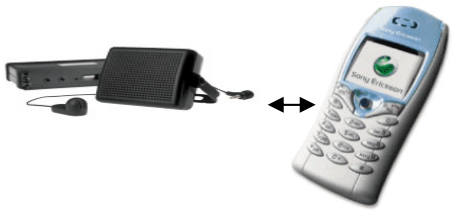


Figure 5 Ericsson Advanced Car Kit with Sony Ericsson T68i.

The Ericsson Advanced Car Hands-free, once installed on a wheelchair and used with a compatible Ericsson phone (eg. Sony Ericsson T68i), enables users with only voice ability to make calls using voice recognition. The user can activate the voice recognition mode of the phone through the use of a "Magic word" function and then use voice to call up to 15 pre-stored phone numbers. The microphone and speakers enabled complete hands-free voice calls.

Solution 6: RehaPhone (Infrared phone)

Figure 6 A RehaPhone – infrared controllable phone with speakerphone function.

RehaPhone from Siemens provides infrared capability through infrared remote controllable communication devices or an AAC device such as the Pathfinder.

Up to 8 pre-stored numbers can be set up in the RehaPhone's memory. It also has speakerphone capability and other functions like any other standard phones. All functions are controllable by infrared signals.

Appendix 5-2 Ethics approval confirmation

Women's
& Children's
Hospital
ADELAIDE

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www.wch.sa.gov.au

28th March 2003

Mr R Garrett
Regency Park Rehabilitation Engineering Dept
Crippled Children's Association.
PO Box 2438
REGENCY PARK SA 5942

Dear Mr Garrett

Re: Clinical Trials of Mobile Phone Technologies. REC1440/3/2006.

Thank you for submitting the above protocol to the WCH Research Ethics Committee. It was approved at the Committee's meeting on 26th March 2003.

I remind you approval is given subject to:
- immediate notification of any adverse events to subjects;
- immediate notification of any unforeseen events that might affect continued ethical acceptability of the project;
- submission of any proposed changes to the original protocol. Such changes must be approved by the Committee before they are implemented;
- immediate advice, giving reasons, if the protocol is discontinued before its completion;
- submission of a brief annual report on the state of progress of the study, and a final report when it is completed.

Approval is given for a period of three (3) years only, and if the study is more prolonged than this, a new submission will be required. Please note the approval number above indicates the month and year in which approval expires and it should be used in any future communication.

Yours sincerely

PETER BAGHURST
A/CHAIR
WCH RESEARCH ETHICS COMMITTEE

Appendix 5-3 Introduction letter, Information sheet and Consent form for participants

Introduction letter for Participants

John Citizen
xx Buccleuch Avenue
FINDON SA 5023

Clinical Trial of Mobile Phone Technologies

Dear John,

You are receiving this letter because you recently replied to an invitation letter reconfirming your interest in taking part in the upcoming Clinical Trials of Mobile Phone Technologies. As explained in the previous letter, the CCA has successfully secured a Telecommunications Research Grant from the Department of Communications, Information Technology and the Arts (DCITA) to carry out trials of "Possible mobile phone solutions for people with disabilities" with ten participants.

In this clinical trial the CCA will be trialling the latest mobile phone technologies such as Personal Digital Assistant (PDA) devices (with a mobile phone incorporated), mobile phones with speakerphone capabilities, wireless mobile phone technology, and other mobile phone accessories. More information on this trial can be found in the Information Sheet ***attached***.

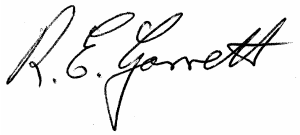
All personal information and information obtained through the assessment forms will be kept strictly confidential.

Approval for this research has been given by the Women's and Children's Hospital Research Ethics Committee. The Committee's Secretary, Ms Brenda Penny, can be contacted on (08) 8161 6521.

I have also included with this letter a consent form. If you are aged 18 or over, and would like to take part in this trial, please sign the consent form and send it back to me in the Reply Paid envelope provided. If you are under 18 years of age, and would like to take part in this trial, please arrange for a parent, guardian or carer to sign the consent form. Please send the signed consent back to me in the Reply Paid envelope provided by 14th April, 2003. I have included 2 copies of the consent form so that you can keep a copy.

If you do choose to participate, we will contact you to arrange an initial interview.
Whether you decide to participate or not, services provided by the CCA will not be affected in any way. Thank you for your consideration.

Yours sincerely,



ROB GARRETT
BTech GradDipMaths MIE Aust CPEng ATP
Manager, Research & Development

Information Sheet for Participants

Clinical Trials of Mobile Phone Technologies

Findings from the **Mobile and Home Phone Needs Analysis Survey** during May of 2002 have identified a "technology gap" within the disability community. Apart from the general difficulties in performing tasks on current phones, most people with a disability are **not aware** of the available technology and, if they are**, do not use it to the fullest extent**. This has prompted the need to trial and evaluate viable and alternative solutions to improve the awareness and telecommunications experience of people with disabilities. A Telecommunications Research grant from the Department of Communications, Information Technology and the Arts (DCITA) has enabled this trial to happen.

The purpose of the project is to trial a range of current products that have been identified as being potentially suitable for use by people with disabilities (for example, there are now phones that can have a wireless connection (using Bluetooth Technology) to a PDA (Personal Digital Assistant), respond to voice activation, and have the ability to be used "hands-free"). These possible solutions will be evaluated for the impact they have on the lifestyle of someone with a disability. For example, access to features such as the use of SMS (Short Messaging Service), email and news, sport, and weather updates will be made easier, and this may influence social interaction and participation. For individuals who use non-verbal communication, the SMS and email technology may open a whole new form of communication and social interaction.

The following activities will be involved during the trialling process:

1) Each participant's mobile communication needs will be identified through an initial assessment questionnaire and alternative solutions will be suggested.
2) Each participant will individually trial the technology for a period of approximately two weeks.
3) Prior to the trial, each participant will receive training in the use of the device and have all the features and associated applications of the technology explained in detail. Re-training and going over the applications and programs that are available will take place during the "follow along" phase of the study if the participant has forgotten how to access some of the features that were explained at the beginning of the trial.
4) Before, during and after the short-term trial, participants will be asked to fill out a survey questionnaire that is designed to measure the users' satisfaction and quality of life of the participants. In addition, an in-house questionnaire that specifically addresses the technical aspects (functional performance) of the equipment will also be used for each stage mentioned.

For the duration of the trial period, participants will be given a $20 credit to use with the technology, provided via a prepaid card.

All the above activities will take place over the period between May and September. Results from all activities will be kept confidential in a secure place and anything stored on a computer will be password protected. Responses to all questions are grouped together and reported only as a total response. Participants are therefore **not** individually identifiable in the result. Findings may be published, but no names will be connected to the specific results. A copy of the findings will be available upon request. Participants may withdraw from the trial at any stage and the services provided by the Crippled Children's Association will not be affected in anyway.

If there are any questions, please feel free to contact any of the people below:

Mr. Rob Garrett, Manager, Research & Development, Regency Park Rehabilitation Engineering, PO Box 2438, Regency Park SA 5942. Phone: 08 8243 8263

Mr Toan Nguyen, Research Assistant, Regency Park Rehabilitation Engineering, PO Box 2438, Regency Park SA 5942. Phone: 08 8243 8263

Ms Brenda Penny, Secretary of Committee, Research Secretariat, the Women's and Children's Hospital Ethics Committee, Phone: 08 8161 6521.

Consent forms for participants

The Crippled Children's Association of SA Inc*.,
Consent Form for persons 18 years old or over

I _____

hereby consent to my involvement in this trial entitled: *Clinical Trials of Mobile Phone Technologies*.

9. The nature and purpose of the trial described on the attached Information Sheet has been clearly explained to me. I understand it, and agree to take part.

10. I understand that:

- I may not directly benefit by taking part in this trial.
- While information gained in the trial may be published, I will not be identified and information will be confidential.
- I may choose not to answer any questions in the assessment process and can withdraw at any stage of the trial. This will not affect medical care or any other aspects of their relationship with the Crippled Children's Association of SA Inc.
- I will be receiving an honorarium of $50 for taking part in this trial.
- I will be given a pre-paid voucher to use with the mobile phone technology provided.
- Some photos may be taken of me using the technology and that I may be approached for permission to use these photos in reports, newsletters and other publications.

11. I am aware that I should retain a copy of the Consent Form, when completed, and the Information Sheet.

N.B: The names of the contact person are on the information sheet if you have any questions.

Signed: .....

Full name of Participant: .....Dated:.....

I certify that I have explained the study to the participant and consider that he/she understands what is involved.

Signed: .....

Title: .....Dated: .....

*The new name is Novita Children's Services as of May 2004.

The Crippled Children's Association of SA Inc*.,
Consent Form for persons less than 18 years of age

I_____

being the parent / guardian / carer of

_____

hereby consent to his / her involvement as a participant in this trial entitled: *Clinical Trials of Mobile Phone Technologies*.

12. I understand the nature and purpose of the trial described on the attached Information Sheet and consent to the participant, named above, to take part.

13. I understand that:

- The participant may not directly benefit by taking part in this trial.
- While information gained in the trial may be published, the participant will not be identified and information will be confidential.
- The participant may choose not to answer any questions in the assessment process and can withdraw at any stage of the trial. This will not affect medical care or any other aspects of their relationship with the Crippled Children's Association of SA Inc.
- The participant will be receiving an honorarium of $50 for taking part in this trial.
- I will be given a pre-paid voucher to use with the mobile phone technology provided.
- Some photos may be taken of the participant using the technology and that the participant may be approached for permission to use these photos in reports, newsletters and other publications.

14. I am aware that I should retain a copy of the Consent Form, when completed, and the Information Sheet.

N.B: The names of the contact person are on the information sheet if you have any questions.

Signed: .....

Full name of parent/guardian/carer: .....Dated:.....

I certify that I have explained the study to the participant and consider that he/she understands what is involved.

Signed: .....

Title: .....Dated:.....

*The new name is Novita Children's Services as of May 2004.

Appendix 5-4 Initial Assessment of Matching the Participant to the Available Technology

Matching participant to the available technology

(to be completed in conjunction with the Researcher)

Name:_____

Part A: Mobile Communication Usage

The following is a list of mobile communication usage options available. Please rank (1 to 6) the following communication tools in order of ***importance***.
(Priority scale: 1 – Highest …. 6 – Lowest)

Communication media	Priority	Don't know (*tick, if applicable*)
Voice calls		☐
Text messaging (SMS)		☐
Email		☐
Voicemail		☐
Internet access		☐
Information access (such as news, weather, sports etc)		☐

Comments (if applicable):

_____

_____

Part B: Accessibility of Mobile Phone Users

Please rate the ease in performing these tasks **ON YOUR OWN** when using your mobile phone and the level of frustration when performing them. ***(Please rank from 1 to 10)***

Tasks	**Performance rating** *(1=very easy 5= achievable with difficulty 10=not possible)*	**Frustration rating** **(Rank in order of frustration 1=none 10=highest)**	**Don't know** *(Tick where applicable)*
Pressing the keypad keys			☐
Pressing the other buttons			☐
Pressing keys in time			
Navigate through the menus			☐
Dialling a number			☐
Answering a call			☐

Tasks	**Performance rating** *(1=very easy 5= achievable with difficulty 10=not possible)*	**Frustration rating** *(Rank in order of frustration 1=none 10=highest)*	**Don't know** *(Tick where applicable)*
Creating an Email or text messaging (SMS)			☐
Editing the phonebook entries			☐
Adding new phonebook entries			☐
Holding the phone for the duration of the call			☐
Lifting the phone to the ear			☐
Reading the visual display			☐
Ending a call			☐
Recharging the phone battery			☐
Using the services available (for example, voicemail, information such as news, weather)			☐
Other (specify, if applicable) _____			☐

Comments (if applicable):

Accessibility of non–mobile phone users (telephone)

(To be completed for those not using a mobile phone)
Please rate the ease in performing these tasks **ON YOUR OWN** when using your home phone and the level of frustration when performing them. ***(Please rank from 1 to 10)***

Tasks	**Performance rating** *(1=very easy 5= achievable with difficulty 10=not possible)*	**Frustration rating** *(Rank in order of frustration 1=none* 10=highest)	**Don't know** *(Tick where applicable)*
Moving to the phone in time to answer an incoming call			☐
Lifting the handset to take the phone to be off the hook			☐

Tasks	Performance rating *(1=very easy 5= achievable with difficulty 10=not possible)*	Frustration rating *(Rank in order of frustration 1=none 10=highest)*	Don't know *(Tick where applicable)*
Holding the handset to your ear and mouth for the duration of call			☐
Using a regular phone keypad to dial a phone number			☐
Dialling the required phone number before the telephone "times out"			☐
Hanging the phone up after a conversation is over			☐
Other (specify, if applicable) _____			☐

Comments (if applicable):

Part C: Mobile Communication Solutions

The following is a list of mobile communication solutions available. Please prioritise (1 to 4) your communication needs.
(Priority scale: 1 – Essential, 2 – Important, 3 – Useful to have, 4 – Not Required)

- ☐ Speakerphone (hands-free operation)
- ☐ Voice dialling (hands-free operation)
- ☐ Voicemail / answering machine (hands-free operation)
- ☐ Speed/quick dialling
- ☐ Predictive text for faster text messaging (SMS)
- ☐ Access to mobile phone via a desktop or laptop computer
- ☐ Attachable keypad (small)
- ☐ Attachable computer keyboard (standard)
- ☐ Headset (cordless)
- ☐ Headset (with cord)
- ☐ Larger display
- ☐ Other (specify your own solution) _____

Comments (if applicable):

Thank you for taking the time to fill in this survey for us! ☺

Appendix 5-5 Canadian Occupational Performance Measure (COPM) Questionnaire

CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

(Modified May 2003)

Authors:
Mary Law, Sue Baptiste, Anne Carswell,
Mary Ann McColl, Helene Polatajko, Nancy Pollock

The Canadian Occupational Performance Measure (COPM) is an individualized measure designed for use by occupational therapists to detect self-perceived change in occupational performance problems over time.

Client Name:		
Age:	Gender:	ID#
Respondent (if not client): -		
Date of Assessment:	Planned Date of Reassessment:	Date of Reassessment:

Therapist:
Facility/Agency: The Crippled Children's Association Inc. of South Australia
Program: New Technological Options trial

STEP 1: **IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES**	**STEP 2:** **RATING IMPORTANCE**
To identify occupational performance problems, concerns and issues, interview the participant, asking about daily activities with communication and telecommunications use. Ask participants to identify daily activities, which they want to do, need to do or are expected to do, by encouraging them to think about a typical day. Then ask the participant to identify which of these activities are difficult for them to do now to their satisfaction. *Also consider:* *What the participant wants to be able to do that they can't now?* *What is preventing the participant from using or carrying out task(s) effectively?*	Using the scoring card provided, ask the participant to rate, on a scale of 1 to 10, the importance of each activity. Place the ratings in the corresponding boxes in Steps 1A or 1B.

STEP 1A: Communication (in general)		IMPORTANCE
Mode of communication (e.g. voice, text)	_____ _____ _____	☐ ☐ ☐
Mode of telecommunication use (e.g. phone, mobile phone, SMS, Internet, E-mail)	_____ _____ _____	☐ ☐ ☐
Purpose of use (e.g., security, emergency, independence, call taxi) *[What is it used for?]*	_____ _____ _____	☐ ☐ ☐

STEP 1B: Telecommunication use (& context of use)		
Home use (e.g., contact friends & family)	_____ _____ _____	☐ ☐ ☐
Play/School use (e.g., security, call home, taxi)	_____ _____ _____	☐ ☐ ☐
Community use (e.g., work activities, emergency, independence)	_____ _____ _____	☐ ☐ ☐

STEPS 3 & 4: SCORING – INITIAL ASSESSMENT and REASSESSMENT

Confirm with the participant the 5 most important problems and record them below. Using the scoring cards, ask the participant to rate each problem on performance and satisfaction, then calculate the total scores. Total scores are calculated by adding together the performance or satisfaction scores for all problems and dividing by the number of problems. At reassessment, the participant scores each problem again for performance and satisfaction. Calculate the new scores and the change score.

