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A Backcountry Tour Guide

Adding Value to the Great Outdoors
Experience

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Engineering
in
Electronics and Computer Systems Engineering

at Massey University, Manawatu
New Zealand.

Kenneth Everett York

2010

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To promote outdoor activity by novice and casual walkers a device was constructed to increase the perceived value of their walks with ongoing feedback of their progress on the walk and engaging information about natural features in their immediate surroundings. The interface design promoted ease of use and quickness of learning for the users. The device did increase the perceived value of the walks by the users.

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This project was evaluated by peer review and judged to be low risk. Consequently, it was not reviewed by any of Massey University's Human Ethics Committees.

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Chapter 1

Motivation & Thesis

There is a vast resource that is going to waste. New Zealand has more than eight million hectares of conservation land (Department of Conservation 2009a) available to the public with nearly thirteen thousand kilometres of trails (Department of Conservation 2008b) and almost one thousand huts (Department of Conservation 2008b). Even with this resource on their back doorstep, literally in some cases, only forty percent of New Zealanders got out onto conservation land in 2008 (Department of Conservation 2008a). This resource goes untapped while half of New Zealand adults are not physically active, one in four is obese and one in twenty is diabetic (Gerritsen et al. 2008). The main obstacle to using this resource may be the simple inertia that keeps people on the couch even when more enjoyable pastimes are available. However, there is another obstacle between many people and the great outdoors, namely the fear of the unknown. Worries like: 'How far is it?' 'How long will it take me?' 'What will I see when I get there?' and the very practical concern 'Where are the toilets?' add height and width to the hurdle that must be overcome before good intentions produce good behaviours.

There are wonders unappreciated. The powerful forces that have lifted and continue to lift the mountain ranges, the violence and splendour of the cataclysms that have punctuated that uplift as well as the irresistible patience of the rivers as they carved great gorges are just a few examples; the evidence for these is all around us but it is mute. As for the creatures and plants, each plays a significant role in the life of these islands but that role is not always obvious. They often have physical features that are marvels of engineering but those features may be at scales that cause them to be easily missed. So, even when people do get out on a trail, few have the knowledge of the flora and fauna or of the forces at work that is required to fully appreciate what they see. On the trail, trampers are literally standing on, moving in and passing by wonders of all sizes from the majestic ranges to the tiniest creature but, for the most part, they don't know how amazing these things truly are. The trampers' foray into the wilderness becomes mostly an exercise in exercise. The greatest reward for their efforts is just the knowledge that they have completed the tramp. If they had been fully aware of the wonders that were all around them as they walked, the tramp would have been much more rewarding, and more likely to be repeated.

There is an existing technology that is not being well used. Portable GPS aware devices have the potential to greatly increase the trampers' sense of confidence and enjoyment as they walk. However, that potential is not being realised. Most GPS devices are designed for use on a road network and are of very little use off-road. GPS devices that have been designed for off-road use do inform trampers of their location and the direction to their destination. However, these GPS devices fail to inform trampers

about how much longer they can expect to be on-trail or what they might see on the way or what amenities are available. Also, these off-road GPS devices have interfaces with characteristics that are in themselves barriers to use by novice and occasional users.

This thesis is an attempt to use the potential of handheld GPS devices to better serve the needs of trampers on the move.

1.1 SMART-MAP

Trampers use conventional maps as a tool for constructing a mental model of an area of terrain. Their value as a tool derives from two properties. First, they represent a large area of real-world terrain, typically on a massively reduced scale. That makes it easy for the user to take in a large area at a glance. Secondly, the features of that area are represented in a simplified, abstract notation, which makes it easy for a trumper to identify important attributes of the area without being distracted by irrelevant information.

These desirable features are the culmination of several centuries of evolution; maps are a mature, and extremely successful, technology. However, there are a number of shortcomings that largely derive from the fact that the paper on which the information is presented is a static vehicle that is not capable of being updated in real-time (except for the sort of pencil markings with which marine and aeronautical navigators add considerable value to their charts). These shortcomings include the following:

- To show a useful scale, maps are quite large and they are cumbersome when unfolded.
- Maps only show one scale and detail level.
- When local landmarks are obscured, maps require a compass to orient them correctly.
- Maps do not directly indicate the trumper's position. In dense bush or fog, a trumper may be less than an hundred metres from a hut and not know it.
- To determine the distance between two points with a map, the trumper needs a way to equate the length of a wiggly line, the trail, to an equivalent straight line length on the distance scale.
- Converting a distance to the time required to walk that distance requires an additional calculation. That calculation requires the trampers to estimate their walking speed over ground which they probably have not seen.
- The map does not come with a calculator.

Recent technological advances, principally the development of the GPS network, have added to the value of paper maps, as it is only necessary to plot the raw GPS data on the map to determine one's location in the surrounding region. However, this does not address the other issues such as size, orientation, fixed detail level or the potential errors that could arise when determining the length of a wiggly line and then using a subjective estimate to calculate the time required to walk a trail.

However, there may be considerable benefit in bringing the two technologies together. A smart-map – a device with GPS, computing capabilities (modern GPS systems have significant computing power) and the ability to present graphical information – would be able to show a trapper's location in an intuitively comprehensible way (i.e. in terms of a map), and would be able to perform useful mathematical calculations to present information in a more easy-to-absorb format than either traditional maps or GPS devices.

HOW FAR?

When trappers are not aware of their current position: all they can do is place one foot in front of the other; their progress is marked by reaching the next turn in the trail; their destination is somewhere ahead. With no measurable progress and the distance to the destination unknown, trappers have to rely on whatever time estimate they may have made at the beginning of the tramp. Without reliable information, trappers can only make uninformed or misinformed decisions. A smart-map would be able to answer such time and distance questions. Armed with the knowledge of the actual distance to their destination and when they might reach it, the trappers can make an informed decision whether to be encouraged and continue on to their destination, which may be quite close, or to rest, rehydrate and move on once they are refreshed.

HOW MUCH TIME IS AVAILABLE?

Whether it is the time that has been arranged to meet transport or the certain arrival of nightfall, tramping always has a time limit. For reasons of convenience, safety or both, the final destination needs to be reached within a certain time frame. Even if trappers have a good idea of their position and the current distance to their final destination, unless they have a good idea of their speed over the ground they have yet to travel they can only make a rough estimate of the time required to reach their destination. If their estimate is too great, they will think that they should move more quickly than necessary and likely miss some enriching experience. If their estimate is too short, they may move too slowly and perhaps miss their deadline or spend the last portion of the tramp under pressure to make up for lost time. A smart-map could use the data it holds about the track as well as what it has observed of the trapper's performance to answer this question. A smart-map could also continuously update this information so that the trapper could moderate their behaviour in small increments to maximize their time on trail and still meet their deadline.

1.2 LOCATION-SPECIFIC INFORMATION

Tramping in the company of someone with extensive knowledge of the history of an area, the geology of its formation as well as its flora and fauna causes a trek to become more than an exercise in covering the distance. Tramping with such a person:

- Increases the trampler's sense of involvement with their surroundings.
- Engages their mind.
- Makes the time pass quickly.
- Makes the effort seem more worthwhile.

Such a person is hard to find and/or expensive to employ. Existing electronic navigational aids do not provide this sort of information. To find this sort of information on their own, trampers need to locate tramping books that cover the trail that they are interested in and read through books about the geology, animals and plants for the area in question.

A handheld GPS device could be loaded with the information an experienced guide would provide. If that information was related to a specific location, the GPS could provide that information when and where the guide would have provided that information.

1.3 HUMAN-COMPUTER INTERACTION FOR HANDHELD TOUCH-SCREEN DEVICES

Every human endeavour comes with a history. The design decisions made in the past significantly affect decisions in the present. For example, the very sensible choices that were made in the design of the original IBM PC limited the hardware architecture of PC's for the next two decades. In the same way, interface decisions made at the beginning of the computer age can limit our thinking when it comes to interfaces for handheld devices. To avoid having these decisions in the past unduly affect decisions in the present; it is important to be aware of the context in which they were made. Human-computer interaction (HCI), even before it was formally studied, first occurred in the context of massive centralized computers communicating with remote terminals with text-based displays. Their graphic capabilities were often limited to what could be accomplished with the use of graphics characters in the ASCII character set. These early interfaces were most often activated by command lines and menus and displayed their status as text. Multi-colour monitors with graphic display capabilities soon followed, one use that employed the new technology well was that of animating the status of processes in industrial plants. For example, the liquid level in a tank was shown as a diagram of a tank with its interior appropriately filled. Alarm states were shown by a change in colour in the display of the affected parameter. These industrial interfaces could be activated by touch-screens or light pens that informed the software when and where the user was touching the screen. The touch-screen was often just another way to activate a menu item or indicate where the user wanted to enter text. The touch-screen was not used to its full potential; it was often seen as little more than a programmable keyboard or

push-button panel. One early paper suggests that it could be part of a ticket kiosk with the touch-screen being used instead of mechanical buttons (Stumpe 1977). Another describes touch-screens as an integral part of a 'Soft Machine' interface philosophy. With a 'Soft Machine' interface philosophy, general purpose machines would be programmed to appear and behave as single purpose machines (Nakatani & Rohrlich 1983). Here again, touch-screens were primarily seen as programmable keyboards.

It wasn't until after the advent of personal computers that Graphical User Interfaces (GUI) began to allow users to interact with the computer in a completely different way. Here a graphical element, an icon, could represent an object in the computer system. The mouse and mouse-pointer became the 'command' device. For example, a file's location in the directory structure of the storage device was indicated by its icon's relative position on the screen. The user could click on the icon representing that file and move the file to another location in the directory structure by literally dragging its icon to another position on the screen. This concept, direct manipulation, was ideally suited to creating, resizing and moving graphical elements in drawing applications or moving text within a document or as in my example moving files within a file system. Partly to respond to the expectations of experienced users, the inertia of history, as well as the fact that direct manipulation does not suit every situation (Hutchins et al. 1985), most computer commands continued to be activated through keyboard accessible menus and keyboard shortcuts. If the user chose to use the mouse to activate commands, the mouse was primarily limited to clicking on the menu choices or shortcut icons. Even today, applications provide alternate ways (at least one using the keyboard and one using the mouse) to invoke almost every command.

The touch-screens on their own, unlike the mouse, do not have buttons and wheels so the touch-screen's event vocabulary is limited. However, when the length, speed, direction and shape of the 'touch-and-drags' are considered, a multitude of unique gestures can be determined and used as specific commands. For example, Swype uses the patterns created as a user traces over the letters that spell out their desired word to accomplish rapid text entry (Kushler & Marsden 2010). Swype uses a dictionary of over 50,000 words to determine which gesture was intended. Gestures can be used to significantly increase the touch-screen's command vocabulary.

The touch-screen has some similarities to the mouse but it also has some significant differences which provide an opportunity to rethink HCI methods. As touch-screens eliminate the mouse, they remove a layer of interface between the user and the device. The mouse requires a uniquely modern skill to be learned; mouse-eye coordination. With touch-screens, the user can again return to using a more natural skill; hand-eye coordination. A touch-screen provides an interface that uses the extant hand-eye coordination we all learned before we were three. To learn about something in our world, we reach out and touch. To change something, we use our fingers to mould and move. It seems that an interface incorporating such natural behaviours would itself seem more natural. Since users are familiar with using their fingers to interact with the real world, using their finger (which touch-screens facilitate) to

interact with the computer seems an appealing idea. The touch-screen can be more than a programmable keyboard or animated button panel. The touch-screen provides the vehicle for a truly direct direct-manipulation interface. The user's finger can be used to select, move and even modify objects. A sliding motion of the user's finger can be used to open or minimise a panel or perhaps pull a hidden panel into view.

1.4 DEALING WITH TECHNOPHOBIA

Existing electronic navigational aids such as the Garmin™ Oregon have interfaces that while functional, require a certain familiarity and boldness with things of a technical nature (Garmin 2010). It assumes that the user knows what a waypoint is and that they will be happy to create and manage their own route data. Setup requires navigating to screens that are several layers deep in a menu structure. To see the information for a point of interest, the user needs to touch the point of interest and then touch a separate button to display the information. The main menu is an animated button panel that has so many buttons that it requires an additional two buttons just to scroll back and forth to see all the choices.

An interface that employs a touch-screen for direct manipulation rather than an animated push-button panel and also avoids technical jargon, both computer and navigational, should make it easier for the first-time and occasional user to benefit from such a device.

1.5 THESIS STATEMENT

GPS aware devices have graphical, storage and computation capabilities that can be used to fully inform trampers of their positional status as well as provide them with information concerning physical features in their immediate vicinity. If the interface for this device is designed to maximise the potential of the touch-screen, the interaction of trampers with the device will seem natural and easy so that they will be encouraged to interact with and to benefit from this device. The information about their positional status combined with relevant information about features in their vicinity will add value to the trampers' on-trail experience. This research project has therefore focused on establishing the validity of the following four contentions

1. It should be feasible to build a GPS-based outdoor trekking assistant device incorporating a 'smart-map' that provides information about a trekker's position on a predefined trail along with ETA/ETT¹ and location-specific information. The validity of this contention can be tested by
 - building a device with a smart-map that has basic positional, ETA/ETT and location-specific functionality in a reasonable amount of time, using a reasonable amount of human resource.
 - determining whether the device tracks the trekker's position with adequate accuracy
 - determining whether predicted ETA and ETT times are acceptably close to actual times
 - determining whether the location-specific information is provided close to the expected location

2. It should be feasible to develop a touch-screen interface for the device that exploits the inherent tactile and visual capabilities of naïve users. The validity of this contention can be tested by
 - designing an interface with the purpose of presenting positional, ETA and ETT information in an intuitively obvious form
 - demonstrating by construction that such an interface is feasible
 - conducting user evaluations to establish its ease of use

3. The interface should enable a naïve user to quickly learn to use the device. The validity of this contention can be tested by
 - conducting *in vitro* usability trials such as simulated treks using stored data and *in vivo* trials similar to orienteering
 - conducting experiments to compare the learning times for the Trekker's Assistant with those of another device representing the state of the existing art (e.g. a Garmin GPS with and without an inbuilt map)

4. The device should add value to an outdoor trekking experience. The validity of this contention can be tested by
 - evaluating its performance using real (naïve) users in at least one real trekking context, such as the Tongariro Crossing

This programme has been followed without major departures². The results point to the validity of all four contentions.

¹ Estimated Time of Arrival/ Estimated Travel Time

² No *in vitro* tests were undertaken, and a shorter, less arduous, trek was substituted for the Tongariro Crossing in the interests of efficiency and safety (the prototype software was not complete and ready for testing until winter, 2010, and the Tongariro Crossing is an eight-hour alpine trek, subject to rapid and unpredictable weather changes at any time of year. It would have been difficult to schedule large numbers of trekkers at this time of year, the supply of trekkers would have been severely limited, and it would have been ethically inappropriate)

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The research project involved surveying the existing literature to determine the current state of research in this area, developing a conceptual foundation for the system, designing and implementing a prototype, and then experimenting to test the quality of the design and implementation.

The project has demonstrated the technical feasibility using a PDA to provide a GPS-enabled Smart-Map for trampers, and has established that it is possible to implement a usable interface for such a device in the space available on a 50mm x 70mm touch-screen without resorting to the use of hardware keys.

Chapter 2

Related Work

This is not the first project intended for use by a person on foot; it is not even the first attempt to use a PDA as an electronic tour guide. To benefit from the experience of others, it is important to see how others have addressed the issues that arise when designing this type of device. This chapter raises the issues that need to be addressed by such a device and discusses how others have addressed those issues.

2.1 DESIGN CONSIDERATIONS FOR MOBILE INTERFACES

This device is meant to be easy to use and quick to learn; there are several design factors that strongly affect a mobile user's ability to learn and use a device.

SIMPLICITY

One factor that has a strong negative impact on the ability of the user to quickly learn and use a novel device is the actual number of user-accessible features. Since each feature requires its own interface component and each interface component requires display space; as the number of features increase, so does the visual and actual complexity of the interface. For example, McGrenere (2002) found that increasing the number of features on offer in an interface has a negative effect on the user's initial experience. An interface that offered only those features that were desired by a user was significantly easier for novice users to learn. When the users in McGrenere's study were required to use a 'full-featured' interface after using their own 'essentials' interface for one month, they experienced a marked decrease in their ability to navigate within the application. In addition, their sense of control of the application and even their confidence in their own ability to learn the features of the application showed a marked decrease. This result is supported in later work by Shneiderman (2003) and Findlater (2007) who recommend a multilayered interface which offers a 'training-wheels' interface (Carroll 1990) to begin with and then adds more features as the user progresses. A multilayered interface is a good way to manage the apparent complexity of a device; it can also provide for the needs of intermediate and advanced users (Constantine 1994). However, to retain an uncluttered, easy-to-use interface for all users, it will be important to keep a tight rein on the number of features on offer in the device. Each feature will need to demonstrate that it is worthy of the demands that it will make on the interface and the user before it is added to the feature list.

TARGET SIZE AND SELECTION

Another usability factor for the mobile user is the actual size of the interface targets. Parhi (2006) recommends that for use with a direct touch selection method

“target sizes should be at least 9.2 mm for single-target tasks and 9.6 mm for multi-target tasks...”

This area, approximately one centimetre square, has been referred to as a Parhi-box.

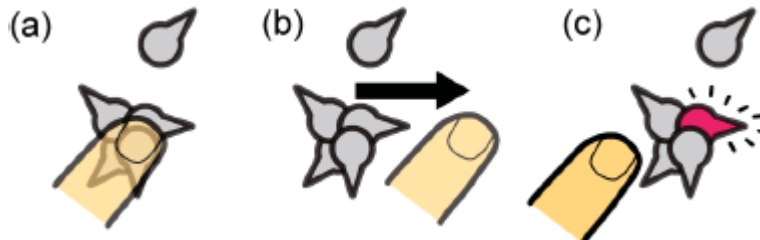


FIGURE 2-1 - ESCAPE TARGET SELECTION TECHNIQUE

- (a) *The user presses their thumb near the desired target.*
- (b) *The user gestures in the direction indicated by the target.*
- (c) *The target is selected, despite several nearby distracters.*

Later work suggests that more than one target may be allowed within a Parhi-box if unique directional gestures are required to select a target as in the Escape method which is illustrated in Figure 2-1 (Yatani et al. 2008). Also smaller targets may be used if methods such as TapTap or MagStick are employed (Roudaut et al. 2008). While these more sophisticated selection methods allow high target density, they are not as intuitive as the direct-touch method.

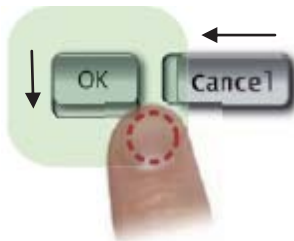


FIGURE 2-2 - AREA SELECTION WITH SLIDING WIDGETS

If the contact point is considered as the centre of a contact area of arbitrary size (dotted circle), the effective width of the control is increased by the same extent (shaded region). Here the detent below the ‘Ok’ button indicates that it is activated by a touch followed by a downward slide. In the same way, the detent to the left of the ‘Cancel’ button indicates that it is activated by a touch followed by a slide to the left.

Figure 2-2 illustrates a promising method suggested by Moscovich (2009) which he refers to as area-selection-with-sliding-widgets. Here the finger contact is seen as an area rather than as a point. This allows the visual aspect of the target to be smaller than a Parhi-box while continuing to provide a convenient selection area. One positive effect is that it increases the effective width of the target without requiring the targets to be spaced farther apart. According to Fitts’s Law, close spacing and wide targets improve accuracy and speed. It also lets the user avoid occluding the target during selection by allowing them to touch below and/or to the side of the target. More than one target may seem to be

selected but the choice is disambiguated by a slide in any one of four directions, not unlike Escape (Figure 2-1). With the area selection method (Figure 2-2), visual cues such as detents can be used to help novice users to learn the interface. Also, the length of the confirming slide may be arbitrarily increased to ensure that the selections are deliberate. This feature may be particularly useful with a mobile device to avoid accidental activation of a feature while the device is being carried or being placed in or removed from a rucksack.

It is important to note that the location of the target on the display is also a factor in usability. The location affects the perceived convenience as well as the accuracy of target-selection by the user. Park (2008) has found that targets that are away from the edge of the display seemed more convenient to touch. Counter-intuitively, users were actually more accurate when touching targets near the side of the display. It may be that, at the edge, the display bezel acts as a 'backstop' to assist accurate finger placement.

MOBILE DESIGN PATTERNS

The user requires timely feedback from the UI to assure them that the device is functioning properly and is working on accomplishing whatever the user has requested. This feedback can be as simple as an interface element changing colour when it is selected or a 'busy' animation. Whenever it is likely that a process will require a perceivable amount of time to complete it is suggested that the user be informed of what is happening and be provided with some indication of progress (Flaminco 2009).

As discussed in Chapter 3 Section 3.7, this backcountry tour guide supports several different user-tasks. One task allows the user to browse through the track and interest point information that is stored on the device even though they are not actually near a track. Another task allows the user to inform the device about themselves and their intended trek. Still another task monitors their progress on a trek and informs them about points of interest in their immediate vicinity. These tasks appear as different screens that offer functionality that is appropriate to each task. The problem will be switching between screens both automatically and manually while assuring the user that the task being switched from is still available as well as providing a sense of the context in which the new task is operating. Nokia (2009) has presented several potentially useful screen transition ideas one of which is Slide-Away. Here one screen remains stable in the background while the image of another screen covers or reveals the background screen. This provides the impression that the background function is always present even while it is hidden; not unlike the sun behind the clouds. Another idea is Zoom-In and Zoom-Out. Here the active screen appears to expand from or collapse to an icon. This provides the impression of the one function arising out of another and would be very good for revealing the context of sub-modes. Still another idea is Fade-In and Fade-Out. Here one screen fades away while another fades in to replace it. This gives the impression of one function replacing the other. The last transition suggested by Nokia is Push-In and Push-Out. Here the incoming and outgoing screens appear to be locked together side-by-side. One screen slides in as the other slides out.

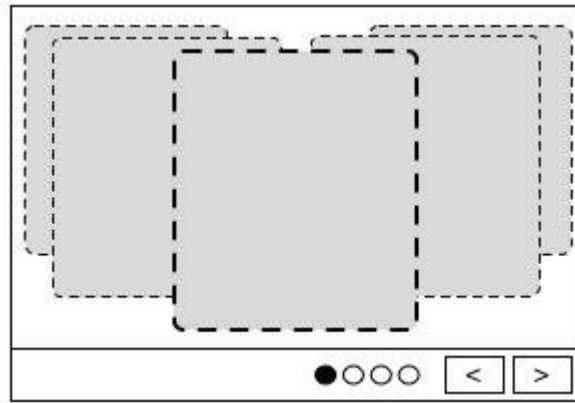


FIGURE 2-3 YAHOO CAROUSEL

Yahoo (2009) suggests the Carousel pattern shown in Figure 2-3 which provides a wider view of the current screen's context.

Either the Push-In/Push-Out or Carousel pattern would provide a natural transition if a swiping gesture were to be used as the command to change screens. The Carousel pattern would allow the user to move between several panels arranged horizontally. Perhaps one of these patterns could be extended to accommodate an array of panels arranged both horizontally and vertically. Our choice of screen transitions will depend on the sense of context that we wish to impress on the user.

There are design patterns currently in use with active maps, such as Google Maps and on-road GPS units. I will discuss those as I discuss the issues that arise with smart-maps.

2.2 SMART-MAP ISSUES

From the user's point of view, a smart-map will be the centerpiece of this device. The smart-map is the user's primary source of information about their current location, their position in relation to points of interest, and the time and distance from their current location to points of interest as well as to the ends of the track. It needs to provide that information without being a distraction, hindrance or frustration to the user. There are several issues that the design of a smart-map needs to address.

MAP STORAGE

The first issue is the form of the map itself. In what manner should the features of interest in the terrain be represented and stored. Two common ways to store the details of a map are in vector or raster form. The vector form is the most memory efficient and, since the visual display is calculated as it is displayed, the level of detail that is shown can be adjusted to suit the scale at which the map is displayed. If the vector data is provided in three dimensions, the map can appear to be tilted and rotated to match the user's perspective. Alternatively, raster images require much less computational effort to display. One drawback of raster images is that they use memory less efficiently. This could be a significant problem because mobile devices are often short on working memory. However, since mobile devices often come with generous amounts of static memory which may be used to store those maps that are not in current use, raster images can be used effectively. The simplicity of use and the speed of display of raster

images are reflected in the fact that all four of the devices that I studied in detail used maps stored in raster form (Abowd et al. 1997; Ohshima et al. 2003; Simcock et al. 2003; Vaittien et al. 2008). Abowd (1997) and his team did consider using a vector-based map but rejected the idea because of the extra computational load that the generation of the map display would have placed on the device.

If a bitmap is used to store the map, it needs to be accurately drawn to scale to allow the GPS position to be shown at the correct location (Abowd et al. 1997). Simcock (2003) also mentions the importance of correctly scaling each element of the map.

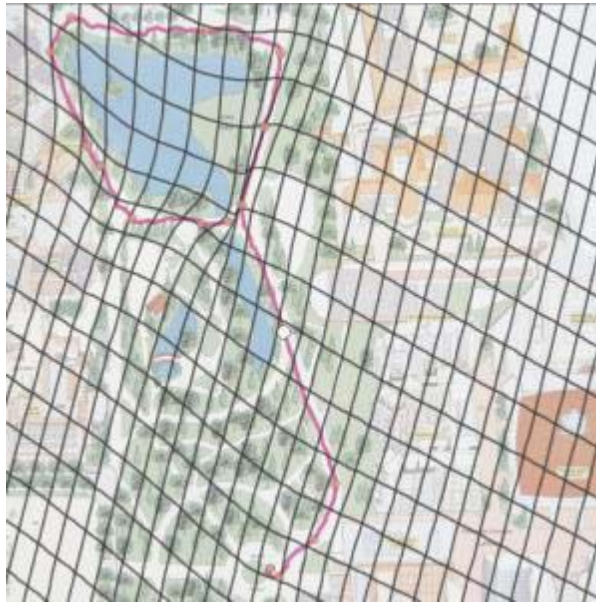


FIGURE 2-4 - RBM DISTORTION GRID

Radial Basis Mapping registers the GPS coordinates corresponding to a subset of the pixels on a map to generate the distortion grid that is used to interpolate the position of other GPS coordinates.

Choudary (2008) did find a way to use Radial Basis Mapping to compensate for the distortions in a hand drawn map but his superior math skills may have overwhelmed his common sense. Correcting and redrawing the base map that was used may have initially required more effort but it would have eliminated the need for the device to continually calculate corrections. Figure 2-4 shows a RBM distortion grid overlaid on a hand drawn map. The grid is not displayed during normal use.

Having the orientation of the map match the orientation of the user in the real world improves navigational accuracy while minimising cognitive effort but Abowd's team (1997) abandoned the feature due to the amount of computation required to rotate the bitmap for display. The difficulty in implementing this feature may be one reason that none of the other devices in my study rotated their maps. It is just as well since, with a palm-sized device, Seager (2007) found that having the users turn the device to match the displayed map to their surroundings was the method most preferred by the users and the least mentally taxing.

MAP SIZE VS. DISPLAY SIZE

Another significant issue is the relative size difference between the map, already a highly stylised and reduced version of the landscape, and the display. If a map of an area that could be covered in a day's walk must fit entirely on the device's display, the map's scale and detail would need to be so severely reduced that it would be of little use or interest. There are several design patterns to address this issue including zooming, panning, and focus+context (Flaminco 2009; Cockburn et al. 2008).

PANNING

Panning is commonly used to allow a map that is larger than the display to be shown one section at a time. To maintain context, panning relies on the user's ability to stitch together an overview of the map from their memory of the various sections that they have seen (Cockburn et al. 2008). Flaminco (2009) advocates *modeless panning* using a touch-and-slide movement anywhere in the map. When implementing the interface for panning, there are two things to consider; what is the user apparently touching and how does the image respond to the finger slide? One idea is that the user's view is through a window over the map and it seems that they slide the window rather than the map. Another idea is that the user is actually touching and sliding the map; as they do, more of the map is pulled into view. Vaittien (2008) and his team found that sliding the map seemed most natural and intuitive. However, they also found that the touch-and-slides intended for panning were easily confused with the touches or touch-and-slides intended for other purposes. They did not suggest a solution to their dilemma. However, I believe that their fundamental error was allowing too many touch-screen functions to be active in an area at the same time. Their experience warns me that the touch-screen functions must be carefully considered and managed to avoid such conflicts. Touch functionality must be considered as a whole and not in an ad hoc, piecemeal manner.

ZOOMING

Both Flaminco (2009) and Cockburn (2008) suggest zooming as another method to help the user see detail in context. Even if users are able to quickly pan to any location on a map, unless they are able to see large portions of the map at once, it is difficult for them to gain an overall sense of their location and of the map as a whole. The problem is that, when the map is scaled so that the user can see the map as a whole, the finer details are obscured and, when the map is scaled to show details, the wider context is lost. Zooming in allows the user to quickly change the scale of the display of the map to show some finer detail while they still retain some memory of that detail's position in the context of the wider area. Conversely, zooming out allows the user to see where the detail on the map lies in relation to the wider area. At its best, zooming should be as intuitive and quick as leaning in to read the fine print on a map and then stepping back to see the entire map. With electronic maps, there needs to be some mechanism to trigger the zoom feature; leaning in and stepping back are not currently recognized as command actions.

