**Purpose**

Goal Management Training (GMT) is used a lot in rehabilitation of people after traumatic brain injury (TBI). Research is underway exploring a new approach to GMT using mobile phones as one of the components. Computerization of Goal Management Training involves three hardware components: RFID tags, RF reader and a mobile phone (see Figure 1). The objective of this project is to determine the kind of mobile phone that would be most acceptable for use in people with TBI and then to build the appropriate user interface for the phone.

![Figure 1: GMT- Technical system Overview](image)

**Overview**

The overall aim of the project GMT involves assisting the person with TBI to choose the goal (an area where they are prone to goal failure) and defining each of the sub-steps
involved in achieving the goal (see Figure 2). GMT is particularly amenable to technology transfer because programming a computer requires setting out specific steps so the computer will move through these in exactly the same order each time. Further, GMT is particularly suited to a personal device because the user would have that device with them.

![GMT Process Diagram]

The GMT process can be summarized as follows:

- Each step is undertaken explicitly and in turn. Thus, defining the main task to be achieved and subsequent steps are successfully attained prior to moving on to Step 5. This facilitates errorless learning – important in TBI rehabilitation.
- If a specific step is not achieved, then progression to the next step does not occur, rather further practice of the specific step being carried out. This step requires prompting until the person with TBI has learned the steps.
- Fundamental to this goal training is that achieving each step will contribute to the individual’s ability to ‘self-regulate’ behaviour and by doing so, contribute both to goal attainment and to an enhanced self-image.
- The types of tasks chosen for GMT vary widely according to the values of the individual patient. Examples include, getting dressed in the morning, remembering to take keys when going out and common cooking task such as preparing a family meal.

Because preventing goal failure is at the heart of GMT, it can introduce a number of practical problems:

1. The time required may mean it is ‘easier’ for the care-giver or a family member to do it for the injured person (in essence creating dependency rather than enhancing autonomy);
2. The care-givers and family members may not focus on the importance of learning the steps before practise thereby unwittingly helping the person learn the error, rather than eventually performing the task with no goal failure.
3. Also, in a therapeutic environment, it requires the practitioner to be with the person with TBI during rehearsal of the steps, making it time-consuming and resource dependent.

Figure 2 – GMT Process
4. Above all, rehabilitation providers will have only general practice. The GMT personal device is intended to be a therapeutic tool to sequentially prompt the person with TBI before errors occur (i.e. aiding learning of the steps). If it works, one would be able to set up goal-related activities for the person with TBI that they can do unmonitored. Finally, the device could potentially store statistics and provide feedback both to the TBI patient and the rehabilitation provider.

**Scope**
For this feasibility study, the current study focuses on testing the utility, functionality and acceptability of the mobile phone for use in people with traumatic brain injury (TBI) and then to build the appropriate user interface for the phone.

**Stakeholder feedback:**
In order to be able to proceed, it is important to ensure that the most suitable mobile phone device is used to continue to carry out this research. Therefore, this sub-study aims to talk with people who have had a TBI to:

- explore their current experience of using mobile phone technology; and
- obtain their views about the type of device and features of the technology that are most acceptable to them.

Participants were identified by Cavit ABI as meeting the following criteria:

- Have had a traumatic brain injury
- Are able to understand the information about the study, and
- Are able to communicate with the interviewer
**Attributes for potential outcome**

People with TBI vary from person to person and every individual might need a slightly different mobile phone, both by its physical characteristics of size, weight and shape but also from the view point of its user-interface elements. Elements such as screen size, size of a menu item or button, and presentation structure have, therefore, been taken as the key factors in the processes of selection of a mobile phone and development of its user-interface.

**Table 1: Critical mobile phone attributes (Choi et al. 2005)**

<table>
<thead>
<tr>
<th>Cell-phone Attributes</th>
<th>Minimal steps or key strokes</th>
<th>Secondary information about contents</th>
<th>Variety of contents</th>
<th>Logical ordering of menu items</th>
<th>Clear menu labelling</th>
<th>Efficient layout or space usage</th>
<th>Variety of Font sizes</th>
<th>Variety of Font colours</th>
<th>Large Amount of Information within a screen</th>
<th>Various options for contents</th>
</tr>
</thead>
</table>