Initial Assessment:			**Reassessment:**	
OCCUPATIONAL PERFORMANCE PROBLEMS:	PERFORMANCE 1	SATISFACTION 1	PERFORMANCE 2/3	SATISFACTION 2/3
1. _____				
2. _____				
3. _____				
4. _____				
5. _____				
Scoring:	PERFORMANCE SCORE 1	SATISFACTION SCORE 1	PERFORMANCE SCORE 2/3	SATISFACTION SCORE 2/3
Total score = Total performance or satisfaction scores / # of problems	/ =	/ =	/ =	/ =

CHANGE IN PERFORMANCE = Performance Score 2/3 [ ] - Performance Score 1 [ ] = [ ]

CHANGE IN SATISFACTION = Satisfaction Score 2/3 [ ] - Satisfaction Score 1 [ ] = [ ]

ADDITIONAL NOTES AND BACKGROUND INFORMATION

Initial Assessment:

Reassessment:

Appendix 5-6 Accessibility Questionnaire

Name:_____

Technology_____

Part A – Accessing the mobile phone

Please rate the ease in performing these tasks **ON YOUR OWN** when using your mobile phone and the level of frustration when performing them. ***(Please rank from 1 to 10)***

Tasks	**Performance rating** *(1=not able to do it at all 5= achievable with difficulty 10=able to do it extremely well*	**Satisfaction rating** *(1=not satisfied at all 10=extremely satisfied)*	**Don't know** *(Tick where applicable)*
Pressing the keypad keys			☐
Pressing the other buttons			☐
Pressing keys in time			
Navigating through the menus			☐
Dialling a number			☐
Answering a call			☐
Creating an Email or text messaging (SMS)			☐
Editing the phonebook entries			☐
Adding new phonebook entries			☐
Holding the phone for the duration of the call			☐
Lifting the phone to the ear			☐
Reading the visual display			☐
Ending a call			☐
Recharging the phone battery			☐
Using the services available (for example, voicemail, information such as news, weather)			☐
Other (specify, if applicable) _____			☐

Comments (if applicable)

_____

_____

Part B – Performance – Time taken to carry out a task

Please indicate the time taken to perform the following tasks (if applicable):

Tasks	Estimate the time taken to successfully carry out task (seconds) *(With the existing technology)*	Estimate the time taken to successfully carry out task (seconds) *(With the provided technology)*	Don't Know or N/A
Creating and sending an SMS/email			☐
Retrieving an SMS/email			☐
Answering an incoming call			☐
Making a call			☐
Connecting the battery charger to the device			☐
Retrieving a voice mail/message			☐
Leaving a voice message			☐
Adding a new number into the phonebook			☐
Editing a phone book number			☐
Accessing information via WAP			☐
Other task(s) (specify) _____			☐

Comments (if applicable)

_____

_____

_____

_____

Thank you for taking the time to fill in this survey for us! ☺

Appendix 5-7 COPM Outcome Measures of each participant

For all the COPM charts of all the participants listed in the following appendix:

- the *light blue* (turquoise) bar represents the scores given by the participants prior to the trial;
- the *blue* bar represents the scores given by the participants at the end of the trial; and
- the *yellow* bar represents the scores given by the participants two weeks after the equipment was taken away.

FIRST PARTICIPANT'S PROFILE

Participant 1 has cerebral palsy (CP) and only has good use of the left hand, which makes it impossible to carry out multiple tasks simultaneous. The participant also has limited mobility and uses a walking aid and a wheelchair to get around. Although currently using a mobile phone, the participant often faces problems that usually require the assistance of other people.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems the participant has with telecommunication use:

- Holding the phone and pressing the buttons on the phone at the same time;
- Holding the phone for longer call duration;
- Messaging takes a long time
- Recharging the phone battery; and
- Understanding people.

PARTICIPANT'S NEEDS

Essential	Important
• Larger display • Predictive text for faster text messaging (SMS)	• Speakerphone • Voice dialling

SOLUTION PROVIDED

Panasonic GD95

PERFORMANCE AND SATISFACTION OUTCOMES

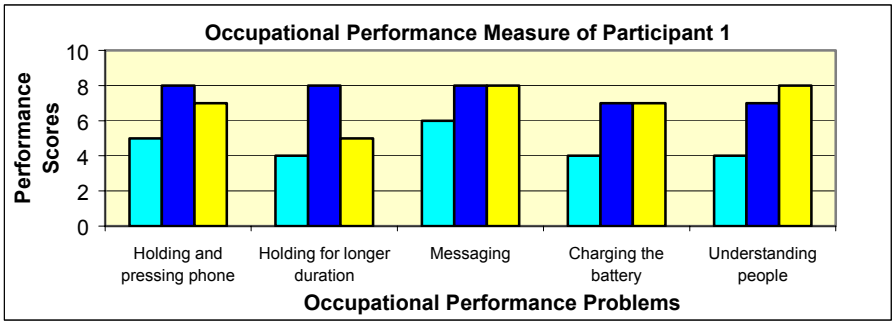


Figure 7 Performance measure of participant 1

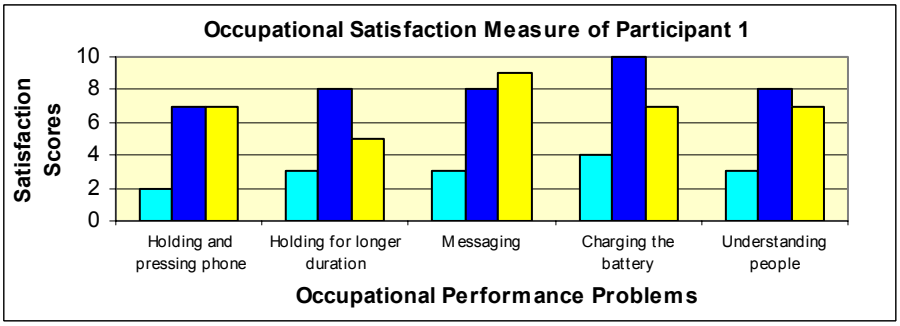


Figure 8 Satisfaction measure of participant 1

TIME RESPONSES

The time response for text messaging improved from approximately 8 minutes to around 5 minutes with the solution provided. The increased performance was due to the predictive text capability of the phone. The time response for making calls remained the same, approximately 20 seconds, while answering incoming calls increased by approximately 10 seconds.

OTHER FEEDBACK

The participant recently had a stroke, which resulted in minor brain damage. As a result, the participant takes longer to understand people, and to convey a message. Due to this cognitive problem, the participant found learning to use a new phone quite challenging and often resorted to old methods of using the phone. However, there were features on the solution provided that the client found to be more accessible. This included a five directional joystick function and icon-based features of the new phone. Features the participant favoured most from the trial included the larger screen and predictive text. Recharging the new phone was much better and quicker than the old phone. The participant also had a 1-week extension with the trial due to the slower learning that was a consequence of the minor brain damage. The participant indicated that the trial should be available of a 1 month period instead of the 3 weeks period.

SECOND PARTICIPANT'S PROFILE

Participant 2 is 80 years old with restricted mobility and is restricted to a wheelchair. The participant has a hearing aid and had previous exposure to mobile phones, but does not own one. Hand tremors and reduced strength in the arms and hands are the participant's main concerns when using a mobile phone. Memory loss associated with older age is also a problem.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Limited address (memory) to store numbers;
- Having a mobile phone when out and about for emergency and security;
- Small buttons are hard to use;
- Ability to recall calls anywhere anytime; and
- Holding the phone for long duration.

PARTICIPANT'S NEEDS

Essential	Important
• Speed dialling	• Speakerphone • Voice dialling • Attachable computer keyboard

SOLUTION PROVIDED

Kyocera QCP 3035 (CDMA phone) (suitable for hearing aid users)

PERFORMANCE AND SATISFACTION OUTCOMES

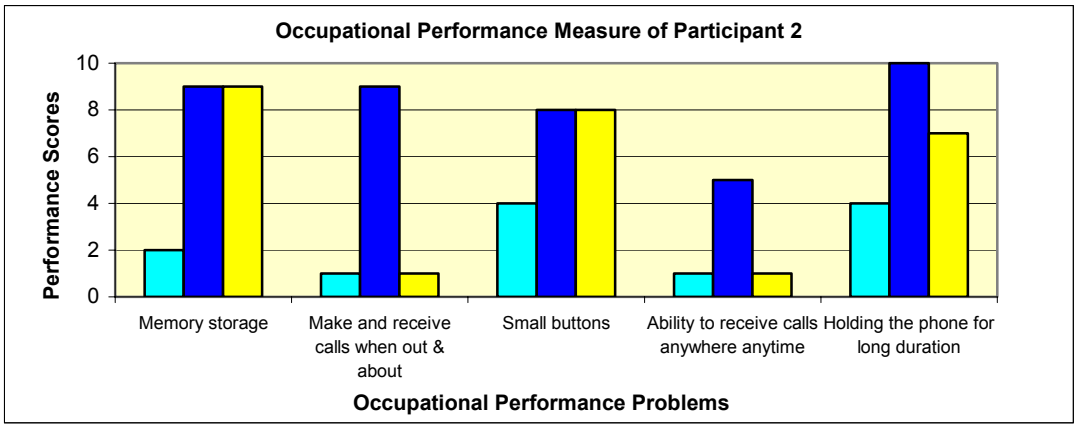


Figure 9 Performance measure of participant 2

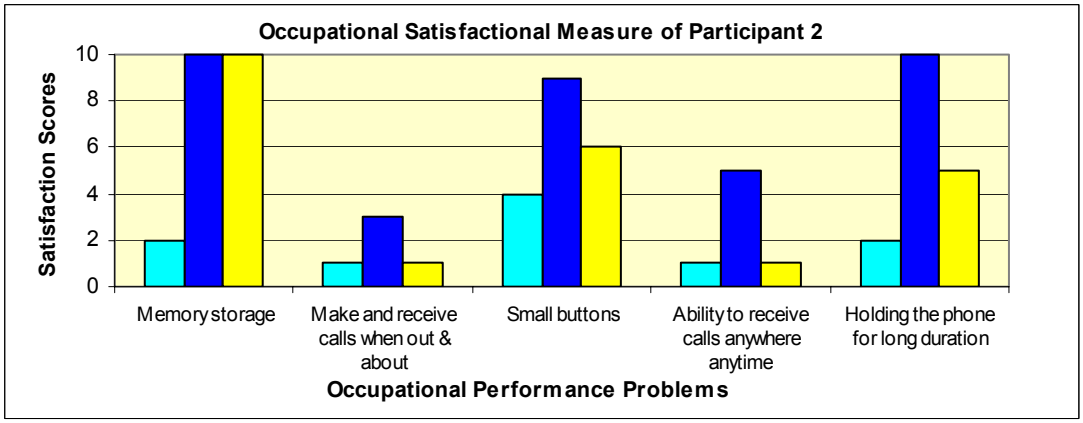


Figure 10 Satisfaction measure of participant 2

TIME RESPONSES

The time response for making calls reduced from approximately 30 seconds to around 10 seconds when using preset numbers. The time response for answering calls reduced from approximately 1 minute to around 15 seconds.

OTHER FEEDBACK

This trial has given the participant the opportunity to experiment with a mobile phone and ascertain what works and what doesn't before buying one for personal use.

The participant uses a speakerphone-enabled telephone with up to ten pre-stored numbers at home but wants to have more stored numbers. However, due to deteriorating memory, storing more then ten locations was a new experience for the participant because of the fear of forgetting the location number. Nevertheless, this proved very successful during the trial.

Voicemail was a new feature the participant had trouble with initially but gradually became familiar with its use. Given more time the participant believed that proficient use of this technology could be achieved.

Hand tremors caused the participant to accidentally repeat numbers that were not necessary when dialling. The participant believes that a hardware solution to prevent this from occurring is necessary for elderly people.

Generally, the participant favoured the speakerphone function but had trouble with the small display and print as well as the small five directional joystick on the solution provided. Separate buttons for each direction would have helped the participant in this situation.

The participant also indicated that the trial should be longer than 3 weeks (~a month) to be familiar with all functions on the phone.

THIRD PARTICIPANT'S PROFILE

Participant 3 is a high school student who has Muscular Dystrophy (Duchenne's) and uses a mobile phone with speakerphone capability. The participant would like to use a personal digital assistant (PDA) that has all the functions of the mobile phone that the participant possesses. Text messaging on the current mobile phone presented a lot of problems for the participant due to the configuration of the buttons on the phone. Accidentally hitting the wrong button can erase minutes of typed text.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Can't use stylus on a PDA; needs alternative access such as a keyboard;
- SMS – pressing the wrong keys;
- Mounting the phone without affecting the voice clarity;
- Can't use speakerphone in a noisy environment; and
- Use a PDA with mobile phone function.

PARTICIPANT'S NEEDS

Essential	Important
• Speakerphone • Predictive text for faster text messaging (SMS)	• Voice dialling • Speed dialling • Attachable keypad

SOLUTION PROVIDED

Personal digital assistant – O_2XDA

PERFORMANCE AND SATISFACTION OUTCOMES

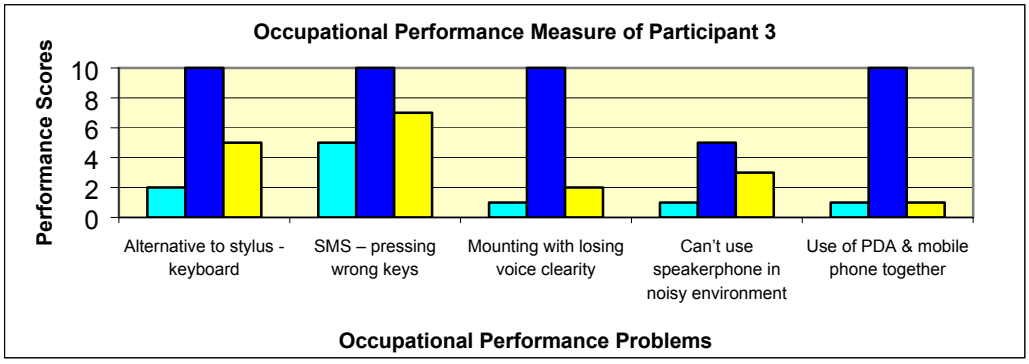


Figure 11 Performance measure of participant 3

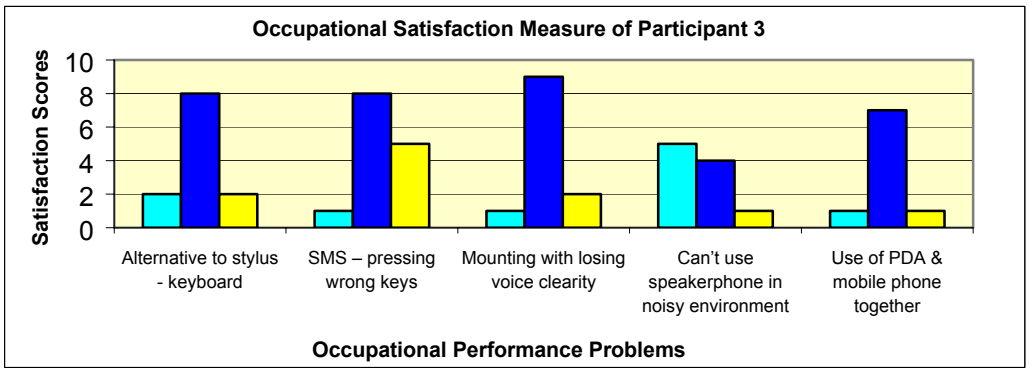


Figure 12 Satisfaction measure of participant 3

TIME RESPONSES

The time response for text messaging improved from approximately 5 minutes to around 2 minutes with the solution provided. The increased performance was due to the attachable keyboard, which the participant is a proficient user of. The time response for answering incoming calls remained the same, approximately 10 seconds. However, the time response for making calls increased from 30 seconds to 1 minutes when keying in digits.

OTHER FEEDBACK

This participant was provided with a PC-Ephone (PDA) that was not favourable due to small text and poor voice quality of the speakerphone. The O_2XDA provided a better solution but the speakerphone was still not good enough for use in a noisy environment. Generally, the participant can use the stylus but fatigues quite easily and therefore preferred the use of the keyboard.

The participant favoured the use of a keyboard with the PDA and the synchronisation with the PC capability of the PDA. The operating system on the PDA is similar to “Windows” and makes it very user friendly. However, the participant commented that the PDA was too big as a mobile phone.

FOURTH PARTICIPANT'S PROFILE

Participant 4 has CP and uses a mobile phone to communicate and maintain contact with family members and carers. Tremors, and reduced strength in the arms and hands, prevent the participant from using their current mobile phone efficiently.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Holding the phone for long call duration;
- Answering the call in time; and
- Recharging the phone battery.

