

Final Report

Research into "a prototype mobile phone interface system that will allow children and adults with a physical disability who cannot speak and use a communication device to communicate to independently use a mobile phone"



Researchers: Mr Toan Nguyen & Mr Rob Garrett



Department of
Communications
Information Technology
and the Arts



This project is supported by the Commonwealth through the Telecommunications Research Grant Program of the Department of Communications, Information Technology and the Arts.



The joy of independence (Courtesy of the Advertiser)

Table of Contents

EXECUTIVE SUMMARY	4
1. INTRODUCTION	6
2. METHODS AND PROCEDURES	7
2.1 PARTICIPANTS	7
2.2 INITIAL ASSESSMENT – MATCHING PARTICIPANT TO AVAILABLE PHONE TECHNOLOGY.....	7
2.3 TRIAL PROTOCOL, PROCEDURES AND ASSESSMENT METHODS	7
3. RESULTS	10
3.1 PARTICIPANTS	10
3.2 PRELIMINARY ASSESSMENT – “MATCHING PARTICIPANT TO AVAILABLE TECHNOLOGY”.....	10
3.3 OUTCOME MEASURES.....	12
3.3.1 Canadian Occupational Performance	12
3.3.1.1 First Participant’s Results	12
3.3.1.2 Second Participant’s Results	13
3.3.2 Equipment Usability Questionnaire	15
3.3.2.1 Using the system	15
3.3.2.2 Participant’s Performance – time taken to do tasks	16
3.3.2.3 System’s performance	16
4. DISCUSSION	17
5. RECOMMENDATIONS	21
6. CONCLUSION	22
7. ACKNOWLEDGMENTS.....	22
8. REFERENCES.....	23
APPENDICES.....	24
APPENDIX A: CANADIAN OCCUPATIONAL PERFORMANCE MEASURE FORM.....	24
APPENDIX B: EQUIPMENT USABILITY QUESTIONNAIRE FORM.....	28
APPENDIX C: INDIVIDUAL PATHFINDER PROGRAMMING AND VOCABULARY.....	30
Participant 1	30
Participant 2	31
Sampled Activity icons and meaning	32

Executive Summary

Accessible mobile phones for people with physical disabilities is an area that is still developing, with various hardware and software solutions and new services emerging to assist these people access telecommunications equipment and services that are currently available. This research trialed, validated and evaluated a prototype mobile phone to speech generating device interface system developed by NovitaTech. The system enabled the user to independently initiate, answer and terminate voice calls and send text messages through the use of their communication device. The trial included two participants (a child and an adult) with a physical disability who cannot speak and require a communication device to communicate and to independently use a mobile phone.

Based on the outcomes of the trial it was found that:

- Both participants who initially had **no independent access** to a mobile phone can now **access** and use a mobile phone successfully.
- Both participants showed very high results in terms of their overall performance and satisfaction with the use of the system developed for them. A maximum score was given to the systems overall performance and ease of use.
- Access to a mobile phone has not only given the participants a sense of independence, safety and security, but it has also contributed to their communication skills, leading to the self confidence to engage in conversation and social activities. These are qualities that are important to everyone.

The provision of an effective mobile phone solution for a communication device user can be achieved by involving the user at the earlier stages of the solution's development, in combination with thorough training and on going support to accommodate for the users changing needs and new found abilities.

Recognising the significant benefits to users of the system, it is recommended that:

1. Further refinement of the system to reduce the amount of scanning and selection required by switch scanning users. It is suggested that this could be achieved by giving the user full access to the phone's functions and menus navigational key control and soft keys selection instead of programming all the functions on the Pathfinder itself.
2. There needs be a process in place that ensures that the end user is involved at the initial stages of equipment interfacing and set up. In addition thorough training and ongoing support will also improve the user's access method and effective use of the system, leading to an increased self-esteem and confidence and inevitably result in better communication and social interaction. This can be achieved through periodic review of the user's needs and abilities as they change over time. The process can be initiated by the user or carer and assessed and implemented by a trained personal with the necessary skills and knowledge.
3. For communication device users to access mobile phones more effectively and economically:
 - a) That there need to be concessional access rates for users who take longer to convey the same message across the network;
 - b) That the number of rings from an incoming call be extended beyond its current maximum of 30s. This would be significant for powered wheelchair and single switch scanning users;
 - c) Users need to consider utilising the pre-paid options that are currently available with Optus, Vodafone etc whereby, \$30 pre-paid will give \$150

worth of voice calls and text messaging and so on. This would give the user more control over their spending;

- d) Users need to consider utilising the Australian Communication Exchange's National Relays Service which only cost users an un-timed local call to any home or mobile phone number.

Through this research it was concluded that people who cannot speak and who require a communication device to communicate can use and should have equal access to mobile phones and services. This research and trial have shown that even the more severe communication devices users who can only converse via single word, keyword, phrases or sentences via single switch scanning method can independently and effectively use a mobile phone for voice calls and text messaging. This was something that was not possible for these people prior to the research and trial.

1. Introduction

A recent report undertaken by the Allen Consulting Group for the Australian Mobile Telecommunications Association (AMTA¹) indicated that in 2004-05, the mobile phone penetration rate² was 81% (or 16.2 million subscribers). In 2005-06, it is estimated to exceed 94% (or almost 19 million subscribers) [1]. Nevertheless, children and adults with a physical disability do not have equitable access to mobile telecommunications technology. Not only do they experience difficulty typing, handling the phone, or dialling and answering calls, but for those who are unable to speak, the only option is to type messages using whatever functional control sites of their bodies are available.

The ability to independently operate telecommunications technology that is in common use is a right that all people should have. This applies particularly to children and young adults during their formative years as, without it, their educational, personal and social development will be restricted. In addition to the formal use, communications technologies are of major significance for children with a disability who are trying to develop friendships with their peers. Parents of teenage children and young adults would be acutely aware of the amount of time their teenagers spend on the phone to friends. This includes both mobile (text and voice) and home phones. This project explores a practical way for children and adults with a physical disability to participate in the extensive community of mobile phone users.

The aim of this research is to trial, validate and evaluate a prototype mobile phone to speech generating device interface system developed by NovitaTech. The system enabled the participants to independently initiate, answer and terminate voice calls and send text messages through the use of their communication device. The trial included two participants (a child and an adult) with a physical disability who cannot speak and require a communication device to communicate to independently use a mobile phone. Previously this was not possible. A demonstration of the prototype system at the 2005 Australian Group on Severe Communication Impairment (AGOSCI) Conference [2] and the NovitaTech Snowy Hydro Telecommunications Road Show workshop series around Australia [3] has sparked a genuine interest in the technology by many therapists and potential end-users.

The outcomes from this trial will be used to refine the prototype system and define the final product for use by other Augmentative and Alternative Communication (AAC³) device users to independently access a mobile phone, thus opening up a whole new range of educational, recreational, and social opportunities to them.

Our research hypothesis is *“that people with disabilities who currently cannot use a mobile phone will increase their interpersonal communications skills, become initiators of conversations, and become more active participants in their community through the use of a suitable mobile phone interface”*.

¹ The peak national body representing the mobile phone industry

² The mobile phone penetration rate is the number of mobile phone services per 100 people.

³ 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 an electronic aid. It attempts to provide those with severe expressive disorders with an efficient communication system

2. Methods and Procedures

2.1 Participants

Two participants were sourced for the trial – a client of Novita Children’s Services Inc. and a former client who also participated in the DoCITA 2003 telecommunications options trial. See *Section 3.3.1* for details of their profiles.

2.2 Initial Assessment – Matching participant to available phone technology.

The task was to assess the participant’s needs and abilities so that an appropriate system can be set up for the trial to obtain tangible feedback and outcomes that would refine the final product. This was carried out through a preliminary assessment of “*matching the participant with the available technology*” process. This involved:

- assessing of the participant’s method of access to their AAC device (switch scanning or direct access);
- assessing options for equipment interface, set up and mounting on the participant’s wheelchair;
- identifying the participant’s main mode of communication (voice calls or text messaging);
- assessing the participant’s best method of interacting with the system; and
- developing the individual ‘activity rows’¹ on the speech generating device for each participant to interact with the system. A Prentke Romich Company “Pathfinder” device was used for this trial.

2.3 Trial Protocol, Procedures and Assessment Methods

Following the recruitment of the two participants (a child and an adult) from the preliminary assessment, a decision and agreement on the appropriate prototype set up with each participant was made. Equipment training followed thereafter, whereby each participant received training in the use of the provided prototype system, with all the features and associated applications of the technology were explained thoroughly. This was a standard protocol for each participant. The participant did not start the trial until they were proficiently trained and had shown that they were ready for independent use through various simulated scenarios. Re-training was an ongoing process throughout the trial when required by the participant.