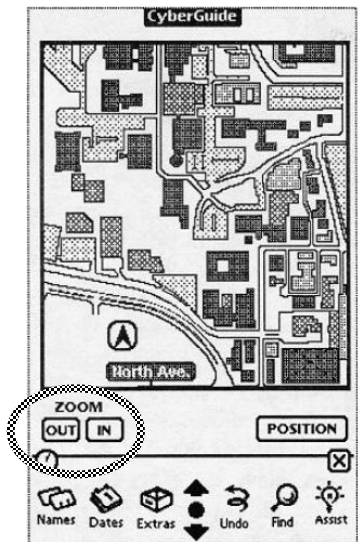


FIGURE 2-5 CYBERGUIDE - URBAN MAP



FIGURE 2-6 KUUKKELI - MAP

Common zoom widgets.

CyberGuide - zoom buttons at lower left consume significant dedicated screen real estate.

Kuukkeli – zoom slider at right consumes even more.

On existing applications, zooming is often activated by virtual buttons (such as a plus or zoom-in button and a minus or zoom-out button) or by a slider. Figure 2-5 shows a typical zoom button interface at the lower left and Figure 2-6 shows a typical zoom slider on the right. Both zoom interfaces consume significant screen real estate.

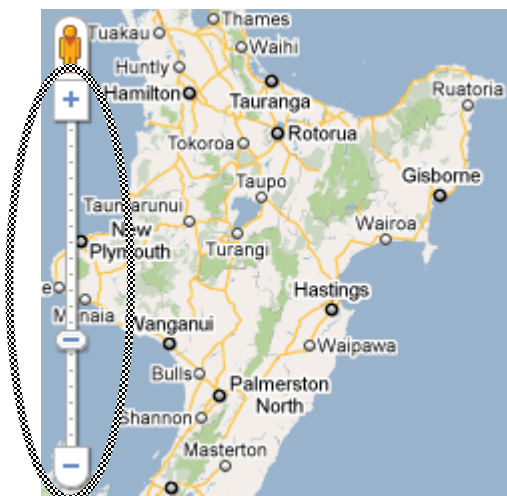


FIGURE 2-7 GOOGLE MAPS - COMBINATION ZOOM WIDGET

Google Maps – Combining zoom buttons with a zoom slider and incorporating the widget at the left of the map. The user is free to use either the buttons or the slider and the real estate devoted to the widget does not affect the screen size of the map.

It is interesting to note that Google Maps (2010) combines these two ideas with zoom buttons at either end of their zoom slider. Figure 2-7 shows how they incorporated the zoom widget with the map which allows the map to be larger on screen. Other methods have been proposed for activating zoom, such as the rub-tap gesture suggested by Olwal (2008). The rub gesture involves sliding back and forth once or twice with the same start and end points. A rub that begins in a downward direction could signal a

zoom-out. A rub that begins in an upward direction could signal a zoom-in. The starting point of the rub could be used as the centre of the new display. Signalling a zoom in this way would have the advantage of not requiring any screen space for a zoom widget. The disadvantage is that there is no visual cue that the feature is available. Plus/minus buttons and zoom sliders seem to be the most common widgets and as such are likely to be familiar to new users. Using one of these widgets for activating zoom should help reduce the learning that is required of a new user before they activate the the zoom feature.

If a bitmap is used, there is an issue with matching the level of detail in the image with the apparent scale of the display when the image is zoomed. For example, small text that is easily legible on one scale quickly becomes illegible as the scale is reduced. Other fine details, such as grid and contour lines, show a similar effect. One way to deal with this is to limit zooming and then set the detail level to suit the smallest zoom scale as Abowd (1997) did with the CyberGuide. Another way is to have a separate bitmap for each scale as Vaittien (2008) did with the Kuukkeli. Having a separate bitmap for each scale may have been a contributing factor to Vaittien’s decision to only provide three zoom-levels. With just three zoom-levels, Vaittien (2008) reported that one user complained about the map being either too large or too small.

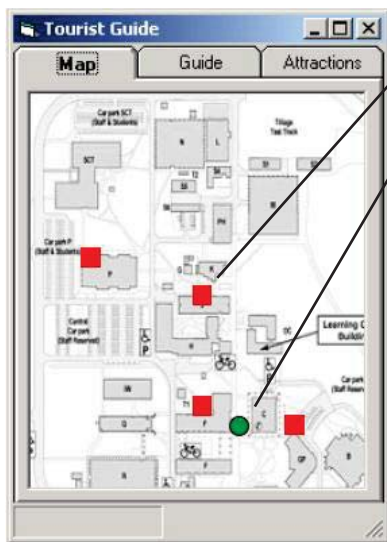


FIGURE 2-8 TOURIST GUIDE – MAP

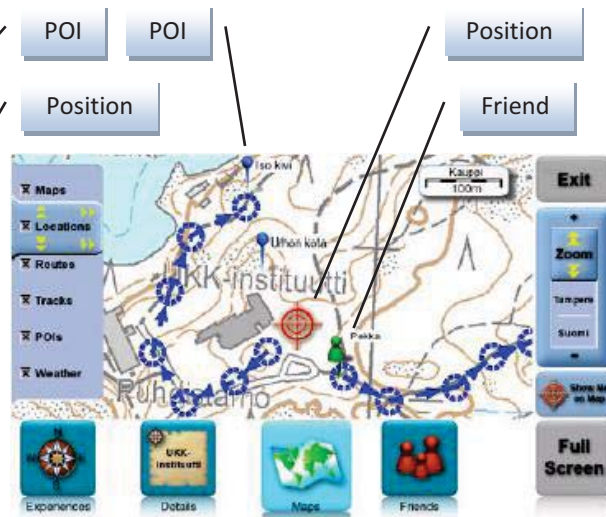


FIGURE 2-9 KUUKKELI - MAP

Maps using bitmap backgrounds with simple icons drawn on the foreground.

One other method uses a hybrid raster/vector approach; the map is stored as a bitmap but the embellishments are drawn with vector data. This allows some of the details of the display to be adapted to the scale of the map without incurring the cost of calculating the image of the entire map. Figure 2-8 shows how the Points of Interest were indicated by simple red squares on the Tourist Guide (Simcock et al. 2003) and Figure 2-9 shows how the Kuukkeli (Vaittien et al. 2008) used a relatively simple raster image of the map as a background and drew the points of interest, user location, and other embellishments as foreground layers at display time. This multi-layer approach is recommended by Aaltomen (2005) as well. As the computational power of the target device allows, additional details could be included in this scheme. For example place names could be displayed or hidden dynamically; at

lower zoom settings, only major place names might be shown while at higher zoom settings, minor place names could be shown as well.

DISTORTION ORIENTATED DISPLAY



FIGURE 2-10 AUSTRALIA ON A FRUSTUM

A fairly detailed view of a mythical city on the East coast of Australia shown in the context of the whole country without losing any detail at the edge of the magnified area.

One example of the focus and context principle (Flaminco 2009) is the distortion-oriented display. Anderson (1996) suggests implementing a distortion-oriented display by projecting the map onto a frustum. Figure 2-10 shows how the overall map is continually displayed to provide context while a highly detailed view of a small portion is displayed at its correct location without losing any of the detail at the edge of the magnified area, as occurs with other distortion-oriented magnifiers.

CURRENT POSITION

We want to provide the user with an accurate indication of their current position on the track. One method would be to show a very tiny dot at the user's location. That would be accurate but a tiny dot is easily missed. Each device in my study uses a different icon to indicate the user's current position.

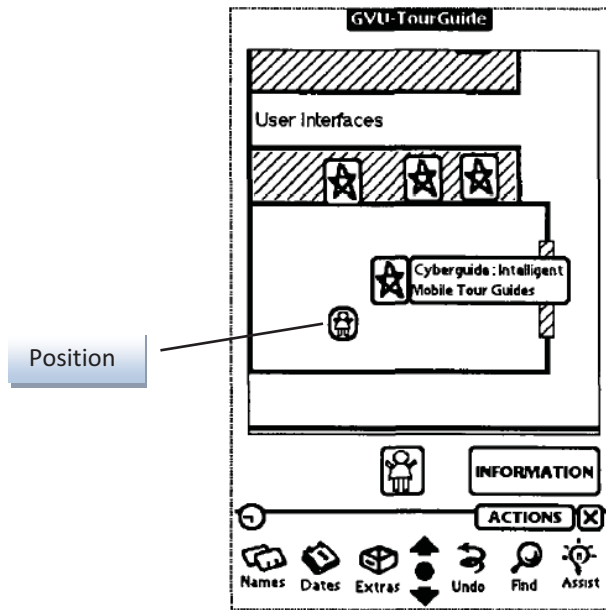


FIGURE 2-11 CYBERGUIDE – INDOOR MAP

The CyberGuide position icon.

Some are anthropomorphic like the simple drawing of a person in Figure 2-11 (Abowd et al. 1997). Some projects used simple geometric shapes like the green dot in Figure 2-8 (Simcock et al. 2003), the triangle used by Aaltonen (2005) or the circle used by Fukatsu (1998). Figure 2-9 shows the targeting icon that Vaittäinen (2008) used. In these projects, there was no discussion concerning how well any of these icons were perceived by users. Since the test users had little or no prior experience with devices that indicate their current position, it seems that they tended to accept whatever icon was used. Since no particular icon for indicating a person’s position has been established as a standard, we are free to choose an icon that we believe best suits the needs of our users. I would look for one that covers enough screen area to be easily found, provides a relatively precise indication of position and, obscures as little as possible of the underlying map. Something that performs at least as well as the targeting icon on the Kuukkeli would be ideal.

TIME AND DISTANCE

We also want to provide the user with a reliable indication of the time it should take them to reach any point of interest on the track as well as an accurate reading of the track distance to that point. These features are often found on navigational aids. As the industry standard for off-road use, Garmin provides the straight-line distance between any two points on a map as well as the time and distance from any point on a recorded track to the end of that track (Garmin 2010). There seems to be little specific research on the best way to display time and distance information. However, we can refer to established mobile patterns that suggest using a compact style in pop-ups that display data only when requested (Flaminco 2009).

Another shortcoming for the Garmin is that the time it gives for a recorded track is the time of the original recording but it does not consider more recent data such as the performance of the current user. So the time value it provides may not match the current user.

2.3 LOCATION-SPECIFIC INFORMATION

One feature that distinguishes an electronic tour guide from other navigational aids is that it provides information that is specific to the user's current location. This information can be relevant text, a photograph or other image, an audio recording of a narrator or animal sound, a video or some suitable combination of these information forms. The key points are that the information is relevant and that it is triggered as the user reaches some specific location. For the devices in this study, this information was typically presented as hyperlinked pages.

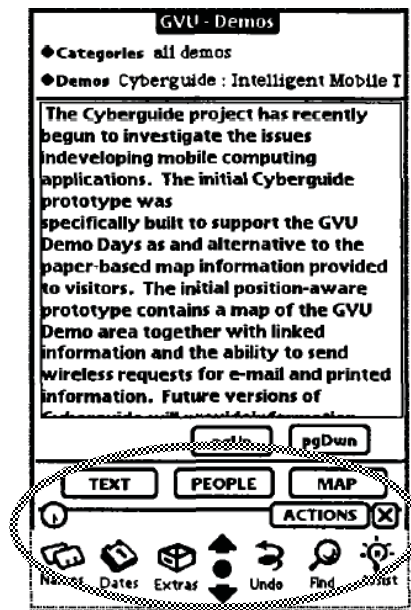


FIGURE 2-12 CYBERGUIDE – INFORMATION

A CyberGuide text-only information page. Note the significant screen real estate devoted to application navigation and other command icons.

Figure 2-12 shows an example of the information-pages from the CyberGuide; they were primarily textual (Abowd et al. 1997).

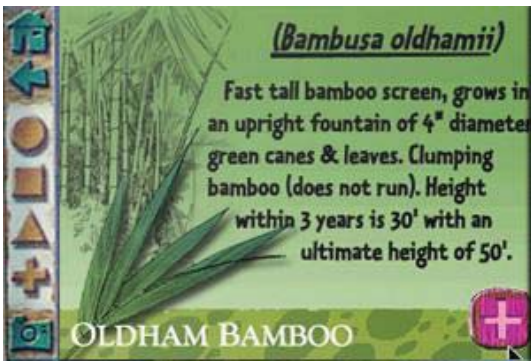


FIGURE 2-13 THE PARKS PDA - BOTANICAL TOUR



FIGURE 2-14 THE PARKS PDA - GUIDE INFO

The designers for the Parks device put artists in charge of the format of the pages.

Figure 2-13 and Figure 2-14 show examples of the graphical information-pages of the Parks device (Ohshima et al. 2003).

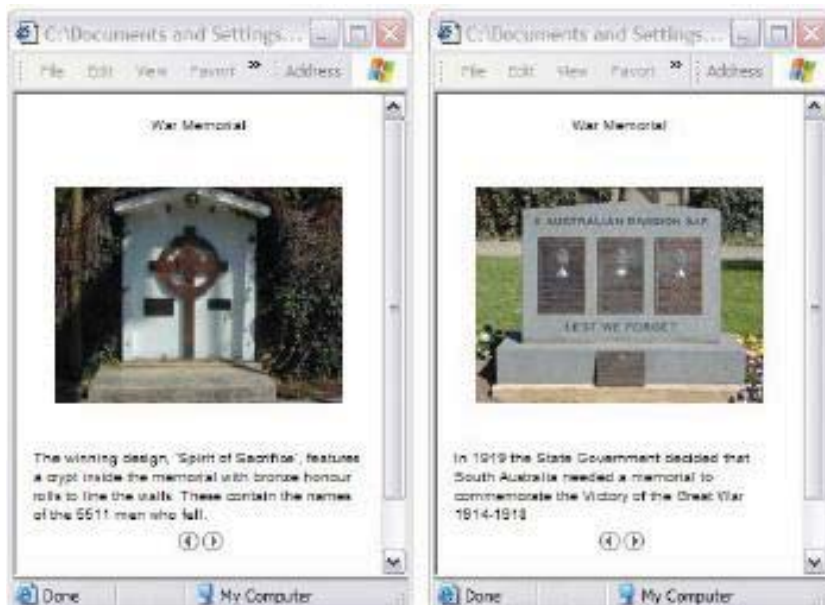


FIGURE 2-15 TOURIST GUIDE – ATTRACTION PAGES

Samples of Tourist Guide attraction pages. HTML file that were viewed in a browser.

Figure 2-15 shows examples of the information-pages (called *attraction pages*) from the Tourist Guide; they were simple HTML pages with photos and text (Simcock et al. 2003).



FIGURE 2-16 POLICE NOTIFICATION WITH POP-UP

A Police Status Pop-Up. The pointer indicates its related information point.

If there is only a small amount of information, Figure 2-16 shows that an information pop-up is sufficient (Streefkerk et al. 2008). This allows the information to be shown along with its proper context on the map.

One way to think about electronic tour guides is that their primary purpose is to be a platform that provides context appropriate information. Presenting relevant information in a high quality compelling format is more important than any navigational assistance that the device may provide. With this paradigm in mind, the designers for the Parks device put artists in charge of the format of the pages and provided them with tools to order and display the pages exactly as they would be ordered and presented on the actual device (Ohshima et al. 2003). This released artists, whose expertise was in the effective use of visual space and colour rather than in programming, to create the information-pages and then immediately validate the overall effectiveness of their content. The result was that the Parks device was the most attractive and least technical in appearance of all of the devices in this review.

BROWSING LOCATION-SPECIFIC INFORMATION

When the user reaches an interest point, we want to display its location-specific information. We also want the user to be able to view that information without actually moving to the interest point. While each device in this study displayed the location-specific information on a screen or pop-up that was separate from the map, they all indicated the location of each point of interest on the map itself. They also allowed the user to display the location-specific information by selecting its icon on the map. We cannot assume that the spacing of the interest points on the terrain will provide adequate spacing on the map for reliable finger activation of the screen targets. It may be that there are even multiple interest points at the same location.

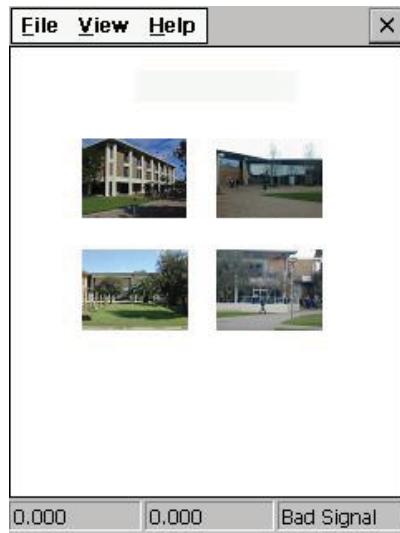


FIGURE 2-17 TOURIST GUIDE - MULTIPLE ATTRACTIONS

When multiple attractions were selected, Tourist Guide showed thumbnail images which allowed the user to clarify their selection.

Figure 2-17 shows how Tourist Guide (Simcock et al. 2003) dealt with overlapping interest points. When the selection was ambiguous, they displayed multiple thumbnails to allow the user to clarify their selection. This avoided the problem of having the device, which does not possess sufficient knowledge of the user's intention, being forced to guess which information point the user desired to see.

2.4 ROUTE SELECTION

If the tour guide has the potential to store and offer information about more than one trail, it requires a feature that allows the users to choose between the trails on offer.



FIGURE 2-18 KUUKKELI - EXPERIENCES

Kuukkeli experience selection screen. Note user mode navigation buttons.

Figure 2-18 shows how Kuukkeli provided that feature by showing the user a list to choose from. The list included a short description as well as the time and status of each trek. The user was also given the opportunity to create and save new treks; this involved selecting a map and setting a series of waypoints upon it. They called the treks, *Experiences* (Vaittien et al. 2008).

Perhaps using the map as a background would provide a better context for route selection. While the list easily supports the selection of a trek from a display of several treks, the list does not provide a visual indication of the general area for the trek. Also, the experience (trek) creation page does not provide for using an existing trek as the basis for creating another trek. Even a minor revision such as changing the direction of the trek, requires the user to start a new experience from scratch.

There are several automated route creation algorithms such as the *multi-rule partial sequenced route* algorithm suggested by Chen (2008) or the *heuristic algorithms* suggested by Kanza (2008). These algorithms involve assigning relative values to visiting each location weighted against the overall distance covered. They even provide a way to insist that certain types of locations are visited in a particular sequence. The algorithms generate good though not necessarily optimum routes. However, given the small number of nodes and limited number of available paths, our users may prefer the direct approach of choosing their own routes. The device could still assist their decision making by providing information concerning the distance and expected time required for any particular portion of the route as well as what points of interest there are on each path.

2.5 NAVIGATING WITHIN THE APPLICATION

The manner in which the device interacts with the user while they remain within any one page or user-task is important. However the overall navigation, the manner in which the user is meant to move between pages and the various functional modes, is important as well. The method used for navigating to and from various functional modes within the application should be as intuitive as possible so that the novice user is not locked on one screen while a feature, that would be of great benefit to them, is on another screen just one unknown touch-screen gesture away. The method used for overall navigation should also consume as little screen area as possible to leave room for the functions and displays the user is most interested in. The projects in this study provide well developed examples of the types of overall navigation that are in common use. Figure 2-12 shows how CyberGuide (Abowd et al. 1997) used virtual buttons, which also took up over thirty percent of the screen. The icons were friendly but their meaning was not always clear though the addition of text was of assistance to English speakers. The icons were also quite detailed for their size, this contributed to a busy and cluttered appearance. Figure 2-18 shows that Kuukkeli (Vaittäinen et al. 2008) used virtual buttons as well but they limited the number to four choices rather than six, this simplified the overall impression of the interface. They ended up using almost half the screen space but, to compensate, there was a full screen toggle that hid most of them while the user was not navigating between functional modes.

A Backcountry Tour Guide

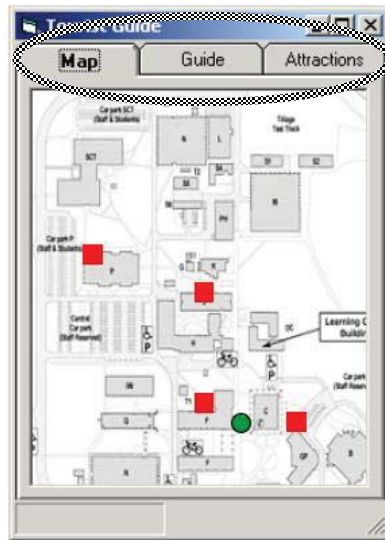


FIGURE 2-19 - TOURIST GUIDE MODE NAVIGATION

Tourist Guide used tabs to allow the user to navigate between three modes.

Tourist Guide (Simcock et al. 2003), as shown in Figure 2-19, used tabs which gave a simpler, cleaner appearance and used much less screen space.



FIGURE 2-20 THE PARKS PDA - HOME PAGE

The Parks PDA used the entire screen for overall navigation when required. Once the navigation was complete, the entire screen was made available to the sub-mode.

The one project that used a fresh idea was the Parks (Figure 2-20); this used dedicated virtual buttons for actions such as Home, Back and Zoom but overall navigation between functional modes was activated by hyperlinked images on the home page. This method consumed the entire home page but it did not use any screen space on the sub-pages (Ohshima et al. 2003). Using the entire screen to good effect while navigating between modes and keeping the navigation method hidden the rest of the time is a good concept to keep in mind as we develop our own design.

2.6 KEEPING IT FRIENDLY

Mobile tour guides are meant to be used as part of a leisure time activity. We want users to be attracted to our device so that they take it up voluntarily and are even prepared to pay for its use. The initial impression engendered by the appearance of the device is critical. Specifically, the device must not look like work. That is, it must not remind the user of work and it must not appear difficult to use.



FIGURE 2-21 THE PARKS PDA - HOME PAGE



FIGURE 2-22 THE PARKS PDA - AREA MAP

The Parks PDA's simple look and feel was made possible by limiting the total functionality of the device and presenting only a few functions at any one time.

The Parks device as seen in Figure 2-20, Figure 2-13, Figure 2-14, Figure 2-21 and Figure 2-22 was the only one in my study that did not look like an ordinary computer application. This was by design not by accident. It was one of their primary design goals. As they stated in their paper (Ohshima et al. 2003),

... we wanted the Parks PDA experience to be primarily graphical. Thus, every page of our content is a full-screen graphic image and every hyper-link is a graphical button. Using pre-rendered, full-screen images gave the artists complete control over the visual experience; there were no tool bars, window, or menus that might remind guests of daily business tools or frustrating computer experiences.

The Parks' design team did not publish the results of their user testing; therefore it is not possible to comment on the user's impression of their overall design. However, I was able to contact them directly and I am grateful to Andy Ogden (2002) for providing a link to his web portfolio that contains more artwork from the device. The colourful, completely custom interface gives me the impression that this is a friendly, simple, potentially useful device.

Chapter 3

Design Criteria

This chapter sets design criteria for the implementation of a device that should achieve the overarching goals for a Trekker's Assistant. These goals have not yet been fully stated in this paper. The thesis statement is informed by these goals but it does not describe them. These goals need to be given before the design criteria are set.

3.1 DESIGN GOALS

- The device should provide information to trekkers concerning the track as well as their status in relation to the track.
 - This is the primary goal of this device.
- The device should allow trekkers to easily communicate their intentions and interests to the device.
 - In order to provide information that is actually of interest to trekkers, the device needs to know which track or tracks they intend to use and which types of information they are interested in. The interface needs to be interactive.
- Novice users should quickly be able to learn how to use the device.
 - Since this device is intended for novice users as well as the more experienced and it will be used without support by people in the field, novice users must quickly learn to use it independently.
- The device should be easy to use.
 - This device is meant to support rather than eclipse the trekking experience. The more time and effort that it requires to operate this device, the less there will be to enjoy the trek.
- The design should be able to be implemented on any suitable platform.
 - Many PDAs, mobile phones and purpose-built navigational aids have built-in GPS capability. These mobile, location-aware devices are able to support the functionality required for this application. If this design is commercially successful, it is expected that it will be implemented on multiple platforms.

3.2 DESIGN CONSIDERATIONS

This device will be primarily used outdoors in lighting conditions that range from direct sunlight to the darkest night. The users may be stationary or even seated but they will often be on their feet and on the move. The combined display and control functions will be provided through a surface whose display visibility is significantly reduced by direct sunlight and whose size is smaller than the typical Post-it™ note.

The following questions were useful in determining effective design criteria. What information would benefit trekkers and what was the best method to convey it to them? What information must be supplied by trekkers to accomplish a certain purpose and how should they provide it? What overall structure for the interface would increase the probability that the functions and information trekkers most need to do and know were the functions and information that were most available?

3.3 ESSENTIAL HARDWARE FEATURES

Since there are several handheld, location-aware devices on the market that are capable of supporting the functionality of this design, it would be inefficient and short-sighted to limit the use of this design by forming the design around features that are unique to any one device. On the other hand, it would limit the functionality of the design to disregard useful features that are commonly available. Consequently, ***this design should use hardware features that are likely to be found on a range of handheld, location aware devices.***

The following is a list of hardware features that are commonly available and are essential to this design. This list may also be used to determine if a device is suited to this design.

The device should:

- allow a third-party program to be installed and run,
- be aware of its geographic location (This supports location-specific actions.),
- be easily held in one hand (This supports convenient mobile use.),
- be able to support a graphical, touch-activated interface,
- have a palm-sized, touch-sensitive screen capable of displaying graphical images in colour,
- have sound output, and
- be able to network with other computers from time to time (This allows the application to be updated and location-specific information to be downloaded for later use.).

These devices may have other hardware features such as an electronic compass or they may even be able to detect their vertical orientation. The design may use these features, if available, but these features should not be made an essential part of the design.

3.4 GPS RELIABILITY

The location-awareness that this design relies on will most likely be provided by GPS. Since the device is mobile, its location may change at any time. Ideally, the device should be able to continuously update its location. The difficulty is that, occasionally, the location information will be unavailable due to the GPS signals being attenuated by terrain or foliage. Consequently, ***the design should gracefully deal with GPS dropouts.***

3.5 NETWORK RELIABILITY

The device will be able to network with other computers but in the backcountry, which is its primary operational environment, wireless data links and cell phone coverage are not always available. Consequently, ***the design should not rely on network connectivity while in the field.***

3.6 DESIGN GUIDELINES FOR RECREATIONAL HANDHELD DEVICES

The primary interface for this device is a 50mm x 70mm touch-screen. An important goal of this project is that the interface be quick to learn and easy to use. The literature review has shown that for an interface to be quick to learn and easy to use it must appear to be simple. A significant number of essential functions have been outlined in previous discussion. The challenge, made even greater by the extremely limited screen space, is to provide all these functions with an uncluttered interface.

Each function should use as little of the screen as possible. The screen is not just a two dimensional resource; Kärkkäinen & Laarni (2002) suggest that time is a factor as well. That is, the amount of screen resource that is used by each function is determined both by the screen area that it uses and the amount of time that it is displayed. Consequently, ***the visual elements of the design should be as small as they can be, while effectively conveying their meaning and serving their function, and should only be displayed when their function is required.***

This device is intended to be used by people who freely choose to use it as part of a recreational activity; using it should not remind them of work. Consequently, ***the design should use interface components that are not likely to remind users of office related applications.***

This device will be viewed in sunlight and shade. In sunlight, colour is lost and images require strong contrast to be seen. However in the shade, colours can be seen and a vibrant colour scheme will give the interface a quality look. Consequently, ***the design should use colour well while maximising effective contrast.***

There is minimal working storage available on the hardware platform. Consequently; ***the software design should employ good object creation and disposal hygiene, and graphical elements should use minimal storage.***

The interface will appear sluggish and unresponsive when the visual response to the user requires a significant amount of calculation to be done or graphics to be drawn. Consequently; ***while the user is manipulating the interface, the design should minimise redraw time and when a perceivable delay remains likely, the design should inform users of its activity*** (Flaminco 2009).

A mobile device may not have an efficient method for text entry. Consequently; ***the design should avoid text entry whenever possible*** (Flaminco 2009).

While in the field, this device may be carried in a backpack or some other general-purpose bag; there it will be subject to physical contact from any direction at time. This means that any action that can be triggered by a single touch or a series of touches on the screen may be triggered unintentionally. Consequently, ***the design should avoid using a single touch or a series of touches at the same screen-point to activate those actions whose inadvertent activation would be problematic.***

3.7 USER-TASKS

One way to minimise the apparent complexity of the interface without actually eliminating functions is to minimise the number of functions on offer at any one time. If the functions are grouped into user-tasks which are done sequentially, only those functions required by the current task need be on offer.

The following usage scenario can be used to provide insight into the user-tasks that should be catered for by the Trekker's Assistant.