PARTICIPANT'S NEEDS

Essential	Important
• Voice dialling • Speed dialling	• Speakerphone • Voicemail / answering machine • Predictive text for faster text messaging (SMS)

SOLUTION PROVIDED

Panasonic GD95

PERFORMANCE AND SATISFACTION OUTCOMES

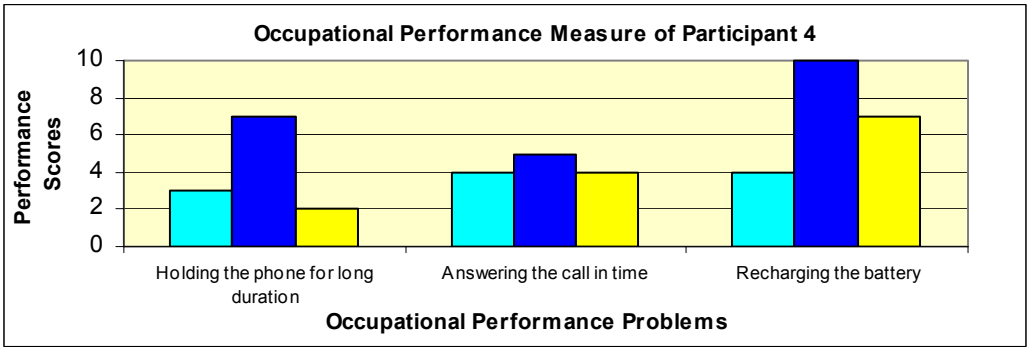


Figure 13 Performance measure of participant 4

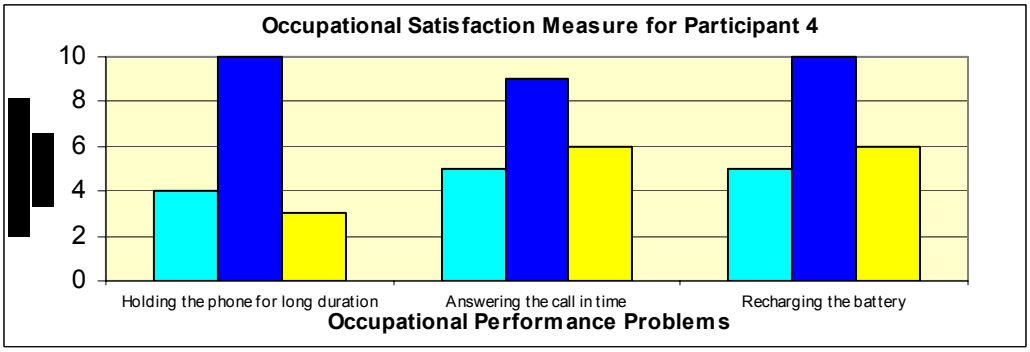


Figure 14 Satisfaction measure of participant 4

TIME RESPONSES

The time response for text messaging improved from approximately 30 minutes to around 15 minutes with the solution provided. The increased performance was due to the predictive text feature of the phone. The time response for making and answering incoming calls remained the same, approximately 3 minutes each.

OTHER FEEDBACK

Holding the phone for the duration of the call has always been a problem for the participant. This was alleviated by the use of a speakerphone feature of the provided solution. This was the feature that the participant favoured the most. Another feature was the speed and voice dialling capability of the phone. The five directional joystick proved inefficient for the participant but could be better if it was separated into buttons. The participant also indicated that the trial should be longer (~ a month) to full appreciate the new technology.

FIFTH PARTICIPANT'S PROFILE

Participant 5 is restricted to a wheelchair and has reduced strength in their hands. The participant had no previous exposure to mobile phones but uses a speakerphone-enabled telephone at home. Emergency and security is the main motivation for using a mobile phone.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following is the occupational performance problem with telecommunication use:

- When out and about – use a mobile phone for emergency and security

PARTICIPANT'S NEEDS

Essential	Important
• Speakerphone • Voice dialling • Speed dialling	• Voicemail / answering machine

SOLUTION PROVIDED

Nokia Bluetooth Car Kit

PERFORMANCE AND SATISFACTION OUTCOMES

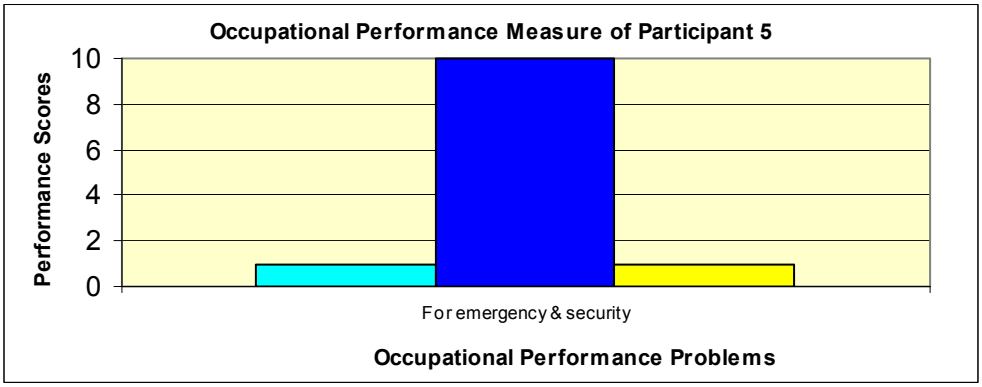


Figure 15 Performance measure of participant 5

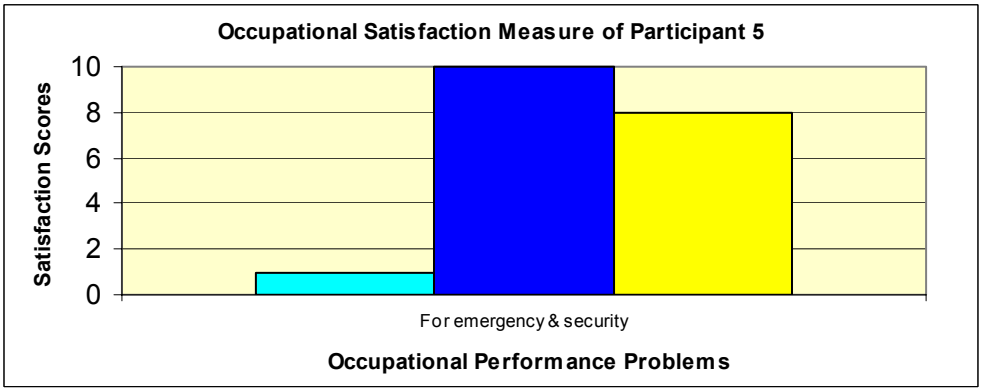


Figure 16 Satisfaction measure of participant 5

TIME RESPONSES

The time response for making calls reduced from approximately 20 seconds to around 5 seconds with preset numbers. The time response for answering calls reduced from approximately 30 seconds to around 5 seconds.

OTHER FEEDBACK

The solution presented no problems for the participant apart from the Bluetooth connection between the mobile phone and the car kit. Remembering the steps for this connection was the main problem for the participant. The participant found the buttons on the phone to be quite small but reasonable to use.

SIXTH PARTICIPANT'S PROFILE

Participant 6 has limited mobility and restricted movement. The participant can't press buttons due to reduced strength. Once in a wheelchair the participant can only use the index finger to control two modified switches to operate the wheelchair. The participant has a speakerphone at home and can only use it to some extent. Most of the time a family member or carer would pick up and answer the phone on the participant's behalf.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Can't use phone/mobile when out and about without help.
- Emergency and security;
- General use – calling taxi etc.

PARTICIPANT'S NEEDS

Essential	Important
• Speakerphone	Voice dialling

SOLUTION PROVIDED

- Ericsson Advanced Car Kit – total hands-free solution

PERFORMANCE AND SATISFACTION OUTCOMES

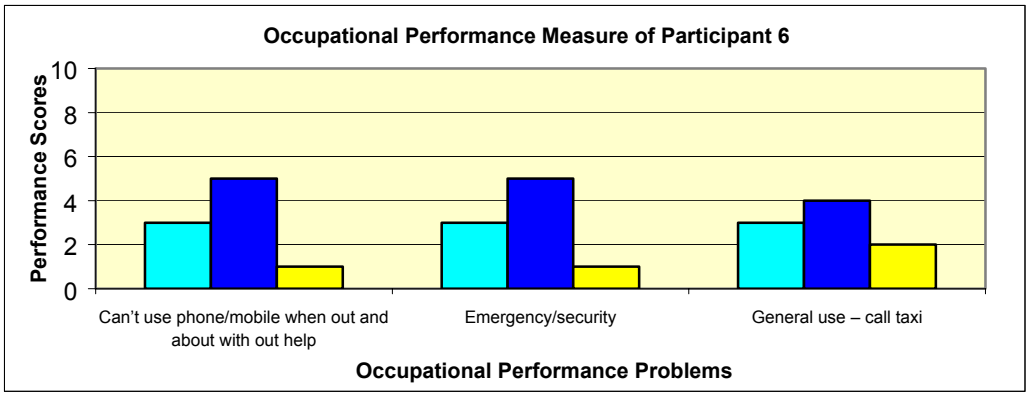


Figure 17 Performance measure of participant 6

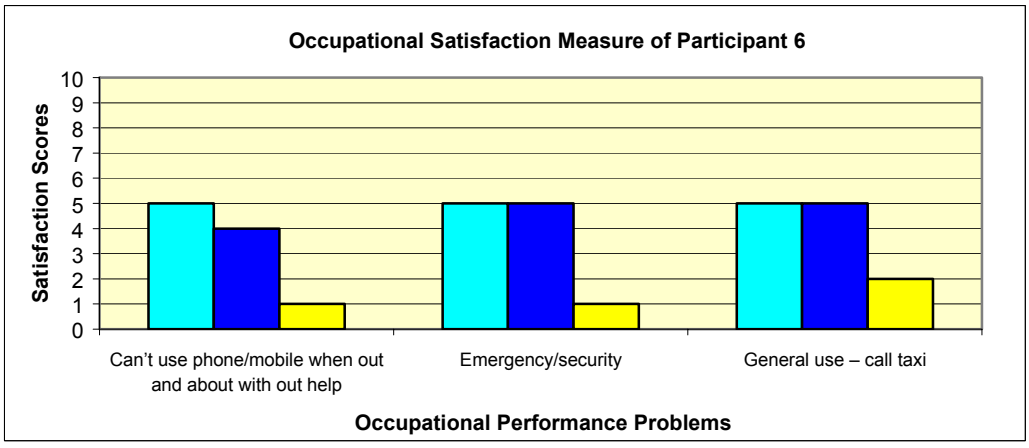


Figure 18 Satisfaction measure of participant 6

TIME RESPONSES

The time response for making calls reduced from approximately 15 seconds to around 5 seconds when using preset numbers. The time response for answering calls reduced from approximately 30 seconds to around 5 seconds.

OTHER FEEDBACK

The participant found the concept of a "***total hands-free***" solution perfect. This system assists those people with good verbal communication but with no or very limited physical movement. The total hands-free solution implements a "***magic word***" function to activate

the ‘voice recognition’ mode of the phone, allowing voice dialling, answer, and rejection to calls possible without the participant having to ever touch the phone. However, the participant found the car kit and mobile phone system used during the trial to be unreliable due to problems that arose during the trial. The “magic word” function of the system activated itself erratically, without the participant saying the magic word. Efforts were made to correct this malfunction through a software upgrade and hardware replacement. The participant had to change between different car kit systems and mobile phones to eventually get the right solution working to a satisfactory level. To this date, certified installers and repairers had not been able to identify and correct the malfunction – although a stand-alone system through the use of this system did not produce any of this behaviour. This problem only occurs when the system is connected to a wheelchair and power is drawn directly from the wheelchair’s batteries.

The participant commented that if the technology had worked as specified, their performance and satisfaction rating would have been significantly higher.

SEVENTH PARTICIPANT'S PROFILE

Participant 7 had problems using a mobile phone efficiently due to reduced strength as a direct result of their condition (Muscular Dystrophy). Pressing buttons, lifting the phone and holding the phone has always presented problems.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Holding the phone during a conversation;
- Lifting the phone up to the ear;
- Can't press buttons – reduced strength; and
- Recharging the phone battery.

PARTICIPANT'S NEEDS

Essential	Important
• Speakerphone • Voicemail • Predictive text for faster text messaging (SMS)	• Voice dialling • Speed dialling • Headset (with cord and cordless)

SOLUTION PROVIDED

Kyocera QCP 3035

PERFORMANCE AND SATISFACTION OUTCOMES

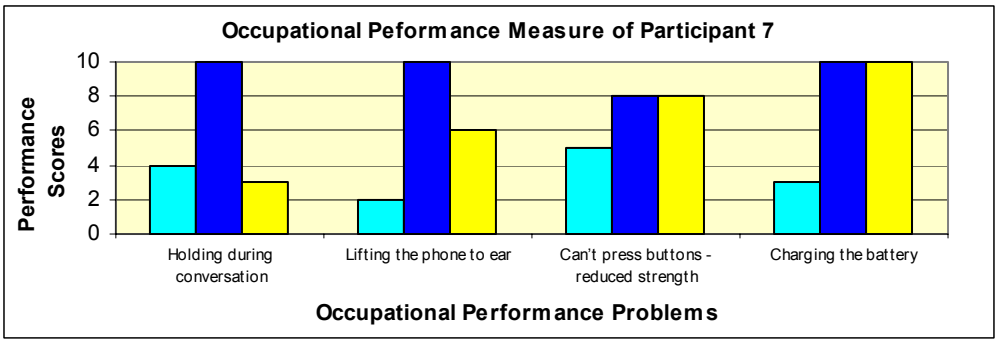


Figure 19 Performance measure of participant 7

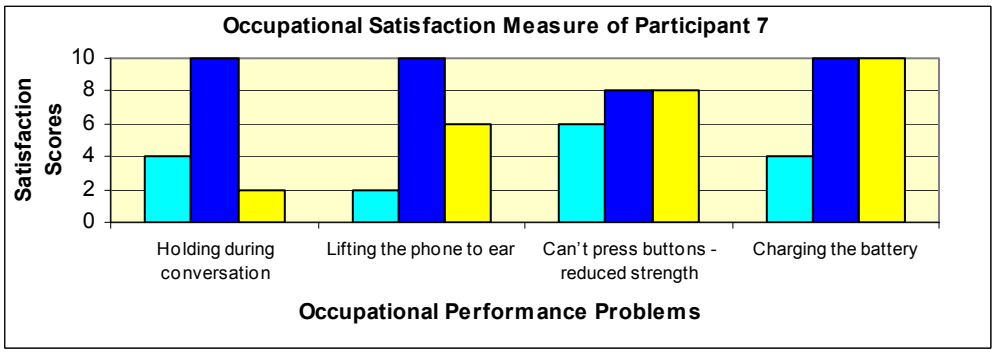


Figure 20 Satisfaction measure of participant 7

TIME RESPONSES

The time response for text messaging improved from approximately 3 minutes to around 40 seconds with the solution provided. The increased performance was due to the predictive text feature of the phone.

The time response for making calls reduced from approximately 30 seconds to around 10 seconds. However, the time response for answering calls remained the same, approximately 30 seconds.

OTHER FEEDBACK

The speakerphone feature helped alleviate many problems for this participant. Although, the Bluetooth headset was used by the participant, it was not favoured because of the set up involved in establishing the Bluetooth connection between the mobile phone and the cordless headset.

EIGHTH PARTICIPANT'S PROFILE

Participant 8 has CP, and is more cognitively than physically challenged. Due to this fact, the participant finds it hard to do tasks such as reading and writing. Text messaging on the mobile phone is a slow and tedious process. The participant uses a mobile phone to communicate with friends and family members.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- The screen on the current phone is too small;
- Problem with navigating through the menus; and
- Messaging takes too long on existing phone.