An “ABA” style approach was implemented throughout the trial period:

A – *Before intervention*: without equipment (prior to the trial);

B – *During intervention*: with equipment (end of the trial);

A – *After intervention*: when equipment had been withdrawn for two weeks or more.

This process involved a measure of the participant’s performance and satisfaction relating to the problem area(s) identified by the participant. The whole process of clinical trial protocol and procedures for this trial is illustrated in Figure 2-1. At each period during the trial, represented by *ABA*, an assessment was carried out through

¹ These include the activity icons that the participant select to call, answer or hang up a call, create and send a text message or use to converse during a phone call.

the use of a customised Canadian Occupational Performance Measure (COPM¹) questionnaire [4] (*Appendix A*) and an Equipment Usability Questionnaire² (*Appendix B*). Table 2-1 below shows the rating scales used for COPM during the trial.

COPM was used throughout the trial to measure the performance and satisfaction of the broader issues, concerns and problems that a participant had with mobile phone access to evaluate the research aim and hypothesis, while the Equipment Usability Questionnaire handles the technical aspects of the system's use and its overall performance from the participant's perspective.

Outcomes measure	Scales
Performance	1 – not able to do at all ... 10 –able to do extremely well
Satisfaction	1 – not satisfied at all ... 10 – extremely satisfied

Table 2-1. Rating scales used throughout the trial

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

- Voice calls (*directly from the user's Pathfinder or if possible from the phone*);
- Text messaging (SMS) (*create & send*);
- Voicemail (*retrieve as well as use*);

In addition, monitoring to provide the performance indicator was carried out by:

1. Researcher:
 - Calling the client to check on the trial's progress;
 - Sending an SMS and asking the client to respond to the message; and/or
 - Leaving a voicemail message in the participant's INBOX asking them reply back using the voicemail feature.
2. Participant:
 - Calling back to the researcher at some specified time to report on progress;
 - Replying or sending an SMS back to the researcher.

Furthermore, a data logging feature on the Pathfinder known as the Language Activity Monitor (LAM) was activated for about a week to monitor the phone activities during the trial. LAM is the intentional monitoring of the language activity of people who rely on AAC systems. The LAM has implications in three primary areas of AAC: clinical intervention, outcomes measurement, and research. The LAM records each language event (one or more letters or words) and adds a time stamp (24-hour format with a resolution of one second). This data provides a record of what was said and when it was said. Time information allows determination of the language representation method(s) being used and the communication rate being achieved.

Each participant was given a \$100 worth of call and SMS costs for the duration of the trial. Access to the network via pre-paid was the chosen method to enable the researcher's control on participant's spending (particularly over spending) and room for adjustment to spending habits as participant's use varies over the period of the trial etc...

¹ COPM is a standardised outcome measure tool designed to detect change in a participant's self-perception of occupational performance over time

² Was specifically designed to evaluate the performance, satisfaction and the time responses when performing the common tasks on the provided system. Time response is the participant's perceived time required to carry out a task when using the system.

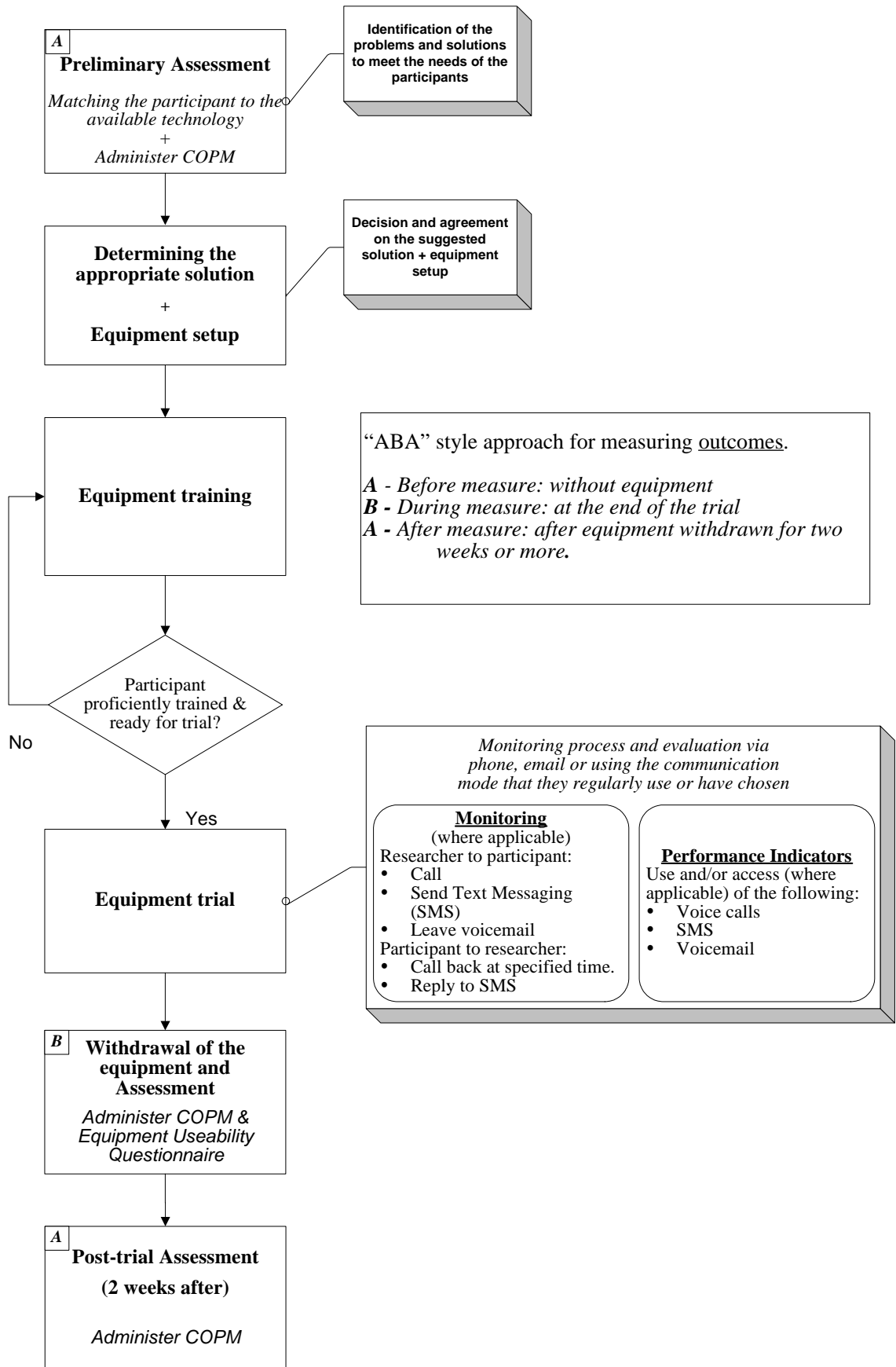


Figure 2-1. Clinical trial protocol and procedures

3. Results

3.1 Participants

The profile of the two participants of the trial is outlined in Table 3-1. Participant 1 had expressed interest in the trial prior to its commencement and was immediately recruited when the trial began. Participant 2 was recruited (from a group of 4 other interested participants) after referrals and recommendations from several Novita Speech Pathologists. These two participants were chosen based on their motivation to have access to mobile phone use. See section 3.3.1 for more details.

Participant	Age	Diagnosis	Access method to AAC device	Previous telecommunications technology exposure
1	18	Athetoid Cerebral Palsy (CP) (severe), and a powered wheelchair user.	Single switch quadrant scanning on the Pathfinder	Telephone access via the Pathfinder, but not mobile phone access
2	16	Cerebral Palsy (moderate to severe), and a powered wheelchair user.	Direct access (left-handed) on the Pathfinder Plus ¹ - slow and strenuous.	None

Table 3-1. Details of the trial participants.

3.2 Preliminary Assessment – “Matching participant to available technology”

After methodical analysis and consideration of the participant’s situation and abilities, two similar systems were set up for the participants. Figure 3-1 shows the components of the system:

1. **Nokia 6310i** – Bluetooth-enabled phone with built-in modem;
2. **BlueAnt SuperTooth II** - portable hands-free unit that connects wirelessly via Bluetooth to the Nokia phone to provide the microphone and speakerphone components of the system;
3. **Serial Cable** – that interfaces between the Pathfinder and the phone for the user to control the phone for voice calls and text messaging; and
4. **Custom-made phone holder** – that secures the phone to the wheelchair and provides the user with visual display of incoming messages and outgoing / incoming calls on the phone.