Based on the criteria above, three different mobile phones have been shortlisted for use in the study: Apple’s iPhone, Nokia 5800 Express and Blackberry (refer to Figure 3). They are of the line of Internet and multimedia-enabled smart-phones and commonly offer features such as a camera phone (also including text messaging and visual voicemail), a portable media player (equivalent to a video iPod), and an Internet client (with e-mail, web browsing, and Wi-Fi connectivity) and soft-touch screen to provide a virtual keyboard in lieu of a physical keyboard.
However, what makes each phone distinctly unique is their menu presentation structure. Ji Hye & Kun Pyo discuss three ways of organizing menus: a) grouping menus on the basis of their thematic similarities (iPhone); b) grouping menus according to categories in terms of parent-child taxonomy (Nokia); and c) functional an combination of a) and b) (Blackberry). The user’s anthropometrics were also considered in the selection of phones, especially the screen-size and weight parameters were thought to be important to TBI patients (See Table 2).

<table>
<thead>
<tr>
<th>Phone Model</th>
<th>Size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPhone</td>
<td>115.5 x 62.1 x 12.3</td>
<td>135 grams</td>
</tr>
<tr>
<td>Nokia 5800 xpressmusic</td>
<td>111 x 51.7 x 15.5 mm</td>
<td>109 grams</td>
</tr>
<tr>
<td>Blackberry Storm</td>
<td>112.5 x 62 x 13.9 mm</td>
<td>160 grams</td>
</tr>
</tbody>
</table>

Table 2 – Mobile phone Comparison

**Materials**

First of all, the phones shortlisted for use need to be acquired / borrowed
Secondly, the software tools required to design the user-interface:

1. Microsoft Visio
2. IBM Rational Rose™ - a UML tool
**Constraints**

- This study needs ethical approval from the Northern X Regional Ethics Committee.
- The project depends upon receiving data from participants who have had a TBI and their volatile health & mental condition may cause delays in the project delivery.
- The functional requirements of the system needs to be adequately described in detail given the changing mood and views of the participants due to their TBI condition.
- Key computer resources need to be available on timely basis and the key decision-makers are easy to contact when issues arise.
- Remote recruitment using phone calls and emails was not possible and the expenses for travelling across the rehabilitation locations must, therefore, include in the budget. All this, along with the acquisition of the smart phones proposed for the study could create budgetary constraints.

**Data-collection Procedure**

In order to identify and explore the specific requirements necessitated by the individual difficulties of each participant, the interviews encapsulated certain critical areas of focus as presented in Table 3.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Components</th>
<th>Prompts</th>
</tr>
</thead>
<tbody>
<tr>
<td>To build client profile</td>
<td>Familiarity with the features of mobile phone &amp; frequency of use</td>
<td>Calling, texting, internet, alarm, mute, reminders</td>
</tr>
<tr>
<td>To understand physical difficulties</td>
<td>Preferences between virtual keyboard and touch keys/ using a stylus or finger</td>
<td>Clients try and use three different phones</td>
</tr>
<tr>
<td>To understand cognitive difficulties</td>
<td>Preference of menus for ease of use</td>
<td>word-menus or picture-menus</td>
</tr>
<tr>
<td>To understand any preferences</td>
<td>Preference of other features</td>
<td></td>
</tr>
</tbody>
</table>

*Table 3 – Semi Structured interview Guide*
Each interview took approximately 35-40 minutes and was held at a time and agreed upon by the participants. The first ten minutes was used for gathering the profile-building information such as the participants’ previous experience of using mobile phones, any problems or difficulties they encountered, and any features of a mobile phone that they see as important. In the next 20 or so minutes they were asked to look at some mobile phones in order to give their opinion on aspects of the design that are most acceptable to them. In this process the mobile phone handsets were introduced one after the other. They were primarily used as prompts to initiate discussion according to the interview guide (see Table 3).

The interviews were recorded and transcribed separately. Employing the Content Analysis techniques suggested by Patton (2002) transcripts were coded and content analysis conducted, taking into consideration the context and role of the contributor. Initial categories were collated from each source, with comparisons then made within data sources (e.g. one client’s data were compared and contrasted with another client’s). Through this process, categories were then linked into themes. QSR nVivo® was used to assist with data management during the coding process.
Details of the outcome: specifications