PARTICIPANT'S NEEDS

Essential	Important
• Voice dialling • Speed dialling	• Larger display

SOLUTION PROVIDED

Panasonic GD95

PERFORMANCE AND SATISFACTION OUTCOMES

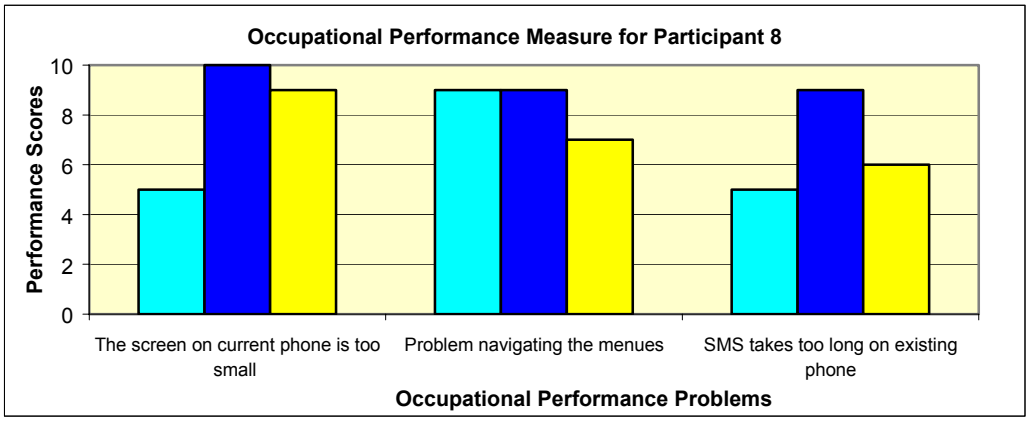


Figure 21 Performance measure of participant 8

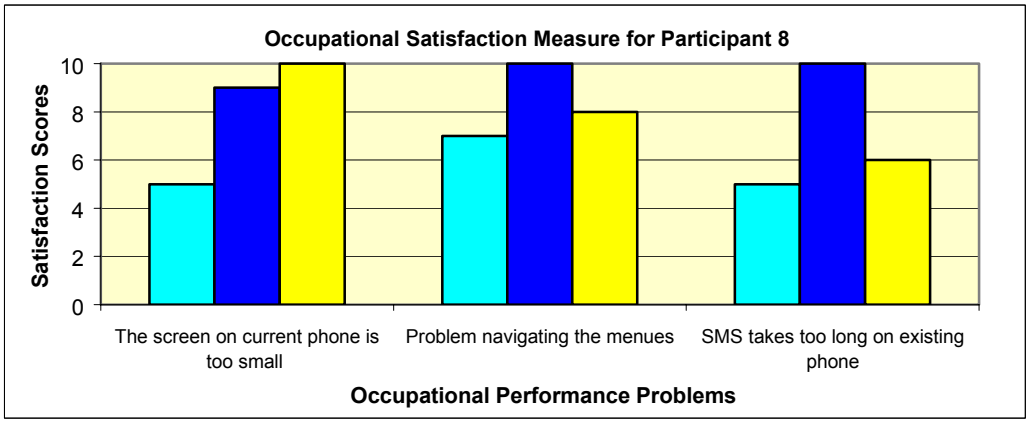


Figure 22 Satisfaction measure of participant 8

TIME RESPONSES

The time response for text messaging improved from approximately 7 minutes to around 5 minutes with the solution provided. This increased performance was due to the predictive text feature of the phone. The time responses for making and answering calls remained the same, approximately 20 seconds for both.

OTHER FEEDBACK

The participant favoured speed dialling over voice dialling.

NINTH PARTICIPANT'S PROFILE

Participant 9 has Athetoid CP and is restricted to a wheelchair and uses an AAC device to communicate (using a single, scanning switch positioned on the headrest). Because of this fact, communication is a slow process. The participant can't initiate or answer calls on the home phone. However, with speakerphone capability, the participant is able to join the conversation.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Can't dial/answer/hang up a call;
- Maintain contact with people; and
- Security and independence.

PARTICIPANT'S NEEDS

Essential	Important
• Speakerphone • Voice dialling • Voicemail/ answering machine	• Access to mobile phone via a desktop or laptop computer

SOLUTION PROVIDED

RehaPhone – Infrared telephone

PERFORMANCE AND SATISFACTION OUTCOMES

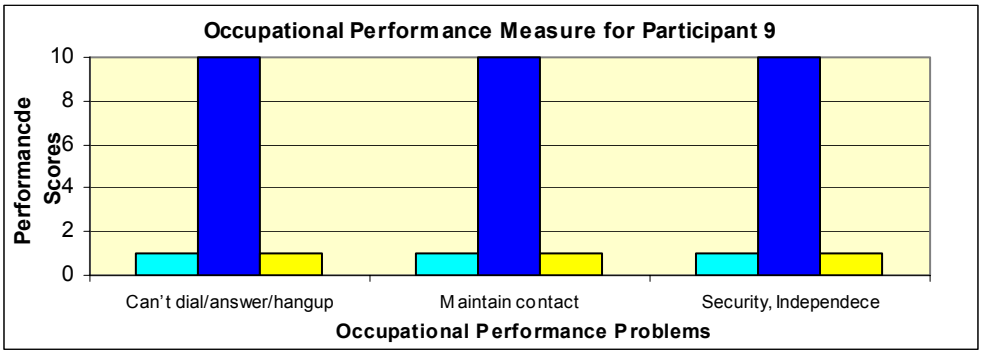


Figure 23 Performance measure of participant 9

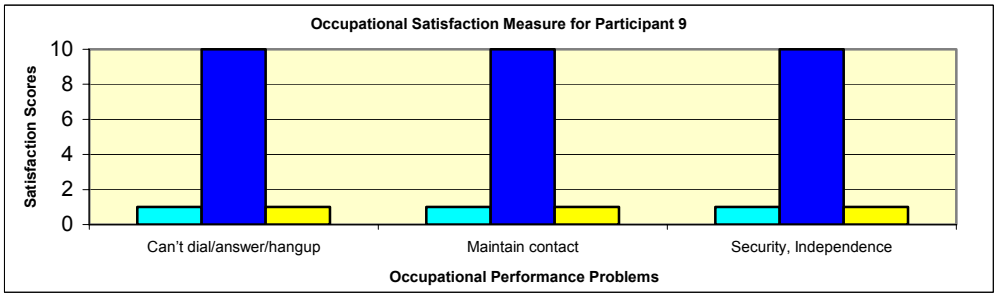


Figure 24 Satisfaction measure of participant 9

TIME RESPONSES

Making calls or answering calls were not possible prior to the trial. With the provided solution this was made possible. The participant normally takes less than a minute to make calls using preset numbers programmed on their Pathfinder (AAC device). Answering incoming calls normally takes about 10 seconds when the participant is situated within the vicinity of the phone's infrared signal.

OTHER FEEDBACK

The trial has opened a whole new world of communication for this participant – something the participant hasn't been able to do independently previously. They now have full control of the phone at home. Checking for messages (through "Message 101") was the most frequently dialled number on the new phone. This was something the participant did consistently everyday after school. The participant's mum also indicated that trial should also be at least a month to be fully familiar with the new technology.

TENTH PARTICIPANT'S PROFILE

Participant 10 has CP and is restricted to a wheelchair and uses an AAC device to communicate via a modified joystick operated by the foot. This is a slow communication process. The participant currently has a mobile phone but all calls are initiated and answered by the carer on behalf of the participant. The message is then relayed to participant. The participant also has a speakerphone at home whereby the participant occasionally joins in the conversation.

PARTICIPANT'S OCCUPATIONAL PROBLEMS

The following are the occupational performance problems with telecommunication use:

- Unable to accept calls when out and about;
- Carry out a live conversation; and
- Maintain contact with people during the day.

PARTICIPANT'S NEEDS

Essential	Important
• Voice dialling • Speed dialling • Predictive text for faster SMS. • Larger display	• Speakerphone

SOLUTION PROVIDED

Ericsson Advanced Car Kit

PERFORMANCE AND SATISFACTION OUTCOMES

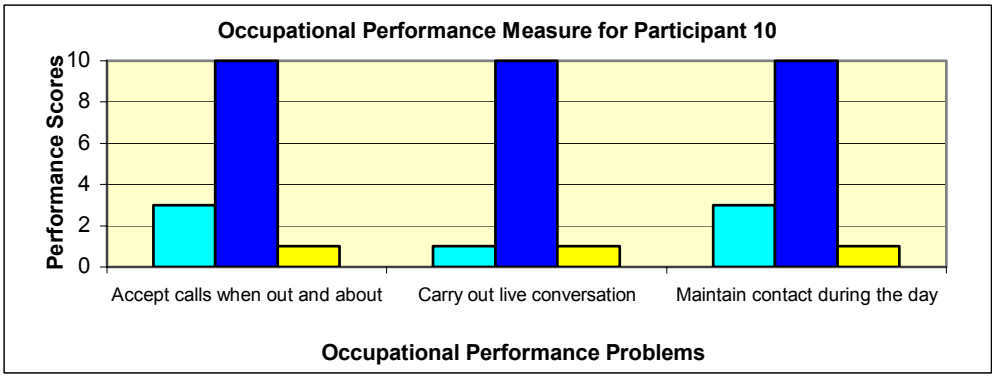


Figure 25 Performance measure of participant 10

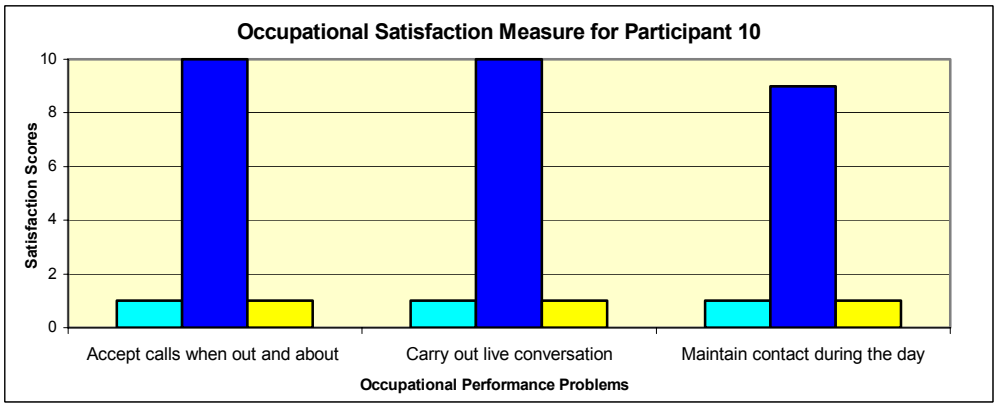


Figure 26 Satisfaction measure of participant 10

TIME RESPONSES

Making or answering incoming calls was not possible prior to the trial. While the solution provided allowed for answering incoming calls through the automatic answering capability built in the mobile phone system, initiating calls still requires the assistance of a carer.

OTHER FEEDBACK

With the provision of the speakerphone system installed on the wheelchair the participant was able to join in the conversation and able to receive calls automatically. This is something that the participant was not able to do at all previously, and was extremely satisfied with.

Appendix 6 Mobile phone access for AAC device users

Appendix 6-1 Standards for GSM AT commands

Standard	Title	Scope
International Telecommunications Union – Telecommunications Standardization Sector (ITU-T) Recommendation V.25ter (V.250) (05/99)	Series V: Data communication of telephone network control procedures: Serial asynchronous automatic dialling and control	Defines commands and responses for use be a DTE to control a V-series DCE using serial data interchange over a asynchronous interface.
European Telecommunications Standards Institute (ESTI) Global Systems for Mobile Communication (GSM) 07.07 version 7.6.0 Release 1998. (also known as (aka) ETSI Technical Specification (TS) 100 916 v7.60 (2001-03))	Digital cellular telecommunications system (phase 2+); AT command set for GSM Mobile Equipment (ME)	Specifies a profile of AT commands and recommends that this profile be used for controlling Mobile Equipment (ME) functions and GSM network services from a Terminal Equipment (TE) through a Terminal Adaptor (TA).
ESTI GSM 07.05 version 7.0.1 Release 1998. (aka ETSI TS 100 585 v7.0.1 (1999-07))	Digital cellular telecommunications system (phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)"	Defines three interface protocols for control of SMS functions within a GSM mobile telephone from a remote terminal via an asynchronous interface.
ETSI Third-Generation Partnership Project (3GPP) Technical Specification (TS) 27.005 version 4.1.0 Release 4. (aka ETSI TS 127 005 v1.4.0 (2001-09))	Digital cellular telecommunications system (phase 2+); Universal Mobile Telecommunications System (UMTS); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)"	Defines three interface protocols for control of SMS functions within a GSM/UMTS mobile telephone from a remote terminal via an asynchronous interface.
ETSI 3GPP 27.007 version 5.1.0 Release 5 (aka ETSI TS 127 007 v51.0 (2002-03))	Digital cellular telecommunications system (phase 2+); Universal Mobile Telecommunications System (UMTS); AT command set for GSM User Equipment (UE)	Specifies a profile of AT commands and recommends that this profile be used for controlling Mobile Termination (MT) functions and GSM/UMTS network services from a Terminal Equipment (TE) through a Terminal Adaptor (TA).
ITU-T Recommendation T.31	Asynchronous facsimile Data Communications Equipment (DCE) control, service class 1	Describes a Facsimile DCE that includes physical and data layer functions. The corresponding DTE must implement the T.30 session protocol and any necessary higher function.
ITU-T Recommendation T.32	Asynchronous facsimile Data Communications Equipment (DCE) control, service class 2	Protocols allowing a computer to control a fax modem.
Telecommunications Industry Association International Standard (TIA IS)-99	Data Services Option Standard for Wideband Spread Spectrum Digital Cellular System	An architecture that adapts low speed mobile data over higher speed digital channels.
TIA IS-135	800 MHz Cellular Systems, Time Division Multiple Access (TDMA) Services, Asynchronous Data and fax"	Govern how data calls are handle with TDMA.

Table 1 GSM Standards implementation.

Appendix 6-2 Nokia GSM AT Commands (Functional Groups)

The following outlines the GSM AT commands that are implemented on selected Nokia phones, in their individual functional groups.

1. Call Control

ATA	Answer Command
ATD	Dial Command
ATH	Hang Up Call
ATL	Monitor Speaker Loudness
ATM	Monitor Speaker Mode
ATO	Go On-Line
ATP	Set Pulse Dial as Default
ATT	Set Tone Dial as Default
AT+CSTA	Select Type of Address
AT+CRC	Cellular Result Codes

2. Data Card Control Commands

ATI	Identification
ATS	Select an S-register
ATZ	Recall Stored Profile
AT&F	Restore Factory Settings
AT&V	View Active Configuration
AT&W	Store Parameters in Given Profile
AT&Y	Select Set as ***s*** Powerup Option
AT+CLCK	Facility Lock Command
AT+COLP	Connected Line Identification Presentation
AT+GCAP	Request Complete Capabilities List
AT+GMI	Request Manufacturer Identification
AT+GMM	Request Model Identification
AT+GMR	Request Revision Identification
AT+GSN	Request Product Serial Number Identification

3. Phone Control Commands

AT+CBC	Battery Charge
AT+CGMI	Request Manufacturer Identification
AT+CGMM	Request Model Identification
AT+CGMR	Request Revision Identification
AT+CGSN	Request Product Serial Number Identification
AT+CMEE	Report Mobile Equipment Error
AT+CPAS	Phone Activity Status
AT+CPBF	Find Phone Book Entries
AT+CPBR	Read Phone Book Entry
AT+CPBS	Select Phone Book Memory Storage
AT+CPBW	Write Phone Book Entry
AT+CSCS	Select TE Character Set
AT+CSQ	Signal Quality

4. Computer Data Card Interface Commands

ATE	Command Echo
ATQ	Result Code Suppression
ATV	Define Response Format
ATX	Response Range Selection
AT&C	Define DCD Usage

AT&D	Define DTR Usage
AT&K	Select Flow Control
AT&Q	Define Communications Mode Option
AT&S	Define DSR Option
AT+ICF	DTE-DCE Character Framing
AT+IFC	DTE-DCE Local Flow Control
AT+IPR	Fixed DTE Rate

5. Reporting Options Commands

AT+CLIP	Calling Line Identification Presentation
AT+CR	Service Reporting Control
AT+DR	Data Compression Reporting
AT+ILRR	DTE-DCE Local Rate Reporting

6. Network Communication Parameter Commands

ATB	Communications Standard Option
AT+CBST	Select Bearer Service Type
AT+CEER	Extended Error Report
AT+CRLP	Radio Link Protocol
AT+DS	Data Compression

7. Miscellaneous Commands

A/	Re-Execute Command Line
AT?	Command Help
AT*C	Start SMS Interpreter
AT*T	Enter SMS Block Mode Protocol
AT*V	Activate V.25bis Mode
AT*NOKIATEST	Test Command
AT+CESP	Enter SMS Block Mode Protocol