Figure 3-1. Components of the mobile phone system

¹ Latest model of the Pathfinder from the Prentke Romich Company

Figures 3-2 and 3-3 show the mounting position of the system on each of the participant's wheelchair.



Figure 3-2. First participant's system set up.

Figure 3-3. Second participant's system set up.

Figure 3-4 shows a typical 'phone menu' activity row for Participant 1 when the mobile phone application is selected.

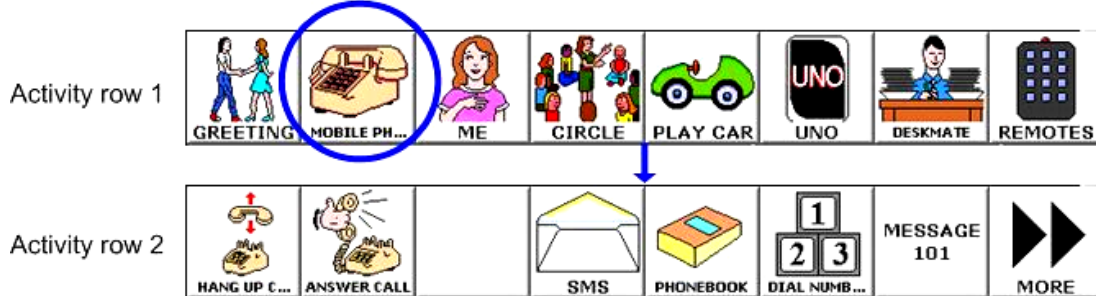


Figure 3-4. A typical 'phone menu' activity row when "Mobile Phone" application is selected

Figure 3-5 shows the typical 'SMS' sequences Participant 2 uses to create and send a text message. Appendix C shows the individual program used to control the phone and vocabulary used for voice calls and text messaging during the trial.

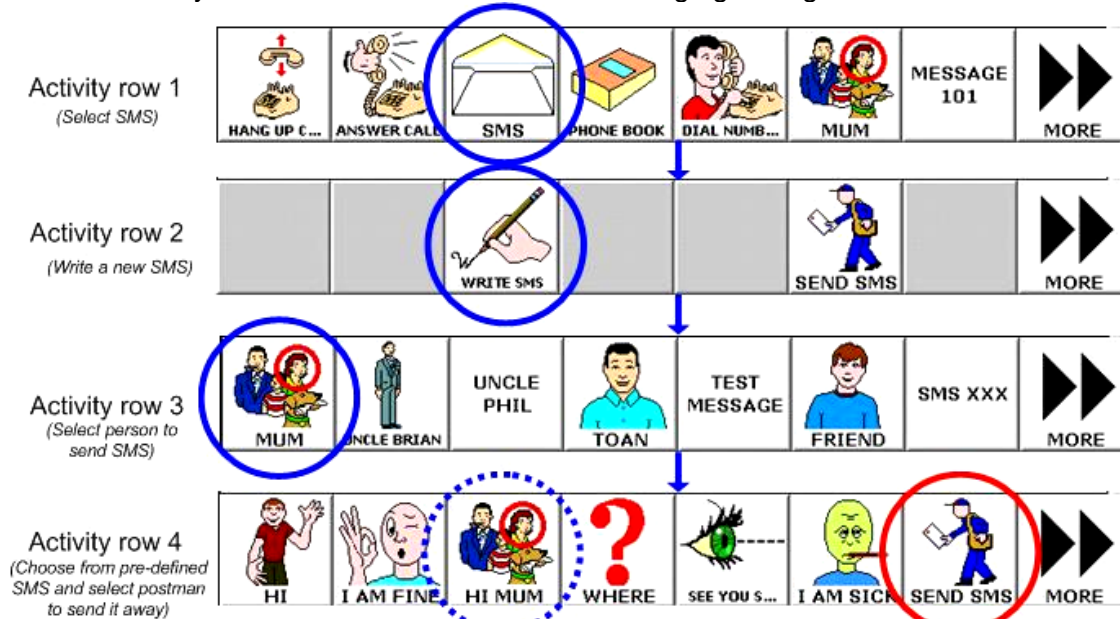


Figure 3-5. Activity row sequences to create and send an SMS

3.3 Outcome Measures

3.3.1 Canadian Occupational Performance

A direct interview was undertaken with participants to identify the occupational performance problems, issues and concerns they have with the use of mobile phones and telecommunications in general.

3.3.1.1 First Participant's Results

Participant 1 has Athetoid Cerebral Palsy, is a powered wheelchair user and uses an AAC device to communicate (through a single scanning switch positioned on the headrest). The participant uses language methods such as single word, keyword, phrases or sentences created by using Minspeak¹ to converse. The DoCITA 2003 trials showed that an AAC device user can be an extremely slow communicator while carrying out a phone conversation [4]. Cornish and Higginbotham [5, 6] 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.

Understandable communication with the participant can be a slow and tedious process. It also means that the carer or person that the participant communicates with would have to interpret what she's conveying. Following the 2003 DoCITA trial, the participant now has access to an infrared home phone. The participant sends the appropriate infrared signal from her AAC device to control the phone. The participant uses the home phone very well.

Participant's Occupational Problems

The following are the occupational performance problems with telecommunication use:

- Calling and (texting) people while out and about (or anytime).

Solution Provided

Hardwired mobile phone system

- Cable connection to phone;
- Bluetooth connection between phone; and
- Supertooth II hands-free unit.

Figure 3-6 shows Participant 1 interacting with the system using a single switch located on the headrest. The participant uses the single switch to scan through the options displayed on the Pathfinder's screen and then selects the item at her discretion.



Figure 3-6. Participant 1 interacting with the system using a single switch located on the headrest.

¹ Minspeak is a visual language designed for use in augmentative communication. A message is created using a sequence of symbols.

Telecommunications Network

- Telstra pre-paid (first 2 weeks) & Vodafone pre-paid (last 2 weeks)

Performance and Satisfaction Outcomes

Occupational Performance Measure for Participant 1

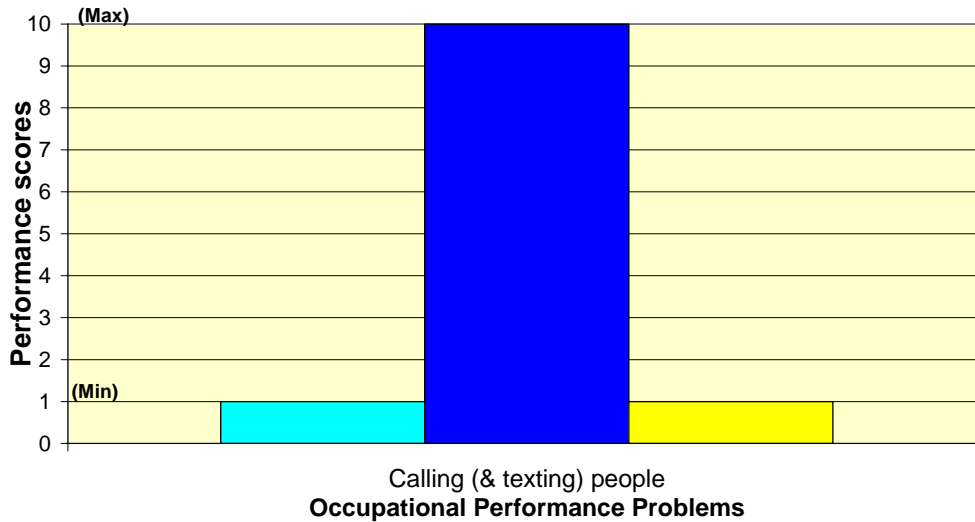


Figure 3-7. Performance measure of Participant 1

Occupational Satisfaction Measure for Participant 1

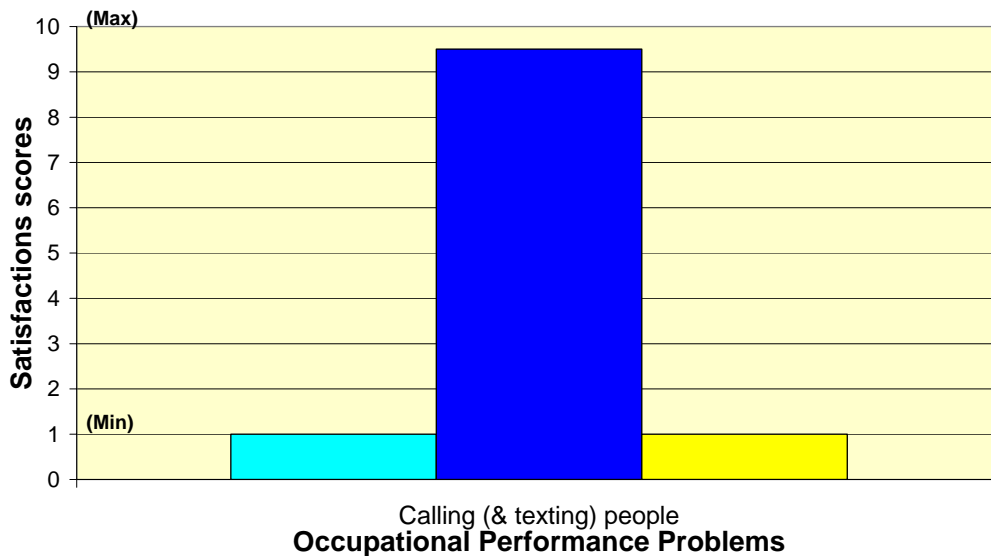
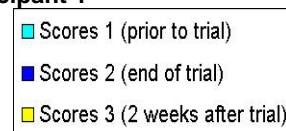