Sometime before going on a trek, hypothetical trekkers browse the information stored on a Trekker's Assistant to determine a track or group of tracks that are of interest them and that they will be able to complete in a reasonable amount of time. In order to present information that is of particular interest and provide meaningful time estimates, the Trekker's Assistant will need to know their preferences and their usual walking pace. Having found a suitable area to trek in, the trekkers then plan a specific trek by indicating the track segments that they intend to use as well as the sequence and direction in which they intend to use them. The Trekker's Assistant can then provide them with the total distance of the trek and a good estimate of the time it will require to complete. Once the plan is set, they are free to actually walk the trek while the Trekker's Assistant continuously updates their status regarding the trek with information such as their current position and an updated estimate of their completion time and, as they approach any point of interest, the Trekker's Assistant displays the information that relates to that point.

A review of the above usage scenario reveals that, from the users' perspective, there are six major tasks. The rationale and function of each of those tasks are discussed in the following subsections. Ordinarily, the tasks would be done in sequence with the results of one task being the base for the next. However they are not necessarily performed sequentially and the user may want to return to a previous task for reference or to make changes; where practical, the functionality of all the tasks should be available regardless of which particular task the user is primarily involved in. Consequently, ***the required functionality of the device should be divided into several modular user-tasks and the device should allow the user to move back and forth between those tasks.***

SET TREKKER PROFILE

The traverse time prediction algorithm (Gawith et al. 2009) that is used for this design accommodates a range of walking speeds which can vary significantly. These predictions must be as accurate as possible because they will help the users to choose their route, the distance they will attempt, and their starting time. Consequently, ***the device should provide a set trekker profile task which allows users to indicate their expected walking pace.*** This task does not depend on information from any other task but other tasks depend on information from it. Consequently, ***the device should start-up with the set trekker profile task.***

INDICATE TREKKER INTERESTS

The location-specific information may be grouped according to its type such as *geological*, *botanical*, *zoological* or *amenity*. Furthermore, not every user will be interested in every type of information. Consequently, ***the device should provide an indicate trekker interests task which allows the user to specify the types of information that interest them.***

BROWSING TRACKS

One motivation for taking a trek is the anticipation of seeing the sights along the way. The location-specific information stored on the device is a catalogue of those sights. There may also be information specific to a particular region rather than to a particular location. Regional information concerning prevailing weather patterns, general track conditions, minimum fitness requirements and equipment requirements should all be considered by trekkers as they decide how, when and even if they will attempt a certain trek. In addition to the location and region-specific information, trekkers should also consider the length and expected travel-time of the track as well as its incline as they choose a trek. (This information is provided by the smart-map which is discussed in Section 3.8.) It is important that trekkers have all of the information mentioned in this section before they plan their trek. Consequently, ***the device should provide a browsing tracks task which allows users to view information provided by the smart-map in addition to location-specific and region-specific information even when the device is not located in the vicinity of the track and/or no trek has been planned.*** This task requires information from the *set trekker profile* and *indicate trekker interests* tasks. Consequently, ***the device should present the browsing tracks task only after the trekker's profile and interests have been set.***

PLANNING A TREK

In order to display the status of trekkers in relation to their trek, the device needs to know which tracks they intend to use. In addition to knowing the tracks of interest, the device needs to know the sequence and direction that the tracks will be traversed. Travel time, finish time and distance are three pieces of information that trekkers use to help them decide what they will attempt to cover on a trek and when they should start. Once trekkers have indicated the sequence and direction that the tracks will be traversed (the walking pace has already been estimated based on the trekker's profile and the characteristics of the track), the distance and time for the trek can be determined. However in order for the device to provide a meaningful estimate for the finish time, trekkers must provide an estimated start time. Consequently, ***the device should provide a planning a trek task which allows the user to indicate the sequence and direction that the tracks will be trekked along with an estimated start time.*** This task requires information from the *set trekker profile* and *indicate trekker interests* tasks. Consequently, ***the device should present the planning a trek task only after the trekker's profile and interests have been set.***

TREKKING

This task requires a preset plan and an active GPS. Consequently, ***the device should present the trekking task only after a plan has been set and should insure that the GPS is active as the task is begun.***

Trekkers need to know their current position in relation to their chosen track so that they can compare their current position to their desired position and take appropriate action to keep from going too far off track. Consequently, ***during ‘trekking’, the device should indicate the trekker’s location.*** If trekkers do go off-track it is likely that the safest route back to the track is to retrace their steps. Consequently, ***during ‘trekking’, the device should indicate the history of the trekker’s location.*** When trekkers are not making progress on their planned trek, whether they are taking a rest stop or have gone off on some unplanned side-trip or for any other reason, this non-progress time adds directly to the overall trek-time. If trekkers are aware of their non-progress time versus their progress time, they can make informed decisions about future non-progress time. Consequently, ***during ‘trekking’, the device should indicate the history of the trekker’s progress and non-progress times.*** Decisions that trekkers make about when and where to rest are also affected by their perceived proximity (both in distance and time) to desirable resting spots, points of interest, amenities and their final destination. Consequently, ***during ‘trekking’; the device should indicate the distance and time from the trekker’s location to other locations of significance.*** Initially, time estimates are based on the expected pace provided by the user as part of their profile. However, “Past behaviour predicts future behaviour.” (Ouellette & Wood 1998). Consequently, ***during ‘trekking’, all time estimates should be based on the user’s observed walking pace.***

One of the features of this device is that it provides location-specific information. If this information is provided when trekkers are actually at the location in question, it should increase the trekkers’ sense of involvement with their surroundings, engage their mind, and make the whole trek seem more worthwhile. Consequently, ***during ‘trekking’, the device should cause information that is of interest to appear spontaneously as the trekker approaches the location to which it relates.***

VIEWING LOCATION-SPECIFIC AND REGION-SPECIFIC INFORMATION

Viewing location-specific and region-specific Information (*viewing information*) is a sub-task that may occur as part of the *browsing tracks*, *planning a trek* and *trekking* tasks. This information is a major component of the track information that is referred to by the primary goal in Section 3.1. The ability of users to view this information at its best advantage is critical to their use and appreciation of this information. Consequently, ***the device should display location-specific and region-specific information in the largest format that can be supported by the device.***

CHANGING THE ACTIVE TASK

Switching between tasks will be a common action and will likely be one of the most common actions done by the user. While *browsing tracks* and while *trekking*, users will likely switch back from the information screen to the map screen at least once for every item of location-specific information on each track. Consequently, ***the device should allow the user to switch between tasks quickly and easily.***

GENERAL STRUCTURE OF THE USER-TASKS

The six major user-tasks for this device can be divided into three categories, Setup tasks (*set trekker profile* and *indicate trekker interests*), Trek-Related tasks (*browsing tracks*, *planning a trek* and *trekking*) and an Information viewing task (*viewing information*). The Trek-Related tasks all incorporate the smart-map and rely on the Setup tasks as well as each other for their function. These three tasks also have a sequential relationship; generally the user will browse one or more tracks before planning a trek and a trek must be planned before it is trekked. If these tasks are first grouped according to type then arranged sequentially, they form a two dimensional grid like the one shown in Figure 3-1. The third column in that sketch, Information, represents the *viewing information* task which can be considered a sub-task of the three Trek-Related tasks; users only view location-specific and region-specific information when they are in a Trek-Related task. Even though *viewing information* is only one user-task, it is shown three times in Figure 3-1 to illustrate that switching from *viewing information* always returns users to their current Trek-Related task.

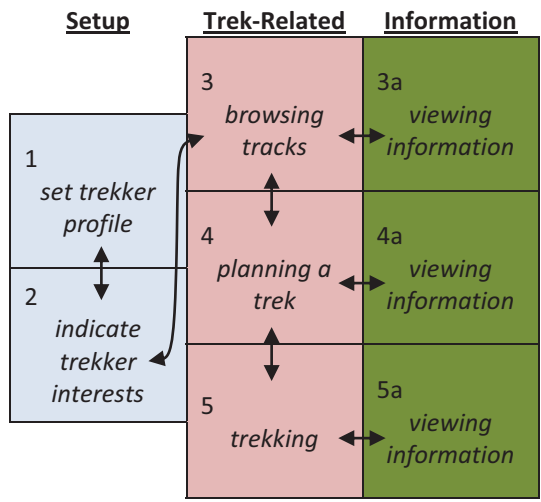


FIGURE 3-1 – 2D TASK LAYOUT

The numbering in Figure 3-1 illustrates the expected sequence of tasks that the user will perform. The arrows illustrate the context of each task.

The two dimensional grid shown in Figure 3-1 illustrates the context of the tasks. A good mental model of the context of the tasks will assist users as they learn and use this device. Consequently, **the device should support the user’s development of a good mental model of the context of each task.**

3.8 SMART-MAP ISSUES

A LARGE MAP IN A SMALL WINDOW

As discussed in Chapter 2, Section 2.2, a useful map of the trek area will be too large to display in its entirety. Two methods mentioned in that section, panning and zooming, are commonly used with digital maps. These two methods, when used in tandem, effectively address the ‘Large Map – Small Window’ issue. Since they are in common use, they also have the advantage that a novice user of this device will probably have some prior experience using them. This experience will help them quickly learn to use

these methods on this device. Consequently, ***the device should enable the user to zoom the map.*** *Modeless panning* (Flaminco 2009), panning by touching-and-sliding anywhere on the map without first entering a special interface state, makes the panning function most accessible. If they happen to touch the display, novice users may even discover the panning function by accident. Panning allows the user to view any region of the map that is of interest to them. However there is also a case for automatically panning the map while the user is trekking. During 'trekking', the trekkers' current location is the main focus for the device. If the map tends to pan to the current location, it will contribute to the trekkers' sense of progress and make it easier for them to find their location on the map. Since the trekkers' location, in terms of the map, will change very slowly, automatic panning can also be done quite slowly and still keep up with changes in the trekkers' location. If automatic panning is done slowly enough, trekkers will still be able to pan to and observe any region on the map before the region-of-interest moves off the screen. Consequently, ***the device should enable the user to modelessly pan the map.*** ***During 'trekking', the device should also, over time, centre the map at the trekker's current location.***

REVEALING TRACK INCLINE

Uphill tracks as well as downhill tracks require more effort to travel than do level ones, the steeper the track the greater the effect. Trekkers make route and pace decisions based upon the track's incline (direction and steepness of slope).

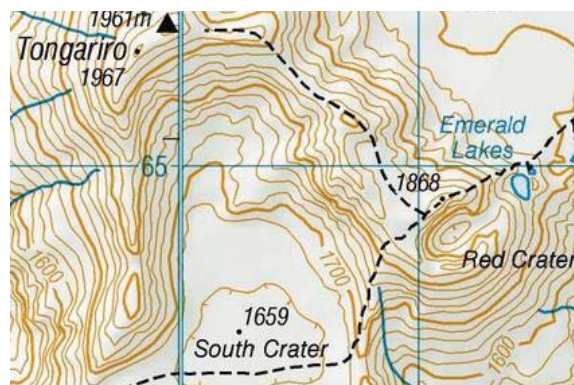


FIGURE 3-2 CONTOUR MAP

It would therefore be helpful if the device could indicate the track's incline. There are two standard approaches to this. One way, like the example in Figure 3-2 (Land Information New Zealand 2010), is to decorate a plan view of the terrain with contour lines (often coupled with relief shading).

A Backcountry Tour Guide

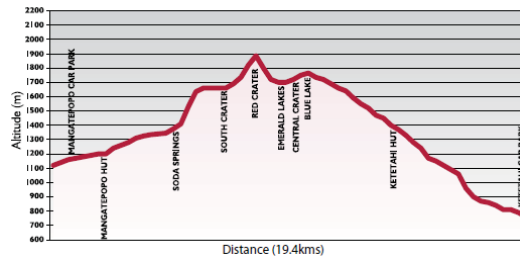


FIGURE 3-3 TONGARIRO PROFILE

Another approach, like the example in Figure 3-3 (Department of Conservation 2010), is to show an elevation profile of the path through the terrain. The latter approach is less general, because it is only valid for a particular path across the terrain; each path will have its own unique set of elevations. However with smart-maps, this is not a problem; the three dimensional data required to create these profiles is already part of the track data.

In the context of a device intended for use by first-time trekkers, the first approach is less appealing. Contour lines are a fairly abstract representation of elevation, and it requires good visuospatial ability and practice to convert patterns of contour lines into an image of bluffs, ravines and other three-dimensional landscape features (Underwood 1981) and then to trace the track through this mental image to determine the track's incline.

Conversely, the second approach is more appropriate in the context of a smart-map; given that the device knows the track the trekker will be following, and the altitude of the points along the track, it can easily generate an elevation profile of the track like the one shown in Figure 3-3. Also to make fully informed decisions while trekking, trekkers need to know their current location on the profile. Consequently, ***if a trek is planned, the device should provide the user with an altitude profile of that trek. During 'trekking', the device should indicate the user's current location on the profile.***

Relating a specific region on the profile to its corresponding region on the map can be useful to trekkers' as they are planning the trek. One example would be when one of two alternative tracks has a gentler profile. Relating the profile to the map also requires good visuospatial ability and would be easier to do if the incline of each portion of the track was indicated on the map as well as the profile. Consequently, ***the device should provide the user with an indication of the track's incline on the map itself.***

TRACK INTERSECTIONS

The ends and the intersections of track segments are points of interest in their own right. Intersections and ends are landmarks that can be used to mark progress and they are often associated with amenities such as water, toilets, huts and car parks. For these reasons, it can be useful to indicate when trekkers will reach these points (Estimated Time of Arrival, ETA), the amount of time it will take to reach them (Estimated Travel Time, ETT), and how far away they are. To answer these questions, the device will need to know which end or intersection is of interest. Consequently, ***the device should indicate the***

location of individual track end-points and intersection-points on the map and make it possible to display information about them.

INFORMATION POINTS

Information points or *Points of Interest* (POI) are also often used to mark progress and often refer to features that are well suited to being used as rest stops such as scenic views, waterfalls, streams, picnic tables and huts. The information related to POI can assist trekkers in planning their anticipated rest stops, choosing the track that will best suit their purpose, and they may even help motivate potential trekkers to do the trek. Therefore, indicating the location of the information points on the map will assist trekkers with making informed choices as they plan. During 'trekking', the device can also provide time and distance information, which trekkers can use to make informed decisions about when and where to rest. Consequently, ***the device should indicate the location of points of interest on the map and allow users to view information that is related to whichever point they may choose. During 'trekking', the design should also provide distance, ETT and ETA information for points that are viewed.***

The design has no way to limit the number of information points or ensure a minimum spacing for them on the map. In fact, information points may be co-located. Consequently, ***the device should gracefully handle the selection of multiple points of interest and allow users to disambiguate any ambiguous selections.***

3.9 OVERALL EFFECT

This chapter has discussed the various functions of this device; what they are, what benefit they may be to users, and how they may be grouped into tasks. The overall effect of this design must also support the goals that have been set for this device. However clever the functions, however cleverly they are implemented, this device will not be used if it does not appear as accessible to the user. Visually, the overall design needs to be simple. The functions need to be simple to activate. The information provided by this device must be presented simply. Simplicity appears accessible to a potential user. Simplicity can be compactly displayed. Simplicity is easy to learn and use. Consequently, ***all aspects of the interface should be designed to be as simple as possible, consistent with their purpose.***

3.10 CRITERIA BY USER-TASKS

To provide a compact reference centre for the criteria they are organised here into categories according to the area of the design they most impact upon.

GENERAL

1. *all aspects of the interface should be designed to be as simple as possible, consistent with their purpose*
2. *this design should use hardware features that are likely to be found on a range of handheld, location aware devices*
3. *the design should not rely on network connectivity while in the field*
4. *the visual elements of the design should be as small as they can be, while effectively conveying their meaning and serving their function, and should only be displayed when their function is required*
5. *the design should use interface components that are not likely to remind users of office related applications*
6. *the design should use colour well while maximising effective contrast*
7. *the software design should employ good object creation and disposal hygiene, and graphical elements should use minimal storage*
8. *while the user is manipulating the interface, the design should minimise redraw time and when a perceivable delay remains likely, the design should inform users of its activity*
9. *the design should avoid using a single touch or a series of touches at the same screen-point to activate those actions whose inadvertent activation would be problematic*

TASK SWITCHING

10. *the required functionality of the device should be divided into several modular user-tasks and the device should allow the user to move back and forth between those tasks*
11. *the device should allow the user to switch between tasks quickly and easily*
12. *the device should support the user's development of a good mental model of the context of each task*

SET TREKKER PROFILE

13. *the device should start-up with the set trekker profile task*
14. *the device should provide a set trekker profile task which allows users to indicate their expected walking pace*
15. *the design should avoid text entry whenever possible*

INDICATE TREKKER INTERESTS

16. *the device should provide an indicate trekker interests task which allows the user to specify the types of information that interest them*

SMART-MAP

17. *the device should enable the user to zoom the map*
18. *the device should enable the user to modelessly pan the map. During 'trekking', the device should also, over time, centre the map at the trekker's current location*
19. *if a trek is planned, the device should provide the user with an altitude profile of that trek. During 'trekking', the device should indicate the user's current location on the profile*
20. *the device should provide the user with an indication of the track's incline on the map itself*
21. *the device should indicate the location of individual track end-points and intersection-points on the map and make it possible to display information about them*
22. *the device should indicate the location of points of interest on the map and allow users to view information that is related to whichever point they may choose. During 'trekking', the design should also provide distance, ETT and ETA information for points that are viewed*
23. *the device should gracefully handle the selection of multiple points of interest and allow users to disambiguate any ambiguous selections*

BROWSING TRACKS

24. *the device should provide a browsing tracks task which allows users to view information provided by the smart-map in addition to location-specific and region-specific information even when the device is not located in the vicinity of the track and/or no trek has been planned*
25. *the device should present the browsing tracks task only after the trekker's profile and interests have been set*

PLANNING A TREK

26. *the device should provide a planning a trek task which allows the user to indicate the sequence and direction that the tracks will be trekked along with an estimated start time*
27. *the device should present the planning a trek task only after the trekker's profile and interests have been set*

TREKKING

28. *the design should gracefully deal with GPS dropouts*
29. *the device should present the trekking task only after a plan has been set and should insure that the GPS is active as the task is begun*
30. *during 'trekking', the device should indicate the trekker's location*
31. *during 'trekking', the device should indicate the history of the trekker's location*
32. *during 'trekking', the device should indicate the history of the trekker's progress and non-progress times*
33. *during 'trekking'; the device should indicate the distance and time from the trekker's location to other locations of significance*
34. *during 'trekking', all time estimates should be based on the user's observed walking pace*
35. *during 'trekking', the device should cause information that is of interest to appear spontaneously as the trekker approaches the location to which it relates*

VIEWING INFORMATION

36. *the device should display location-specific and region-specific information in the largest format that can be supported by the device*

Chapter 4

Implementation

The design may be implemented on any of several mobile, GPS-aware platforms. This includes devices with operating systems by Apple, Java, Android and Microsoft. The devices that were available to use with this project were the HP iPAQ 5710 and the Getac PS535F. Both are GPS-aware PDAs with 50 mm x 70 mm touch sensitive screens. Both screens use resistive rather than capacitive touch technology; as such they respond better to contact with hard implements such as a stylus or a fingernail rather than a fingertip. Both have Windows Mobile as their operating system; the HP has version 5.5 and the Getac has version 6.1. The difference in versions was not an issue in this project. The Getac also has an internal compass and camera but the Trekker's Assistant does not use them¹. The one difference that did have an effect on the implementation was that the Getac's screen resolution is 480 x 640 while the HP's resolution is 240 x 320; this meant that the pixel sizes for objects on the screen needed to be defined in terms of percentage of screen size rather than assigned a fixed number of pixels. Both devices have a working storage of just 128 MB which requires that memory usage be minimal and efficient. Both devices have USB connectivity and were given a generous amount (2 GB) of static storage; these allowed the map images along with the track and point information to be quickly downloaded from a laptop or desktop before setting out on treks.

4.1 FILE STORAGE

The GPS coordinates for each waypoint and each information point are stored in comma-delimited CSV files; one for each track section. Each information point in the track file refers to an HTML file that, when viewed in a browser, provides information about the point in the form of text, images and audio. The track and information files were generated using pre-existing software and devices that are outside the scope of this project. These files are stored on the device in a predictable folder structure to facilitate automatic retrieval by the software. The map images are stored in a folder structure that is based on their relationship to each other; each map's folder is stored as a subfolder of its containing area. The names and resolution of the map images along with their area name, location and extent are stored in GPX files. The GPX schema (GPX Developers Forum 2004) is well suited to link files with metadata that includes their GPS coordinates.

4.2 DEVELOPMENT PLATFORM

C# with .NET 3.5 was used as the programming language and Visual Studio 2008 was used as the IDE. The standard version of .NET 3.5 comes with a good graphics library but the graphics functionality for the

¹ Criterion 2 - *this design should use hardware features that are likely to be found on a range of handheld, location aware devices*

mobile version is significantly reduced to minimise memory usage. Additional classes were created using compact.NET, to support desirable features such as transparent backgrounds for bitmaps and controls. Not drawing their backgrounds, allowed the controls to have rounded corners which gave them a non-standard look² and minimised the amount of display space they consumed on the screen³. The technique that .NET uses to draw controls causes trouble when drawing screens that include these transparent controls. Since .NET expects that controls will draw their own background, it does not draw any portion of the screen that the controls' background would cover if it were drawn. Since the transparent controls do not draw their background, this leaves gaps in the display. To overcome this, each time the screen is drawn the controls with transparency are temporarily hidden while the rest of the display is drawn. The controls with transparency are then unhidden and drawn.

4.3 SMART-MAP DEVELOPMENT

The smart-map provides the trekker their position and status on the trek; it also shows the location of track-ends and information points. It is always visible, at least in part, during the *browsing tracks*, *planning a trek*, and *trekking* tasks.

REVEALING TRACK CONTOURS

The smart-map is required to show the vertical contour (the steepness and the direction of the slope) of the track in two ways.

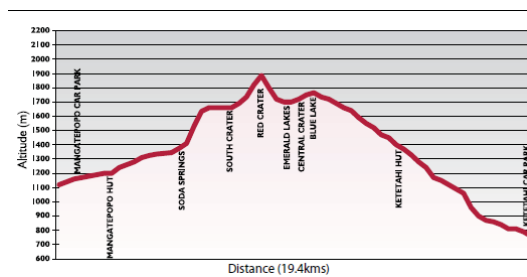


FIGURE 4-1 TONGARIRO PROFILE, LANDSCAPE

Actual size on screen of Tongariro profile in landscape mode at a scaling ratio of 6/1.

The first way of showing vertical contour is with a track profile⁴ like the one of the Tongariro Crossing (Department of Conservation 2009b) shown in Figure 4-1. With most tracks, the horizontal distances involved are much larger than the vertical distances. To compensate, the vertical scales on profiles are often exaggerated. Here the scaling ratio is approximately 6/1. If the ratio is too exaggerated, the user can get quite a distorted impression of the steepness of the track.

² Criterion 5 - *the design should use interface components that are not likely to remind users of office related applications*

³ Criterion 4 - *the visual elements of the design should be as small as they can be, while effectively conveying their meaning and serving their function, and should only be displayed when their function is required*

⁴ Criterion 19 - *if a trek is planned, the device should provide the user with an altitude profile of that trek. During 'trekking', the device should indicate the user's current location on the profile*

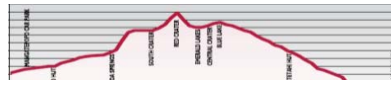


FIGURE 4-2 TONGARIRO PROFILE, PORTRAIT

Actual screen size of Tongariro profile sized to fit in portrait mode. The scaling ratio is 4/1

It may be good to use the same aspect ratio for every track so that when tracks are compared the impression of the steepness each track is consistent. Comparing the profile in Figure 4-2 with the first profile illustrates the effect; both are the same profile with the first at a scaling ratio of 6/1 and the second at a 4/1 scaling ratio. The second profile seems less daunting even though it is of the same track as the first. As implemented, the vertical scale of the profile was set to maximise the verticality of each track while remaining within the vertical limits of the display and the horizontal scale was set to maximise the horizontal representation of the trek while remaining within the horizontal limits of the display. Consequently, the scaling ratio for a track is not constant but is affected by the total length and altitude range of the trek that is planned.

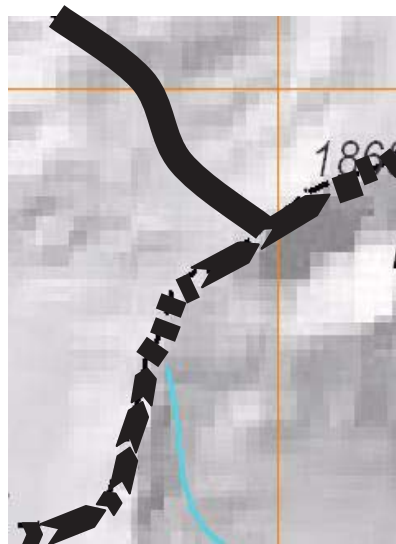


FIGURE 4-3 TRACK CONTOUR, TRACK INTERRUPTED

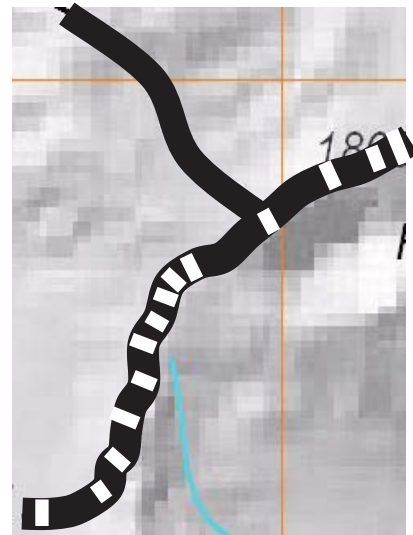


FIGURE 4-4 TRACK WITH CONTOUR LINES

Track contour indicated by interruptions or by lines

The second way of showing the vertical contour of the track is on the map itself⁵. Several methods were explored. Figure 4-3 shows the effect of introducing a gap in the track line at every contour line with the longer sections being shown as an arrows pointing in the 'up' direction. This causes the flatter parts of the track to consist of long, uninterrupted lines while the steeper parts consist of a series of short dashes. Figure 4-4 shows the effect of having stripes at the contour lines instead. This gives a less cluttered image but there is no indication of slope-direction.

⁵ Criterion 20 - *the device should provide the user with an indication of the track's incline on the map itself*

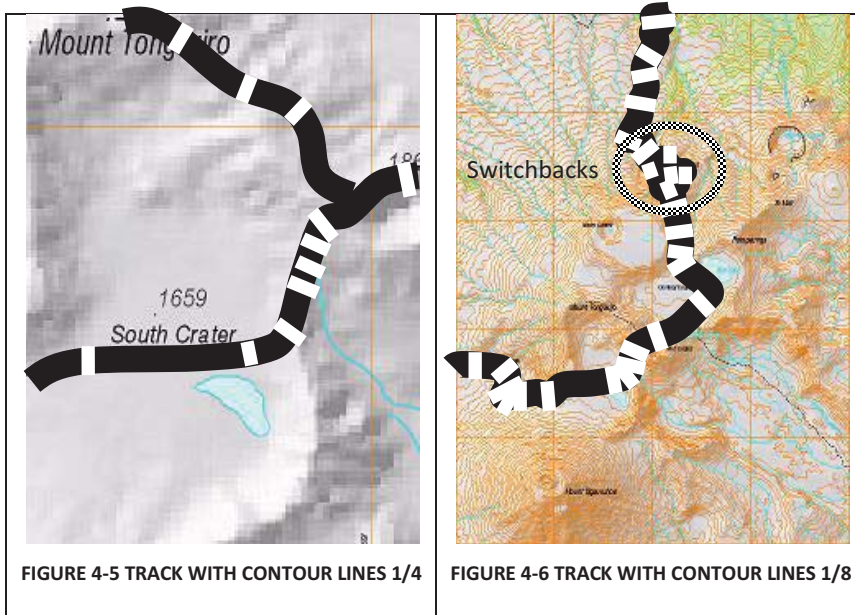


FIGURE 4-5 TRACK WITH CONTOUR LINES 1/4

FIGURE 4-6 TRACK WITH CONTOUR LINES 1/8

*Track contour at 1/4 scale and at 1/8 scale.
Note the loss of coherency when the track does switchbacks.*

Figure 4-5 and Figure 4-6 show the same area at one-fourth and one-eighth of the scale of Figure 4-4 respectively. The vertical offset that is represented by each contour line is adapted to suit the scale of the underlying map. These views appear to be quite promising but it is apparent in the part of Figure 4-6 that includes switchbacks, the lines overlap awkwardly and the display becomes chaotic.