8. SMS Commands SMS Text Mode

AT+CSMS	Select Message Service
AT+CPMS	Preferred Message Storage
AT+CMGF	Message Format
AT+CSCA	Service Centre Address
AT+CSMP	Set Text Mode Parameters
AT+CSDH	Show Text Mode Parameters
AT+CSCB	Select Cell Broadcast Message Types
AT+CSAS	Save Settings
AT+CRES	Restore Settings
AT+CNMI	New Message Indications to TE
AT+CMGL	List Messages
AT+CMGR	Read Message
AT+CMGS	Send Message
AT+CMSS	Send Message from Storage
AT+CMGW	Write Message to Memory
AT+CMGD	Delete Message

9. SMS PDU Mode

AT+CMGL	List Messages
AT+CMGR	Read Message
AT+CMGS	Send Message
AT+CMGW	Write Message to Memory

(http://www.tele-servizi.com/nokiasecrets/nokia/gsm_at_commands_en.html)

Appendix 6-3 GSM AT commands test results for the Motorola V3688

Task Description	Implementation	Command	Responses
General Commands			
Request manufacture identification	Optional	*+CGMI* *+CGMI=?*	Motorola OK
Request model identification	Optional	*+CGMM* *+CGMM=?*	Soft Modem: Motorola Smart CELLect Handset: Motorola OK
Request revision identification	Optional	*+CGMR* *+CGMR=?*	Soft Modem: V1.01.5472 130449 OK
Request product serial number identification	Optional	*+CGSN* *+CGSN=?*	S/W VB9.06.18 OK
Select TE character set	Optional	*+CSCS?* *+CSCS=?*	(“GSM”) (“GSM”, “IRA”)
Request international mobile subscriber identity	Optional	*+CIMI* *+CIMI=?*	ERROR ERROR
Multiplexing mode	Mandatory	*+CMUX*	ERROR
PCCA STD-101 select wireless network	Optional	*+WS46?* *+WS$=?*	12 – “GSM digital cellular” (012)
Capabilities of TA	Optional	*+CGCAP* *+CGCAP?* *+GCAP=?*	+CGSM+FCLASS, +W +CGSM+FCLASS, +W 000 OK
Call control commands and methods			
Select PhoneBook Memory Storage	Mandatory	*+CPBS* *+CPBS=?*	ERROR (“LD”, “ME”, “MI”, “SM”,)
Direct dialling from Phonebooks	Mandatory when direct dialling is implemented. Also phonebook commands implementation is required.	*D><”string”>* *D+#* *D>location*	ATD> “NHA” ATD>104
Call mode	Mandatory when alternating mode calls are implemented in the TA.	*+CMOD* *+CMOD=?*	CME ERROR = operation not supported CME ERROR = operation not supported
Hang-up call	Mandatory when alternating mode calls implemented in the TA.	*+CHUP* *+CHUP=?*	OK 000
Voice or fax capabilities		*FCLASS?* *+FCLASS=?*	0 0,1,2
Select bearer service type	Mandatory when data calls implemented.	*+CBST?* *+CBST=?*	007, 000, 000 (000-007, 065, 066, 068, 070, 071), (000), (000.1)
Radio link protocol	Mandatory when RLP implemented.	*+CRLP* *+CRLP=?*	061,061,090,006 (001-006), (001-061), (048-255), (006-255)
Service reporting control	Mandatory when data calls implemented.	*+CR* *+CR=?*	000 (000,000)
Extended error report	Optional	*+CEER* *+CEER=?*	No information available OK
Cellular result codes	Mandatory when data or fax circuit mode calls implemented.	*+CRC* *+CRC?*	000 (000,001)
High Speed Circuit Switched Data (HSCSD) device parameters	Mandatory when HSCSD implemented.	*+CHSD=?*	ERROR
HSCSD transparent call	Mandatory when	*+CHST?*	ERROR

configuration	transparent HSCSD implemented.	*+CHST=?*	ERROR
HSCSD non-transparent call configuration	Mandatory when non-transparent HSCSD implemented.	*+CHSN?* *+CHSN=?*	ERROR ERROR
HSCSD current call parameters	Optional	*+CHSC* *+CHSC=?*	ERROR ERROR
HSCSD parameters report	Mandatory when HSCSD implemented.	*+CHSR?* *+CHSR=?*	ERROR ERROR
HSCSD automatic user initiated upgrading	Optional	*+CHSU?* *+CHSU?*	ERROR ERROR
Single numbering scheme	Optional	*+CSNS?* *+CSNS=?*	ERROR ERROR
Voice Hang-up Control	Optional	*+CVHU?* *+CVHU=?*	ERROR ERROR
V.120 rate adaption protocol	Mandatory, if the ME supports V.120 interworking.	*+CV120?* *+CV120=?*	ERROR ERROR
Network service related commands			
Subscriber number	Optional	*+CNUM* *+CNUM=?*	ERROR? OK
Network registration	Optional	*+CREG* *+CREG?* *+CREG=?*	OK 0,1 0,1,2
Operation selection	Optional	*+COPS?* *+COPS=?*	0, 0, “Telstra ERROR
Facility lock	The call barring supplementary service control is mandatory for ME supporting AT commands only and not supporting the control through dial command *D*.	*+CLCK=?*	ERROR
Change password	Optional	*+CPWD*	ERROR
Calling line identification presentation	Optional	*+CLIP* *+CLIP=?*	000, 002 (000, 001)
Calling line identification restriction	Optional	*+CLIR?* *+CLIR=?*	ERROR ERROR
Connected identification presentation	Optional	*+COLP?* *+COLP=?*	ERROR ERROR
Closed user group	Optional	*+CCUG?* *+CCUG?*	ERROR ERROR
Call forwarding number and conditions	Optional	*+CCFC=?*	ERROR
Call waiting	Optional	*+CCWA?* *+CCWA=?*	ERROR ERROR
Call related supplementary services	Optional	*+CHLD=?*	ERROR
Call deflection	Optional	*+CTFR=?*	ERROR
Unstructured supplementary service data	Optional	*+CUSD?* *+CUSD?*	ERROR ERROR
Advice of Charge	Optional	*+CAOC?* *+CAOC=?*	ERROR ERROR
Supplementary service notification	Optional	*+CSSN?* *+CSSN=?*	ERROR ERROR
List current calls	Optional. Recommended when *+CHLD* command is implemented.	*+CLCC=?*	ERROR
Preferred operator list	Optional	*+CPOL?* *+CPOL=?*	ERROR ERROR
Read operator names	Optional	*+COPN=?*	ERROR

Mobile Equipment control and status commands			
Phone activity	Mandatory when ME can be operated from TE	*+CPAS* *+CPAS=?*	000 (000, 001, 003, 004)
Set phone functionality	Optional	*+CFUN* *+CFUN=?*	ERROR ERROR
Enter pin	Mandatory for ME not supporting the *+CKPD* command and supporting AT commands only	*+CPIN?* *+CPIN=?*	READY
Battery Charge	Optional	*+CBC* *+CBC=?*	000, 100 (000 –001), (000-100)
Signal Quality	Optional	*+CSQ* *+CSQ=?*	031, 099 (000-031, 099), (099)
Mobile Equipment Control Mode	Optional	*+CMEC* *+CMEC=?*	ERROR ERROR
Keypad Control	Optional	*+CKPD* *+CKPD=?*	ERROR ERROR
Display Control	Optional	*+CDIS* *+CDIS=?*	ERROR ERROR
Indicator Control	Optional	*+CIND* *+CIND=?*	ERROR ERROR
Mobile Equipment event reporting	Mandatory when any of the keypad, display, or indicator result codes is implemented	*+CMER* *+CMER=?*	CME ERROR = operation not supported CME ERROR = operation not supported
Keypad Event	Optional	*+CKEV* *+CKEV=?*	ERROR ERROR
Display Event	Optional	*+CDEV* *+CDEV=?*	ERROR ERROR
Indicator Event	Optional	*+CIEV* *+CIEV=?*	CME ERROR = operation not supported CME ERROR = operation not supported
Select phonebook memory storage	Mandatory when phonebook read, find, or write command, or direct dialling is implemented	*+CPBS* *+CPBS=?*	0, 0 (“LD”, “ME”, “MT”, “SM”,)
Read phonebook entries	Optional	*+CPBR* *+CPBR=?*	CME ERROR = operation not allowed CME ERROR = operation not allowed
Find phonebook entries	Optional	*+CPBF* *+CPBF=?*	CME ERROR = unknown CME ERROR = unknown
Write phonebook entry	Optional	*+CPBW* *+CPBW=?*	CME ERROR = operation not allowed CME ERROR = operation not allowed
Clock	Optional	*+CCLK* *+CCLK=?*	CME ERROR = operation not supported CME ERROR = operation not supported
Alarm	Optional	*+CALA* *+CALA=?*	CME ERROR = operation not supported CME ERROR = operation not supported
Generic SIM access	Optional	*+CSIM* *+CSIM=?*	ERROR ERROR
Restricted SIM access	Optional	*+CRSM* *+CRSM=?*	ERROR ERROR
Secure control command	Optional	*+CSCC?* *+CSCC=?*	ERROR ERROR
Alert sound mode	Optional	*+CALM?* *+CALM=?*	ERROR ERROR

Ringer sound level	Optional	*+CRSL?* *+CRSL=?*	ERROR ERROR
Vibrator mode	Optional	*+CVIB?* *+CVIB=?*	ERROR ERROR
Loudspeaker volume level	Optional	*+CLVL?* *+CLVL?*	ERROR ERROR
Mute control	Optional	*+CMUT?* *+CMUT=?*	ERROR ERROR
Accumulated call meter	Optional	*+CACM?* *+CACM=?*	ERROR ERROR
Accumulated call meter maximum	Optional	*+CAMM?* *+CAMM=?*	ERROR ERROR
Price per unit and currency table	Optional	*+CPUC?* *+CPUC=?*	ERROR ERROR
Call Meter maximum event	Optional	*+CCWE?* *+CCWE=?*	ERROR ERROR
Power class	Optional	*+CPWC?* *+CPWC=?*	ERROR ERROR
Set Language	Optional	*+CLAN?* *+CLAN=?*	ERROR ERROR
Language Event	Optional	*+CLAE?* *+CLAE=?*	ERROR ERROR
Set Greeting Text	Optional	*+CSGT?* *+CSGT=?*	ERROR ERROR
Set Voice Mail Number	Optional	*+CSVM?* *+CSVM=?*	ERROR ERROR
Ring Melody Playback	Optional	*+CRMP=?*	ERROR
Master Reset	Optional	*+CMAR=?*	ERROR
List all available AT commands	Optional	*+CLAC=?*	ERROR
Mobile Equipment errors			
Report Mobile Equipment error	Optional	*+CMEE?* *+CMEE=?*	ERROR ERROR
Mobile Equipment error result code	Optional	*+CME ERROR*	ERROR
AT GSM COMMAND SETS FOR SMS			
Text Mode			
General Configuration Commands			
Select Message Service	Mandatory	*+CSMS?* *+CSMS=?*	000, 001, 001, 001 (000)
Preferred Message Storage + CPMS	Mandatory	*+CPMS?* *+CPMS=?*	“SM”,002, 0034, “SM”,002, 0034 (“SM”), (“SM”)
Message Format	Mandatory when only one mode implemented	*+CMGF?* *+CMGF=?*	000 (000)
Enter SMS Block Mode Protocol	Mandatory when block mode implemented	*+CESP* *+CESP=?*	OK OK, and then freezes screen?
Message Configuration Commands			
Service Centre Address	Mandatory	*+CSCA?* *+CSCA=?*	ERROR OK
Set Text Mode Parameters	Mandatory when text mode implemented	*+CSMP?* *+CSMP=?*	ERROR, since ONLY PDU mode is implemented with this particular model.
Show Text Mode Parameters	Mandatory when text mode implemented	*+CSDH?* *+CSDH=?*	ERROR, since ONLY PDU mode is implemented with this particular model
Select Cell Broadcast Message Types	Optional	*+CSCB?* *+CSCB=?*	ERROR ERROR
Save Settings	Optional	*+CSAS=?*	ERROR
Restore Settings	Optional	*+CRES=?*	ERROR

Message Receiving and Reading Commands			
New Message Indications to TE	Mandatory when any of the new message indications implemented	*+CNMI?* *+CNMI=?*	002, 001, 000, 000, 000 (000-002), (000,001), (000, 001), (000, 001), (000, 001)
List Messages	Optional	*+CMGL=?*	(000-004)
Read Message	Optional	*+CMGR=?*	OK
New Message Acknowledgement to ME/TA	Optional	*+CNMA* *+CNMA=?*	ERROR, not in text mode.
Message Sending and Writing Commands			
Send Message	Optional	*+CMGS=?*	OK
Send Message from Storage	Optional	*+CMSS=?*	ERROR
Write Message to Memory	Optional	*+CMGW=?*	OK
Delete Message	Optional	*+CMGD=?*	OK
Send Command	Optional	*+CMGC=?*	ERROR
More Messages to Send	Optional	*+CMMS=?*	ERROR
PDU Mode			
List Messages	Optional	*+CMGL=?*	(000-004)
Read Messages	Optional	*+CMGR=?*	OK
Send Message	Optional	*+CMGS=?*	OK
Write Message to Memory	Optional	*+CMGW=?*	OK
Send Command	Optional	*+CMGC=?*	ERROR
New Message Acknowledgement to ME/TA	Mandatory when <service> value 1 of command Select Message Service +CSMS is supported	*+CNMA=?*	ERROR
Send Message from Storage	Optional	*+CMSS=?*	ERROR

Table 2 GSM AT commands test results for the Motolora V3688 (ESTI GSM 07.07, 1998).

Appendix 6-4 GSM AT Command line, Information Response & Result Codes and Character Codes

GSM AT command line

Figure 1 shows the general structure of a command line. Standardized *basic* commands (without "+" prefix) are found only in V.25ter (ITU-T V.25ter, 1999). GSM commands use syntax rules of *extended* commands. Every extended command has a:

- *test command* (trailing "=?") to test the existence of the command and to give information about the type of its subparameters;
- *read command* (trailing "?") to check the current values of subparameters.

There are also *action type* commands that do not store the values of any of their possible subparameters, and therefore do not have a read command.

A command line can consist of several commands and is initiated by an AT prefix followed by basic commands and/or GSM commands. Basic commands are delimited with a space, while GSM commands are delimited with a semicolon. The actual command is terminated with a Carriage Return, <CR>, character.

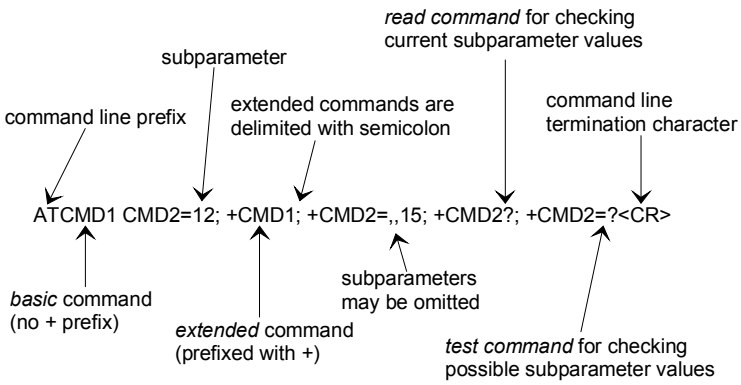


Figure 1 Basic structure of a command line (ESTI GSM 07.07, 1998)

Information responses and result codes

When verbose responses are enabled with the command V1 (where V is the TA response format (1 = verbose (default), 0 = numeric) and all commands in a command line has been performed successfully, result code <CR><LF>OK<CR><LF> is sent from the TA to the TE. <CR> is the "Carriage Return" character and <LF> is the "Line Feed" character. If numeric responses are enabled with command V0, result code 0<CR> is sent instead.

When verbose responses are enabled with command V1 and subparameter values of a command are not accepted by the TA (or command itself is invalid, or command cannot be performed for some reason), result code <CR><LF>ERROR<CR><LF> is sent to the TE and no subsequent commands in the command line are processed. If numeric responses are enabled with command V0, result code 4<CR> is sent instead. ERROR (or 4) response may be replaced by +CME ERROR: <err> when command was not processed due to an error related to ME operation.

The TA response for the example command line of Figure 1 could be as shown in Figure 2. For this response, the *verbose* format is enabled with command V1. If numeric format V0 would have been used, <CR><LF> headers of *information responses* would have been left out and *final result code* changed to 0<CR>.