Figure 3-8. Satisfaction measure of Participant 1



3.3.1.2 Second Participant's Results

Participant 2 is 16 years old with Cerebral Palsy who uses a powered wheelchair and an AAC device to communicate. The participant has no experience in using a mobile or home phone. The participant is a direct access user and accesses the Pathfinder Plus using his left-hand and drives the wheelchair using his right hand. Accessing the Pathfinder is slow and requires much effort and concentration to hit the right sequences. The participant also uses language methods such as single word, keyword, phrases or sentences created by the keyboard and Minspeak to converse.

Participant's Occupational Problems

The following are the occupational performance problems with telecommunication use:

- Emergency and security;
- Ring for assistance / help / illness / transport;
- Contact family members;

Solution Provided

Hardwired mobile phone system

- Cable connection to phone
- Bluetooth connection between phone and the Supertooth II hands-free.

Figures 3-9 shows the participant interacting with the system.



Figure 3-9. Participant 2 interacting with the system directly.

Telecommunications Network

- Telstra pre-paid

Performance and Satisfaction Outcomes

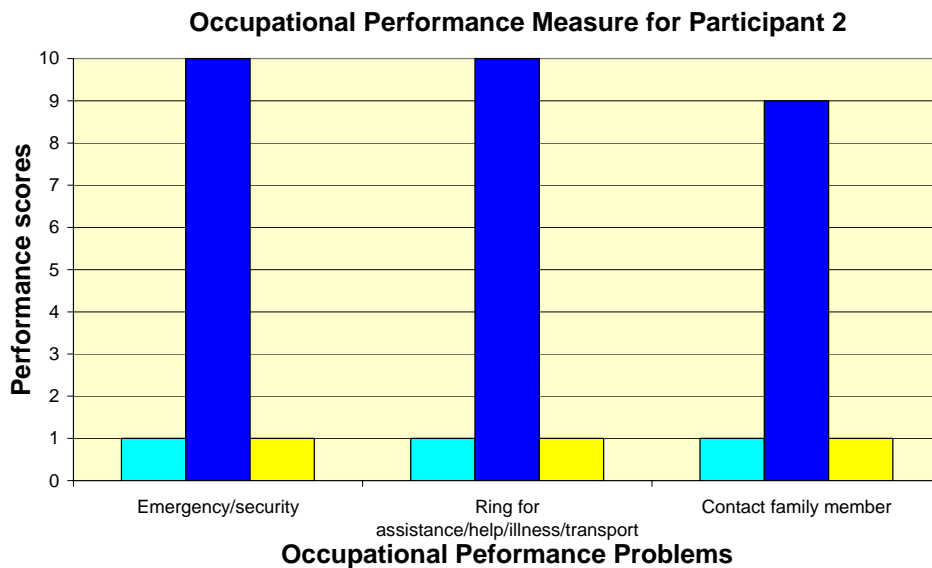


Figure 3-10. Performance measure of participant 2

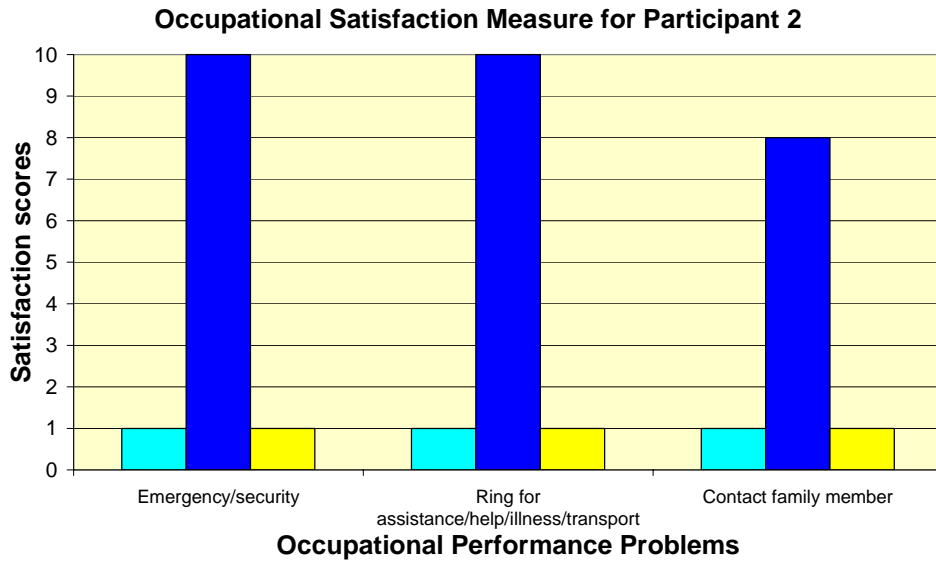
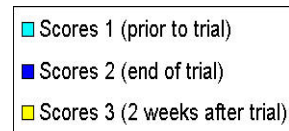


Figure 3-11. Satisfaction measure of participant 2



3.3.2 Equipment Usability Questionnaire

An Equipment Usability Questionnaire was administered at the end of the equipment trial to collect the user’s view of the system and its overall performance.

3.3.2.1 Using the system

Table 3-2 shows the results obtained when the participants were asked to rate the ease in performing the most commonly used tasks on a mobile phone using the provided system and the level of satisfaction when performing them.

Tasks	Participant 1		Participant 2	
	Performance	Satisfaction	Performance	Satisfaction
Dialling a phone number from the system’s memory	10	10	10	8
Dialling a phone number from scratch	N/A	N/A	10	10
Answering a call	*	*	9	8
Ending a call	10	10	10	7
Creating and sending a text message (SMS)	9.5	1 ^ψ	10	10 [~]
Navigate through the menus on the system	10	10	10	10
Reading the visual display on the mobile phone	10	9.5	10	9.5

Table 3-2. Performance and satisfaction level when performing common phone tasks.

* The ringing was too short to start off with (about 6-7 rings (15s)) – impossible to answer for a single switch scanner. When the ring time was extended to the maximum (30 seconds) the participant could answer an incoming call.

^ψ Participant 1’s least favoured mode of communication.

[~] Participant 2’s favourite mode of communication.

3.3.2.2 Participant's Performance – time taken to do tasks

Each participant was asked to estimate the time it would take them to perform a common task using their system. The outcome is shown in Table 3-3. The results were also confirmed with the data logged obtained (for a week) from the Pathfinder that shows all the activities that have been carried out during the trial.

Tasks	Estimate the time taken to successfully carry out task(s) (seconds)	
	Participant 1	Participant 2
Dialling a number from system's memory	< 15s	< 15s
Dialling a number from scratch	N/A	~ 25s [#]
Answering an incoming call	20s – 30s ⁺	< 15s
Ending a call	< 10s	< 5s
Creating and sending an SMS	< 1 min	< 1 min

Table 3-3. Estimated time take to perform a common task.

[#] Varies if the number is a short number such as Telstra's prepaid 1258888, home phone number or a mobile phone number.

⁺ Typically the participant is able to answer a phone call when in a calm and relaxed state within this time range. The participant is unable to answer a phone call when too excited or tensed.

3.3.2.3 System's performance

Participants were also asked to give feedback on the overall performance of the system, its ease of use, which features were most liked, and what else could be improved. Table 3-4 highlights the participant's responses.