FIGURE 4-7 TRACK CIRCLES

*Circles are well spaced at the bottom where the track is flat
and overlapping towards the right where it is steeper.
It is also apparent that, from left to right, the track is gaining altitude.*

In spite of this problem, the idea of using short segments of track line to indicate steep parts of the track looked promising, and a direction-insensitive modification was developed. This used circles, capitalising on the fact that circles join or overlap neatly at any angle. Figure 4-7 shows a track which is marked by circles which are filled with a contrasting colour and whose spacing is related to the slope of the track. The circles are at maximum spacing where the track is flat and overlapping where the track is steep. If discs (circles whose interior is filled with the same colour as their perimeter) are used, there is an indication of steepness of slope, but no indication of direction. However, when circles filled with a contrasting colour are drawn in order of increasing altitude, they assume the appearance of a stairway, indicating both the direction and the steepness of the slope. From an implementation point of view there is a further advantage; circles do not require any angle or orientation to be calculated before they are drawn.



FIGURE 4-8 - SOUTH CRATER AS IMPLEMENTED, CIRCLES INDICATE BOTH STEEPNESS AND DIRECTION OF SLOPE

Figure 4-8 shows the track markers as implemented and tested; this is the same section of track as Figure 4-7. The circles' spacing was increased to make the screen seem less cluttered; then a line was added to provide visual continuity for the track. The width of the connecting line as well as the width and spacing of the circles are calculated in terms of screen pixels to keep their screen-size and –density constant regardless of zoom level. With this implementation, the circles do not correspond to any particular contour lines on the map; in practice, this has not been found to cause any problems.

TRACK INTERSECTIONS



FIGURE 4-9 DOTTED INTERSECTIONS



FIGURE 4-10 LARGE DOT INTERSECTIONS

*Dotted intersections allow the tracks to intersect at any angle.
Large dots smooth the overall image while continuing to provide a selection target.*

The smart-map needs to indicate the track-ends and track-intersections⁶. The intersections will be selection points for track-time and track-distance queries as well as information points in their own right. Again, since circular icons join or overlap nicely at any angle (as illustrated in Figure 4-9 and Figure 4-10), solid-filled discs were used for the track-ends and track-intersections. In the implementation that was tested, a large cyan disc was chosen for this purpose.

⁶ Criterion 21 - *the device should indicate the location of individual track end-points and intersection-points on the map and make it possible to display information about them*

INFORMATION POINTS



FIGURE 4-11 INFORMATION POINTS



FIGURE 4-12 INFORMATION POP-UPS

Touching an information point icon should bring up an information point pop-up which includes time and distance information.

Two pop-ups, with alternative time formats, are shown; the upper pop-up displays minutes while the lower pop-up displays decimal hours.

The smart-map needs to show the location of any information points on the track as well as be able to preview the information for any specific point⁷. To accomplish this, we considered an 'Info' icon like the ones in Figure 4-11 at or near their related location on the map. When the user tapped an information point, 'info' pop-ups would appear like the ones shown in Figure 4-12. During trekking, when the information was available, these pop-ups included the distance and estimated travel time (ETT) to the point as well as an estimated time of arrival (ETA). These pop-ups are shown with two different ETT formats, one for minutes and another for decimal hours. Note the compact layout of the information in the pop-ups, which is provided by using a single space rather than a tab between distance and time, as per Flaminco (2009).

⁷ Criterion 22 - *the device should indicate the location of points of interest on the map and allow users to view information that is related to whichever point they may choose. During 'trekking', the design should also provide distance, ETT and ETA information for points that are viewed*

OVERLAPPING INFORMATION POINTS



FIGURE 4-13 AGGREGATING OVERLAPPING POINTS

Tapping the 'super' info box would reveal its contents.

Tapping on the name of a specific information point would reveal its details.

To accomplish the goals of de-cluttering the screen and dealing with any overlapping information points⁸, one method that was considered was to aggregate several points that were near-neighbours into 'super' info boxes as illustrated in Figure 4-13. When the 'super' box was tapped, the names of the information points that had been aggregated were shown. If any one of those names were then tapped, that particular info pop-up was shown. This scheme is similar to the one used by Simcock (2003).

Another method that was considered was to allow the information points to overlap and to display pop-ups for all the information points within a certain radius of a tap. The user could then, by moving and/or dismissing unwanted pop-ups, be able to choose the specific information point they desired. While this method does not de-clutter the screen, it is more consistent than the previous one since all information icons relate to one and only one information point; it is also much easier to implement.

⁸ Criterion 23 - *the device should gracefully handle the selection of multiple points of interest and allow users to disambiguate any ambiguous selections*

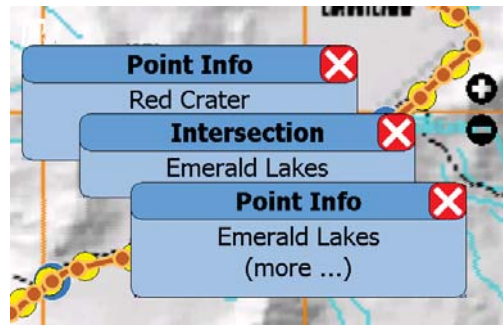
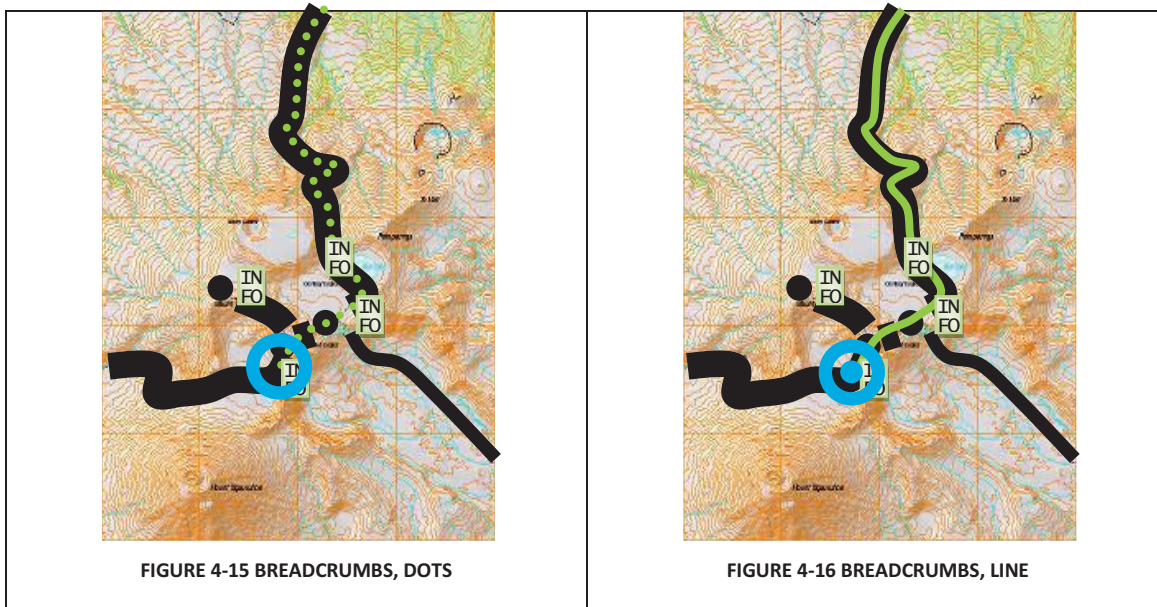


FIGURE 4-14 - MULTIPLE POP-UPS

Figure 4-14 shows the method that was implemented and tested; if multiple points are within a certain radius of a tap, multiple pop-ups are arranged in a cascade and displayed so that users can dismiss the points they are not interested in and display more from the ones they are interested in.

BREADCRUMBS & CURRENT POSITION



*Trekker's progress as indicated by a string of dots or a thin line.
A large circle/target is showing both position and GPS status.*

The smart-map needs to show trekkers their current position⁹ as well as where they have been¹⁰. To do this, a selection of different position markers and 'breadcrumbs' were considered. Figure 4-15 and Figure 4-16 illustrate how the current position on the track could be shown by a position marker and how the position-history could be shown by a trail of dots of a size smaller than the track or as a thinner line. The position marker could also change to indicate the status of the GPS¹¹ by blinking when the GPS was attempting to acquire a fix and then going solid when a fix was acquired. A central dot or cross could indicate an excellent fix.

⁹ Criterion 30 - *during 'trekking', the device should indicate the trekker's location*

¹⁰ Criterion 31 - *during 'trekking', the device should indicate the history of the trekker's location*

¹¹ Criterion 28 - *the design should gracefully deal with GPS dropouts*

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FIGURE 4-17 - POSITION MARKERS AS IMPLEMENTED

Figure 4-17 shows the position markers that were implemented and tested; the small black dots are the 'breadcrumbs' showing where trekkers have been and the large triangle indicates their current position. The large triangle was used because it was visually simple and was reminiscent of the large arrows that are commonly used to indicate the location of stationary maps that are often installed at trailheads. The indicator was made large so that it would be easily spotted by the trekkers; its interior was left empty to minimise occlusion of the underlying map. The triangle is not displayed when the GPS signal is not usable, it is yellow when the signal is weak, and it is green when the signal is strong.

INDICATING A TREKKER'S PROGRESS

The smart-map needs to let trekkers know how far they've come¹⁰, how far they have yet to travel¹², what portion of their day has been spent walking and how much has been spent resting¹³ and, how much time will it take to finish their trek¹². There also needs to be a way for trekkers to know if their ETA drifts past some limit. The three displays that follow are attempts to show all this information in an accessible format that uses the least display space. They show the progress for a trek at about noon. They indicate the progress so far as well as what portion of the morning was spent moving or stopped. The estimated time of arrival is about 4PM and the trek needs to be completed by 4:30PM.

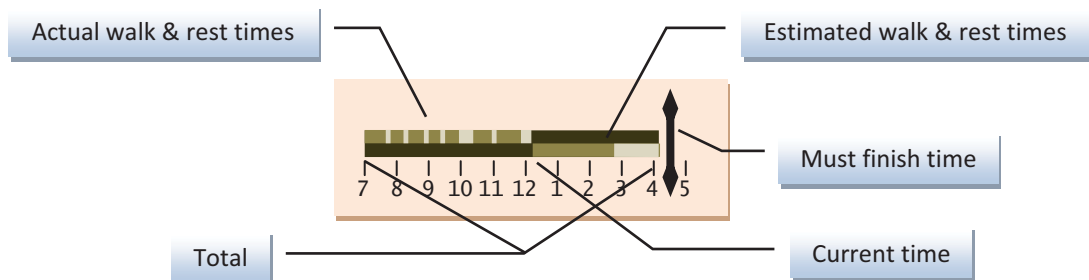


FIGURE 4-18 - PROGRESS, DETAIL TREK/REST TIME

This progress bar shows the trekking and resting times in detail.

Figure 4-18 shows the total trek time (actual plus estimated) as the darkest bar. On that bar and to the left, the actual times spent trekking are shown slightly lighter and the times spent resting are shown lighter still. The estimated times, both trekking and resting, are indicated to the right of the bar with colours that match those that were used for the actual times. The hours of the day are indicated by numerals and the warning time is indicated by a double headed staff.

¹² Criterion 33 - *during 'trekking'; the device should indicate the distance and time from the trekker's location to other locations of significance*

¹³ Criterion 32 *during 'trekking', the device should indicate the history of the trekker's progress and non-progress times*

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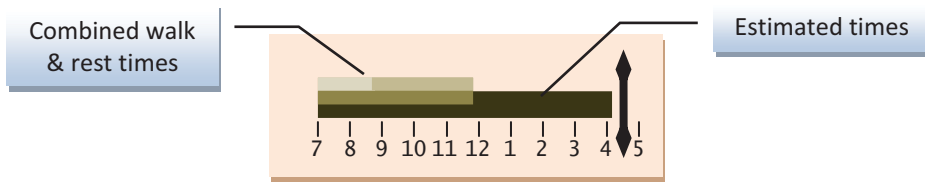


FIGURE 4-19 PROGRESS, COMBINED TREK/REST TIME

This progress bar combines the trekking and resting times.

Figure 4-19 shows a progress bar which is simplified by combining the trekking and resting time into two bars and eliminating the trekking and resting details for the estimated time.

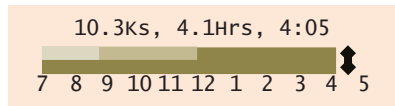


FIGURE 4-20 PROGRESS, TEXT ETE ETA

This progress bar is the most compact but it includes the distance to finish which is not shown by the first two. It also shows ETT and ETA with a greater precision than the user could expect to read from the analogue scales.

Figure 4-20 further compresses the progress bar but adds textual representations of distance, ETT, and ETA. The text provides more precision than the user could read from the analogue scales. This last progress bar uses very little screen area and can accommodate a trek that is up to 12 hours long. If the bar could be scrolled from side to side, longer treks could be shown.

THE COMBINED EFFECT



FIGURE 4-21 CONCEPT VIEW

Simple concept view; map, profile, progress.

Figure 4-21 shows an image that combines these views into a display that a trekker might see as they walk along. This view incorporates the profile and the progress bar on the same screen as the map along with zoom buttons. The trekker will likely want the ability to hide the Progress Bar and the Profile to further simplify the display. While clean and simple, this display does not provide information about the

range of altitude for the trek or the actual altitude of any point. Also, except for the beginning and the end, it does not provide information about when the trekker was at any previous point or when they might reach any future point on the trek. Also, with the fixed time scale of the progress bar shown alongside the fixed distance scale of the profile, this display implies that time has a fixed relationship with distance; which is not true. Also from a graphic design perspective, there is no visual distinction between the map, profile and progress displays which present their respective information in very different ways; the profile and progress displays do not have a distinctive background or any visual framing so the map image would interfere with the user's effort to read information from the other two.

Providing the altitude information with useful precision required more display space which led to setting the display to landscape mode. Then the profile and progress displays were combined so that the relationship between time and distance at each point in the trek could be correctly displayed.

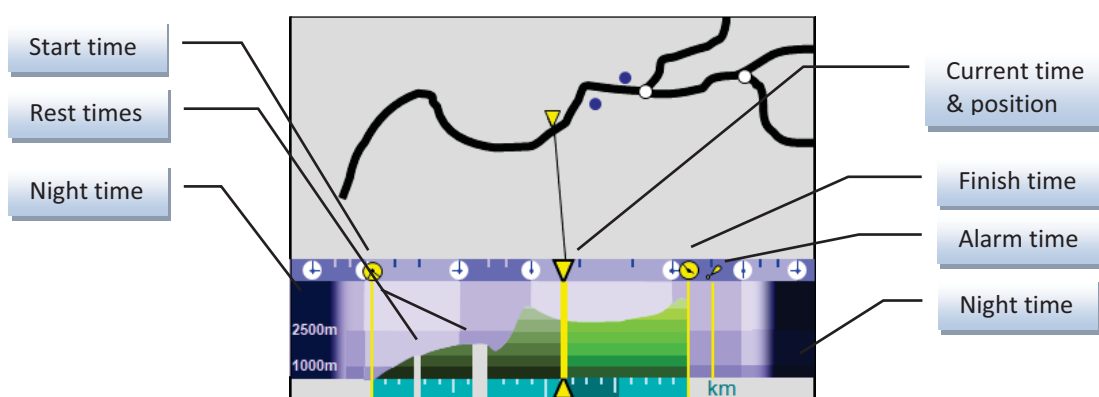


FIGURE 4-22 COMBINED PROGRESS AND PROFILE

The progress bar is combined with the profile to provide a correct impression of distance travelled over time. Since the time scale relates to the distance travelled, it is not expected to be linear in this display. The map is a schematic representation which is intended for illustration only; the Trekker's Assistant uses a topographic map.

Figure 4-22 shows the progress bar combined with the profile and then annotated with time, distance and altitude. The dark bands at either end indicate night time hours. The horizontal banding along with the labels to the left indicate altitude. The central vertical bar indicates the current time and location; this is also related to the trekker's location on the map. The profile to the left of the current time has already been traversed and the profile to the right is still in the future. The distance scale is at the bottom; the gaps in the distance scale and profile relate to rest times when no distance was covered. The time scale, at the top, is marked in one-hour intervals; since the distance scale at the bottom of the progress bar is to scale (except for rest periods), and the trekker's recorded and predicted speed over various types of terrain vary, the time ticks are unevenly spaced. The actual starting time, predicted finishing time and finish-time alarm are also indicated.

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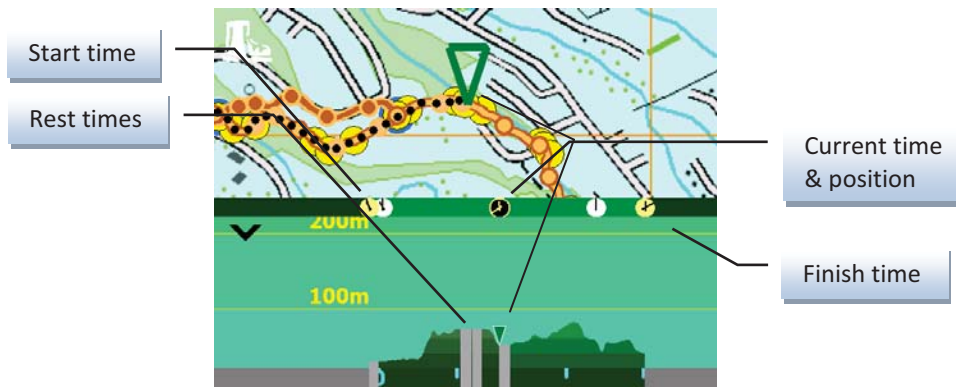


FIGURE 4-23 PROGRESS & PROFILE AS IMPLEMENTED

Figure 4-23 shows the progress/profile bar as it was implemented and tested; it is different from the original concept in several ways. The night-time banding and finish-time alarm were not implemented due to time pressure. The colours used for the altitude banding were chosen for their effectiveness on the devices that were used rather than in print. Lastly, the hourly ticks on the time-bar were eliminated to minimise visual clutter.

When first entering the *planning a trek* task, the trek's start-time is assumed to be the nearest fifteen-minute increment before the current time. Users can adjust the start-time estimate in fifteen-minute intervals by touching-and-dragging in the central area of the progress/profile display. When the trek actually begins, start-time is set to the current time at that moment and then locked.

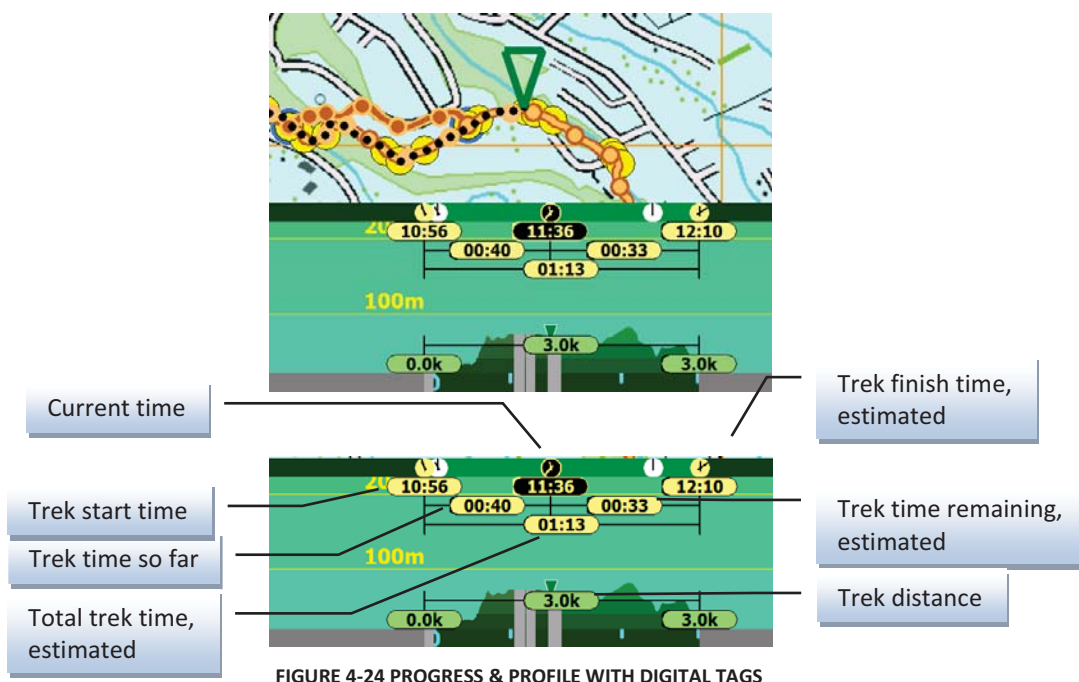


FIGURE 4-24 PROGRESS & PROFILE WITH DIGITAL TAGS

Figure 4-24 shows the textual readouts that appear if the user touches anywhere within the progress/profile display while in the *trekking* task; text allows the information to be read with better precision.

4.4 USER-TASK CONTEXT

The functionality of the device is divided into the tasks suggested in Chapter 3, Section 3.7; they are *set trekker profile*, *indicate trekker interests*, *browsing tracks*, *planning a trek*, *trekking*, and *viewing information*.¹⁴ Task-switching is used to help users develop a good mental model of the context of each task¹⁵, to implement this, the task-prerequisites needed to be well understood and the allowable task-transitions needed to be determined. One prerequisite is that some information about the trekker needs to be set before any trek-related tasks are performed¹⁶. However, if default values are established for all required settings, this criterion does not hamper a novice user from moving straight to *browsing tracks* from *set trekker profile* when the device starts up. Users are still able to set more appropriate values at start-up or any other time if they choose to do so. Allowing this amount of flexibility led to many possible task transitions.

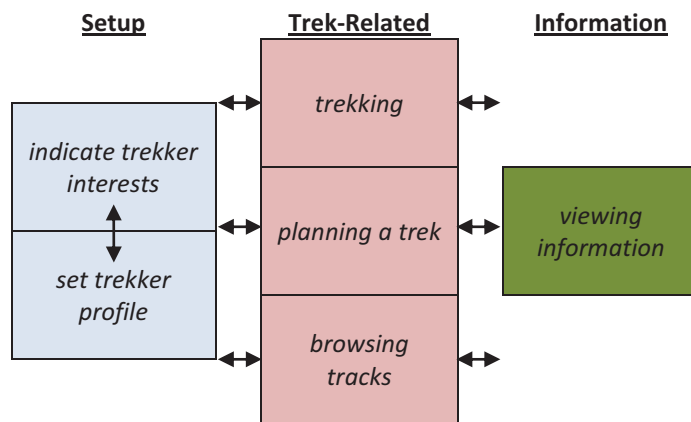


FIGURE 4-25 – POTENTIAL TASK TRANSITIONS

As shown in Figure 4-25, in addition to the Setup and Trek-Related tasks being able to transition to the user-task immediately above or below them within their own column, any Setup task could potentially transition to any Trek-Related task and vice versa. Lastly, Trek-Related tasks would be able to transition to the Information task and back again. Enabling every possible transition whenever it was valid to do so, led to an overwhelming number of possible task-transitions for users to choose from; this made it very difficult for them to keep a sense of context for each task. This complexity was simplified by the idea of keeping track of the ‘task-last-seen’ for each column and allowing inter-column transitions to only be to the ‘task-last-seen’. The task that is active in a column when the user switches to a task in another column is considered to be the first column’s ‘task-last-seen’.

¹⁴ Criterion 10 - *the required functionality of the device should be divided into several modular user-tasks and the device should allow the user to move back and forth between those tasks*

¹⁵ Criterion 12 - *the device should support the user’s development of a good mental model of the context of each task*

¹⁶ Criterion 25 - *the device should present the browsing tracks task only after the trekker’s profile and interests have been set*

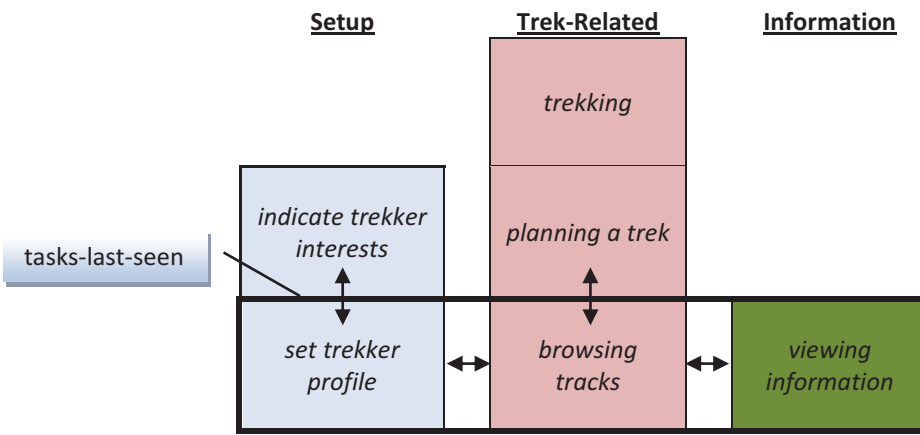


FIGURE 4-26 –TASK LAST SEEN

Figure 4-26 shows the task context at start-up and illustrates how only allowing inter-column transitions that are to a ‘task-last-seen’, reduces the number of potential transitions which makes it easier for users to keep track of each task’s context. Incidentally, there is no functional reason to forbid direct transitions between the Information and Setup columns; this would allow the user to reach any column by only shifting to the right or to the left. However, implementing transitions between those columns confused users.

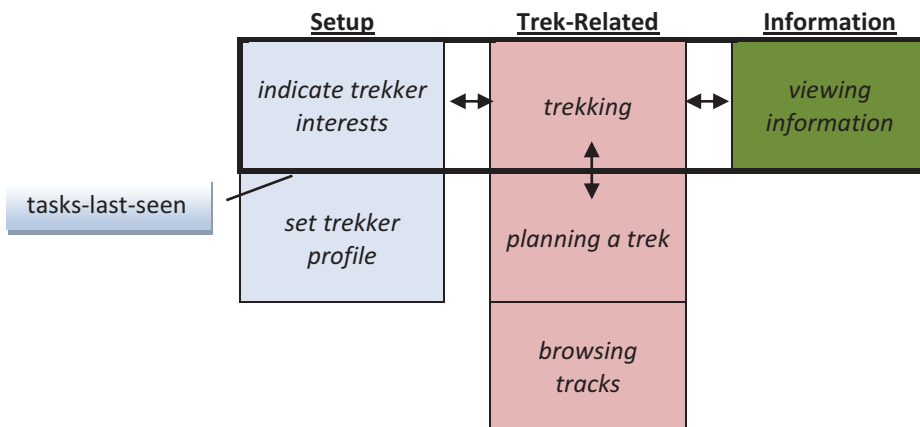


FIGURE 4-27 –TASK CONTEXT DURING TREKKING

Figure 4-27 shows the task context during *trekking*. Since there was a significant overlap in the functionality of the *browsing tracks* and *planning a trek* tasks, one further simplification was made.

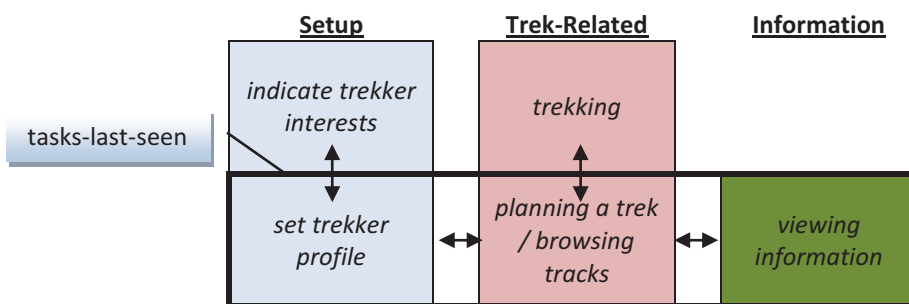


FIGURE 4-28 –TASK LAYOUT AS IMPLEMENTED

Figure 4-28 shows the task layout with the *planning a trek* and *browsing tracks* tasks combined. This was the task layout that was implemented and tested.

4.5 CHANGING THE ACTIVE TASK

Switching between tasks could be accomplished using menu lists on standard menu bars or with tabs as Simcock (2003) did. However, these methods did not satisfy the design criteria since they use a significant amount of screen area¹⁷ and are often used in standard office-related interfaces¹⁸. Since a touch-screen was available, using a touch-and-slide action to accomplish task-switching on the device was considered a good option. Panning would allow users to switch between tasks by using the mechanism of drawing the next task onto the working surface; this should seem easy for them to do¹⁹. However, using the touch-and-slide action for this purpose causes a conflict with another use of the touch-and-slide action. As discussed in Chapter 3, Section 3.8²⁰, the touch-and-slide action is being used to pan the smart-map which is present for all the Trek-Related tasks. The map panning is *modeless*; which means that it is the device's default response to any touch-and-slide action on the map. To avoid this conflict, the device needs to first enter a special task-switching state before users changes tasks; this is activated by tapping a conveniently sized boot icon in the upper left corner of the screen as shown in Figure 4-29. This enables the device to use *modeless panning* for the smart-map, the more common action, while still allowing the use of panning for task-switching (after the user taps the boot icon). Once task-switching is activated, it is done on its own screen. This allows the whole screen to be used while the user is task-switching while minimising the screen real estate that is permanently dedicated to task-switching. This two-step approach also avoids inadvertently activating task-switching²¹.