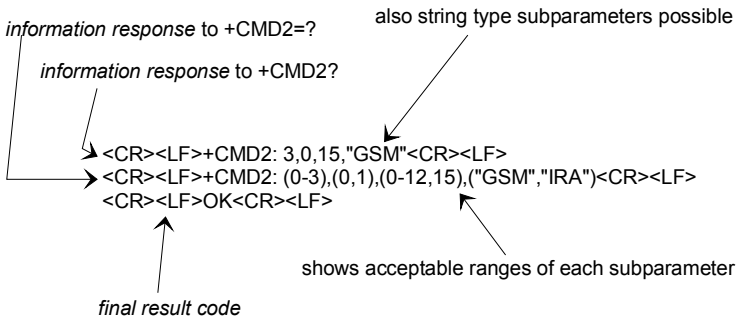


Figure 2 Response to a command line (ESTI GSM 07.07, 1998)

Other responses are also received from the TA and these include:

- *intermediate result codes*, which informs about the progress of TA operation (e.g. connection establishment CONNECT); and
- *unsolicited result codes* , which indicates occurrence of an event not directly associated with issuance of a command from TE (e.g. ring indication RING such as that of an incoming call).

Character codes for key presses on the ME keypad

Character	IRA** (decimal)	Comment (+ some known key symbols)
#	35	hash (number sign)
%	37	percent sign (P)
*	42	star (*)
0... 9	48... 57	number keys
:	58	escape character for manufacturer specific keys
;	59	escape character for string entering
<	60	left arrow
>	62	right arrow
@	64	alpha key (□/ABC)
A/a	65/97	channel A (A)
B/b	66/98	channel B (B)
C/c	67/99	clear display (C/CLR)
D/d	68/100	volume down
E/e	69/101	connection end (END)
F/f	70/102	function (FCN)
L/l	76/108	phone lock (LOCK)
M/m	77/109	menu (MENU)
P/p	80/112	power (PWR)
Q/q	81/113	quiet/mute (MUTE)
R/r	82/114	recall last number (R/RCL/MR)
S/s	83/115	connection start (SEND)
T/t	84/116	store/ memory (STO/M/M+)
U/u	85/117	volume up
V/v	86/118	down arrow
W/w	87/119	pause character
X/x	88/120	auxiliary (AUX)
Y/y	89/121	delete last character (C)
[	91	soft key 1
]	93	soft key 2
^	94	up arrow

Table 3 Character codes than emulate key presses on the ME keypad (ESTI GSM 07.07, 1998)

**** IRA** - International Reference Alphabet is the standard code used for information interchange.

Appendix 6-5 Set up of the HyperTerminal program to operate a mobile phone via GSM AT commands

The following outlines the steps required to set up the HyperTerminal application to communicate with a mobile phone via GSM AT commands.

To set up the HyperTerminal application, carry out the following steps:

1. Open HyperTerminal application by choosing the Start button (Start) → Programs → Accessories → Communications →HyperTerminal

This should bring up a Window with some icons in it. Start up the icon called "Hypertrm.exe". A splash-screen of HyperTerminal by Hilgraeve as shown in Figure 3 appears and goes away in 5 seconds.

Figure 3 HyperTerminal application.

2. Establish a “New Connection”

Another window called "New connection", as shown Figure 4 below will appear. Type in a name such as “Sony Ericsson T610” and click OK.

Figure 4 Establish a new HyperTerminal connection.

3. Establish a COM connection

Using the serial port

A “Connect To” window as shown in Figure 5 below appears. Down at the bottom of the window where it says, "Connect using", pick a Com port that is available, and unused on the system.

Figure 5 Connection using an unused serial COM port.

Another with window “COM2 Properties” as shown in Figure 6 appears. Change the “Port Settings” as displayed and click OK.

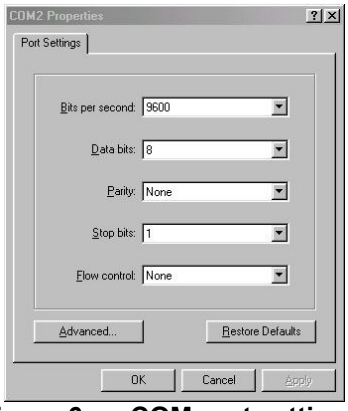


Figure 6 COM port settings.

N.B: Parity (error-checking system) is set to none when all 8 bits are used as data.

Using the Infrared (IrDA) port

Pick a Com port that the IrDA is tied to, for example, Com4. Com4 properties are automatically set once the OK button is selected, Figure 7.

Figure 7 Connection using an unused COM port.

4. Exchange information.

String characters can now be sent to/from the HyperTerminal application and the external device, Figure 8.

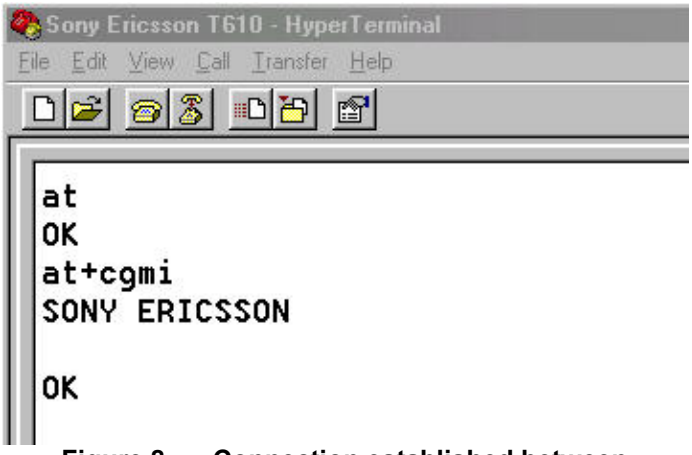


Figure 8 Connection established between

Appendix 6-6 Storing, sending and receiving text messages using HyperTerminal application

Sending and receiving text messages using GSM AT commands

The mobile phone modem supports text messaging (SMS) in two modes: *Portable Data Unit* (PDU) represented by "0" (the default setting), and *Text* represented by "1". The PDU mode is an encoding method for data being transferred to/from a handset over the telecommunications network, while the text mode allows standard ASCII string characters to be transferred. Figures 6-4 and 6-5 show how text messages (SMS) can be sent and received using the same HyperTerminal application.

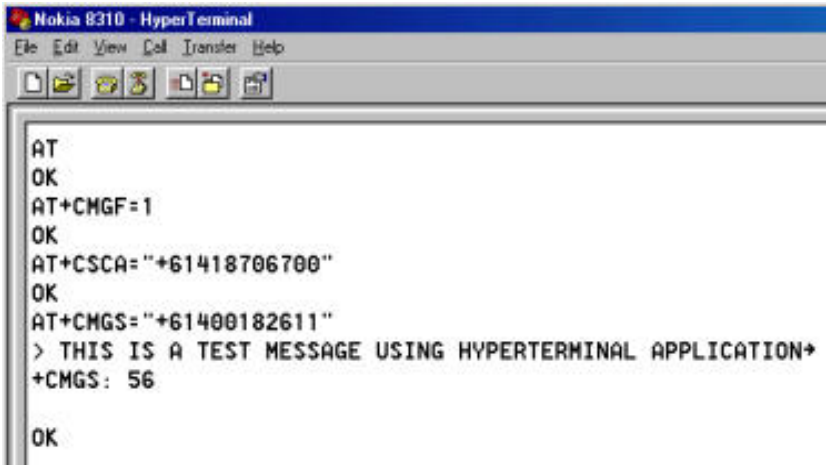


Figure 9 Sending an SMS.

To create and send an SMS message, the first step is to switch the modem to text mode by using the command AT+CMGF=1. This is followed by setting the Message Centre Service Provider[86] number using the AT+CSCA command. That is, for Telstra it is "+61418706700", for Optus it is "+61411990000" and for Vodafone it is "+61415011501", etc, as shown in Figure 6-4. In addition, the phone number to which the SMS will be sent to is entered by the AT+ CMGS command. Finally, the message can be entered and sent off by pressing the control - Z (Ctrl-Z) key combinated (depicted as an arrow (➔)) as shown in Figure 6.4. The response **"+CMGS: 56**", indicates that 56 ASCII characters have been entered and successfully sent.

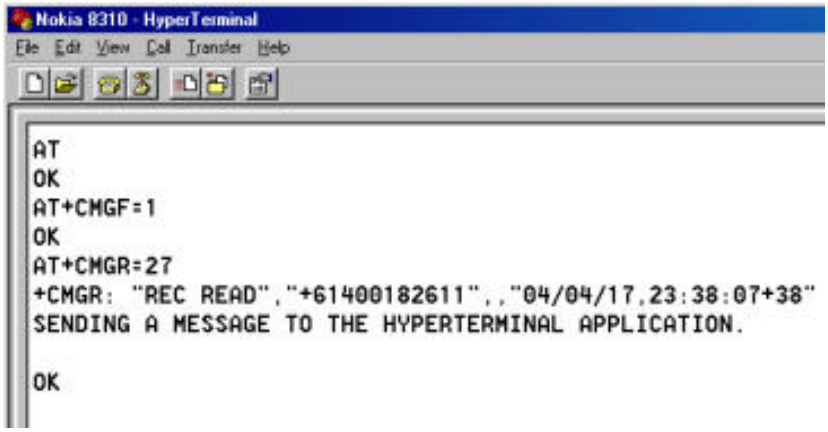


Figure 10 Receiving an SMS.

[86] Message Centre Service Provider number is an allocated number of a telecommunication network provider eg Telstra, whereby all text messages sent across the network gets stored and consequently, forwarded to the appropriate receiver.

To read an incoming SMS message, the modem is firstly switched to text mode by issuing the command **AT+CGMF = 1**. The message received can then be read by the **AT+CMGR** command, followed by the order or location of the message (eg for example in Figure 6-5, message "27" is read from the INBOX tray). Alternatively, all received messages can be displayed by the command **AT+CMGL = "ALL"**. This will list all the messages in the INBOX tray.

Storing and sending text messages SMS to/from memory using GSM AT commands

Alternatively, a user can create pre-stored or template messages that can be later sent by commands **AT+CMGW** and **AT+CMSS**, respectively.

For example, to create a template the following is applied:

AT+CMGF=1
AT+CMGW = "+61400182611" // write message to Toan
>I'll be 15 mins. late to the meeting. ➔
AT+CMGW=7 // index number in storage (memory location storage on SIM card) – a response

To send the message, the following is used:

AT+CMGF=1
AT+CSCA="+61418706700" // Message Centre Service number
AT+CMSS=7 //send message from storage (memory location number 7)

If the message is no longer needed, the command AT+CMGD can be used to delete the message. For example:

AT+CMGD=7 // delete message (at memory location 7)

The ability to create a pre-stored or template message is significant for people with disabilities using an AAC device. Message generation is especially demanding for those controlling an AAC device via single switch scanning method. Cornish and Higginbotham (2000), and Higginbotham (2004) indicated that estimates of the average rate at which augmented communicators can produce messages are on the order of 10 words per minute. A pre-stored message can eliminate the process of creating a message via single switch scanning, which can be a time consuming process when a person wants to text message someone. The number of template messages that can be stored on the mobile phone is limited by the phone's SIM card storage memory, which can be up to 50 messages.

Appendix 6-7 Setting up the "mobile phone" application on the Pathfinder

QUICK STARTER STEP-BY-STEP GUIDE TO: Setting up the "mobile phone" application on the Pathfinder

(© Toan Nguyen, 2004 – The author also received input from therapists and clients of Novita Children's Services on the set up the mobile phone application)

The overall structure of the activity icons layout for mobile phone use on the Pathfinder is as shown in Figure 9 below.

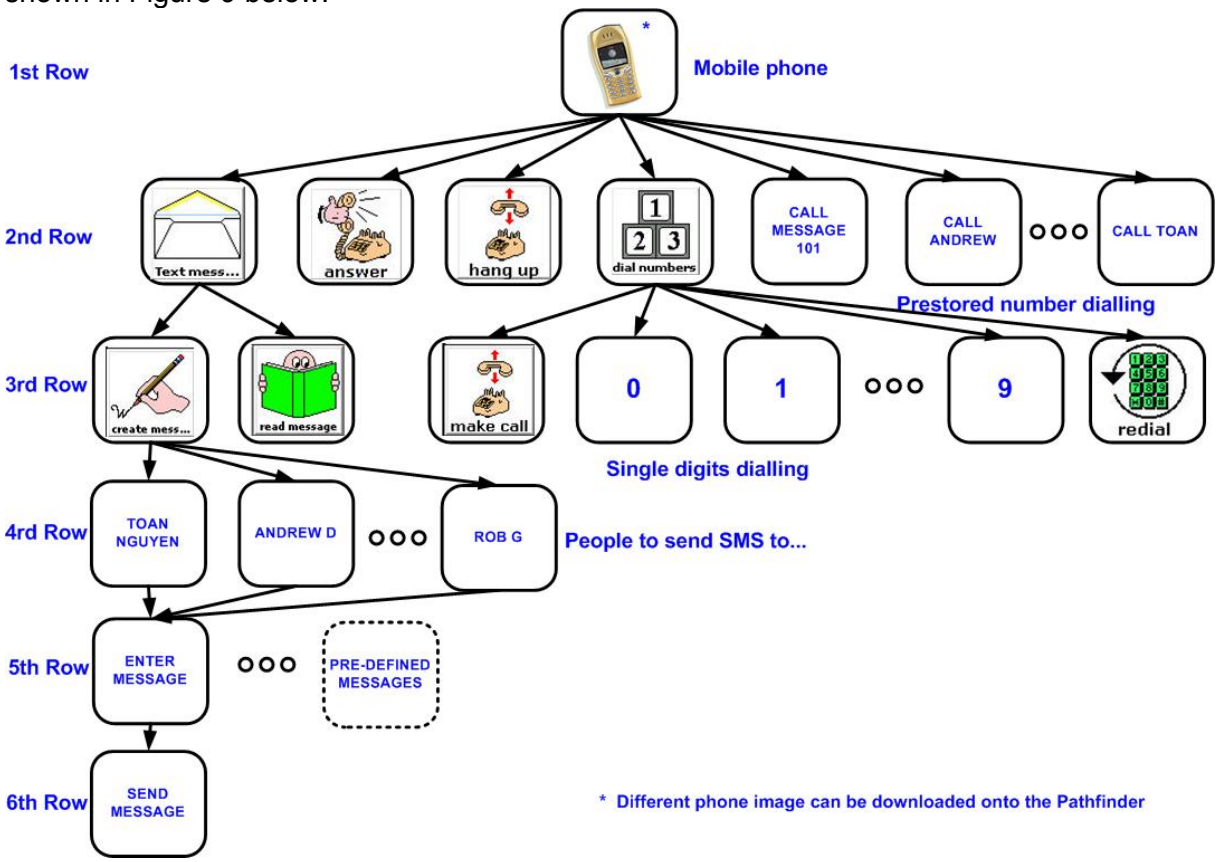
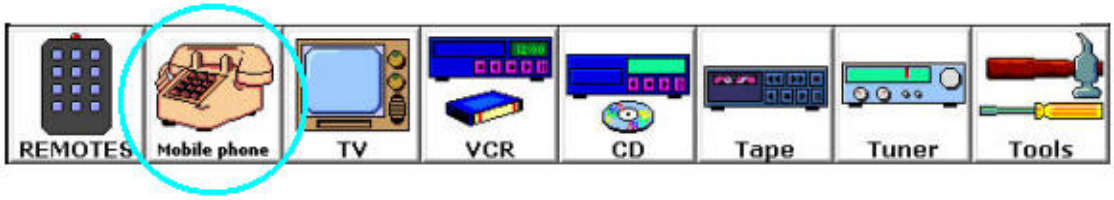


Figure 11 Structural layout of activity-row icons programmed on the Pathfinder

Each of the subsequent parts of this document shows a step-by-step guide to setting up the relevant activity-row icons of the "mobile phone" application.