Feedback	Participant 1	Participant 2
Overall performance	10/10	10/10
Ease of use	10/10	10/10
Most liked feature(s)	Calling people	Texting people
What could be improved	<ul style="list-style-type: none"> Wireless connection to the phone Larger phone display Limit the action/scanning to achieve the same task – i.e., reduce the number activity rows. 	<ul style="list-style-type: none"> More choices for what can be said – predefined (commonly used) phrases. Participant doesn't mind the cable connection
Other comments	<ul style="list-style-type: none"> Mounting of the phone – so that it can be easily removed by carer(s) or do not need to be removed by carers when the participant gets in/out of the chair. 	<ul style="list-style-type: none"> Mounting the portable hands-free in a secure and safe place Using the system has also increased the participant's use of the Pathfinder and communication skills

Table 3-4. User's feedback on the overall system.

4. Discussion

The results outlined in this report successfully validate the research aim and hypothesis. The activities carried out during the trial and the participants' positive assessment outcomes and feedback confirmed the view that through independent use of a mobile phone people with disabilities can increase their interpersonal communications skills, become initiators of conversations and improve their lifestyle and social interaction.

Analysis of the COPM results showed that both participants reported exceptionally high performance and satisfaction outcomes with the solution that was provided to them during the trial. This is illustrated below in Figure 4-1 and Figure 4-2 respectively.

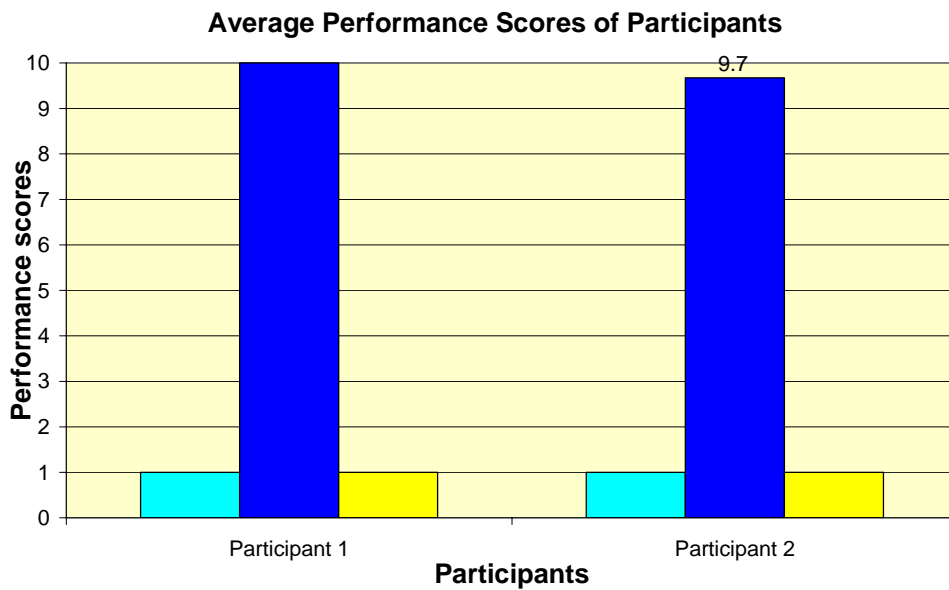


Figure 4-1. Average performances of the 2 participants throughout the trial

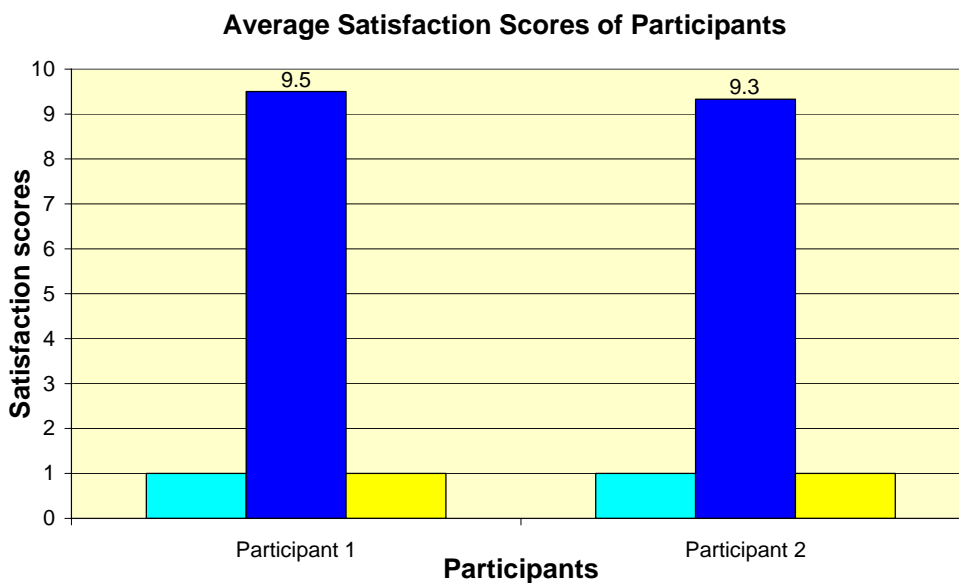
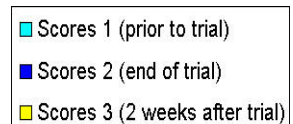


Figure 4-2. Average satisfaction of the 2 participants throughout the trial



After trialing the system for a month, both participants were asked to fill out an Equipment Usability Questionnaire to indicate their level of performance and satisfaction while using the system, how long it took them to carry out common tasks and how they would rate the overall system. The results showed that participants gave a high to maximum score out of 10 for performance and satisfaction while using the system. There was one exception whereby Participant 1 gave a score of one out of ten for text messaging although she could do it very well. Voice calls were this participant's preferred choice of communication as she can hear the person she is talking to. *"Calling people means that she gets an instantaneous respond whereas with SMS the response is not instantaneous. Participant 1 wants instant results and doesn't like to sit and wait for a response"*, commented her mother.

When interviewed Participant 1 said "Sorry" when she gave a score of one out of ten for text messaging and said *"I love it"* when using her Pathfinder for voice calls. Because Participant 1 is a slow communicator through the use of her Pathfinder (i.e., about 2–3 words per minute), and that she preferred voice calls over text message, her phone credit was used up very quickly. The circumstance remained unchanged even when she was encouraged to call people more on the weekends than on weekdays as Telstra's pre-paid deal¹ was cheaper. The situation got to a stage where access to Telstra's network was not a viable a solution. A switch to Vodafone's \$49.95 pre-paid for \$230 worth of calls and SMS was the logical option after two weeks on the trial.

Unlike Participant 1, Participant 2 preferred text messaging more than making voice calls although he could do both equally well. Participant 2 gets excited with text messaging, especially when he receives an SMS back from someone that he had sent a message to. *"The feeling is like going to the mailbox each day and discovering that you got a letter addressed to you"*, describes his mother. Participant 2 did not use up his credits at the same rate as Participant 1, so Telstra pre-paid was still a practical choice – which he remained on for the rest of the trial.

For Participant 1, making calls or answering calls was possible using an infrared home phone prior to the trial. However, in order to do so the participant usually had to drive and position herself in front of the infrared phone. Driving is achieved by a single switch that controls a "click-to-go"² integrated control system. It is a slow and strenuous process before Participant 1 can call someone or answer an incoming call (rarely possible unless the Participant 1 is situated within the vicinity of the phone's infrared signal or anticipated incoming call). With the provided system Participant 1 was able to make a call and answer a call at her discretion.

It normally takes the Participant 1 less than 15s to call someone using preset phonebook numbers programmed on her Pathfinder. This was evident when examining a typical LAM data logged from the Pathfinder:

```

...
06:22:15 ACT3 "DIAL FROM PHONEBOOK" //open phonebook
06:22:24 ACT "CALL MARGATD0437067[REDACTED];" //selects a number from phonebook
06:23:03 ACT "HI THIS IS [REDACTED]. HOW ARE YOU?" //begins a conversation
...

```

Answering incoming calls normally takes 20–30 seconds when Participant 1 is in a calm state or the full 30 seconds (before the phone dials out) and she occasionally

¹ Telstra's pre-paid weekend rate was 1c for the first ten minutes plus connection fee and similarly between 9pm-7am weekdays.

² Master remote control for wheelchair driving, seat function and to operate an external device such as a communication aid/device or environmental control.

³ ACT represents ACTIVITY that is the activity item/icon that was selected.

misses a call when she gets overly excited with the fact that she is actually receiving a call from someone.

It normally takes Participant 1 about one minute to create and send a predefined message.