Task-switching by panning should help the user keep track of the context¹⁵ of each task. The overall interface can be visualized as a set of 50 mm x 70 mm cards with each task presented on its own card. To provide context, these 'task-cards' are laid out on a larger sheet beneath a 50 x 70 window in the rectangular arrangement shown in Figure 4-28. As the array of cards is moved around, the card that is currently visible through the window represents the active task. With this metaphor, the tasks are arranged in a consistent two dimensional arrangement which illustrates their context; their left-to-right, bottom-to-top arrangement reflects their sequential nature.

TASK-SWITCHING MODE

The screen transitions discussed in Chapter 2, Section 2.1 such as Push-In/Out (one screen slides in as another slides out) and Zoom-In/Out (foreground expands from or collapses to a central point) (Nokia 2009) and Carousel (a ring of potential screens rotate until one is chosen) (Yahoo Developer Network

¹⁷ Criterion 4 - *the visual elements of the design should be as small as they can be, while effectively conveying their meaning and serving their function, and should only be displayed when their function is required*

¹⁸ Criterion 5 - *the design should use interface components that are not likely to remind users of office related applications*

¹⁹ Criterion 11 - *the device should allow the user to switch between tasks quickly and easily*

²⁰ Criterion 18 - *the device should enable the user to modelessly pan the map. During 'trekking', the device should also, over time, centre the map at the trekker's current location*

²¹ Criterion 9 - *the design should avoid using a single touch or a series of touches at the same screen-point to activate those actions whose inadvertent activation would be problematic*

2009) were considered and this led to other ideas. The aim was to strengthen the user's sense of context as much as possible.

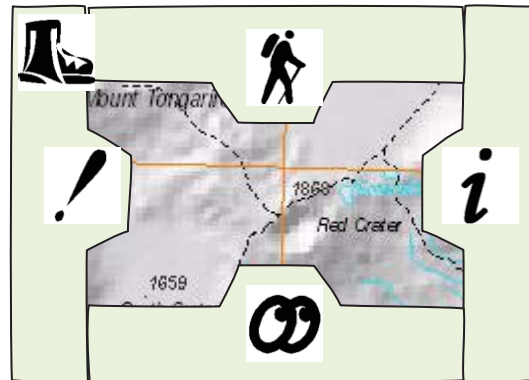


FIGURE 4-29 - PULLTABS

Task-switching with pull-tabs, the boot (upper left) is to initiate or cancel task-switching

One idea was to shrink the display of the current task so that the edges of its neighbouring tasks could be seen. Figure 4-29 shows how pull-tabs with icons were then added to provide a visual cue; the user could pull any one of the adjoining tasks and make it the active task. While experimenting with different amounts of shrinkage, it was discovered that the pull-tabs could be eliminated. If the current and adjoining task displays were shrunk to one third their active sizes, the thumbnail images of the tasks could be used as the task-switching targets.

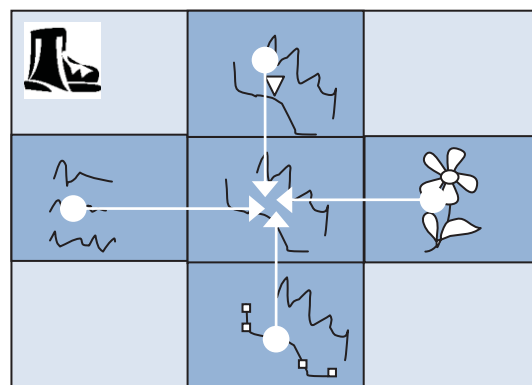


FIGURE 4-30 - THUMBNAILS

Task-switching with thumbnails, white arrows indicate permissible movement

Figure 4-30 shows how the thumbnail images are used as the pull-tabs; whichever image is dragged to the centre becomes the active task. Once task-switching has been initiated, the user can drag a thumbnail either vertically or horizontally; the relative magnitudes of the vertical and horizontal components of that first drag is used to determine which axis is active. To insure that all movement intersects the centre of the screen, once a dominate axis is determined, any movement on the sub-dominate axis is ignored until the user's finger is lifted. The icons that were developed for the pull-tabs were then added to the thumbnails to provide more information about the purpose of each task-thumbnail. The sense of context is further enhanced by smoothing the visual transitions as the images are zoomed in or out.

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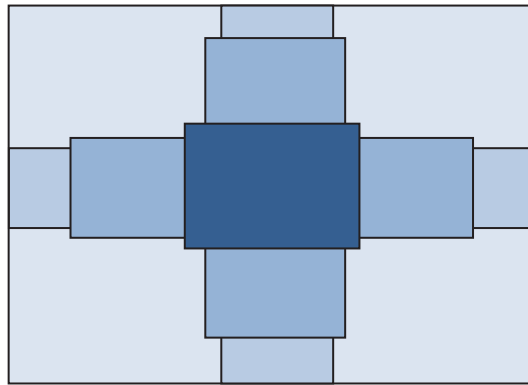


FIGURE 4-31 - INTERSECTING CAROUSELS

Another idea that was considered replaced the two dimensional sheet that seemed to carry the user-tasks with two intersecting carousels (one vertical, one horizontal); this gave each task an adjoining task both vertically and horizontally and allowed the user to move directly from any task to any other task within its row or column. Figure 4-31 is a very simple sketch of what this may have looked like if there were more tasks to transition between. There are too few tasks for this concept to work well and preliminary testing showed that this arrangement confused the user's sense of context for each task; the set of tasks adjoining each task seemed to be chosen randomly and had no apparent rationale. Since context was important, the two dimensional sheet was retained.



FIGURE 4-32 - THUMBNAILS & ICONS

Task-switching with thumbnails and icons

Figure 4-32 is a representative screen display of the implementation that was used for the tests; this particular screen indicates that *trekking* is the current task, *viewing information* is available to the right, *indicate trekker interests* is available to the left, and *planning a trek* is available below.

4.6 USER-TASK IMPLEMENTATION

SET TREKKER PROFILE

FIGURE 4-33 - SET TREKKER PROFILE TASK

Figure 4-33 shows the screen for the *set trekker profile* task. This was the task that is displayed at start-up²². The user tests did not involve any system features that used the name or email of the participants, so this information was not actually collected during the tests; future developments (such as uploading of photographs or trek logs to Facebook or similar sites) will rely on this information; this data can potentially be entered while the device is connected to a laptop or desktop²³ some time before the trekker sets out. For the purposes of the testing described here, the only relevant item of information on this interface was the trekker's estimate of her or his own pace²⁴, which by default was set midway; other items were not fully implemented.

INDICATE TREKKER INTERESTS

Show	Sound	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flora
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Fauna
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Geology
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	History
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Facilities
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Safety

FIGURE 4-34 - INDICATE TREKKER INTERESTS TASK

Figure 4-34 shows the screen for the *indicate trekker interests* task. The ticks in the first column indicate the specific types²⁵ of information that the trekker wants to be automatically displayed and the ticks in the second column indicate which types of information should be heralded by an alerting sound as their

²² Criterion 13 - *the device should start-up with the set trekker profile task*

²³ Criterion 15 - *the design should avoid text entry whenever possible*

²⁴ Criterion 14 - *the device should provide a set trekker profile task which allows users to indicate their expected walking pace*

²⁵ Criterion 16 - *the device should provide an indicate trekker interests task which allows the user to specify the types of information that interest them*

related locations are approached; all the boxes are ticked by default. The underlying functionality was not fully implemented before the commencement of user testing.

BROWSING TRACKS

The *browsing tracks* task allows the user to see all the tracks and information points that are available in the region of interest and to choose to view any other region whose information is stored on the device. This task also allows the device to display information about the wider region rather than specific to a particular location, such as the difficulty rating of the tracks in the region or general safety warnings. The region that is being viewed provides the scope for any trek that may be planned.

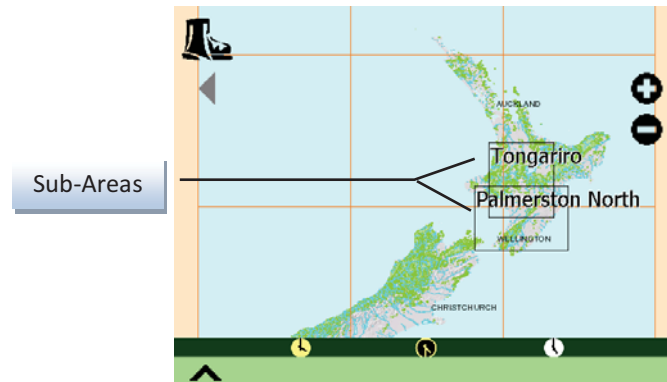


FIGURE 4-35 - *BROWSING TRACKS, TOP-LEVEL*

Figure 4-35 shows the opening screen for the *browsing tracks* task. The opening screen is an overview map which shows sub-areas that contain stored tracks. Here the image shows a map of New Zealand as the top level but, if different information were stored, the device could show a map of the World and work its way through smaller and smaller areas until the local tracks were displayed. In this image the Tongariro and Palmerston North regions have selection rectangles; if the user touches either of these areas on the screen, the map for that area is displayed and the back-triangle, under the task-switching boot, becomes active. The back-triangle, at the top of the image, allows the user to return to a map's parent-level map. The user is able to pan the map *modelessly*²⁰ but they are not allowed to pan an edge of the map past the edge of the screen; this insures that a portion of the map is in view at all times and keeps the user from being confused by a blank screen. Also, to have the map displayed to its best advantage, when the map is smaller than the screen on a particular axis, the map is centred and panning is disabled for that axis. The 'plus' and 'minus' signs in the upper right are the zoom-in and zoom-out controls; each tap on these controls changes the zoom²⁶ level in steps until the maximum- or minimum-level is reached. The bar at the bottom of the screen is the progress/profile bar in minimised mode.

²⁶ Criterion 17 - *the device should enable the user to zoom the map*

A Backcountry Tour Guide



FIGURE 4-36 MAP, ZOOMED IN

Opening Map Screen: Zoomed-in

Figure 4-36 is the same map after zooming in a couple of steps; the size of the selection rectangles for sub-areas is the larger of the size of their area on the map or the minimum size necessary for convenient selection. The text-size for the selection area labels, as with other annotations on the map, are always the same size on-screen regardless of the zoom factor.

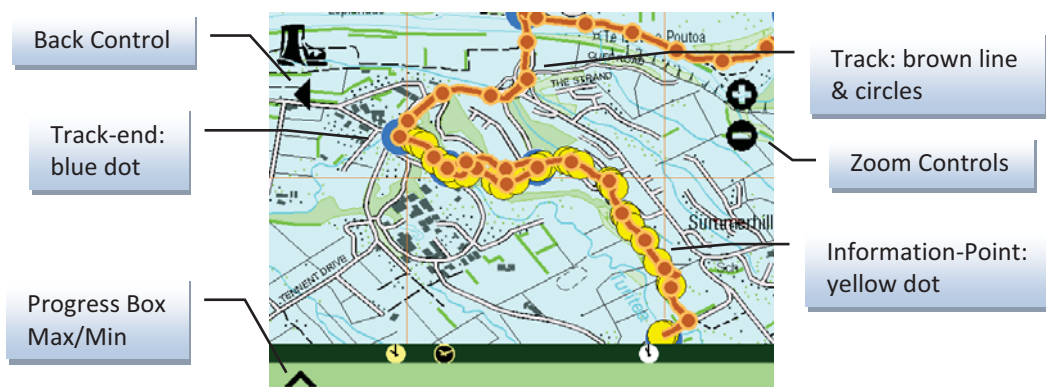


FIGURE 4-37 BROWSING TRACKS, SUB-LEVEL

Figure 4-37 shows a sub-area map for the *browsing tracks* task. Since this is a sub-area, the Back control is active. The Boot, Back, Max/Min and Zoom controls are all rectangular controls with transparent backgrounds; this allowed the apparent shape of each control to be unique, which helps the user distinguish one from the other. The trail is indicated by small circles with joining lines. Larger circles indicate information-points and track-ends; these are also used as tap-targets to display their related information²⁷.

PLANNING A TREK

The user can plan a trek in whichever region they are viewing. *Planning a trek* involves determining a start- and an end-point along with the tracks that will be used to trek between them. The user can then see the distance of the trek along with an estimate of the time that would be required to complete the trek (ETT). An ETA is also shown which is based on the ETT and start-time (which the device initially

²⁷ Criterion 24 - *the device should provide a browsing tracks task which allows users to view information provided by the smart-map in addition to location-specific and region-specific information even when the device is not located in the vicinity of the track and/or no trek has been planned*

assumes and that the user may adjust). The ETT is based, in part, on the expected walking pace that was provided by the user during the *set trekker profile* task. The user can also use the *indicate trekker interests* task to choose which types of information points they want to be informed of on the trek. A trek must be planned before it can be trekked²⁸; in practice this means that at least one track needs to be selected before the user is allowed to switch to the *trekking* task.

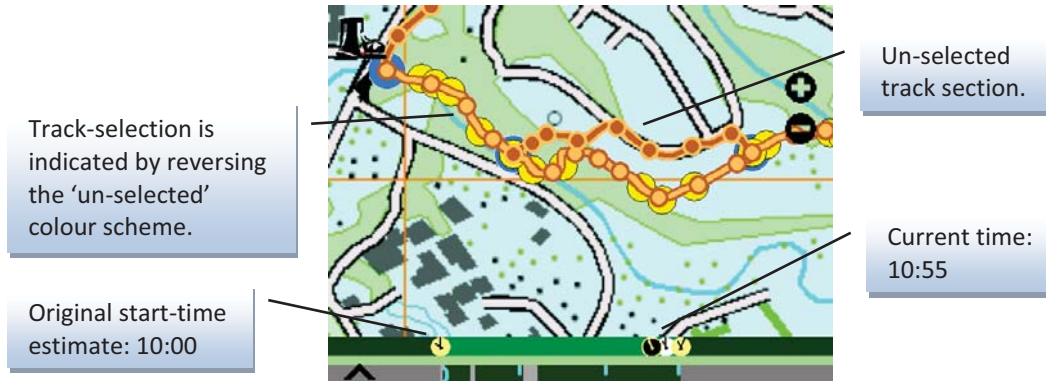


FIGURE 4-38 - PLANNING A TREK

Figure 4-38 shows a screen for the *planning a trek* task. The progress/profile bar indicates that a one-hour, three-kilometre trek is planned; when the bar is maximised, the user can slide the trek along the time scale in fifteen minute increments to set a better estimate for trek start-time²⁷.

The track sections are selected by touching any point on the track section and dragging in any direction. The dragging movement allows the device to differentiate between taps on information points and the selection of track-sections. As track-sections are selected, the distance and estimated time values are indicated on the progress/profile bar whether it is minimised or maximised. The time markings on the timescale are set directly above the distance they correlate to on the distance scale to give an appropriate impression of time vs. distance.

Since default values for the trekker's pace and interests have been set²⁹, the user can switch to this task directly from *set trekker profile* or from *set trekker interests*. Since *browsing tracks* and *planning a trek* are combined, this criterion affects both tasks. Trekkers are expected to select their intended tracks in the sequence they intended to trek them³⁰. Since time constraints did not permit the development of a track selection scheme that allowed a trek which would involve going to some point and then returning by the same route, there is no provision for trekking the same track twice in the same trek. The trek is assumed to begin from an end (the one that is not attached to the rest of the trek) of the track that is selected first. If only one track is selected, a direction is assumed. While in the *trekking* task, the direction of the trekker's progress is monitored and the trek-direction is adjusted by the device; the direction that the user is actually trekking is always considered to be forward and is displayed as such.

²⁸ Criterion 29 - *the device should present the trekking task only after a plan has been set and should insure that the GPS is active as the task is begun*

²⁹ Criterion 27 - *the device should present the planning a trek task only after the trekker's profile and interests have been set*

³⁰ Criterion 26 - *the device should provide a planning a trek task which allows the user to indicate the sequence and direction that the tracks will be trekked along with an estimated start time*

TREKKING

This task is only fully functional if a trek has been planned, the GPS is active and the user is close to or on one of the trek's tracks. In addition to the information that is available during the prerequisite tasks, the user can see their current position in the region and the on-track distance from their current position to any other information-point on the trek along with the time required to reach that point. During the *trekking* task, the time estimates are based on the user's observed walking pace³¹. In addition, the location-specific information that the user has chosen to be informed about, spontaneously appears as the user approaches the location it is related to³².

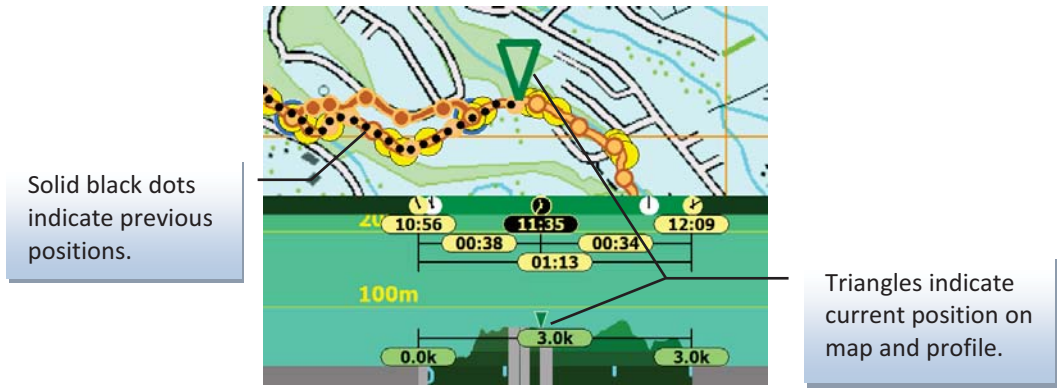


FIGURE 4-39 - CURRENT POSITION & HISTORY

As mentioned earlier, the *trekking* task is only allowed if at least one track is selected; the GPS is activated as *trekking* begins²⁸. Figure 4-39 shows a screen from the *trekking* task. Here the trekker's current position³³ and previous positions³⁴ can be seen on the map; here since the progress/profile bar is maximised, the current position can also be seen on the progress/profile bar. The position triangle shows as green when there is a strong GPS signal, as yellow when the signal is weak, and does not show at all when the signal is insufficient for use³⁵. Figure 4-39 also demonstrates the automatic centring of the current-position marker³⁶.

VIEWING LOCATION-SPECIFIC AND REGION-SPECIFIC INFORMATION

The *viewing information* task is actually a sub-task that occurs as part of the *browsing tracks, planning a trek* or *trekking* tasks. However, it is implemented as a task on its own. This allows it to employ the entire screen while active³⁷; it also allows the user-task switching mechanism to be used to switch back to the task that caused it to be displayed. Since the information only needs to be displayed while it is

³¹ Criterion 34 - *during 'trekking', all time estimates should be based on the user's observed walking pace*

³² Criterion 35 - *during 'trekking', the device should cause information that is of interest to appear spontaneously as the trekker approaches the location to which it relates*

³³ Criterion 30 - *during 'trekking', the device should indicate the trekker's location*

³⁴ Criterion 31 - *during 'trekking', the device should indicate the history of the trekker's location*

³⁵ Criterion 28 - *the design should gracefully deal with GPS dropouts*

³⁶ Criterion 18 - *the device should enable the user to modelessly pan the map. During 'trekking', the device should also, over time, centre the map at the trekker's current location*

³⁷ Criterion 36 - *the device should display location-specific and region-specific information in the largest format that can be supported by the device*

actively being viewed by the user, using the entire screen for *viewing information* does not have a significant impact on the other tasks' access to the screen.

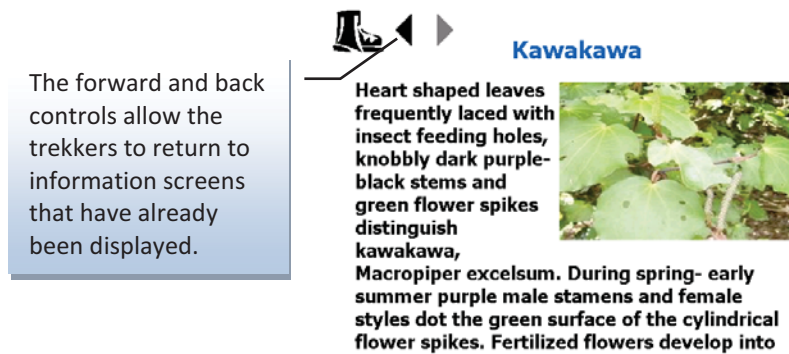


FIGURE 4-40 - LOCATION-SPECIFIC INFORMATION

Figure 4-40 shows a sample of location-specific information from the *viewing information* task. As the trekker approaches an information-point, its related screen is automatically displayed. Trekkers can then use the 'boot' to return to the *trekking* task if they want to or allow the screen to remain until the next information point is displayed. Most of the screens have an accompanying audio narration. When the screen has a narration, a 'replay' button is added at the bottom of the text. The information screens are implemented as HTML files which are displayed using the browser control provided by .net. This browser does not display the HTML in quite the same way as the version of Internet Explorer that is included in Windows Mobile version 5.5 or version 6.1, or any other browser that was tested. In one way or another, each browser's behaviour is different from the others. It would have helped the development of the information screens if an information-screen testing environment had been available that ran on a desktop computer and behaved exactly as the mobile browser.

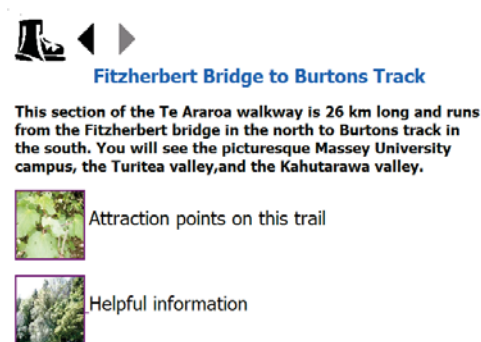


FIGURE 4-41 - REGION SPECIFIC INFORMATION

Figure 4-41 shows a sample of region-specific information from the *viewing information* task.

4.7 SMART-MAP IMPLEMENTATION

TRACK MARKERS



FIGURE 4-42 MAP, TONGARIRO SELECTED

Selected track with flat and steep sections

Figure 4-42 shows the implemented track markers (as discussed in section 4.3) that were tested. Here the progress/profile bar is minimised so that the display space available for the map is maximised. This view shows where the track is flat and where it is steep. The size and spacing of the filled circles that show the steepness of the track are calculated in terms of the device's display size so that the circles' screen-size and screen-spacing are consistent regardless of zoom level.

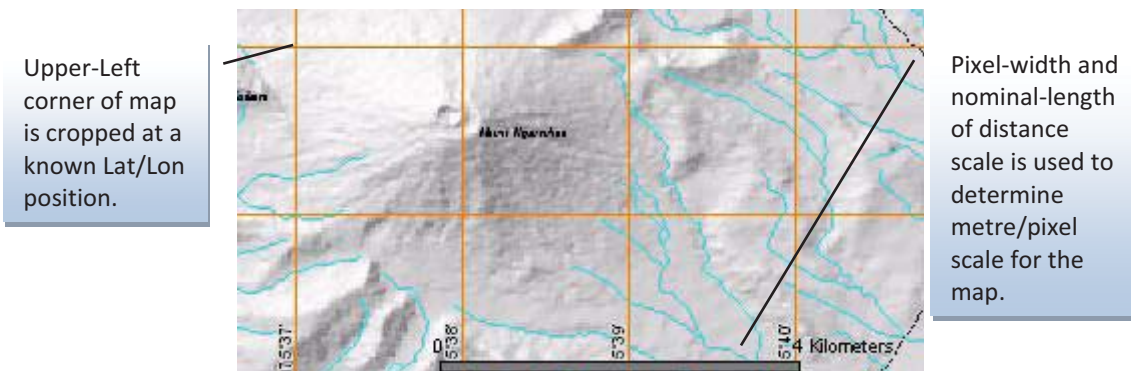


FIGURE 4-43 - MAP IMAGE AS SUPPLIED

The location of each item drawn on the map is determined using a simple degree-to-metres conversion; 360 degrees of Latitude = 40,030,000 metres; this is the circumference of Earth based on its mean radius, 6371.01 kms (Yoder 1995). Horizontal distances are scaled by the cosine of the local latitude (National Geospatial-Intelligence Agency 2008). Figure 4-43 shows how the metres/pixel as well as the latitude and longitude of the upper left corner of the original map images are determined. These factors are used to determine the x-y offset in metres from the upper-left corner of the map which is then converted to an x-y offset in pixels. The Universal Transverse Mercator (UTM) grid coordinates which are based on the World Geodetic System (WGS 84) ellipsoid model of the earth is the model commonly used for converting from positions given in latitude and longitude to positions in metres. There are pre-existing implementations of UTM such as the one provided by Kashon (2008); these do provide more

precision but they also require many more calculations. Since the extra precision that the UTM method provides is not perceivable on screen, the simpler, quicker method is used.

PROGRESS/PROFILE BAR

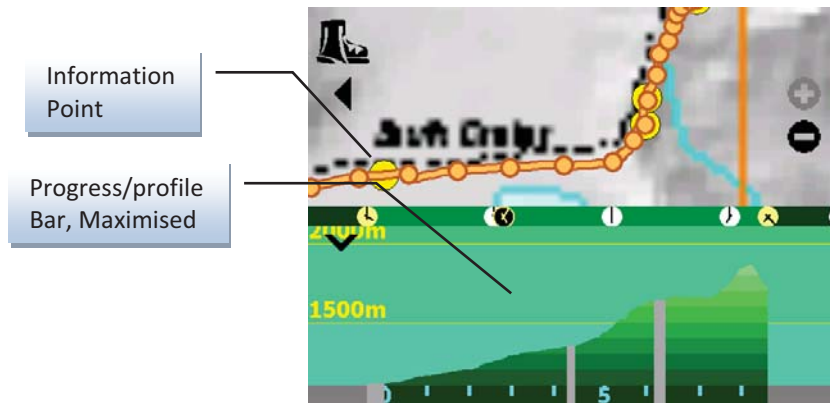


FIGURE 4-44 MAP, TONGARIRO MAXIMISED

Progress/profile bar maximised

In Figure 4-44, the progress box is maximised to show the profile as well. The profile is drawn on the surface provided by the progress box. Each band in the profile is a relatively simple object which is only responsible for drawing itself at an appropriate height and extent. The colour bands in the profile were originally fully saturated with each band slightly brighter than the one below it. However, when the colours were fully saturated the brighter values could not be distinguished on the screen. When the saturation was lowered to seventy-five percent, ten different brightness levels could be distinguished.

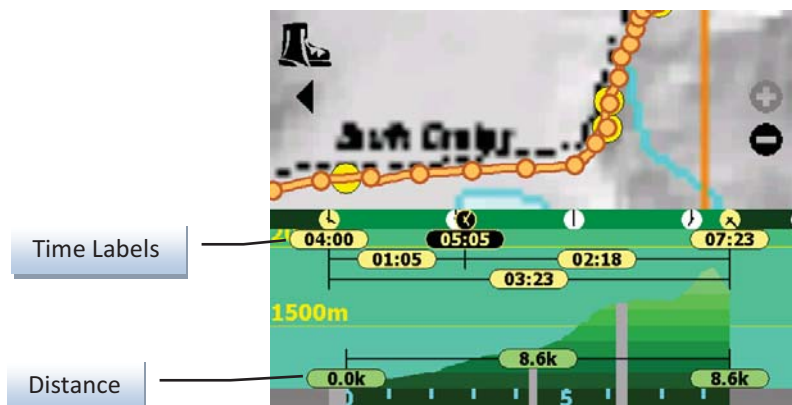


FIGURE 4-45 MAP, TONGARIRO LABELED

Progress/profile bar with labels

When the user touches anywhere on the interior of the progress/profile bar, detail labels are displayed as shown in Figure 4-45. The labels are responsible for drawing themselves. The labels that measure a span are also responsible for drawing their own dimension lines. The labels are always drawn after the profile so that they are fully visible.

INFORMATION POP-UPS

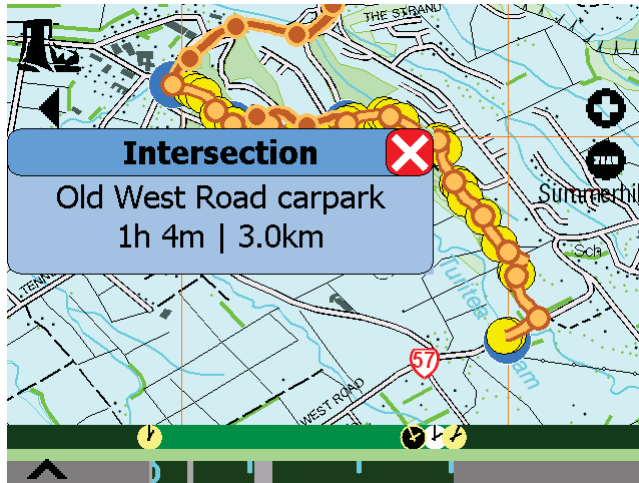


FIGURE 4-46 - INTERSECTION POP-UP

When a user selects an intersection point, a pop-up like the one in Figure 4-46 appears. During the *planning a trek* task, the on-track distance (in kilometres) to the intersection is displayed. During the *trekking* task, the ETT is also displayed. If the time is longer than sixty minutes, an hour-minute format (2h 47m) is used; otherwise, a minute-only format is used (23min). In the minute-only format the abbreviation for minute is extended to 'min' to avoid confusion with the standard abbreviation for metres.