Part A: Creating an Activity on the Pathfinder ('mobile phone' activity)

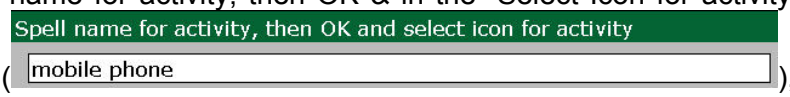
For example:



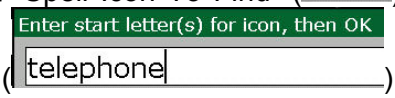
To create the a "mobile phone" activity on the Pathfinder follow these steps:

1. Double click on the “Status Key” ().
2. Select “Activity” menu (

).
3. Select “Create Activity” menu (

).
4. In the “Spell name for activity, then OK & in the “Select Icon for activity” textbook, type “mobile phone”, (

), and then press OK.
5. In the “Select Category”, select “Spell Icon To Find” (

). Then in the “Enter start letter(s)” textbook, type “telephone” (

) and then OK.
6. Select 

.
7. Repeat steps 1 and 2 above and followed by selecting “Modify Activity” (

). Select 

from “Select Activity to Modify” followed by “Change Label” (

) and then change the label to “mobile phone” (

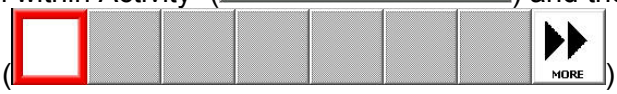
).

Part B: Creating items within the activity rows for “mobile phone” application

Follow these steps:

1. Repeat steps 1 and 2 of **Part A** above.
2. Select “Modify Item within Activity” (

) and then select 

.
3. On blank item row (

), select an empty box to create the sub-activity.
4. Select “Change Icon” (

) and then 

and in the “Enter start letter(s) textbook”, type “envelope” and then select 

.
5. Now select “Change Label” (

) and then change the label to “text messaging”.
6. In the “Spell text for message” (

), then change the label to “text messaging” and then select OK.

7. Repeat Steps 1 – 6 for as many items (sub-activities) as required or until the activity row is filled up (

).

PLEASE NOTE:

- If there is no free item's box left, the user can select 

and 

for another activity row and fill it up as needed.

For example, 

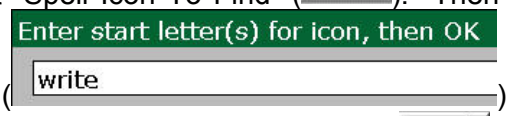
- The user can also use:
  - "Previous Row & Next Row" to Go Back/Forward between the two rows.
  - "Change Position Move Left/Right" to shift the activity left/right.
  - "Clear Key Contents" to clear an activity.
  - "Delete Current Row" to delete the whole row.

Part C: Creating sub-activity rows

Follow these steps:

Sub-activity for text messaging

1. Repeat steps 1 to 3 of **Part A** above.
2. In the "Spell name for activity" type, "text messaging" and then press OK.
3. In the "Select Category", select "Spell Icon To Find" (

). Then in the "Enter start letter(s)" textbook, type "telephone" (

) and then OK.
4. Select 

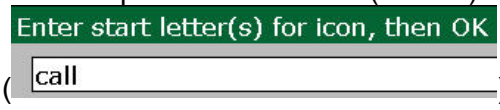
and follow **Step 7** of Part A to change the icon to 

.
5. Follow Part B to create the items for the activity row of "text messaging" such as 

.

Sub-activity for single-digit dialling

1. Repeat steps 1 to 3 of **Part A** above.
2. In the "Spell name for activity" type, "dial numbers" and then press OK.
3. In the "Select Category", select "Spell Icon To Find" (

). Then in the "Enter start letter(s)" textbook, type, "call" (

) and then press OK.

4. Select 

and follow **Step 7** of Part A to change the icon to 

.

5. Follow Part B to create the items for the activity rows for "dial numbers" such as 

and 

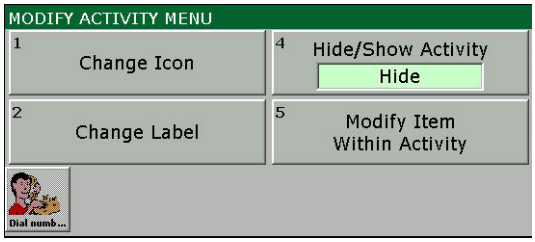
.

N.B: the **STOP** sign is used to bring the screen back to main menu and is achievable by linking it to the "mobile phone" activity icon.

Note:

1. The user can choose to hide the "Dial numbers" activity by:
   - Repeating **steps 1** and **2** of **Part A** and selecting (

) and then choose 

.
   - Select Hide/Show Activity to display "Hide". 

2. This also applies for any sub-activity that does not need to be displayed to the end-user.

Sub-activity for "send message to"

1. Follow **Part A** to create a sub-activity call 

.

2. Follow **Part B** to create the items for the activity rows for "send message to" such as 

.

Sub-activity for "Enter message" and "Send message"

1. Follow **Part A** to create a sub-activity call 

and 

.

Part D: Attaching GSM AT commands to activity items

To attach *GSM AT commands* to activity items of the "mobile phone" application, for example "answer to incoming message" of the answer (

) icon or any subsequent icons, follow these steps:

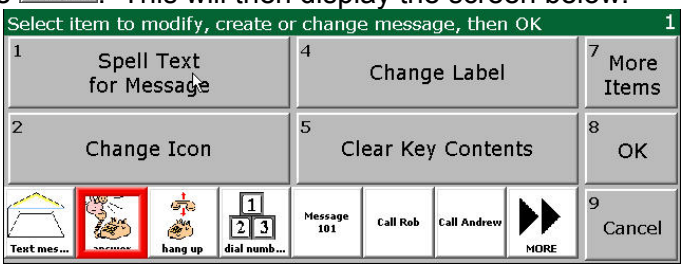
1. Repeat steps 1 and 2 of **Part A** above.

2. Select “Modify Item within Activity” menu (

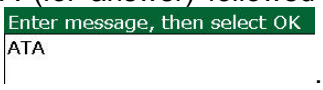
), and choose the activity and subsequently the items that a GSM AT command needs to be attached to.

For example, choose 

. This will then display the screen below.



3. Select the item the “answer” item (highlighted in red) and then choose “Spell Text for Message” and simply type ATA (for answer) followed by a “Return” (

) key from the keyboard layout. For example, 

.

All other necessary GSM AT commands that need to be attached to their respective item within the activity row are shown in Table 4 below.

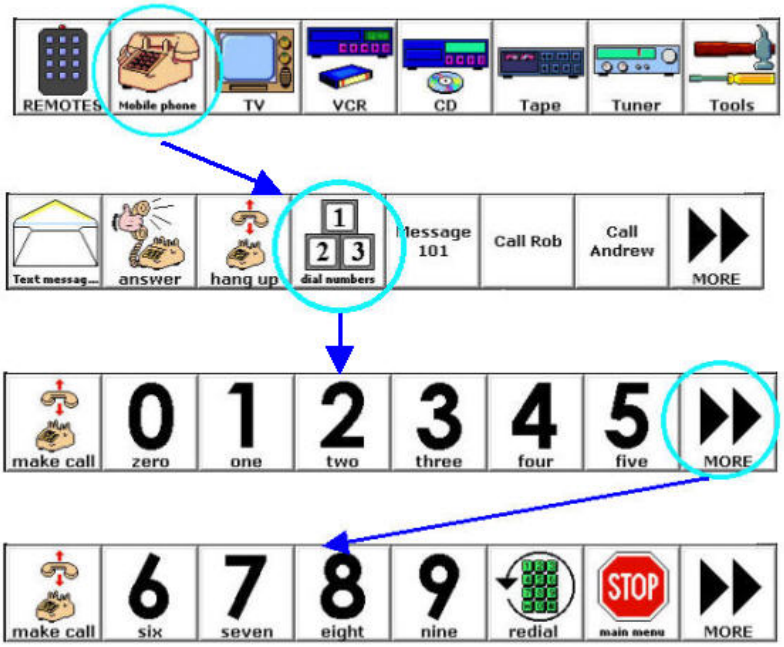
Activity/sub-Activity	Item to attach GSM AT commands	Spell Text for Message (GSM AT commands)
Mobile phone	Answer	ATA↵
	Hang up	ATH↵
	Message 101	ATD101;↵
	Call Rob	ATD0419178094;↵
	…	
	Call David	ATD0412281714;↵
Dial numbers (single-digit dialling)	Dial numbers	ATD
	0	0
	1	1
	…	
	9	
	Make call	;↵
Text messaging	Create Message	AT+CMGF=1↵ AT+CSCA=“+61418706700”↵
	Toan Nguyen	AT+CMGS=“+61400182611”↵
	…	
	Rob G	AT+CMGS=“610419178094”↵
	Send Message	Ctrl+Z (**^C**) - terminator keys

Table 4 Attaching GSM AT commands to activity icons

Part E: Linking activity rows together

Linking activity rows for single-digit dialling

For example:



To link "Dial numbers" activity with its sub-activities as shown above, follow these steps:

1. Repeat steps 1 and 2 of Part A and select 

and 

.

2. Select 

and 

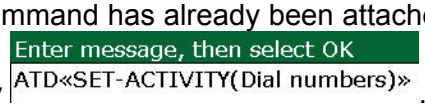
. Then select 

, and then type the letter "**S**" for "Set Activity" **(** 

), follow by selecting 

twice to get to "Set Activity" and finally select 

.

3. Press OK to ***LINK***. Since, an AT command has already been attached to this activity, the "Spell Text for Message" should display 

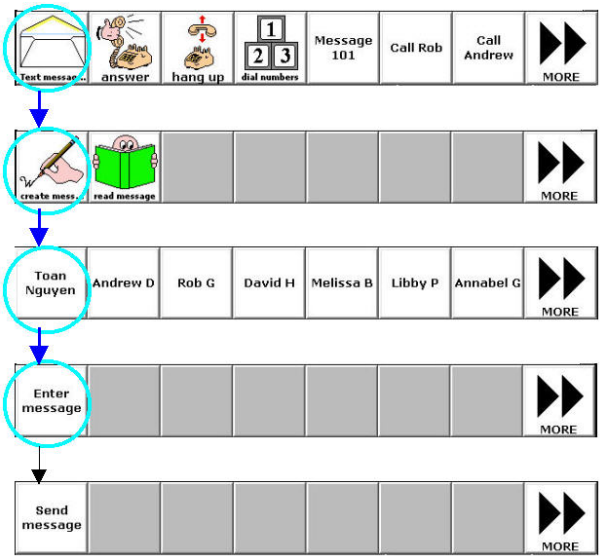
.

*****New***:** The command **AT +CKPD = "S", 5, 1** can be used to activate the voice recognition mode of the mobile phone for voice dialling.

N.B: "5" and "1" represents the time to strike each key and the pause to wait between keystrokes (in tenths of a second).

Linking activity rows for text messaging

For example,



To link "Text messaging" activity with its sub-activities, follow these steps:

1. Repeat steps 1 and 2 of Part A and select 

and 
.

2. Select 

and 

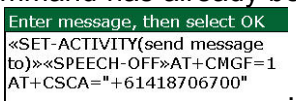
. Then select 

, and then type the letter "**S**" for "Set Activity" (

), follow by selecting 

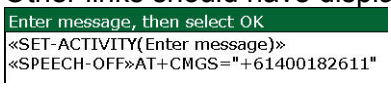
twice to get to "Set Activity" and finally select 

.

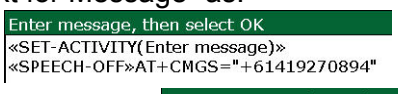
3. Press OK to **LINK**. Since, an AT command has already been attached to this activity the "Spell Text for Message" should display 

.

Other links should have displayed in the "Spell Text for Message" as:



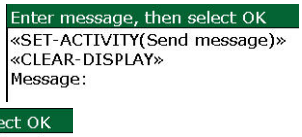
for 

and 

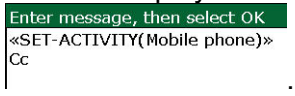
for 

.

Similarly, for 

, "Spell Text for Message" should display 

and for 

"Spell Text for Message" should display 

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CONSULT PATHFINDER's MANUALS FOR FULL INSTRUCTION

Appendix 6-8 Specifications for an Interfacing System between an AAC device and a mobile phone

Interfacing System Concept and Specifications

The Interfacing System is designed to be a versatile interface between the end user (a person with disability), Terminal Equipment (Keyboard, AAC device or switches) and a mobile phone. Ideally, it is not limited to any mobile phone model. Shown below is a conceptual diagram of the Interfacing System.

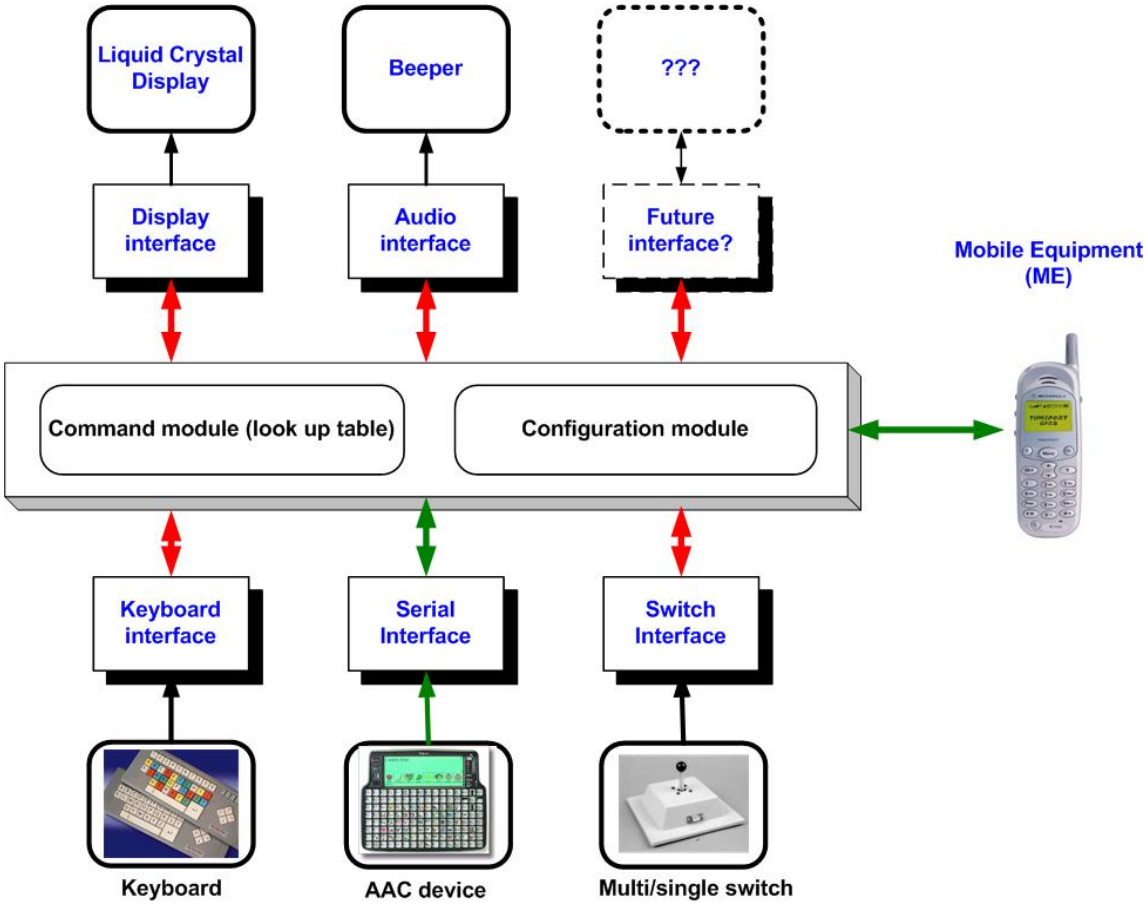

Figure 12 Conceptual Block Diagram of the Interfacing System

The Interfacing System is designed to emulate the basic functions of a standard mobile phone through the use of GSM AT commands as described in Chapter 6, but provide access via methods commonly used by people with mobility, speech and some elements visual or hearing impairment.

Two input methods have been identified: keyboard access, serial access from compatible AAC device (such as switches and communication devices from the Prentke Romich Company, i.e., the Pathfinder, Liberator, Deltatalker, Vantage, Vanguard etc and switches).

Several actions or functions have been identified as being basic and important mobile phone functions. These include the ability to: add a phone number to phonebook or Interfacing System's memory; store and dial "pre-stored" numbers (i.e., a speed dial feature); retrieve a phone number from phonebook or Interfacing System's memory; answer a call and to terminate a call.

In addition to these basic telephone functions, several other functions are deemed important for the Interfacing System. The ability to create read and send a Small Message Service (SMS) text message and to activate the voice recognition mode of voice recognition enabled mobile phones (with the appropriate command or signal).