Participant 2 normally takes about 15 seconds to call someone using preset phonebook numbers programmed on his Pathfinder. Dialing a number from scratch takes approximately:

- 45 seconds (selecting digits on the Pathfinder for a ten digit number from the user's memory)
- 25 seconds (selecting the digits on the Pathfinder with the ten digit number in front of the user)
- 20 seconds (selecting digits on the Pathfinder with 1258888)
- 15 seconds (dialling directly the phone's keypad with 1258888 – dials this free number often to check his balance).

Answering incoming calls normally takes less than 15 seconds and it typically takes about one minute create and send a predefined message. This was confirmed from a typical LAM data logged from the Pathfinder:

```

21:21:16 ACT      "AT+CMGF=1 AT+CSCA="+61418706700" " //sending SMS to
                . . .
                Telstra's Message Service Centre.
21:21:26 ACT      "AT+CMGS="+61400182[REDACTED]" //Number to send SMS to.
21:21:35 ACT      "HI. THIS IS [REDACTED]. HOW ARE YOU?" //the message
21:21:43 ACT      "SEE YOU AT HOME." //additional message
21:21:53 ACT      "MESSAGE SENT" //message successfully sent prompt
                . . .
    
```

“Using the system has also increased Participant 2’s use of the Pathfinder and communication skills”, says his mother. Participant 2’s mother has also noticed remarkable improvement in Participant 2’s technique of interacting with the system. *“Participant 2 didn’t use the Pathfinder much prior to the trial but since the trial Participant 2 has been using it frequently to text message and call family members”* she added. This was something Participant 2 had never been able to do independently. Participant 2 said *‘thank you’* at the end of the trial.

Both participants were overwhelmingly pleased with the system’s overall performance and ease of use. This was attributed to the customised set up and programming of the system through the input of the participants and carers at the onset of the trial. Thorough training and ongoing support also contributed to a successful outcome.

A major suggestion for improvement to the system was to limit the amount of scanning on the Pathfinder a single switch user would need to achieve a single task such as dialling a person from the phonebook. This would mean the reduction of activity rows and different levels a user would have to scan through to get to a name in the phonebook to make the phone call. It was suggested that this could be achieved by giving the user full access to the phone’s actual functions and menus via a single activity row that has the navigational key control and ‘soft keys’¹ selection capabilities.

This requires mobile phones that support these features such as current advanced Sony Ericsson mobile phone models as well as those in the pipeline. Figure 4-3 illustrates this concept. The suggested improvement would mean that all phone numbers and predefined messages will be stored on the phone instead of the Pathfinder which currently makes the activity rows long and multi-level. It will also give carers full access to the phone to add a new phone number in the phonebook instead of the complicated task of adding the new phone number on the Pathfinder.

¹ Also known as ‘selection keys’ and normally designated as the top two buttons (on each corner) below the phone’s main display on most phones. Each key performs the function displayed above it on the main display.



Figure 4-3. Full phone control via joystick and 'soft keys' interface.

The new interface essentially means that user would only need to scan through one activity row to have full control of the phone. This is particularly significant for single switch scanning users since missing an item during a row/column scanning cycle would mean that the user would have to repeat the same cycle over again until they have selected the right item. This can be a frustrating and exhausting process and could inevitably lead to abandonment of the system. The suggested option would also mean that a carer could simply program a new phone number to the phonebook instead of the Pathfinder, which is a less complicated process. The ability to control all phone functions would also mean that the user could also have access to other features such as the digital camera, Internet, Media Player etc, that other phone user take for granted everyday.

There were also minor suggestions to improve the system that would benefit both future users and their carers. This included:

- Wireless connection from the Pathfinder to the phone to remove the cable connection for a neat and cable free system;
- Larger phone display such that the screen can be easily read from a reasonable distance; and
- Mounting of the phone and particularly the hands-free unit in a secure location to avoid theft, tampering and protection from external elements.

5. Recommendations

This research and clinical trial was able to demonstrate that with a suitable mobile phone interface between an AAC device and the integration of other existing off-the-shelf telecommunications equipment, AAC devices users can successfully operate a mobile phone for voice calls and text messaging.

Essential to the success of the trial involved a customised equipment interface, set up and programming as well as thorough training of the system. Participants and their carers also contributed to the successful outcomes by having input at the beginning of the trial during the “*matching the participant with the available technology*” assessment process. This is a concept that encapsulates the fundamental idea of developing and delivering solutions with the end user’s involvement.

Recognising the significant benefits for the users from the system, it is recommended that:

1. Further refinement of the system to reduce the amount of scanning and selection required by switch scanning users. It is suggested that this could be achieved by giving the user full access to the phone’s functions and menus navigational key control and soft keys selection instead of programming all the functions on the Pathfinder itself.
2. There needs be a process in place that ensures that the end user is involved at the initial stages of equipment interfacing and set up. In addition thorough training and ongoing support will improve the user’s access methods and effective use of the system leading to an increased self-esteem and confidence and inevitably result in better communication and social interaction. This can be achieved through periodic review of the user’s needs and abilities as they change over time. The process can be initiated by the user or carer and assessed and implemented by a trained personal with the necessary skills and knowledge.
3. For AAC device users to access mobile phones more effectively and economically:
 - a) That there need to be concessional access rates for AAC users who take longer to convey the same message across the network;
 - b) That the number of rings from an incoming call be extended beyond its current maximum of 30s. This would be significant for single switch scanning users.
 - c) Users need to consider utilising the pre-paid options that are currently available with Optus, Vodafone etc whereby, \$30 pre-paid will give \$150 worth of voice calls and text messaging. This would give the users more control over their spending;
 - d) Users needs to consider utilising the Australian Communication Exchange’s National Relays Service, which would only cost them an un-timed local call to any home or mobile number.

Recommendations 1 and 2 could be easily implemented by the authors prior to the release of the final product. Staffs within NovitaTech have the necessary skills and knowledge to implement this. Following the success of the trials NovitaTech plans to market the trial system for potential AAC device users who need it for mobile phone access while refinement will be made for the next version of the interfacing system. Recommendations 3c) and 3d) is at the discretion of the end-user and recommendations 3a) and 3b) are at the discretion of Telecommunications Services Provider.

6. Conclusion

This research and trial have shown that AAC devices users can independently and effectively use a mobile phone for voice calls and text messaging. This was something that has not been possible for these people prior to the research and trial. The results have shown that by involving the end-user in the early stages of the interface system development and trialing process has produced a very successful outcome. This was further strengthened by providing customised training and ongoing support that accommodated the user's ongoing needs and newfound abilities.

This research has also shown that even more severe AAC devices users who can only converse via single word, keyword, phrases or sentences using single switch scanning methods can also successfully use a mobile phone. However, using the mobile phone can be a slow and tedious process and often relies on the person receiving the call to interpret what has been conveyed. Nevertheless, a positive outcome of the end user has been achieved.

7. Acknowledgments

This NovitaTech project, "a prototype mobile phone interface system that will allow children and adults with a physical disability who cannot speak to communicate to independently use a mobile phone" is supported by the Commonwealth through the Telecommunications Research Grant Program of the Department of Communications, Information Technology and the Arts. The opinions contained in this report are those of the authors and do not necessarily reflect those of the Department of Communications, Information Technology and the Arts.

The authors also acknowledge the support and contributions of the following groups:

STEERING COMMITTEE MEMBERS

Prof. Andrew Downing, Dean of Engineering at Flinders University, Adelaide.

Dr Lloyd Walker, Director of NovitaTech, Novita Children's Services.

Mr Rob Garrett, Group Leader, Research and Development, Engineering & Support, NovitaTech, Novita Children's Services.

Mr David Hobbs, Senior Rehabilitation Engineer, NovitaTech, Novita Children's Services.

Mr Toan Nguyen, Rehabilitation Engineer, NovitaTech, Novita Children's Services.

ASSISTIVE TECHNOLOGY

Ms Libby Price, Speech Pathologist, NovitaTech

Mr Jeff Price, Assistive Technology Technician, NovitaTech

SPEECH

Ms Emma Grace, Speech Pathologist, Novita Children's Services Inc. (Therapy Services)

SEATING AND MOBILITY

Mr Frank Nagy, Technician, Seating, NovitaTech.

Most importantly, the authors would like to thank all the participants (and their families) that took part in the trial.