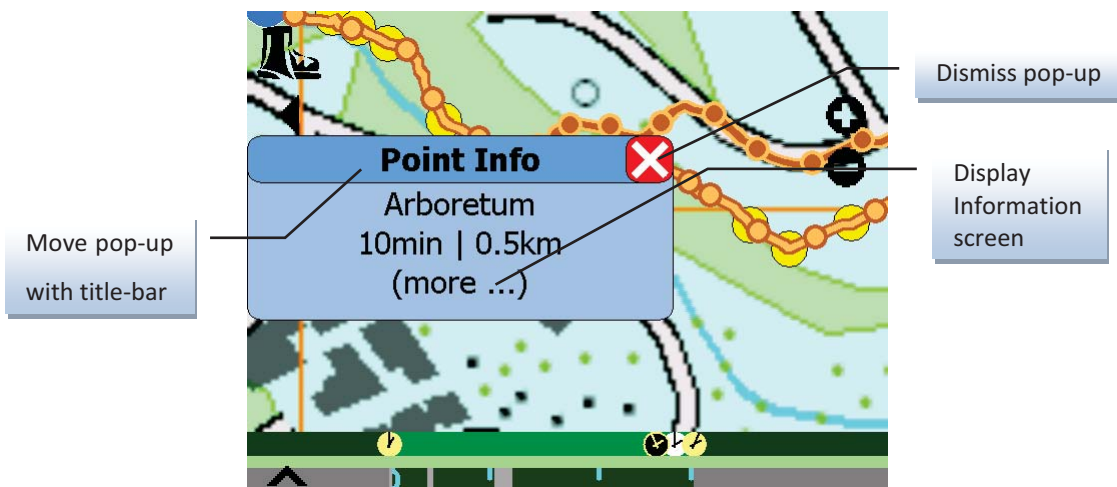


FIGURE 4-47 - INFORMATION POINT POP-UP

When a user selects an information point, a pop-up like the one in Figure 4-47 appears. During the *planning a trek* task, the on-track distance (in kilometres) to the information point is displayed. During the *trekking* task, the ETT is also displayed. The user can dismiss any pop-up by touching the 'X'. The user can move any pop-up around the screen by dragging the title bar. Touching '(more...)', causes the appropriate information screen to be displayed.

Chapter 5

Experiment & Results

The design and its implementation were evaluated by comparing the experiences of persons who used the device with that of persons using conventional maps and trail guides. The persons involved had varying levels of trekking experience and the information concerning their experiences was gathered through third-party observations and user surveys.

5.1 VALIDATING THE THESIS STATEMENT

In Chapter 1 the following four testable contentions were presented.

1. It should be feasible to build a GPS-based outdoor trekking assistant device incorporating a 'smart-map' that provides information about a trekker's position on a predefined trail along with ETA/ETT and location-specific information. Four tests were undertaken to test the validity of this contention:
 - The feasibility of building a device with basic positional, ETA/ETT and location-specific functionality was tested by construction; such a device was tested and built in less than ten months by one programmer. The device was used throughout the rest of the evaluation.
 - The accuracy with which the device can track the trekker's position was tested by demonstration; as long as the GPS signals were adequate, the indication of the trekker's current position on the map corresponded, as precisely as could be displayed, to his or her actual location.
 - The accuracy of ETA and ETT were tested by demonstration; once the trekkers had walked long enough to provide a good baseline (approximately 15 minutes), the estimates were acceptably close to the actual finish times. During the evaluation, as they finished their walks the trekkers were picked up by support staff in vehicles; the ETA provided by the device was successfully used to coordinate the pickup times.
 - The proximity to the intended location when location-specific information was provided was tested by demonstration; while trekking with adequate GPS signals, the information was provided within an acceptable radius (less than 3 metres) of the expected location.

2. It should be feasible to develop a touch-screen interface for the device that exploits the inherent tactile and visual capabilities of naïve users. Three tests were undertaken to test the validity of this contention:
 - The feasibility of designing an interface with the purpose of presenting positional, ETA and ETT information in an intuitively obvious form was tested by construction; the design is documented in Chapter 3.
 - The feasibility of implementing such an interface was tested by construction; the implementation is documented in Chapter 4. This was the interface that was used on the device.
 - The ease of use of this interface in comparison to a standard alternative was tested by demonstration; the results of the user evaluations are documented in this chapter.
3. The interface should enable a naïve user to quickly learn to use the device. The validity of this contention was tested by demonstration; experiments were conducted to determine the learning time for the Trekker's Assistant. The results of those experiments are documented in this chapter.
4. The device should add value to an outdoor trekking experience. The validity of this contention was tested by demonstration; naïve users were surveyed after using the device during an actual trek. The results of those surveys are documented in this chapter.

5.2 EVALUATION FOCUS

Since the validity of the first contention (that it would be feasible to build the device) was demonstrated by successful construction of a prototype and by the informal testing that occurred during that construction process, the focus of the evaluation was to validate the last three contentions (ease of use, ease of learning, and adding value to the trekking experience). To that end, two groups of volunteer trekkers were recruited. The members of the first group were provided with a Trekker's Assistant (and given a 15 minute standardised training session) while the members of the second group were provided with a conventional map and walking guide. Aside from being supplied with different types of navigational aid, members of the two groups of volunteers were treated identically.

They were taken in pairs to the beginning of the Bledisloe Bush Walk, a 3 kilometre track through native bush and farmland adjoining the Massey University campus. They were asked to use their navigational aid as they desired while they trekked and an observer recorded this usage. When they finished their trek, they were returned to the original venue and asked to fill out a questionnaire concerning their experience. To assess the ease of learning, they were also asked to use the navigational aid with which they had been supplied to answer some basic questions about the Tongariro Crossing, a seventeen kilometre alpine crossing in the Tongariro National Park. Their competency was determined by noting the time required to produce the answers and their accuracy. To gauge how much learning occurred during the trek, half of the group were asked to answer questions about the Tongariro Crossing immediately after the training session (i.e., before the trek) and the other half were asked to answer those questions immediately after their trek. The results from the two sub-groups were compared. The

results from the Trekker's Assistant group as a whole were also compared with the results from the map-and-brochure group.

5.3 EVALUATION SCOPE

While the focus of the evaluation was on ease of use, ease of learning and added value, the scope of the evaluation included all of the functions of the *browsing tracks* and *trekking* tasks and one of the functions of the *set trekker profile* task. The original evaluation plan also included the *planning a trek* task as well but pilot tests showed that this was impractical, because attempts to select a track segment are often interpreted by the device as attempts to select information points. The problem is that the decisions to use a tap to select information points and a touch-and-drag to select tracks led to users often having information point pop-ups appearing while they were attempting to select a track. If the touch is intermittent or the drag is too short while the user is attempting to select a track, the gesture is taken to be a tap. Further, if this unintentional tap gesture is at or near an information-point or a track-end, the associated pop-up is activated.



FIGURE 5-1 - SAFE & UN-SAFE TRACK SELECTION AREAS

If the touch-and-drag is done with a firm touch and a long drag, selection of tracks can be done successfully, even where track-regions include information points; however, the only safe method is to zoom-in until a portion of track, clear of information points, is revealed that is long enough to allow track selection without touching an information point. This difficulty is considered in Chapter 6 and a possible solution is proposed. Since the purpose of the evaluation was to determine the usability of the design and that portion of the design had been shown to be difficult to use, the evaluation of that portion of the interface was considered to be complete. And, since negative impressions about one aspect of a design often affect the evaluations of other aspects, it was eliminated from further evaluation.

The evaluation was designed to test various aspects of the interface. To answer the questions about the Tongariro Crossing, the volunteers primarily used the *browsing tracks* and *viewing information* tasks. As they prepared to answer the questions, they also used part of the *set trekker profile* task. During the trek, they used the *trekking* and *viewing information* tasks.

5.4 EVALUATION AND STATISTICAL METHODS

The volunteers were randomly assigned to groups and sub-groups to help ensure that the groups were evenly mixed. However, individual pairs were usually friends or members of the same family, as it is

unusual for members of trekking parties, particularly small parties, to be composed entirely of strangers. The ‘pre-trek’ and ‘post-trek’ ease-of-learning questions were allocated to separate groups so that a learning effect would not occur in the answers to the ‘post-trek’ questions.

Likert Scales were used to allow the volunteers to quickly register their impressions and histograms were used to spot results of interest in an initial analysis of the data. The questions that were intended to assess ease-of-access followed this template - “The <specific information> is easy/difficult to find.” The questions that were intended to assess the importance of the information to the trekkers followed this template – “The <specific information> is very/not useful to know.”

Ease-of-Use Likert Scale - Labels				
1	2	3	4	5
Easy				Difficult
Very Useful				Not Useful

TABLE 5-1 EASE-OF-USE LIKERT SCALES

As shown in Table 5-1, only the extreme ends of the scales were labelled; the volunteers were expected to infer appropriate meanings for each of the scales’ interior points.

The results for each group were then analysed and compared using the Mann-Whitney *U* test (Newbold et al. 2010). This test is well suited for comparing two sample-sets to determine the probability that they were taken from populations with different central values. For this test, the samples must be independent, sample-sets may be relatively small ($n \Rightarrow 10$), and the sample statistic is not assumed to be normally distributed. The sample sizes, at fourteen and twenty-four, were well suited to this test. The distribution of the sample statistics shown in the histograms do not support the idea that the sample statistics are normally distributed, so that the Student’s t-test is not appropriate.

The null hypothesis tested by each of the ease-of-access questions follows this template – “There is no difference between the ease of access to <some specific information> using conventional techniques and the approach that has been developed for the Trekker’s Assistant.” The alternate hypothesis for each of the ease-of-access questions follows this template – “The ease of access to <some specific information> using the approach that has been developed for the Trekker’s Assistant is better than that of conventional techniques.” The questions that ask about the importance of specific information are intended to focus future work on the information that is most important to trekkers.

5.5 EASE-OF-ACCESS EVALUATION RESULTS

In the following sections the smaller the *U* statistic, the more times the information on the Trekker’s Assistant was rated as easier to access than the information on the map. The *p*-value is the one-tailed probability that the sample distributions would have occurred if the null hypothesis were true. A *p*-value < 0.05 is generally considered significant and allows the null hypothesis to be rejected.

TOTAL TREK-TIME AND -DISTANCE

In general, both groups considered trek-time and trek-distance information to be very useful to know. The Trekker’s Assistant group determined the value of the trek-times more easily than did the map group. Even though the Trekker’s Assistant group did not find the trek-distance more easily than did the map group, this does not imply that finding the trek-distance with the Trekker’s Assistant was more difficult than finding the trek-times; the Trekker’s Assistant group gave this information the same rating for ease as they did for the trek-ETT and trek-ETA. The lack of significant difference reflects the fact that the map group gave an ease rating of (2) for the trek-distance information rather than the (3) they gave for the trek-times.

ETT FOR A TREK

The time required for a trek is very/not useful to know.

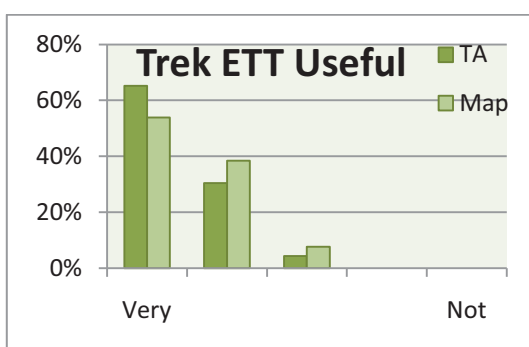


CHART 5-1

The median of the usefulness ratings in Chart 5-1 shows that the majority of both the Trekker’s Assistant and map groups considered the estimated travel time for a trek to be ‘very useful to know’. (Median = 1, $n_t = 23$ $n_m = 13$).

The time required for a trek is easy/difficult to find/determine.¹

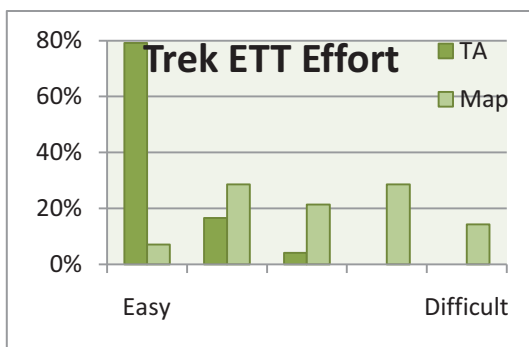


CHART 5-2

Chart 5-2 shows that the majority of the Trekker’s Assistant group easily found the estimated travel time for a trek while the effort required to find this by the map group was evenly spread across the available range. The median response from the Trekker’s Assistant group about the effort required to access this information was ‘easy’ (1) while the median response from the map group was neutral (3). This statistically significant difference (Mann-Whitney $U = 28$, $n_t = 24$ $n_m = 14$, $p < 0.0001$), indicates that this information was easier to find with the Trekker’s Assistant than to determine with the map.

¹ This required two slightly different statements, the Trekker’s Assistant performed the calculation while the map required the trekker to perform the calculation, hence the statement for the Trekker’s Assistant questionnaire finished with “to find” while the statement for the map questionnaire finished with “to determine”.

TOTAL LENGTH FOR A TREK

The length of a trek is very/not useful to know.

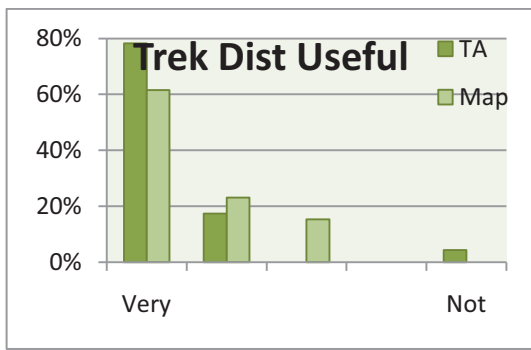


CHART 5-3

The median of the usefulness ratings in Chart 5-3, shows that both the Trekker’s Assistant and map groups rated the length of a trek as ‘very useful to know’ (Median = 1, $n_t = 23$ $n_m = 13$).

The length of a trek is easy/difficult to find/determine.¹

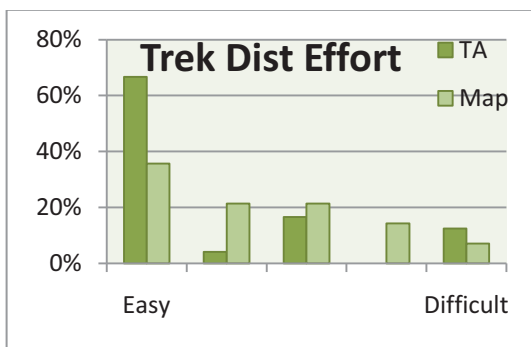


CHART 5-4

As shown in Chart 5-4, the median response from the Trekker’s Assistant group about the effort required to access this information was ‘easy’ (1) while the median response from the map group was between ‘easy’ and neutral (2). This was not a statistically significant difference (Mann-Whitney $U = 125$, $n_t = 24$ $n_m = 14$, $p = 0.0966$). Since the Trekker’s Assistant group gave this information the same rating for ease as they did for the trek-ETT and trek-ETA (1) this lack of significant difference reflects the fact that the map group rated this information as (2) rather than (3) as they did for the trek-times.

ETA FOR A TREK

The time a trek will finish is very/not useful to know.

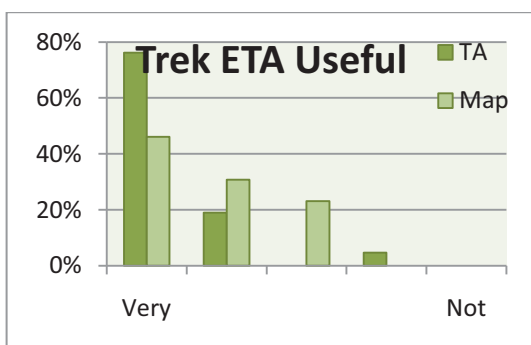


CHART 5-5

The median of the usefulness ratings in Chart 5-5, shows that the Trekker’s Assistant group rated the time a trek will finish as ‘very useful to know’ (1) while the map group rated it between ‘very useful to know’ and medium usefulness (2) (Median; $n_t = 21$ $n_m = 13$).

The time a trek will finish is easy/difficult to find/determine.¹

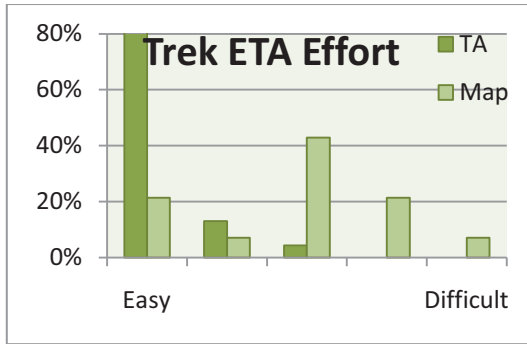


CHART 5-6

As shown in Chart 5-6, the median response from the Trekker's Assistant group about the effort required to access this information was 'easy' (1) while the median response from the map group was neutral (3). This statistically significant difference (Mann-Whitney $U = 46$, $n_t = 23$, $n_m = 14$, $p = 0.0002$), indicates that this information was easier to find with the Trekker's Assistant than to determine with the map.

POINT-OF-INTEREST TIME AND DISTANCE

In general, both the Trekker's Assistant and map groups considered time and distance for interest points to be less important than the time and distance for the total trek, 'quite useful' rather than 'very useful'. As with the trek-time information, the Trekker's Assistant group found the POI-times more easily than the map group. The number of trekkers in the Trekker's Assistant group that had trouble finding the POI-time and POI-distance information may indicate that there is some difficulty with activating the pop-up or with the formatting of the information or perhaps that some users were not even aware that it was available.

ETT FOR A POINT-OF-INTEREST

The time required to reach a point of interest is very/not useful to know.

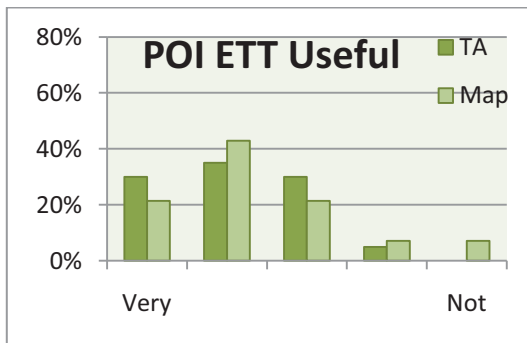


CHART 5-7

The median of the usefulness ratings in Chart 5-7, shows that both the Trekker's Assistant and map groups rated the time required to reach a point of interest between 'very useful to know' and medium usefulness (Median = 2, $n_t = 20$, $n_m = 14$).

The time required to reach a point of interest is easy/difficult to find/determine.¹

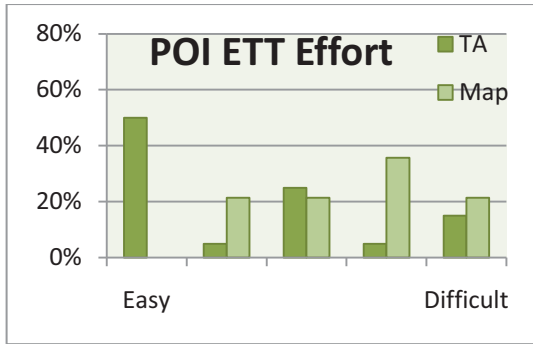


CHART 5-8

As shown in Chart 5-8, the median response from the Trekker’s Assistant group about the effort required to access this information was almost ‘easy’ (1.5) while the median response from the map group was between ‘difficult’ and neutral (4). This statistically significant difference (Mann-Whitney $U = 70$, $n_t = 20$ $n_m = 14$, $p = 0.0072$), indicates that this information was easier to find with the Trekker’s Assistant than to determine with the map.

DISTANCE TO A POINT-OF-INTEREST

The distance to a point of interest is very/not useful to know.

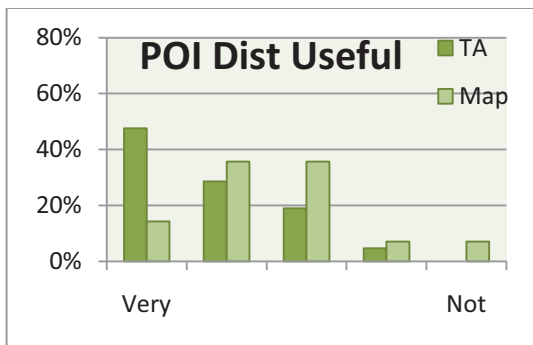


CHART 5-9

The median of the usefulness ratings in Chart 5-9, shows that the Trekker’s Assistant group rated the distance to a point of interest between ‘very useful to know’ and medium usefulness (2) while the map group rated it less so (2.5) (Median; $n_t = 20$ $n_m = 14$).

The distance to a point of interest is easy/difficult to find/determine.¹

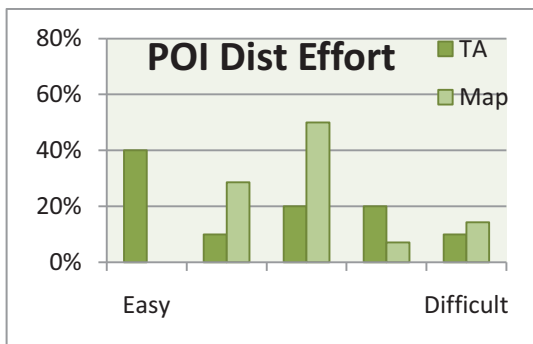


CHART 5-10

As shown in Chart 5-10, the median response from the Trekker’s Assistant group about the effort required to access this information was almost neutral (2.5) while the median response from the map group was neutral (3). This was not a statistically significant difference (Mann-Whitney $U = 106$, $n_t = 20$ $n_m = 14$, $p = 0.1171$). The difference in effort rating between POI-ETT (1.5) and POI-distance (2.5) for the Trekker’s Assistant is surprising since the pop-up that shows the ETT for a POI also shows its distance.

ETA FOR A POINT-OF-INTEREST

The time a point of interest will be reached is very/not useful to know.

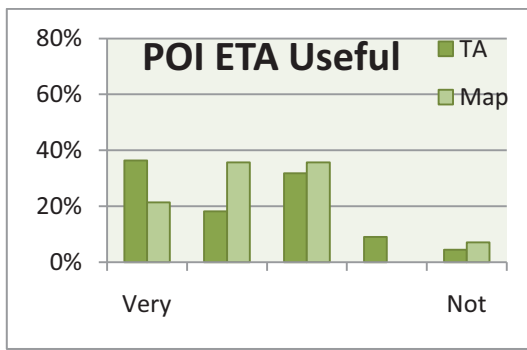


CHART 5-11

The median of the usefulness ratings in Chart 5-11, shows that both the Trekker's Assistant and map groups rated the time a point of interest will be reached between 'very useful to know' and medium usefulness (Median = 2, $n_t = 22$ $n_m = 14$).

The time a point of interest will be reached is easy/difficult to find/determine.¹

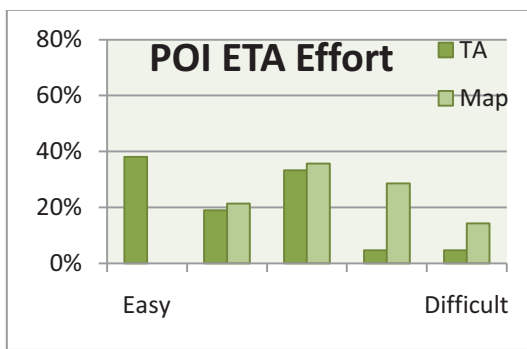


CHART 5-12

As shown in Chart 5-12, the median response from the Trekker's Assistant group about the effort required to access this information was between 'easy' and neutral (2) while the median response from the map group was neutral (3). This statistically significant difference (Mann-Whitney $U = 67.5$, $n_t = 21$ $n_m = 14$, $p = 0.0037$), indicates that this information was easier to find with the Trekker's Assistant than to determine with the map.

SMART-MAP INFORMATION

TIME AVAILABLE FOR REST

How much time is available for a rest break is very/not useful to know.

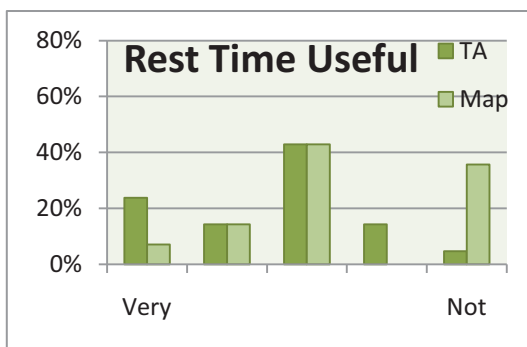


CHART 5-13

The median of the usefulness ratings in Chart 5-13, shows that both the Trekker's Assistant and map groups rated the time available for a rest break as of medium usefulness (Median = 3, $n_t = 21$ $n_m = 14$).

How much time is available for a rest break is easy/difficult to determine.



CHART 5-14

As shown in Chart 5-14, the median response from the Trekker’s Assistant group about the effort required to access this information was neutral (3) while the median response for the map group was almost neutral (2.5). There is no significant difference in this measure (Mann-Whitney $U = 151.5$, $n_t = 22$, $n_m = 14$, $p = 0.4677$). This feature is an area of the interface that may need to be improved. If the information is more accessible, trekkers may find that it is very useful information, especially for day-long treks.

TRAIL INCLINE

Where the trail is steep or flat is very/not useful to know.

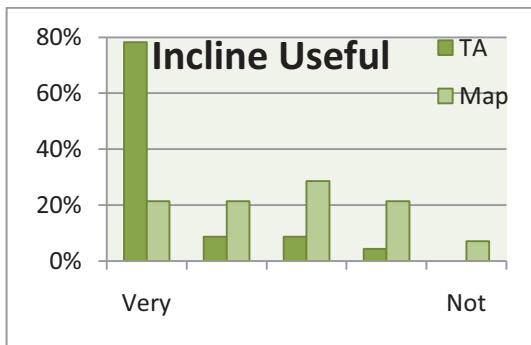


CHART 5-15

The median of the usefulness ratings in Chart 5-15, shows that the Trekker’s Assistant group rated where-the-trail-is-steep-or-flat as ‘very useful to know’ (1) while the map group rated it as of medium usefulness (3) (Median; $n_t = 23$, $n_m = 14$).

It is interesting to note the different character of the usefulness ratings for this specific information type. For the other information types, both groups gave usefulness ratings that appear to be similar when charted. Here they are quite different; almost 80% of the responses from the Trekker’s Assistant group were at one extreme while the responses from the map group were evenly dispersed. The confidence intervals of the Wilcoxon Signed Rank (Newbold et al. 2010) test for each group show that this was a statistically significant difference (WSR Trekker’s Assistant confidence interval: 1 – 1.5, Map confidence interval: 2 – 3.5).

Where the trail is steep or flat is easy/difficult to determine.

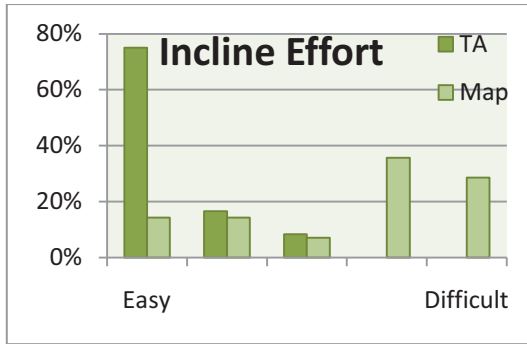


CHART 5-16

As shown in Chart 5-16, the median response from the Trekker’s Assistant group about the effort required to access this information was ‘easy’ (1) while the median response from the map group was between neutral and ‘difficult’ (4). This was a statistically significant difference (Mann-Whitney $U = 39$, $n_t = 24$ $n_m = 14$, $p < 0.0001$). This difference is likely related to the prominent display of the profile and the clear, on-track indication of incline.

The effort required to determine the track’s incline, on the Trekker’s Assistant or on the map, was significantly different; this difference may have contributed to the significant difference in importance-rating that each group gave this information. If so, this may show that if information is readily available users will find that it is useful, or conversely that trekkers may discount the importance of information that is not readily accessible.

FINDING A POINT-OF-INTEREST

Finding a specific point of interest is very/not useful to do.