Furthermore, the Interfacing System will provide visual feedback that is suitable for indoor display of alphanumeric characters (from a reasonable distance) to view responses from the phone as well text messages send and received on the phone. Audible feedback of ringing and confirmation of other events will be covered.

Using a Keyboard for Access

The Interfacing System will be capable of accepting input from an IBM-AT compatible keyboard. Keyboards such as: Big Keys LX, Lower Case, Cherry Compact, Maltron Dual or one handed; with AT or PS/2 cable are all suitable examples.

The Interfacing System is a device designed to simply translate a single key press from the keyboard to a single mobile phone command. Modifier keys on the keyboard are not supported in the same way that they would be with a personal computer. The only user configurable parameter associated with the keyboard is the layout parameter. One of several key-maps may be chosen. Key maps vary such that some maps exclusively use certain parts of the keyboard, and such that there is varying levels of functionality associated with each map. Figure 11 to Figure 13 show the key maps of the possible keyboard layout and their associated functions. Tables 6 and 7 show corresponding ASCII strings for the essential (such as answer, dial, hang up a call) and extended functions (such as text messaging and adding a phone number in the phonebook) of the mobile phone.

Serial Access from Compatible AAC devices

The Interfacing System is able to accept input (ASCII strings) from the serial output port of compatible AAC devices. The Pathfinder will be used in the first instance for verification of the process. Subsequent development with other AAC devices will follow.

Using Direct Switch Access (Activation of Voice Recognition mode)

Single switch operation is supported. A single switch will support three mobile phone functions. When the phone is idle, pressing a switch will activate the voice recognition mode of the phone, letting the user to dial anyone stored in the phone book of the mobile phone with a voice recognition tag. When the phone is ringing, pressing the switch will answer the phone. When there is a call in progress, pressing any switch will terminate the call. A time delayed of 1 – 10 seconds (which is adjustable) will apply to each function to prevent accidental use. In addition, multi-switch operation could also be supported, whereby each switch has a particular function.

Adding a Novel Phone Number to Phonebook

Building a novel phone number simply means creating a number to be dialled or stored that has not previously been stored in the Phonebook of the unit's memory.

A novel phone number can be created with most of the keyboard maps or can be directly done via an AAC device such as the Pathfinder using appropriate GSM AT commands. The phone number could also be entered directly onto the phone with the assistance of a carer.

Storing a Pre-stored Number

Storing a pre-stored number requires a novel number to be constructed and then to be stored in one of the memory locations (phonebook or system's memory). Storage of a number may be achieved using some of the key-maps. Alternatively, if a Pathfinder is used, then it is limited to how pre-stored numbers are programmed as "icons" on the activity row.

Dialling a Pre-stored Number

Dialling a pre-stored number refers to the dialling of a number that has been previously built up and stored in one of the 100 memory locations of the system's memory or the mobile's phonebook. Pre-stored numbers may be dialled using most keyboard maps when using the keyboard options. Alternatively, if a Pathfinder is used, then pre-stored number "icons" on the activity row can be used to dial number.

Answering and Hanging Up the Mobile Phone

These functions are fundamental phone procedures. They must be achievable using keyboard or single switch signals. There will be corresponding AT command for these keyboard or switch functions.

Creating, reading and sending an SMS

Creating an SMS message can be achieved by activating a designated key on the keyboard or Pathfinder followed by the creation of the message using some of the key maps on the keyboard or the Pathfinder. A similar key designated for sending an SMS can be pressed to send the created message, or similarly another key can be pressed to view incoming messages or messages stored in the INBOX folder of the mobile phone.

Visual Feedback (Liquid Crystal Display)

Visual feedback will provide visual confirmation and indication of:
- Telephone numbers;
- System's and the mobile phone's status; and
- SMS text sent and received.

Any text message that is output from the Interfacing System and any responses from the mobile phone are shown on the LCD.

Audible Feedback (Beeper)

Audible feedback is used for two purposes:
- To indicate that there is an incoming call (beeping, similar to a pager)
- To indicate that the single switch operation is active (answer or terminate a call).

The audible feedback can be turned off when the single switch operation is not in used, such that the only sound output is from the mobile phone.

Programmable Interface Controller (PIC) microcontroller

A PIC16F877 chip will be used to implement all the features and functions of the Interfacing System. The PIC chip has sufficient memory and input/output ports to cater for the different interfaces mentioned. Table 5 lists the features of the chip's capabilities. C programming

will be used to control the chip to carry out the separate functions. Serial initialisation between the PIC chip and external device could follow the structure:

```
void main (void){
RS232_init();          // initialisation I/O port and set baud rate procedure
RS232_outchar();       //writes a character to the serial port procedure
RS_232_getchar()       //gets a character from the serial port procedure
}
```

Each of the procedure will written to carried their function in C code.

PIC16F87(7) Chip	Features
Operating speed	DC – 20 MHz clock input
Memory	Up to 8K x 14 words of FLASH PROGRAM Memory Up to 368 x 8 bytes of Data Memory (RAM) Up to 256 bytes of EEPROM Data Memory
I/O ports	**A:** 6 bit wide, bi-directional port (bit0-bit3, bit5 can be input/output or analogue input) **B:** 8 bit wide, bi-directional port **C:** 8 bit wide, bi-directional port (bit6 (RC6) can be used for USART Asynchronous Transmit and bit7(RC7) can be used for USART Asynchronous Receive or Synchronous Data) **D:**8 bit, bi-directional port (can be set as a 8-bit microprocessor) **E**: has 3 pins that can individually be configured as I/O.
I/O serial communication	Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection. Synchronous Serial Port (SSP) with SPI (Master mode) and I^2C (Master/Slave).
Special function Registers required for: Asynchronous transmission	**INTCON** – Control Register (Bit7 = GIE, Bit6 = PEIE) **PIR1** – Peripheral Interrupts Flag Register (bit4 = TXIF) **RCSTA** – Receive Status and Control Register (bit7 = SPEN) ***TXREG*** – *USART Transmit Data Register* **PIE1** – Peripheral Interrupts Enable Register (bit4 = TXIE) **TXSTA** – Transmit Status and Control Register (Bit6 = TX9, Bit5 = TXEN, Bit4 = SYNC, Bit2 = BRGH, Bit1 = TRMT and Bit0 = TX9D) **SPBRG** – Baud Rate Generator Register
Special function Registers required for: Asynchronous reception	**INTCON** – Control Register (Bit7 = GIE, Bit6 = PEIE) **PIR1** – Peripheral Interrupts Flag Register (Bit 5 = RCIF) **RCSTA** – Receive Status and Control Register (Bit 4 = CREN) ***RCREG*** – *USART Receive Data Register* **PIE1** – Peripheral Interrupts Enable Register (Bit5 = RCIE) **TXSTA** – Transmit Status and Control Register (Bit4 = SYNC and Bit2 = BRGH) **SPBRG** – Baud Rate Generator Register

Table 5 Features of PIC microcontroller to be used to implement the Interfacing System

Key maps for IBM-compatible Keyboard

Key map 1 – Answer, Dial & Hang up

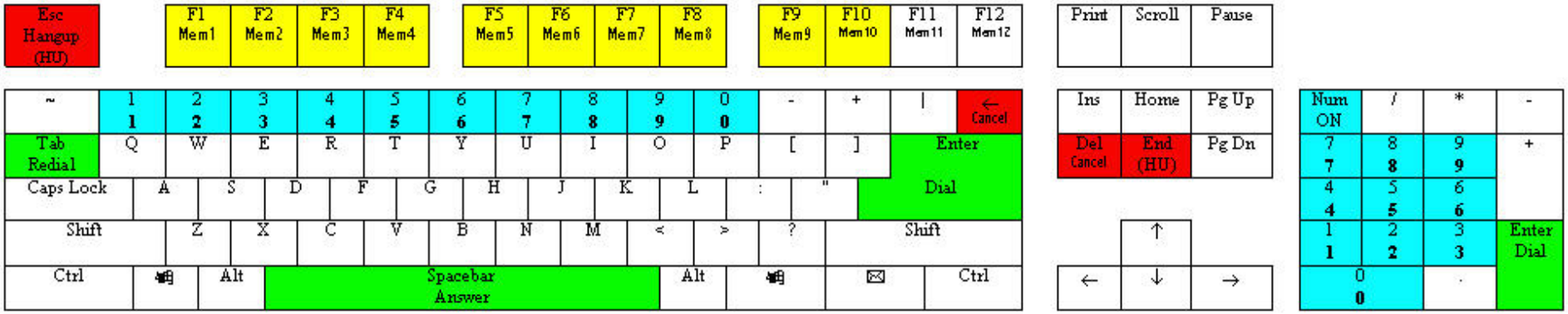

Figure 13 Key maps for answering, dialling and hanging up of call functions of a mobile phone (modified from NovitaTech's *MiPhone* design).

Use these keys to build up a phone number
Use these keys to dial or store a speed dial number
Use these keys to perform other phone operations
Use these keys to delete keys or terminate a call

N.B Mem 11 and 12 are not implemented on some keyboards.

Key Name Key Function	An indication of the name as it appears on a standard IBM-AT keyboard. The telephone function performed by the key when pressed

Key map 2 – Answer, Dial, SMS & Hang up

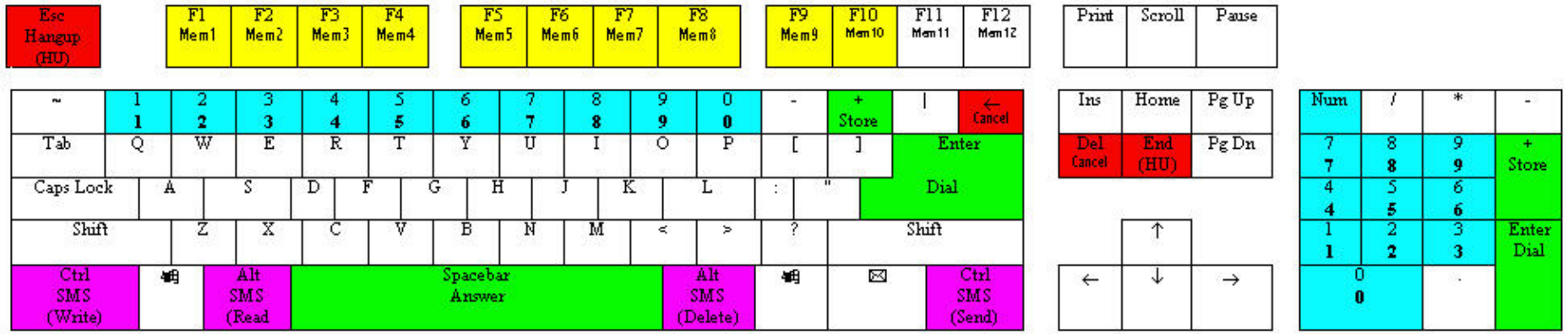

Figure 14 Key maps for answer, dial, SMS and hang up functions of a mobile phone (modified from NovitaTech's *MiPhone* design).

Use these keys to build up a phone number
Use these keys to dial or store a speed dial number
Use these keys to perform other phone operations
Use these keys to delete keys or terminate a call
Use these keys to create, read, delete or send an SMS message

Key Name Key Function

An indication of the name as it appears on a standard IBM-AT keyboard.
The telephone function performed by the key when pressed

Key map 3 – Text messaging

Use these keys to build up a phone number
Use these keys to dial or store a speed dial number or typing text.
Use these keys to perform other phone operations
Use these keys to delete keys or terminate a call
Use these keys to create, read, delete or send an SMS message

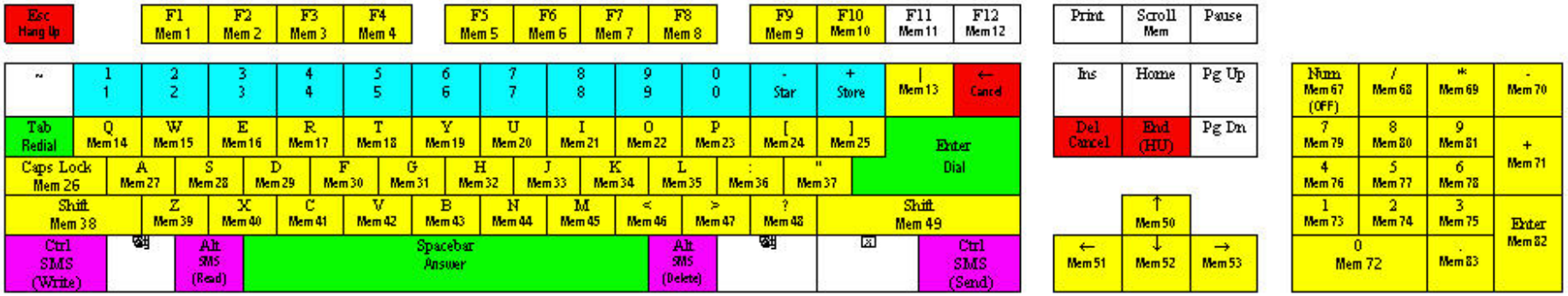

Figure 15 Key maps for outputting ASCII text (modified from NovitaTech's *MiPhone* design).

Key Name Key Function	An indication of the name as it appears on a standard IBM-AT keyboard. The telephone function performed by the key when pressed

ASCII output of the Essential Functions

Action to be performed (Essentials)	AT compatible key press	ASCII character to be sent from AAC device	Character to be displayed on the AAC device	ASCII character to be sent to the Mobile Phone	Output on the system's display
Answer a call	Spacebar key	<esc>spacebar.	Answer call	ATA	Answer call
Dial a number	8201 5158 + Enter key	<esc>82015158.	Calling 8201 5158.	ATD82015158;	Calling 8201 5158 (or name of the person)
Dial a number from memory	F1… F10 key	<esc>f1…f10.	Calling # or "string" (*stored at position Mem ?)*	ATD#; ATD>"UNI"; ATD>1;	Calling: • # • Name (UNI) • Location *If number stored in memory display "Name". If number not in memory display number.*
Redial previous number dialled	TAB key	<esc>tab.	Redialling…	ATD(previous number);	Redial previous number
Store a number into memory	+/= key	Number and name: • <esc>plus. or • <esc>kpplus. Location: • <esc>f1…f10.	Location (F1…F10): • Number • Name	AT+CPBW=(F1…F10),"number", 129,"Name",	Number Stored
Find a number from memory	? or / key	<esc>slash	Location: number Name: "name_string"	AT +CPBR=location or "name_string" AT+CPBF=location or "name_string"	Number: Name: Location:
Hang Up	Esc key End key	<esc>esc. <esc>end.	Call terminated	ATH or AT+CHUP	Call terminated

Table 6 ASCII string output for essential functions on the mobile phone.

ASCII output of Extended Functions

Action to be performed (Essentials)	AT compatible key press	ASCII character to be sent from AAC device	Character to be displayed on the AAC device	ASCII character to be sent to the Mobile Phone	Output on the system's display
Voice dialling	V key	See Appendix 6-7	After the tone, say the command eg. "*Call xxx*"	AT+ CKPD = "S",5,1	Voice dialling activated
List Message	🗏key		-	AT+CMGL= Location # "ALL"	Reading message: Location # "ALL"
Read Messages	Left "Alt" key	-	-	AT+CMGR= Location # "ALL"	Actual message received
Show Message on phone's screen	S key	See Appendix 6-4	Display message on phone's screen	AT+ CKPD = "[",5,1 or AT+ CKPD = "]",5,1	
Write message directly	Left "Ctrl" Key	See Appendix 6-7	See Appendix 6-7	AT+CMGF=1 (text mode) AT+CSCA="+61418760700" AT+CMGS="+61400182611" "Message xxx"	"Message xxx" Message sent
Write Messages to memory	Left "Ctrl" Key	See Appendix 6-7	See Appendix 6-7	AT+CMGF=1 (text mode) AT+CMGS="+61400182611" "Message xxx"	Message stored at location "xxx"
Send Message from storage	Right "Ctrl" Key	See Appendix 6-7	See Appendix 6-7	AT+CMGF=1 (text mode) AT+CSCA="+61418760700" AT+CMSS= Location #	Message "xxx" sent
Send Message	Right "Ctrl" Key	See Appendix 6-7	See Appendix 6-7	Ctrl+Z (Control Z)	Message sent
Delete Message	Right "Alt" key	See Appendix 6-7	See Appendix 6-7	AT+CMGD= Location #	Message deleted

Table 7 ASCII string output for extended functions (read/write text or SMS) on the mobile