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Specifications</th>
<th>Fitness to purpose</th>
</tr>
</thead>
</table>
| Screen size      | The population with disabilities is at a physiological disadvantage compared to the main stream population | 1. The need for larger buttons/icons  
2. need picture based icons supported by unambiguous and reasonably sized text titles  
3. Each such icon/button is allotted one and only one function.  
4. The only apprehension is the likelihood of losing any accessory such as a stylus. |
| Button size      |                                                                                                                                         |                                                                                                                                                   |
| Button type      |                                                                                                                                         |                                                                                                                                                   |
| Touch type       |                                                                                                                                         |                                                                                                                                                   |
| Using stylus     |                                                                                                                                         |                                                                                                                                                   |
| Text size        |                                                                                                                                         |                                                                                                                                                   |
| Text size        |                                                                                                                                         |                                                                                                                                                   |

**Display/Appearance - Cognitive**

| Icon type        | Cognitive and emotional characteristics of people such as the ability to learn, memorize, and tolerate errors, the perceived ease of use are at low |
| Menu depth       | A design implication of this for a person with a deteriorated short term memory having difficulties with memorizing would be that a menu is wide as opposed to a deep menu structure will be preferred by such an individual. |

**User friendliness – UX feature**

| Voice Control    | Need for ease of use |
| Voice Control    | Voice activation would save them from digging deep to find out certain control themselves. |
Timeline

PHASE 1
Define Requirements

- Define the need
- Gather requirements
- Budget allocations
- Project approvals

PHASE 2
Designing

- Refine requirements
- Rough sketches
- Prototype approval
- Coding

PHASE 3
Development

- Function verification
- Product verification

PHASE 4
Evaluation

- Acceptance testing

PHASE 5
Integration

- 4 Weeks
- 2 Weeks
- 4 Weeks
- 2 Weeks
- 1 Week

Project Planning

Analysing

Programming

4 Weeks
2 Weeks
4 Weeks
2 Weeks
1 Week
Product Architecture
Product Sketches

The product

The study shows that there are three types of knowledge required for successful interaction with a cellular phone: the knowledge that functions are arranged hierarchically (survey knowledge), the representation of the menu depth (route knowledge), as well as memorizing under which super-ordinate term/icon each function is located (landmark knowledge). People with TBI, however, showed a shallow knowledge of the menu and got repeatedly stuck in allocating functions correctly to super-ordinate terms/icons resulting in inferior navigation performance. This is probably due to the deficits in memory and spatial abilities related to the TBI. With such cognitive demands it appeared difficult for them to orient themselves in the menu-tree. This difficulty is more likely with mobile phone technology especially when icons relating to functions are hidden from sight due to its small display. In addition the people with TBI develop quite a few physical limitations some of which this study identifies. As a result the following
recommendations (see product image Figure 5) are made for developing a mobile user interface for use with people with TBI:

**Buttons:**
1. larger buttons/icons than presented with any of the three mobile phones
2. picture based icons supported by unambiguous and reasonably sized text titles
3. one allotted function per icon/button

**Features:**
4. soft touch
5. stylus (for use with virtual keyboard).
6. voice control

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Another aspect – in terms of designing the clock – comes from Idhe’s (1983) discussion of the development of a ‘clock’ as a “perception of time through technology”. The mental operation for telling the time, using an analogue clock, involves TBI patients to ‘see’ time as a ‘spatial’ relationship, whereas with a digital clock they can be forced into ‘calculative thought’ in order to ascertain a notion of time, which of course, creates a cognitive load on their already staggering brains.

**Classroom Implications**

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

**Technological Knowledge (Usability):** The User-Centered Design methodology enables students to focus on what the users need and want (Oshlyyansky et al., 2004). This approach has been extensively used by usability engineers and human factors engineers, and they emphasize the participation of the end users in the design process. The main features of usability are:

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

Understanding accessibility enables students to be more concerned with making interfaces perceivable, operable, and understandable (Henry, 2002).

**Nature of Technology (Sustainability):**

- **Equitable Use:** The design is useful and marketable to people with diverse abilities.
- **Flexibility in Use:** The design accommodates a wide range of individual preferences and abilities.
- **Simple and Intuitive Use:** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- **Perceptible Information:** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- **Tolerance for Error:** The design minimizes hazards and the adverse consequences of accidental or unintended actions.
• **Low Physical Effort:** The design can be used efficiently and comfortably and with a minimum of fatigue.

• **Size and Space for Approach and Use:** Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

**References**


international symposium on Computer human interaction in mobile technology, Singapore. doi:http://doi.acm.org/10.1145/1378063.1378146