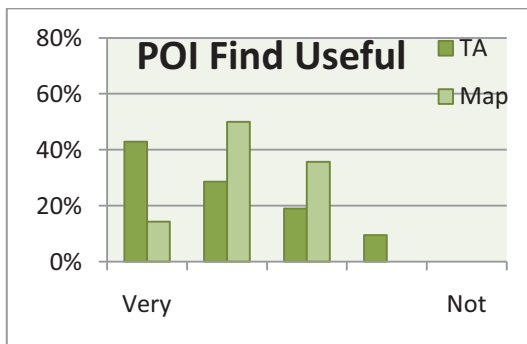


CHART 5-17

The median of the usefulness ratings in Chart 5-17, shows that both the Trekker’s Assistant and map groups rated finding a specific point of interest between ‘very useful to do’ and medium usefulness (Median = 2, $n_t = 21$ $n_m = 14$).

Finding a specific point of interest is easy/difficult to do.

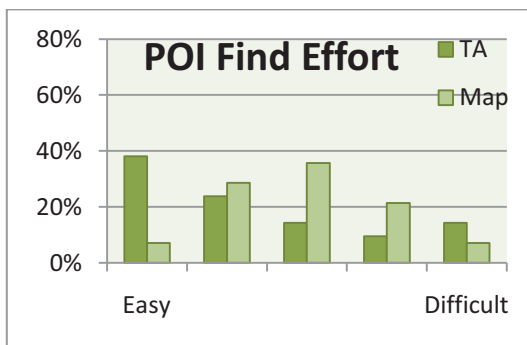


CHART 5-18

As shown in Chart 5-18, the median response from the Trekker’s Assistant group about the effort required to access this information was between ‘easy’ and neutral while the median response from the map group was ‘neutral’. This was not a statistically significant difference (Mann-Whitney $U = 105$, $n_t = 21$ $n_m = 14$, $p = 0.0786$).

DISPLAYING/FINDING THE INFORMATION FOR A POINT-OF-INTEREST²

Displaying/Finding the information for a point of interest is very/not useful to do.

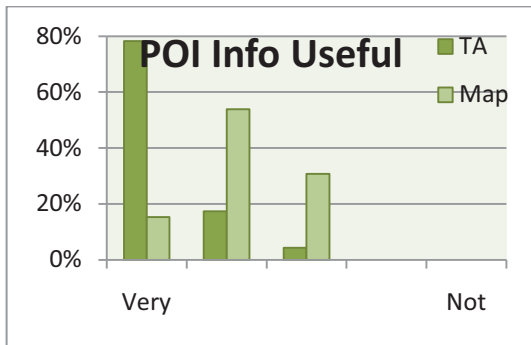


CHART 5-19

The median of the usefulness ratings in Chart 5-19, shows that the Trekker’s Assistant group rated finding the information for a point of interest as ‘very useful to do’ (1) while the map group rated it between ‘very useful to do’ and medium usefulness (2) (Median; $n_t = 23$ $n_m = 13$).

Displaying/Finding the information for a point of interest is easy/difficult to do.

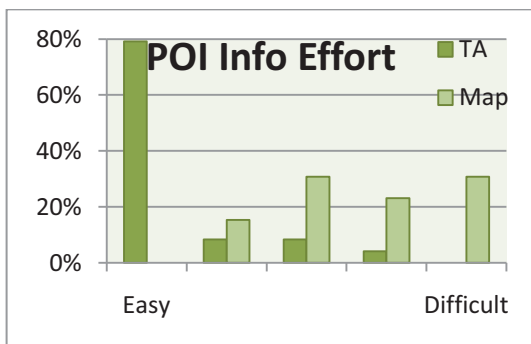


CHART 5-20

As shown in Chart 5-20, the median response from the Trekker’s Assistant group about the effort required to access this information was ‘easy’ (1) while the median response from the map group was between neutral and ‘difficult’ (4). This was a statistically significant difference (Mann-Whitney $U = 17.5$, $n_t = 24$ $n_m = 13$, $p < 0.0001$). This difference is likely related to the location-specific information being displayed automatically by the Trekker’s Assistant while the map group had to search for relevant information in the brochure.

MOVING BETWEEN THE INFORMATION AND TREKKING PANELS

Moving between panels was specific to the Trekker’s Assistant and this question was only on the Trekker’s Assistant questionnaire, so no comparison between the Trekker’s Assistant and the map can be done for this feature. However the Wilcoxon Signed Rank test can be used to analyse the responses.

² This required two slightly different statements, the Trekker’s Assistant (TA) displayed the information onscreen while the map and brochure required the trekker to find the place on the map or in the brochure that the information was shown, hence the statement for the TA questionnaire began with “Displaying ...” while the statement for the Map questionnaire began with “Finding ...”.

Moving between the information and the trekking panel is very/not useful to do.

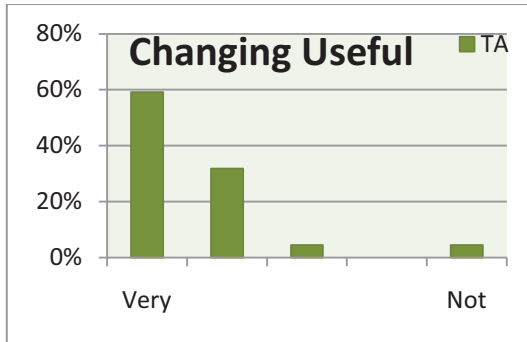


CHART 5-21

The median of the usefulness ratings in Chart 5-21 shows that the Trekker’s Assistant group rated this action as ‘very useful to do’ (1) (WSR confidence interval: 1 – 2, n = 22).

Moving between the information and the trekking panel is easy/difficult to do.

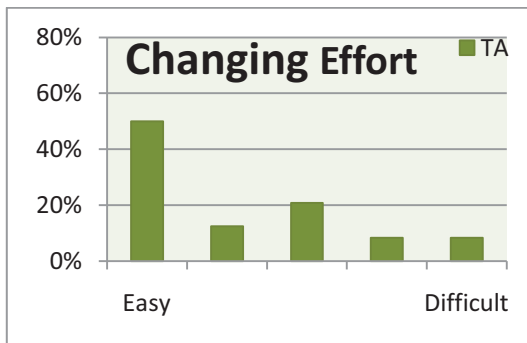


CHART 5-22

As shown in Chart 5-22, the median response from the Trekker’s Assistant group about the effort required to move between panels was almost ‘easy’ (1.5) (WSR confidence interval: 1.5 - 2.5, n = 24).

That the effort required to move between panels was not rated as ‘easy’ is likely related to the lack of sensitivity of the touch-screen to the touch-and-slide action (four user comments support this contention), and the two-step nature of the command (three user comments support this contention). There was one comment about this action being difficult for left-handed persons; the control that activated the panel-moving feature could be shifted to the other side of the screen by the user but this feature was not pointed out in the tutorial, and the user had not discovered this for him/herself.

This brings into focus a problem associated with the small screen size of the target devices; features that would occasionally be useful, such as hints about the ability to shift a control from one side of the screen to the other, have had to be eliminated in favour of essential functionality. Such features could be explained in a user manual, but the use cases for the trekker's assistant include casual, short-term hireage by tourists, and it is unlikely that a (large, multilingual) manual would be very heavily used in such a situation. Perhaps a structured video tutorial could be installed on the device to allow interested users to explore such secondary features.

EASE-OF-USE SUMMARY TABLE

Question	Usefulness			Effort Required		
	Very	Not	Easy	Difficult		
ETT for a Trek						
Trekker's Assistant	↑			↑		
Map	↑				↑	
Total Length for a Trek						
Trekker's Assistant	↑			*	↑	
Map	↑			*	↑	
ETA for a Trek						
Trekker's Assistant	↑			↑		
Map		↑			↑	
ETT for a Point-of-Interest						
Trekker's Assistant		↑		↑		
Map		↑				↑
Distance to a Point of Interest						
Trekker's Assistant		↑		*		↑
Map		↑		*		↑
ETA for a Point-of-Interest						
Trekker's Assistant		↑			↑	
Map		↑			↑	
Time Available for Rest						
Trekker's Assistant			↑	*		↑
Map			↑	*		↑
Trail Incline						
Trekker's Assistant	↑			↑		
Map			↑			↑
Finding a Point-of-Interest						
Trekker's Assistant		↑		*	↑	
Map		↑		*		↑
Finding Point-of-Interest Information						
Trekker's Assistant	↑			↑		
Map		↑				↑
Moving between Panels						
Trekker's Assistant	↑			↑		

TABLE 5-2 EASE OF USE SUMMARY

* - No significant difference

Users rated nine out of eleven activities with the Trekker's Assistant as 'Easy' or near to 'Easy' to do; six out of ten activities were rated as easier to do with the Trekker's Assistant than with a map or brochure.

5.6 EASE-OF-LEARNING EVALUATION

One way of measuring learning is to measure a person's increase in competence. If the members of the Trekker's Assistant group showed significantly more competence in their use of the Trekker's Assistant after their trek than before their trek, it could be stated that they learned about the use of the Trekker's Assistant during the trek itself. With this possibility in mind, the competence of one group of volunteers was measured before their trek with the Trekker's Assistant and the competence of another group was measured after their trek. The competence of the 'pre-trek' group was then compared to the competence of the 'post-trek' group. To test the volunteers' competence with the Trekker's Assistant,

they were asked to use it to find the answers to a series of questions. Their answers and how long it took to produce them were recorded.

The following four questions were used to explore this aspect of the system:

- Distance: How long is the Tongariro Crossing?
- Time: How long will it take to reach the Ketetahi Hut from the start?
- Info: How many bunks are there at the Ketetahi Hut?
- Incline: Which leg crosses the highest point on the trail?

NUMBER OF CORRECT ANSWERS

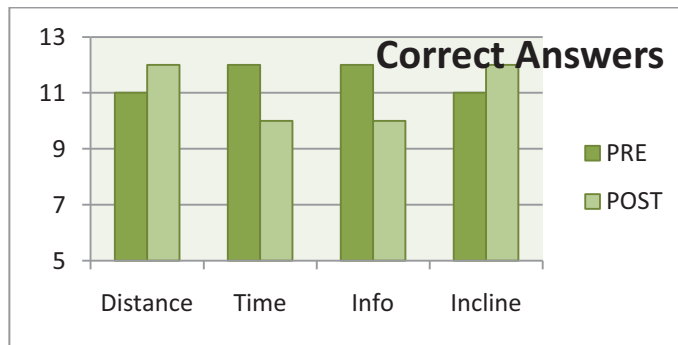


CHART 5-23 CORRECT RESPONSES

One measure of competence is the number of questions a person can answer correctly. As shown in Chart 5-23, for each question, at least ten of the responses from each group were correct. The ‘post-trek’ group had one more correct answer for two of the questions but the ‘pre-trek’ group had two more correct answers for the other two questions. These results do not provide any evidence that learning occurred during the trek.

ANSWER TIMING

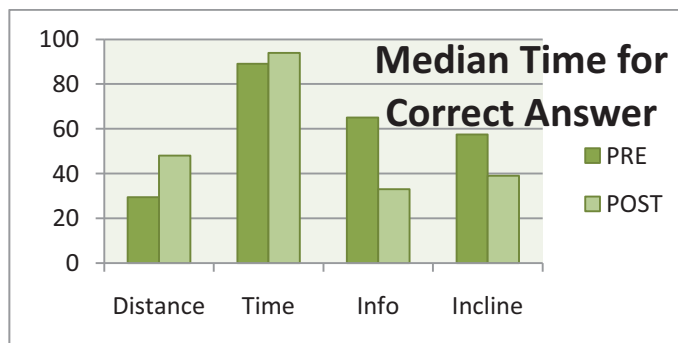


CHART 5-24 TIME REQUIRED FOR CORRECT RESPONSES

Another measure of competence is the amount of time a person requires to correctly answer a question. The time required for each correct answer was compared using the Mann-Whitney *U* test. As shown in Chart 5-24, the ‘post-trek’ group did better with two of the questions while the ‘pre-trek’ group did better with the other two. However, none of these differences were significant.

- Distance: 'Pre' Time < 'Post' Time, $U = 90.0$, $p = 0.0531$
- Time: 'Pre' Time < 'Post' Time, $U = 110.0$, $p = 0.5000$
- Info: 'Pre' Time > 'Post' Time, $U = 137.0$, $p = 0.0552$
- Incline: 'Pre' Time > 'Post' Time, $U = 116.5$, $p = 0.2027$

As with comparing the number of correct answers, there is no evidence that learning occurred during the treks.

Users rated nine out of eleven activities with the Trekker's Assistant as 'Easy' or towards 'Easy' to do; six out of ten activities were rated as easier to do with the Trekker's Assistant than with a map or brochure.

If little or no learning can be shown to have occurred during the trek and this was the first time any of our volunteers had seen the Trekker's Assistant, when did they learn to use it as well as they did? The Trekker's Assistant group must have had a reasonable level of competence with the Trekker's Assistant to rate it as 'Easy' or towards 'Easy' to use for nine out of eleven activities and as easier to use than a map or brochure in six out of ten activities as shown in the Ease of Use Summary (Table 5-2). The learning must have occurred sometime during the fifteen minute tutorial that the volunteers were given.

Since the volunteers were able, within fifteen minutes, to learn to use the Trekker's Assistant well enough to:

- trek with it,
- rate it as 'Easy' or 'Moderately Easy' to use in almost all measured activities,
- and rate it as easier to use than a map or brochure in the majority of measured activities,

it can be stated that the existing Trekker's Assistant interface can be quickly learned.

5.7 VALUE-ADDED EVALUATION

The added value that the Trekker's Assistant provided can best be described and assessed by the volunteers' own comments and their answers to a question about the price that they would be prepared to pay to hire the Trekker's Assistant.

POI COMMENTS

When asked how and why the interest-point information affected their trek, the volunteers in the Trekker's Assistant group gave comments such as these:

- Stopped to listen & observe the POI instead of going past.
- I liked different things being pointed out, some I would never have known. It made me take notice of my surroundings more. It did slow us a bit, but in a good way.
- I thought it was very useful, particularly since I'd walked this track many times and wasn't aware of the information presented.

A Backcountry Tour Guide

- Very informative, made us stop and be more aware of our surroundings.
- I learned a great deal about points of interest, promoted conversation.

In general, the Trekker's Assistant group was very pleased by the interest-point information. The trek-observers reported that some trekkers began to eagerly anticipate the appearance of the interest-point information and would use the device to check their position as they approached the next interest-point. In addition to being informative, the information helped them to appreciate their surrounding more and to interact with their companions on the way. The trek became more than getting from point A to point B; the journey was rewarding as well.

RECOMMENDATION-TO-OTHERS COMMENTS

When the Trekker's Assistant group was asked if they would recommend the Trekker's Assistant to others, their responses provided more insight into why they valued it.

They gave comments such as these:

- It is very useful for the group in terms of directing the way and you will not get lost! It also gives you useful information about the place and you can estimate the time that you will take for walking.
- Gives useful info along (the) way to add to the experience, also gives a guide as to stopping places, danger spots, distance to travel, timing etc.
- For people unfamiliar with this walk it gives the pertinent information relating to the walk. Helps with plan for rest steps, what facilities avail etc at rest points. Group can assess how far they may manage in a day.
- I found it fun to use. Would utilize the map re: heights, distances etc. Good reassurance on right pathway especially with the information points and educational tool.

The Trekker's Assistant group found value in the direction, distance and height information the Trekker's Assistant provided. They also saw that this information could help them decide when and where to rest as well as how far to attempt to trek in a day.

ADDED VALUE IN DOLLARS

Value-Added Likert Scale - Labels				
1	2	3	4	5
I would definitely not hire	I would probably not hire	I might or might not hire	I would probably hire	I would definitely hire

TABLE 5-3 VALUE-ADDED LIKERT SCALE

After their trek, the Trekker’s Assistant group was asked if they would be prepared to pay \$49.00 to hire the Trekker’s Assistant for an all-day trek over the Tongariro Crossing. Using the Likert scale in Table 5-3, their median response was ‘I would probably hire’ (4) (Wilcoxon Signed Rank confidence interval 3.5 - 4.0).

Those that responded ‘I would probably hire’ or ‘I would definitely hire’ were then asked what was the most they were prepared to pay. The median response was \$80.00 (Wilcoxon Signed Rank confidence interval \$70.00 - \$95.00).

Given these results, it can be stated that the majority of those using the Trekker’s Assistant for the first time found that it added value to their trek. Also it can be stated that, among those who considered that it added value, the majority valued the Trekker’s Assistant experience at \$70.00 or more.

Chapter 6

Conclusions & Recommendations

6.1 TO ADD VALUE TO THE TREKKING EXPERIENCE

This research began with the desire to increase the use of New Zealand's conservation estate by providing a device that adds value to the trekking experience without either hindering or eclipsing that experience. The focus was on creating a device that provides information concerning the trekker's status on the track along with additional information concerning the natural features of the trek. The user interface for the device was designed with the intention that novice users would find it easy to learn and use.

6.2 VALIDITY OF INITIAL CONTENTIONS

This research sought to establish the validity of four contentions. The first contention was:

1. It should be feasible to build a GPS-based outdoor trekking assistant device incorporating a 'smart-map' that provides information about a trekker's position on a predefined trail along with ETA/ETT and location-specific information.

Four of the results presented in Chapter 5, Section 5.1 demonstrate the validity of this contention.

- The feasibility of building this device was tested by having one programmer build and verify the function of such a device (the Trekker's Assistant) in less than ten months. The Trekker's Assistant was used throughout the rest of the evaluation.
- The accuracy with which the Trekker's Assistant could track the trekker's position was tested and the indication of the trekker's current position on the map corresponded to his or her actual location.
- The accuracy of the ETA and ETT were tested and these estimates were acceptably close to the actual finish times. The ETA provided by the Trekker's Assistant was successfully used during the evaluation to coordinate the trekkers' pickup times by support staff.
- The actual location where location-specific information was provided was compared to the intended location and the Trekker's Assistant provided the information within a 3 metre radius of the expected location.

From these results, it can be concluded that such a device is well within the capabilities of current technology.

The second contention was:

2. It should be feasible to develop a touch-screen interface for the device that exploits the inherent tactile and visual capabilities of naïve users.

Three of the results presented in the preceding chapters demonstrate the validity of this contention

- The feasibility of designing such an interface was tested by developing an interface design that attempted to exploit these particular user capabilities. (Chapter 3, Section 3.10)
- The feasibility of implementing such an interface was tested by implementing this interface design and using it on the Trekker's Assistant. (Chapter 4)
- The ease of use of this interface was compared to the ease of using of a map and brochure and was rated as easier to use in most categories. (Chapter 5, Section 5.5)

For the ease-of-use evaluation, users rated nine out of eleven activities with the Trekker's Assistant as 'Easy' or towards 'Easy'; six out of ten activities were rated as easier to do with the Trekker's Assistant than with a map or brochure. From these results, it can be concluded that such an interface can be designed and implemented even though there is room for improvement in this particular interface.

The third contention was that:

3. The interface should enable a naïve user to quickly learn to use the device.

The results presented in Chapter 5, Section 5.6 demonstrate that:

- Given a fifteen minute tutorial, the results did not show that any significant learning had occurred with the users during the trek though each user was able to use the device satisfactorily during the trek.

From these results, it can be concluded that, given an effective tutorial, the Trekker's Assistant interface can be learned in fifteen minutes or less.

The last contention was that:

4. The device should add value to an outdoor trekking experience.

Interviews with naïve users after they had used the device during an actual trek (Chapter 5, Section 5.7) suggest that this is a valid contention; the users' comments highlighted a range of positive effects that stemmed from carrying the Trekker's Assistant with them as they walked. It was gratifying to read the comments by the trekkers concerning the effect of the interest-point information on their trekking experience. Their comments often paralleled (occasionally using the same words) the effects that are anticipated in Chapter 1, Section 1.2.

- Their comments indicated that:
 - the trekkers took more notice of their surroundings;
 - they learned useful information;
 - they knew how much time they could take along the way;
 - they felt that the Trekker's Assistant added to their experience.
- Also, a majority indicated that they probably or even definitely would hire the Trekker's Assistant, if it were available.

From these survey results, it can be concluded that the Trekker's Assistant does add value to the trekking experience.

6.3 OVERALL CONCLUSION

With the validity of the four initial contentions demonstrated, it can be stated that the Trekker's Assistant is feasible to build, easy to use, can be quickly learned, and adds value to the trekking experience. Novice users have taken this device trekking, have enjoyed its benefits and have found it to be an asset to them. The Trekker's Assistant does not just succeed as a functional piece of technology that behaves predictably within established parameters. It has been seen as a valued tool/companion for trekkers and as such has begun to accomplish the overarching purpose for its creation as discussed at the beginning of Chapter 1; that purpose is threefold:

- to encourage people to get outdoors and on-foot,
- to have them appreciate the wonders that they find there,
- and to motivate them to do these things more often.

While (as will be discussed in Section 6.4) there are some areas that can be improved upon and some features that still need to be implemented before the Trekker's Assistant is made available for general use, the Trekker's Assistant that has been developed and tested serves well as a proof of concept.

6.4 RECOMMENDATIONS

A few areas of concern remain.

IMPROVEMENTS & ADDITIONS

The first area that might be improved is the information pop-ups. During testing, many trekkers seemed to have difficulty accessing the information that is provided by the pop-ups (Chapter 5, Section 5.5). While the results of the testing do not provide any specific insight into the primary cause of this difficulty, it may be one of or a combination of four possibilities:

- the trekkers didn't know that the information was available on the pop-ups;
- they didn't know how to activate the pop-ups;
- activating the pop-ups was difficult;
- there was some difficulty with reading the information from the pop-ups once activated.

Since the pop-ups are activated by a single tap, the third possibility is unlikely to be the cause. There were no comments that mentioned any difficulty with reading the information from the pop-ups, so that is not a likely cause either. The two possibilities that remain are that some trekkers may not have known the information existed on the pop-ups and that some of the trekkers may have known about the information but did not know how to activate the pop-ups. The solution may be as simple as emphasising the use of the pop-ups during the tutorial; alternatively, there may be a way to make the existence and use of the pop-ups more self evident.

An area that does require improvement is the manner of entering the intended track-sequence for the trek in the *planning a trek* task; this needs to address two issues. The first is that there is no provision for trekking a track more than once in a trek; time constraints did not allow the development of a track selection scheme that provided for round-trip treks. Since treks often involve going to some point and returning via the same or similar route, this issue needs to be addressed before this device is released for general use. The other track-selection issue was mentioned in Chapter 5, Section 5.3; while attempting to select a track, the users often activate pop-ups unintentionally. There may be sophisticated selection gestures that would deal with this issue, but it may be more appropriate to eliminate its cause. At the end of Section 4.4, it was stated that it had been decided to combine the *browsing tracks* and *planning a trek* tasks; combining these tasks requires that the selection of both information points and tracks be active simultaneously.

If these tasks were separate, these selection functions would only need to be active in their respective tasks. If the selection of information points only happened in the *browsing tracks* task and the selection of tracks only happened in the *planning a trek* task; this would have several effects:

- An attempt to do either of these actions would not be confused as an attempt to do the other.
- The scheme to allow round-trip treks could be developed without the concern of clashing with the activation of information pop-ups, which should allow the use of simpler gestures.
- If trekkers did need information from a pop-up while they are *planning a trek*, they would need to briefly return to *browsing tracks* to find it.

The benefits of the first two effects would likely outweigh the inconvenience of the third effect. If these tasks were separate, it would be good to have a clear visual indication of which task was active so that trekkers knew which items were selectable. Perhaps the Trekker's Assistant boot icon on the task-switching control could be replaced by the icon of the current task or, more directly, the selectable items could change in appearance (i.e. in full colour when available, greyed out otherwise).

Other issues involve the Profile/Progress Bar. The night-time/day-time indication and the finish-time alarm as shown in Chapter 4, Figure 4-22 are yet to be implemented; also, colours, other than the ones used, might show the altitude bands more effectively. In addition, as mentioned in Chapter 4, Section 4.3, the vertical and horizontal scales for the Profile/Progress Bar are not fixed but rather depend on the vertical and horizontal spans of the trek that is currently planned. The consequence of this is that the representation of the vertical span and steepness of the tracks are not consistent. If panning and zooming were implemented for the Profile/Progress Bar as it is for the map, the ratio between the vertical and horizontal scaling (aspect ratio) could be fixed; this would provide a consistent representation of steepness.

Other implementation issues, as mentioned in Chapter 4, Section 4.6, involve the need to complete the underlying functionality for the *set trekker profile* and *indicate trekker interests* tasks.

There are several ways that the use of graphics during task-switching might also be improved.

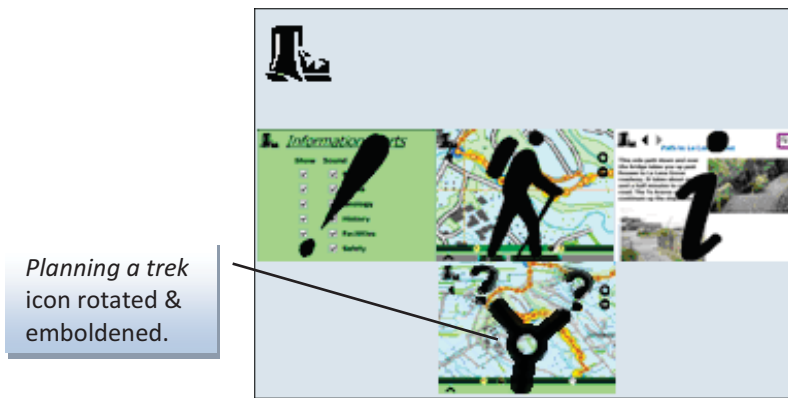


FIGURE 6-1 - POTENTIAL IMPROVEMENTS FOR TASK SWITCHING GRAPHICS

Figure 6-1 shows a potential improvement for the *planning a trek icon*; if it were rotated slightly and drawn with heavier lines, it would be a better match for the other icons. An idea that may improve the user’s sense of context would be to use a colour for the current-task icon that was different from the rest. Finally, if the icons were drawn so that they appeared to be semitransparent, they would be less imposing visually.

Lastly, one area of potential improvement is the position indicator used for the Trekker’s Assistant; as mentioned in Chapter 4, Section 4.3, colour was used to indicate the status of the GPS signal. An alternative worth investigating would be to have the position indicator flicker or blink when the GPS signal is weak and go solid when the signal is strong; this may be more effective with the low-colour viewing conditions that occur in direct sunlight.

BASIC QUESTIONS

During the design stage of this project, existing research did not seem to address two very basic questions. They may not warrant a full thesis but they are gaps in the research.

The first is, “What makes a good You-Are-Here indicator?” Several papers used YAH indicators but they were all different from each other and none that I found provided any rationale for the choice of indicator. It would be good if someone would research this specific question. Now that devices which incorporate position-awareness are so common, we need to know whether, as a YAH, an icon reminiscent of a target works better than cross-hairs or a dot and why.

The second basic question is, “Do graphic elements with transparent interiors and rounded corners make the screen appear more open and less cluttered than do solid and rectangular elements?” This was assumed to be true and was the rationale for using such elements in the interface for the Trekker’s Assistant. None of the mobile design patterns that I found addressed this issue. Now that hand held devices with small screens are so common, it would be good if someone would research this particular issue.

APPENDICES

Trekker Questionnaire

TrekWizard Field Trials – Interface Usability

Trekker No: _____

Date: _____

- 1. As you were walking, Trekwizard indicated the progress you were making in several ways.
- 1.1. Please list as many as you were aware of.

1.2. Which was most useful?

1.3. Which was least useful?

- 2. Please finish the following sentences according your impression of the Trekwizard at the completion of your trek. Please comment on your ratings:

- 2.1. The time required for a trek is
 - easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.2. The length of a trek is
 - easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.3. The time a trek will finish is
- easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.4. The time required to reach a point of interest is
- easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.5. The distance to a point of interest is
- easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.6. The time a point of interest will be reached is
- easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.7. The time available for a rest break is
- easy to determine.
 -
 -
 -
 - difficult to determine.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.8. Where the trail is steep or flat is
- easy to determine.
 -
 -
 -
 - difficult to determine.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 2.9. Finding a specific point of interest is
- easy to do.
 -
 -
 -
 - difficult to do.
 - very useful to do.
 -
 -
 -
 - not useful to do.

Comment: _____

- 2.10. Displaying the information for a point of interest is
- easy to do.
 -
 -
 -
 - difficult to do.
 - very useful to do.
 -
 -
 -
 - not useful to do.

Comment: _____

- 2.11. Moving between the Information & Trekking panels is
- easy to do.
 -
 -
 -
 - difficult to do.
 - very useful to do.
 -
 -
 -
 - not useful to do.

Comment: _____

3. Did the information provided at the interest points affect your trek? yes, no

3.1. If so, how did that information affect your trek?

3.2. In either case, please explain?

4. Which information provided by Trekwizard seemed particularly valuable?

5. Which information provided by Trekwizard didn't seem particularly valuable?

6. What additional information would you like to see provided?

Symbols

Which of the following symbols you remember seeing? What is their meaning or purpose?

Symbol	Seen	Meaning/Purpose
!		
i		
Ω		
Y		
hiker		
boots		
◀		
∨ ^		
⊖ ⊕		

Screen Shots

This is a screen shot showing the track for South Crater and Red Crater.

Circle the portions of the track that are steep.