8. References

- [1] Australian Mobile Telecommunications Association (AMTA) (2005), *An Australian Mobile Telecommunications Industry Report*, September 2005. www.amta.org.au
- [2] Nguyen, T., Price, L., Garrett R. (2005), *Mobile Phone Use via an Augmentative and Alternative Communication Device*, Australian Group on Severe Communication Impairment (AGOSCI), Conference paper, Brisbane, Australia.
- [3] Nguyen, T., Hobbs D., (2005), *NovitaTech Snowy Hydro Telecommunications Workshop*, Novita Children's Services Inc., Adelaide, Australia.
[http://www.novitatech.org.au/library/RoadShowReportFinal\(1\).pdf](http://www.novitatech.org.au/library/RoadShowReportFinal(1).pdf)
- [4] Law, M., et al. (1999). *Canadian Occupational Performance Measure*, (3rd ed.), CAOT Publications ACE, Ottawa, Canada.
- [5] Nguyen, T., Garrett R. (2003), *New technological options for people with physical disabilities, through the use of telecommunications equipment*, Department of Communications, Information Technology and Arts.
<http://www.novitatech.org.au/library/NewTelecomOpShortReport.pdf>
- [6] Cornish J., Higginbotham J. (2000). *Tool for Evaluating Communication Rate in Interactive Contexts*, Technical Report: Communication and Assistive Device Laboratory, University at Buffalo, State University of New York.
<http://www.cadl.buffalo.edu/download/BigUnits1.pdf>
- [7] Higginbotham J. (2004). *Communication Enhancement Center (Research Project R4): Evaluating and Enhancing Communication Rate, Efficiency and Effectiveness*, Technical Report: Communication and Assistive Device Laboratory, University at Buffalo, State University of New York.
<http://www.cadl.buffalo.edu/download/Rate.pdf>

Appendices

Appendix A: Canadian Occupational Performance Measure form

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 individualised 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: Toan Nguyen (Rehabilitation Engineer)
Facility/Agency: Novita Children's Services
Program: <i>Mobile Phone Access for People Using an Augmentative and Alternative Communication Device</i>

STEP 1: IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES	STEP 2: RATING IMPORTANCE
<p>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.</p> <p><i>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?</i></p>	<p>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.</p>
STEP 1A: Communication (in general)	IMPORTANCE
<p>Mode of communication (e.g. voice, text)</p>	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
<p>Mode of telecommunication use (e.g. phone, mobile phone, SMS, Internet, E-mail)</p>	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
<p>Purpose of use (e.g., security, emergency, independence, call taxi) <i>[What is it used for?]</i></p>	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
STEP 1B: Telecommunication use (& context of use)	
<p>Home use (e.g., contact friends & family)</p>	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
<p>Play/School use (e.g., security, call home, taxi)</p>	<input type="text"/>
	<input type="text"/>
	<input type="text"/>

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:

OCCUPATIONAL PERFORMANCE PROBLEMS:

1. _____
2. _____
3. _____
4. _____
5. _____

PERFORMANCE 1

SATISFACTION 1

Reassessment:

PERFORMANCE 2/3

SATISFACTION 2/3

Scoring:

$$\text{Total score} = \frac{\text{Total performance or satisfaction scores}}{\text{\# of problems}}$$

PERFORMANCE SCORE 1

SATISFACTION SCORE 1

/

/

=

=

PERFORMANCE SCORE 2/3

SATISFACTION SCORE 2/3

/

/

=

=

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 (1/2):

Appendix B: Equipment Usability Questionnaire form

Equipment Usability Questionnaire

(to be completed by the Researcher in conjunction with the participant at “B” stage of the “ABA” approach)

Name: _____

Technology _____

Part A - Accessing the mobile phone

Please rate the ease in performing these tasks **ON YOUR OWN** when using your provided system and the level of satisfaction when performing them. **(Please rank from 1 to 10)**

Tasks	Performance rating (1= not able to do at all 10= able to do it extremely well)	Satisfaction rating (1=not satisfied at all 10=extremely satisfied)	Don't know (Tick where applicable)
Dialling a phone number from the system's memory			<input type="checkbox"/>
Dialling a phone number from scratch			<input type="checkbox"/>
Answering a call			<input type="checkbox"/>
Ending a call			<input type="checkbox"/>
Creating and sending a text message (SMS)			<input type="checkbox"/>
Navigate through the menus on the system			<input type="checkbox"/>
Reading the visual display on the mobile phone			<input type="checkbox"/>
Other (specify, if applicable)			<input type="checkbox"/>

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) <i>(With the provided system)</i>	Don't Know or N/A
Dialling a number from system's memory		<input type="checkbox"/>
Dialling a number from scratch		<input type="checkbox"/>
Answering an incoming call		<input type="checkbox"/>
Ending a call		<input type="checkbox"/>
Creating and sending an SMS		<input type="checkbox"/>
Other task(s) (specify) _____		<input type="checkbox"/>

Comments (if applicable)

Part C - Performance of the system

1. How would you rate the system's overall performance out of 10? ____

2. How would you rate the system's ease of use out of 10? _____

3. What are features of the system you like the most and why? _____

4. What features of the system could be improved? _____

5. Any other comments about the system? _____

Thank you for taking the time to fill in this survey for us! 😊

Appendix C: Individual Pathfinder programming and vocabulary

Participant 1

Phone call – Figure C-1 shows the steps that Participant 1 has to follow through in order to make a phone call and converse using pre-defined phrases or using Minspeak.

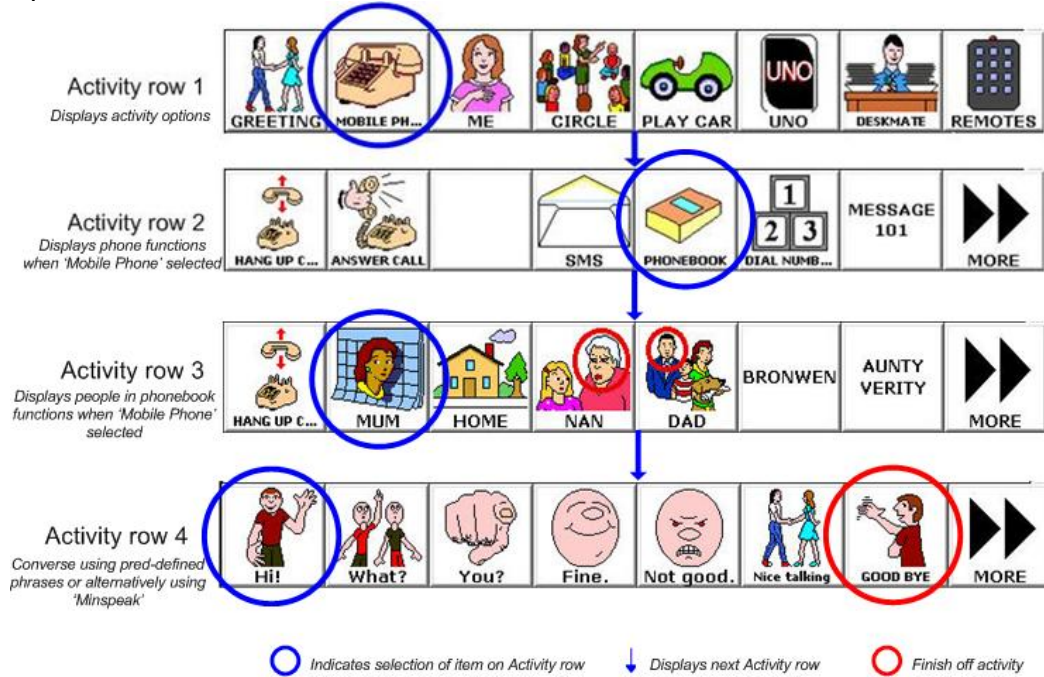


Figure C-1. Making a phone call using the Pathfinder.

Text messaging – Figure C-2 illustrates the steps that Participant would use to create and send a text message.