How long is this track section? _____ km

How long should it take to walk it?
 _____ hrs _____ min



Comments:

This is a screen shot of a trek in progress. Please circle the trekker's current location on the map and on the profile.

How far have they come? _____ km

What time did they start? _____

How long have they been walking?
 _____ hrs _____ min

What time is shown as the current time? _____

How much longer will it take to complete the trek?
 _____ hrs _____ min

What time will they finish? _____



Comments:

This is a screen shot of an information point popup.

How far is it to the point? _____ km

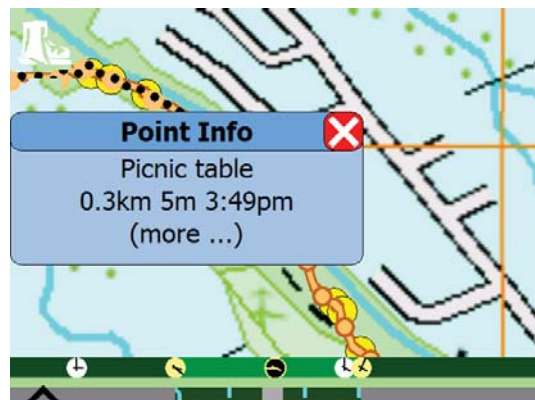
How long will it take to reach it?
 _____ hrs _____ min

What time will they arrive? _____

How would you get rid of this popup?

How would you move this popup?

How would you get more info?



Comments:

7. If you were part of a group intending to walk the Tongariro crossing, how would you advise the group about Trekwizard?

Strongly discourage them from using Trekwizard

Probably discourage them from using Trekwizard

Not recommend **either using or not using** Trekwizard

Probably encourage them to use Trekwizard

Strongly encourage them to use Trekwizard

Give reasons for your recommendation.

.....
.....
.....
.....

8. If you could hire Trekwizard at the start of the Tongariro track and return it at the end of the track, how likely would you be to hire Trekwizard if it cost \$49?

I would **definitely not hire** Trekwizard

I would **probably not hire** Trekwizard

I **might or might not hire** Trekwizard

I would **probably hire** Trekwizard

I would **definitely hire** Trekwizard

Comment:
.....
.....

9. If you answered the question above by ticking probably or definitely hire Trekwizard if it cost \$49. At what price point would you **definitely not hire** Trekwizard? (Please circle)

\$60 \$70 \$80 \$90 \$100 \$110 \$120 \$130 \$140 \$150

Comment:
.....
.....

How might this product be improved?

.....
.....
.....
.....

trekkerID	ETT Easy	ETT Useful	TrekDist Easy	TrekDist Useful	TrekETA Easy	TrekETA Useful
P002	2	2	2	2	1	1
P003a	1	1	1	1	3	1
P003b	1	1	1	1	1	1
T001a	1	2	1	1	1	1
T001b	1	1	3	1	1	1
T002a	1	1	5	1	1	1
T002b	1	1	3	1	1	1
T003a	3	1	1	1	3	2
T003b	1	1	1	1	1	1
T004a	2	2	2	2	2	2
T004b	1	1	1	1	1	1
T005a	1	1	1	2	1	1
T005b	1	1	1	1	1	1
T006a	2	2	3	2	2	2
T006b	1	2	1	2	1	4
T007a	2	2	5	1	1	1
T007b	1	2	5	1	1	1
T008a	1	1	1	1	1	1
T008b	1	1	1	1	1	1
T009a	1	1	3	1	1	
T009b	2	1	1	1	2	1
T010a	1		1		1	
T010b	1	1	1	1	1	1
T011a	1	1	1	1	1	1
T011b	1	1	1	1	1	1
T012a	1	2	1	1		
T012b	1	3	1	5	1	2

trekkerID	poiETT Easy	poiETT Useful	poiDist Easy	poiDist Useful	poiETA easy	poiETA useful
P002	3	2	2	2	4	3
P003a	5	2	5	5	4	4
P003b	5	2	5	5	4	4
T001a	1	1	2	1	1	1
T001b	3	2	4	2	3	2
T002a	1	1	3	1	2	1
T002b	2	2	1	1	2	2
T003a	3	2	3	2	3	2
T003b	1	1	1	1	1	
T004a	1	2	1	2	1	2
T004b	1	4	1	4	1	4
T005a	1	1	1	1	2	1
T005b	3	3	3	3	3	3
T006a	4	3	4	3	3	3
T006b	1	3	1	2	1	3
T007a	5	2	4	1	1	1
T007b			5		1	1

trekkerID	poiETT Easy	poiETT Useful	poiDist Easy	poiDist Useful	poiETA easy	poiETA useful
T008a	3	1	4	1	4	1
T008b	1	2	1	1	1	3
T009a	3	1	3	1	3	1
T009b						
T010a	1			1		1
T010b	1	3	1	2	2	5
T011a	5	2	5	2	5	3
T011b		3		3		3
T012a					3	4
T012b	5	3	2	3	3	3

trekkerID	RestTime Easy	RestTimeUseful	Steep Easy	Steep Useful	poiFind Easy	poiFind Useful
P002	2		3	3	4	2
P003a	4	4	1	1	1	1
P003b	5	5	1	2	2	2
T001a	4	1	1	1	4	1
T001b	2	3	1	1	1	1
T002a	4	2	1	1	5	4
T002b	4	3	2	1	2	2
T003a	3	3	2	3	5	2
T003b	1	4	1	1	1	1
T004a	1	1	2	2	2	2
T004b	1	4	1	1	3	3
T005a	3	1	1	1	2	1
T005b	3	3	1	1	1	1
T006a	4	3	2	4	4	4
T006b	2	2	1	1	1	1
T007a	5	3	1	1	1	1
T007b			1	1		
T008a	5	1	1	1	3	1
T008b			1	2	2	2
T009a	5	1	1	1	1	1
T009b	2	2	1	1		
T010a	1		1		1	
T010b	1	5	1	1	1	2
T011a	5	3	3	3	5	2
T011b	3	3	1	1		3
T012a	1	3	1	1	2	3
T012b	4	4	3	1	3	3

trekkerID	poiInfo Easy	poiInf Useful	poiInfoComment	PanelMove Easy	PanelMove Useful
P002	2	1	Preferred to listen to the commentary as I could keep walking. To consult the written commentary one needs to stop for safety.	2	3
P003a	1	1	Very good made walk more interesting	1	1
P003b	1	1		2	1
T001a	1	1	Very good	1	1
T001b	1	1		1	1

trekkerID	poiInfo Easy	poiInf Useful	poiInfoComment	PanelMove Easy	PanelMove Useful
T002a	3	1		4	1
T002b	1	1		2	2
T003a	2	2		3	3
T003b	1	1		1	1
T004a	1	1	I liked different things being pointed out, some I would never have known.	2	2
T004b	2	3		3	2
T005a	1	1		1	1
T005b	1	1		1	1
T006a	3	2		3	2
T006b	1	1		1	1
T007a	1	1		5	1
T007b	1	1	Liked all the nature & environmental info.	3	1
T008a	1	1	The unit automatically enters the information panel as a pt of int. Is reached. However, it should automatically return to the prev. Panel (trekking e.g.) once a pt of int is left (i.e. Set a tolerance around a pt).	5	5
T008b	1	1		1	2
T009a	1	1		2	1
T009b	1	1		1	1
T010a	1			1	
T010b	1	1	I learned a great deal about points of interest.	1	1
T011a	1	1		4	2
T011b	4	2	I had some problems finding the info then getting back to the map.	1	
T012a	1	1		1	1
T012b	1	2	Varies with info.	3	2

trekkerID	poiInfo EffectHow	poiInfo EffectWhy	Recom'd	Recommend Why
P002	Made it very interesting	Flora, Fauna & Geological things of interest Improved my overall knowledge of the NZ landscape.	5	It is helpful if there is a time constraint on the walk i.e. Bus at the other end.; Helpful for comfort stop availability shelter points.
P003a	Made it more interesting	learnt more about nature.	4	Good for learning about local knowledge. Practice more first. Good for hazard warning
P003b	It can make the trek more interesting		4	Get more information about the walk way
T001a		It helps to understand the information along the track and it is bit fun to relax and chat and discuss	4	It helps to know the total time / total distance / time to reach to a point of interest / details about a point / mature of the track (steep / flat)

trekkerID	poiInfo EffectHow	poiInfo EffectWhy	Recom'd	Recommend Why
T001b	We will try to find the special things (tree e.g. Spider tunnel) and will slow down the walk but enjoy it.		5	There are many attractive places and specialty and also some history, esp about the eruption. This device can give many precious information along the way from the beginning till the end.
T002a	Makes it easier and faster to reach the destination.		5	
T002b		It is very useful information for describing each place.	5	It is very useful for the group in term of directing the way and you will not get lost! It also gives you useful information about the place and you can estimate the time that you will take for walking.
T003a	Made it more interesting	Gave me the opportunity to notice more points of interest.	5	Gives useful info along way to add to the experience, also gives a guide as to stopping places, danger spots, distance to travel, timing etc.
T003b	Stopped to listen & observe the POI instead of going past.	Also the junctions - where options on path to be taken was useful.	5	For people unfamiliar with this walk it gives the pertinent information relating to the walk. Helps with plan for rest steps, what facilities avail etc at rest points. Group can assess how far they may manage in a day.
T004a	Made me take notice of my surroundings more.	It did show us a bit but in a good way.	4	They would get more out of the walk because they would get more information about their surroundings as they go along.
T004b	Learnt lots, ie points of interest & vegetation.	Great to pick up "points" of interest - added depth to the walk.	4	I found it fun to use. Would utilize the map re:heights, distances etc. Good reassurance on right pathway especially with the information points and educational tool.
T005a		I've done the walk before so I have vague memories.	5	Its very easy to use, very handy.
T005b			4	
T006a	New information	Types of trees and history	4	Could be useful in emergency or sudden change in weather.
T006b	It makes me to keep an eye on the information as the hint???sometimes.		5	Because it's really helpful
T007a	Added much to the interest.	I like to hear history & geography described.	5	V. Helpful on a track which can be very risky - esp in poor weather.

trekkerID	poiInfo EffectHow	poiInfo EffectWhy	Recom'd	Recommend Why
T007b	Adds value to the landscape	Learned some extra knowledge	4	Some extra info provided. Time & distance indications.
T008a	I thought it was very useful, particularly since I'd walked this track many times and wasn't aware of the information presented.		4	The unit would suit novice/intermediate walkers who are interested in a running narration of the walk.
T008b	Slowed us down	Made us stop at places we wouldn't have)e.g. Funnelweb spider.	4	Useful for progress, info & sticking to track - may be very useful in snowy conditions/poor visibility.
T009a	Made it more interesting & enjoyable		4	Depending on how well they know the track I would recommend for those who've not done it before.
T009b	Made it more interesting	It was good to learn more about the environment.	4	Makes it more interesting if you know when/where/what to look out for.
T010a	Very informative. Made us stop and be more aware of our surroundings.		5	Very useful with lots of information.
T010b	Promoted conversation.		5	If I can use it this easily, then most people would be able to especially after only a minimal training session.
T011a	It helped us learn about nature but it slowed us down.		5	This is a great tool for education & also guidance.
T011b	It was nice to have some explanation of what stuff was for once.		5	I just really enjoyed using it and would like more people to experience.
T012a	Drew attention to items that I would otherwise have missed and/or ignored.		4	Tells where you are. Points of interest
T012b	Stopped briefly to make use of info.	Ditto	4	As noted before, the pts of interest keep things fun. But it does take a wee bit of getting used to.

trekkerID	49Dollar	49Dollar Comment	Max Dollar	maxDollar Comment
P002	5	As I enjoy knowing what I am looking at and knowing how far it is to each main stopping point, I would find the walk much more interesting and would feel confident at my ability to keep going from point to point.	100	I would have to compare this with hiring the services of a guide. If relative to this cost, up to \$100 was much cheaper I would go this far if I was particularly interested in knowing as much as I could about what I was seeing on the track.
P003a	2			
P003b	2	It is not easy to operate.		
T001a	3			
T001b	5	I've been there before & keep wondering about how the eruption happened- keen to know more detail about those places; red crater, soda spring, lake (blue,green) & the mountain. Would be very helpful to have the Trekwizard to explain & give more info.	60	It would be possible if I go in a group & share the cost to hire the Trekwizard. Otherwise, I rather study about the place before & after the hiking through internet.
T002a	4		100	
T002b	5	Reasonable price.	100	
T003a	3	Quite expensive		
T003b	5		110	Based on travelling with a group of 4 people over 4 days sharing equip is v. Reasonable cost - especially if not familiar with walk - also saves the bulkiness of maps.
T004a	3			Wouldn't know. It depends if I won lotto. Ha ha.
T004b	3	It is an odd \$ amount - needs to be an even amount. As a single person hiring it \$49.50 probably too much. If cost being split within a group a different story. As a single user \$30-40.		
T005a	5		100	
T005b	3		100	
T006a	3		90	
T006b	5		100	
T007a	4	A useful tool.	60	I think more than \$50 to be too costly
T007b	5	If I was along - definitely. If in a group, may be not - leader might.		
T008a	2	I would bring an information book along.	100	If I could keep the TrekWizard I would be keen. Comment 10 :1.Use vector based maps rather than BMP. 10:2. Auto return to map once left pt of interest. 10:6Too many pts can be shown when trying to find a particular pt of interest.
T008b	4		80	

trekkerID	49Dollar	49Dollar Comment	Max Dollar	maxDollar Comment
T009a	3	Depends on my bank balance! Would do so if I needed to complete it by a certain time.	60	
T009b	4		80	
T010a	4		60	
T010b	5		60	
T011a	5	If I was experienced I wouldn't bother. If I had not done it I would hire.	60	I think it depends on your experience.
T011b	3	I wouldn't usually take money with me on a trek, so if you had eftpos it would be more likely.		
T012a	2	It would maybe distract from enjoying the scenery.		N/A
T012b	3	Perhaps worthwhile, but a bit pricey.		

TrekWizard Field Trials – Map Usability

Trekker No: _____

Date: _____

1. Please finish the following sentences according your impression of the brochure and map at the completion of your trek. Please comment on your ratings:

- 1.1. The time required for a trek is
- easy to determine.
 -
 -
 -
 - difficult to determine.
 - very useful to know.
 -
 -
 - not useful to know.

Comment: _____

- 1.2. The length of a trek is
- easy to find.
 -
 -
 -
 - difficult to find.
 - very useful to know.
 -
 -
 - not useful to know.

Comment: _____

- 1.3. The time of trek completion is
- easy to determine.
 -
 -
 -
 - difficult to determine.
 - very useful to know.
 -
 -
 - not useful to know.

Comment: _____

1.4. The time required to reach a point of interest is

- easy to determine.
-
-
-
- difficult to determine.
- very useful to know.
-
-
-
- not useful to know.

Comment: _____

1.5. The distance to a point of interest is

- easy to determine.
-
-
-
- difficult to determine.
- very useful to know.
-
-
-
- not useful to know.

Comment: _____

1.6. The time a point of interest will be reached is

- easy to determine.
-
-
-
- difficult to determine.
- very useful to know.
-
-
-
- not useful to know.

Comment: _____

- 1.7. How much time is available for a rest break is
- easy to determine.
 -
 -
 -
 - difficult to determine.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 1.8. Where the trail is steep or flat is
- easy to determine.
 -
 -
 -
 - difficult to determine.
 - very useful to know.
 -
 -
 -
 - not useful to know.

Comment: _____

- 1.9. Finding a specific point of interest is
- easy to do.
 -
 -
 -
 - difficult to do.
 - very useful to do.
 -
 -
 -
 - not useful to do.

Comment: _____

- 1.10. Finding the information for a point of interest is
- easy to do.
 -
 -
 -
 - difficult to do.
 - very useful to know.
 -
 -
 - not useful to know.

Comment: _____







2. Which information provided seemed particularly valuable?

3. Which information provided didn't seem particularly valuable?

4. What other information, if any, would you like to see provided?

Symbols

Which of the following symbols you remember seeing? What is their meaning or purpose?

Symbol	Seen	Meaning/Purpose
		
		
		
		
		
		

Stop here and answer the following questions after your walk with the Trekwizard

Now that you have walked with a map and brochure as well as the Trekwizard, please compare the two.

5. Which was easier to use?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Map & Brochure		about the same		Trekwizard

6. Which was most informative?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Map & Brochure		about the same		Trekwizard

7. Which was most enjoyable?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Map & Brochure		about the same		Trekwizard

8. Which was easiest to walk with?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Map & Brochure		about the same		Trekwizard

9. Which did you prefer?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Map & Brochure		about the same		Trekwizard

10. If you were part of a group intending to walk the Tongariro crossing, how would you advise the group about Trekwizard?

Strongly discourage them from using Trekwizard

Probably discourage them from using Trekwizard

Not recommend **either using or not using** Trekwizard

Probably encourage them to use Trekwizard

Strongly encourage them to use Trekwizard

Give reasons for your recommendation.

.....
.....
.....
.....

11. If you could hire Trekwizard at the start of the Tongariro track and return it at the end of the track, how likely would you be to hire Trekwizard if it cost \$49?

I would **definitely not hire** Trekwizard

I would **probably not hire** Trekwizard

I **might or might not hire** Trekwizard

I would **probably hire** Trekwizard

I would **definitely hire** Trekwizard

Comment:
.....
.....

12. If you answered the question above by ticking probably or definitely hire Trekwizard if it cost \$49. At what price point would you **definitely not hire** Trekwizard? (Please circle)

\$60 \$70 \$80 \$90 \$100 \$110 \$120 \$130 \$140 \$150

Comment:
.....
.....

How might this product be improved?

.....
.....
.....
.....

Trekker – Map Data

trekkerID	ETT Easy	ETT Useful	TrekDist Easy	TrekDist Useful	TrekETA Easy	TrekETA Useful
M001a	3	2	4	2	3	2
M001b	4	1	5	3	3	3
M002a	2	1	1	1	1	1
M002b	4	1	3	1	4	1
M003a	3	1	1	1	3	2
M003b	4	1	4	1	4	1
M004a	2	3	2	2	2	3
M004b	3	2	3	3	3	3
M005a	2	1	2	1	1	1
M005b	1		1		1	
M006a	5	1	3	1	5	1
M006b	5	2	1	1	3	2
M007a	2	2	1	2	3	2
M007b	4	2	2	1	4	1

trekkerID	poiETT Easy	poiETT Useful	poiDist Easy	poiDist Useful	poiETA Easy	poiETA Useful
M001a	4	3	4	3	4	3
M001b	5	4	5	3	5	3
M002a	5	2	2	2	2	2
M002b	4	2	3	2	4	2
M003a	4	1	3	4	4	1
M003b	4	1	3	1	3	1
M004a	4	2	3	3	3	3
M004b	3	2	3	3	3	2
M005a	2	2	2	2	2	2
M005b	3	5	2	5	4	5
M006a	3	1	3	1	3	1
M006b	5	3	5	2	5	2
M007a	2	3	3	3	2	3
M007b	2	2	2	2	3	3

trekkerID	RestTime Easy	RestTime Useful	Steep Easy	Steep Useful	poiFind Easy	poiFind Useful	poiInfo Easy	poiInfo Useful
M001a	4	2	5	2	4	2	5	2
M001b	2	3	4	3	5	2	5	2
M002a	4	3	5	3	1	3	4	2
M002b	3	3	1	2	2	2	2	3
M003a	4	5	3	1	4	1	5	1
M003b	4	3	4	3	3	3	3	3
M004a	2	5	4	4	3	2	3	2
M004b	1	5	4	4	3	3	3	2
M005a	2	3	2	1	2	2	4	2
M005b	5	5	5	5	3	2		
M006a	1	1	1	1	3	1	4	1
M006b	5	5	5	4	2	3	5	3
M007a	2	3	4	3	4	3	3	3
M007b	2	2	2	2	2	2	2	2

TrekWizard Field Trials – Interface Accessibility

Trekker No: _____

Date: _____

Note: If you are unable to answer a question promptly, please tick ‘Skip’ and move on to the next one.

Use the Trekwizard device to find the answers required in the next section.

-
- 1. How long is the Tongariro Crossing? _____ km Skip
 - 2. How long will it take to reach the Ketetahi Hut from the start? _____hrs_____min Skip
Hint: The Ketetahi Hut is near to where two track sections meet called the Ketetahi Intersection.
 - 3. How many bunks are there at the Ketetahi Hut? _____ Skip
 - 4. Which leg crosses the highest point on the trail? 1st, 2nd, 3rd, 4th, 5th Skip
 - 5. Approximately how high is the Emerald Lake intersection? _____ m Skip
 - 6. On the map, show your observer one of the steeper portions of the trail. done Skip
 - 7. On the map, show your observer one of the flatter portions of the trail. done Skip
-

- 8. Which of the above questions about the Tongariro Crossing was the easiest to answer?

- 9. Which of the above questions about the Tongariro Crossing was the hardest to answer?

- 10. In general how difficult/easy was it to answer the above question about the Tongariro Crossing using the Trekwizard?

very difficult
very easy

Comments: _____

TrekWizard Field Trials - Interface Accessibility

Trekker No: _____

Observer: _____

Date: _____

Note: If you are unable to answer a question promptly, please tick 'Skip' and move on to the next one.

Use the Trekwizard device to find the answers required in the next section.

1.	Time _____	Correct _____	Proficient: _____ (1 – 5)	19.2
2.	Time _____	Correct _____	Proficient: _____ (1 – 5)	5h11min
3.	Time _____	Correct _____	Proficient: _____ (1 – 5)	26
4.	Time _____	Correct _____	Proficient: _____ (1 – 5)	3rd
5.	Time _____	Correct _____	Proficient: _____ (1 – 5)	1300-1400
6.	Time _____	Correct _____	Proficient: _____ (1 – 5)	
7.	Time _____	Correct _____	Proficient: _____ (1 – 5)	

Learning Curve Data

TrekkerID	Test PreWalk	HowLong	HowLong Time	HowLong Correct	TrekTime	TrekTime Time	TrekTime Correct
P001	TRUE	19.3		TRUE	5:03		TRUE
P002	TRUE	19.2	00:30	TRUE	5:10	01:29	TRUE
P003a	FALSE	19	03:10	TRUE	5:11		TRUE
P003b	FALSE	19	04:10	TRUE	5:10		TRUE
T001a	TRUE	13.1	01:05	FALSE	5:10	02:11	TRUE
T001b	TRUE	13.1	00:22	FALSE	5:11	01:51	TRUE
T002a	TRUE	19.2	04:03	TRUE			FALSE
T002b	TRUE	19.2	00:10	TRUE	5:11	01:15	TRUE
T003a	FALSE	19.2	01:50	TRUE	15:13	03:43	TRUE
T003b	FALSE	19.2	00:40	TRUE	5:11	01:10	TRUE
T004a	TRUE		04:52	FALSE	5:11	14:50	TRUE
T004b	TRUE	19.2	02:16	TRUE	7:18	02:32	FALSE
T005a	FALSE	19.2	00:13	TRUE	5:10	01:30	TRUE
T005b	FALSE	13.1	00:09	FALSE	5:10	02:00	TRUE
T006a	FALSE	19.2	03:00	TRUE		03:40	FALSE
T006b	FALSE	19.2	01:54	TRUE	5:11	03:55	TRUE
T007a	TRUE	19.2	02:09	TRUE	5:11	09:12	TRUE
T007b	TRUE	19.2	00:29	TRUE	5:10	04:07	TRUE
T008a	TRUE	19.2	00:19	TRUE	5:10	01:17	TRUE
T008b	TRUE	19.2	00:15	TRUE	5:10	00:53	TRUE
T009a	FALSE	19.2	00:39	TRUE	5:10	01:48	TRUE
T009b	FALSE	8.03	00:46	FALSE	5:10	01:43	TRUE
T010a	TRUE	19.2	00:12	TRUE	5:10	01:41	TRUE
T010b	TRUE	19	00:34	TRUE	5:10	02:07	TRUE
T011a	FALSE	19	00:43	TRUE		05:02	FALSE
T011b	FALSE	19.2	00:33	TRUE	7:18	01:37	FALSE
T012a	FALSE	19	00:42	TRUE	5:10	04:59	TRUE
T012b	FALSE	19.2	00:53	TRUE		04:52	FALSE

TrekkerID	HutCount	HutCount Time	HutCount Correct	HighestLeg	HighestLeg Time	HighestLeg Correct
P001	26		TRUE	3		TRUE
P002	26	01:48	TRUE	3	04:40	TRUE
P003a	26		TRUE	4	10:31	FALSE
P003b	4	05:17	FALSE	3		TRUE
T001a	26	02:57	TRUE	3	03:35	TRUE
T001b	26	02:41	TRUE	4	03:15	FALSE
T002a			FALSE			FALSE
T002b	26	02:20	TRUE	3	03:15	TRUE
T003a	26	04:00	TRUE		04:30	FALSE
T003b	26	01:50	TRUE	3		TRUE
T004a			FALSE			FALSE
T004b	26	04:32	TRUE	3	15:42	TRUE
T005a	26	01:36	TRUE	3	02:00	TRUE

TrekkerID	HutCount	HutCount Time	HutCount Correct	HighestLeg	HighestLeg Time	HighestLeg Correct
T005b	26	02:20	TRUE	3	02:50	TRUE
T006a		04:02	FALSE	3	05:15	TRUE
T006b	26	04:30	TRUE	3	05:00	TRUE
T007a	26	10:52	TRUE	3	11:52	TRUE
T007b	26	12:10	TRUE	3	12:43	TRUE
T008a	26	01:36	TRUE	3	02:39	TRUE
T008b	26	01:08	TRUE	3	01:44	TRUE
T009a	26	02:13	TRUE	3	03:52	TRUE
T009b	26	03:37	TRUE	3	04:42	TRUE
T010a	26	02:52	TRUE	3	03:19	TRUE
T010b	26	03:36	TRUE	3	05:27	TRUE
T011a		06:21	FALSE	3	07:03	TRUE
T011b		06:36	FALSE	3	06:58	TRUE
T012a	26	05:32	TRUE	3	06:08	TRUE
T012b	26	05:25	TRUE	3	11:51	TRUE

TrekkerID	LakeAlt	LakeAlt Time	LakeAlt Correct	Steep	Steep Time	Steep Correct	Flat	Flat Time	Flat Correct
P001	1800		TRUE	TRUE		TRUE	TRUE	10:35	TRUE
P002	1800	08:06	TRUE	TRUE	08:26	TRUE	TRUE	08:56	TRUE
P003a	1750	14:50	TRUE	TRUE		TRUE	TRUE		TRUE
P003b	1500		FALSE	TRUE		FALSE	TRUE	12:06	FALSE
T001a	0	05:30	FALSE	TRUE		TRUE	TRUE	05:47	TRUE
T001b	0	05:05	FALSE	TRUE		TRUE	TRUE	06:30	TRUE
T002a			FALSE	FALSE		FALSE	FALSE		FALSE
T002b	1800	03:30	TRUE	TRUE	03:40	FALSE	TRUE	04:12	FALSE
T003a	0	05:26	FALSE	TRUE		TRUE	TRUE		TRUE
T003b			FALSE	TRUE		TRUE	TRUE		TRUE
T004a	0		FALSE	FALSE		FALSE	FALSE		FALSE
T004b	1800		TRUE	TRUE	13:50	FALSE	TRUE	13:55	FALSE
T005a	0	03:00	FALSE	TRUE	05:25	FALSE	TRUE	05:25	FALSE
T005b	0	03:30	FALSE	TRUE	04:30	FALSE	TRUE	04:30	FALSE
T006a	0	05:30	FALSE	TRUE	05:45	TRUE	TRUE	05:45	TRUE
T006b	1800	06:00	TRUE	TRUE	06:15	TRUE	TRUE	06:15	TRUE
T007a	1900	16:00	TRUE	TRUE	17:25	TRUE	TRUE	17:36	TRUE
T007b	2000	13:41	TRUE	TRUE	14:00	TRUE	TRUE	14:14	TRUE
T008a	1500	05:05	FALSE	TRUE	05:23	TRUE	TRUE	05:28	TRUE
T008b	1800	04:54	TRUE	TRUE	04:57	TRUE	TRUE	04:59	TRUE
T009a	1700	06:07	TRUE	TRUE	07:14	TRUE	TRUE	07:30	TRUE
T009b	0	07:35	FALSE	TRUE	08:13	TRUE	TRUE	08:16	TRUE
T010a	1800	06:45	TRUE	TRUE	06:59	TRUE	TRUE	07:19	TRUE
T010b	0	08:02	FALSE	TRUE	08:12	TRUE	TRUE	08:13	TRUE
T011a		07:08	FALSE	TRUE	07:56	TRUE	TRUE	08:16	TRUE
T011b	1900	08:52	TRUE	TRUE	12:00	TRUE	TRUE	12:30	TRUE
T012a	1350	07:09	FALSE	TRUE	07:49	TRUE	TRUE	08:51	TRUE
T012b	1500	13:29	FALSE	TRUE	13:58	TRUE	TRUE	14:10	TRUE

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