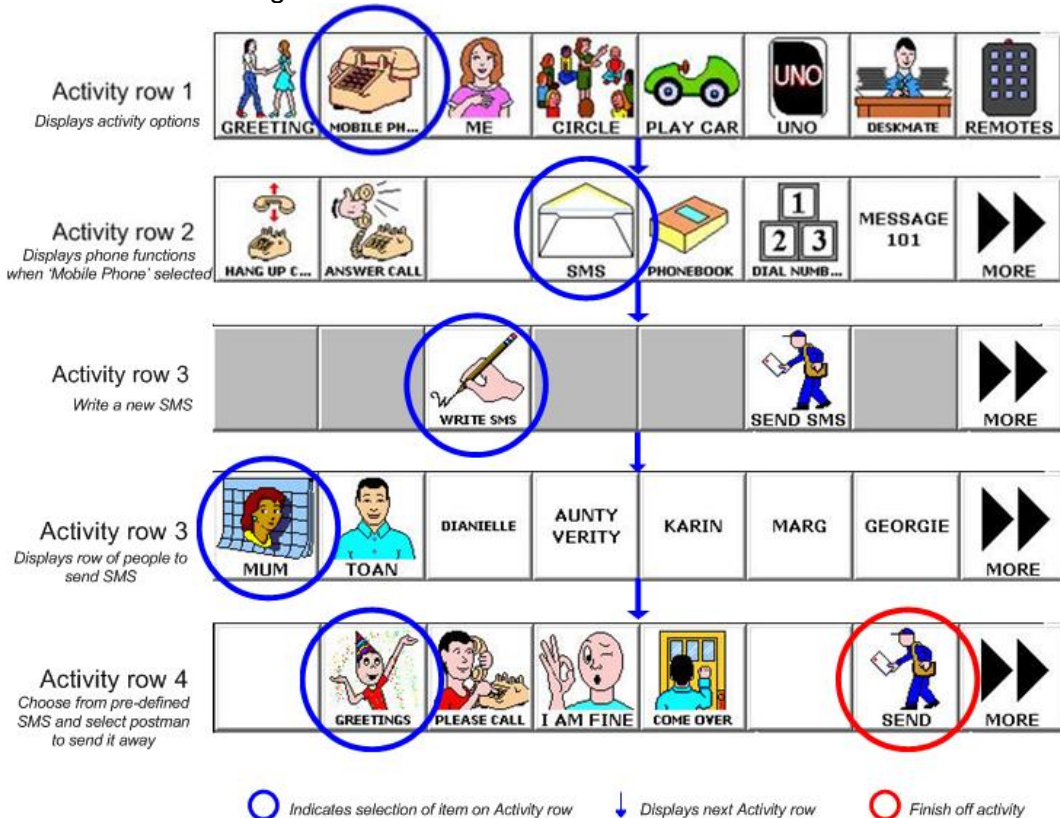


Figure C-2. Creating and sending a text message using the Pathfinder.

Participant 2

Phone call – Figure C-3 shows the steps that Participant 2 has to follow through in order to make a phone call and converse using pre-defined phrases or using Minspeak.

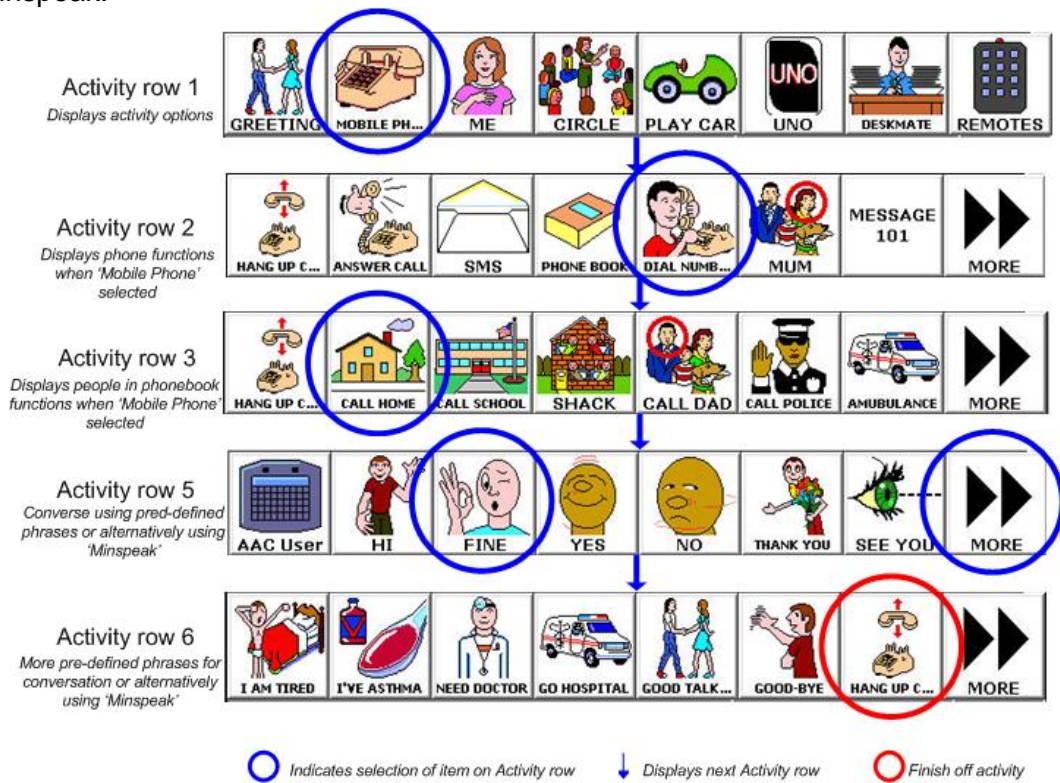


Figure C-3. Making a phone call using the Pathfinder.

Text messaging – Figure C-4 illustrates the steps that the participant would use to create and send a text message.

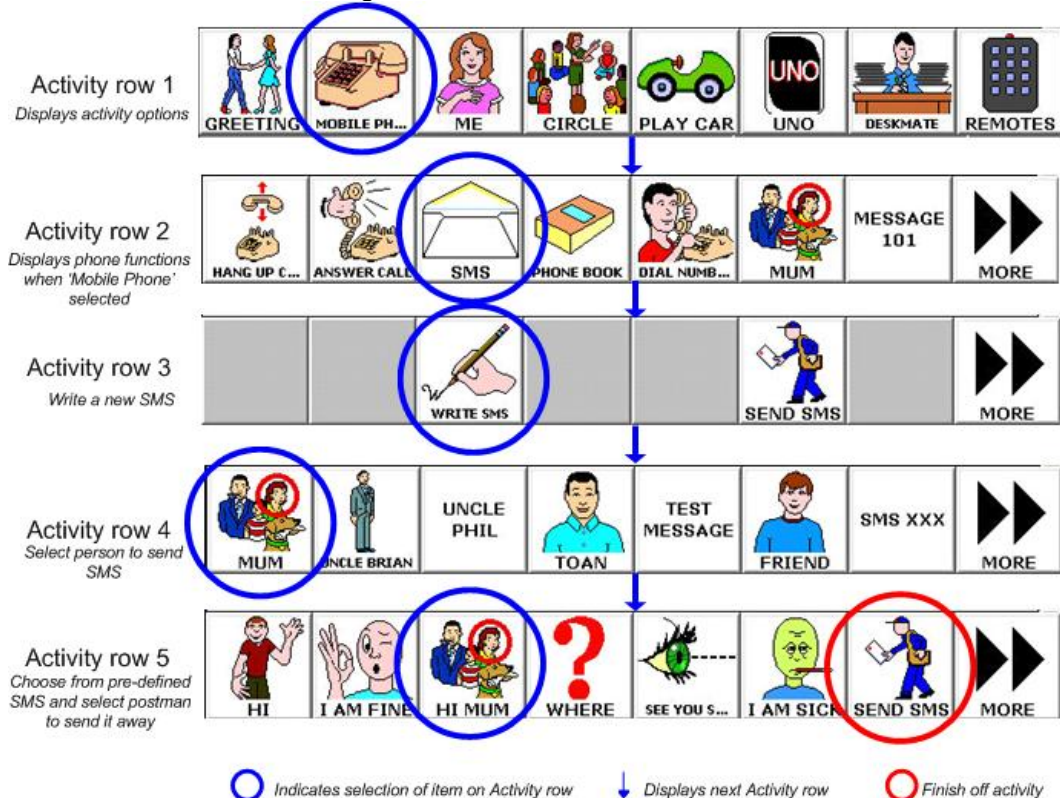


Figure C-4. Creating and sending a text message using the Pathfinder.

Sampled Activity icons and meaning

Table C-1 illustrates sampled phrases (attached to activity icons) used in conversation and text messaging by participants during the trial:



Activity Icons	Meaning	Activity Icons	Meaning
	Hi this is xxx. I am using a communication device to talk so please give me time to respond to you. Thank you.		I need to see a doctor
	Hi this is xxx. How are you?		I need to go to hospital
	I am fine. Thank you.		Good bye
	Yes		Please call me.
	No		It was nice talking to you.
	Thank you.		When are you coming over?
	See you soon		Hi this is xxx. How are you?
	I am sick		How are you?
	I have a sore throat		How are you? Where are you?
	I am tired		What's up?
	I have asthma		I am fine.

Table C-1. Sampled phrases used during the trial.