Australian Flexible Learning Framework

Supporting Flexible Learning Opportunities

New Practices in Flexible Learning

Mobile learning: handheld innovations in flexible learning

Project report

Part 3: Case studies

Marcus Ragus

November 2004

flexiblelearning.net.au

The project has been developed in collaboration with relevant Indigenous persons and readers are advised that the project materials may contain images, voices and comments from Aboriginal and Torres Strait Islanders.

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Preface

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Note: Product or services names are listed alphabetically.

Acer™ n30
Acrobat® 6
Acrobat® Reader®
Adobe® Reader® 6.0 Read Out Loud tool
Bluetooth®
BrailleNotes™
Brando Workshop Screen Protector
Cassiopeia®
Clearview Presenter™
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Colorgraphic® Voyager Presenter™
Colorgraphic® Voyager VGA CF™
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Microsoft® Windows® Mobile™
Microsoft® Word
Motion Computing® M1400
MovableType™
Narrator™
Nokia®
O2® Xda® II
Palm OS®
Palm®
PalmOne™ Zire™ 72
Pendragon® Forms™ 4.0
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Pocket Excel
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Sensory Software International®
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Westek®ClearVue™
Windows CE Computers
Windows Media® Player
Windows Media®
Windows® SE
Windows® XP
Windows® XP Professional
Windows® XP SP2
Windows® XP Tablet PC
ZoomText®

1 Project case studies

1.1 Introducing the case studies

The purpose of these case studies is to provide an insight into the overall project development process as it happened through the teams and individuals perspective. These case studies also provide an account of the activities followed and what was required to undertake them.

1.2 The case studies outlined include:

- the development and trial of four PDA resources for the Horticulture and Tourism area through the Royal Tasmanian Botanical Gardens
- the development of a comparatively simple PDA trial and its application for remote learning on Cape Barron Island by the island's Aboriginal community, based on the use of PDAs for the documentation of an island project
- the use of existing, simple and cost effective software to enable the design of an image-based product for use as a 'just-in-time' resource for bar training in the hospitality industry
- a horticulture trial used with assessors to record assessment data in the field using a PDA and a plug in SD camera with imaging software, incorporating voice and text. This included an additional trial where learners used the devices to record tasks undertaken by them in the workplace essentially as an electronic diary
- the conversion of existing Toolbox learning objects into useable PDA resources that can be used to compliment and enhance existing learning practice through electronic learning 'anywhere, anytime'
- using a Palm® Handheld for informal, reflective learning and knowledge management, based around the concept of moblogging. A case study by Kirsty Sharp.
- issues for people with a disability who wish to use a PDA in an educational setting. A case study by James Newton.

1.3 The evaluation

This encompassed both formal and informal process that involved the use of written, individual face-to-face interview and group discussion evaluation. When the project team was planning for the evaluations, it was identified that there would be a number of different audiences and situations that would have to be evaluated. These included:

- industry staff undertaking the development
- existing learners, including a range of age groups from primary school to adults
- learning practitioners, assessors and trainers
- members of the general public, who may not be formal learners.

1.4 Areas of investigation

- **The technology:** ease of use, usefulness, appropriateness, adaptiveness, efficiency, problems.

- **The trial development process:** effectiveness, impact on industry / community partnerships, future changes/ developments.
- **The trial:** effectiveness, validity, ongoing use, acceptance of process, difficulties encountered.
- **The learning:** impact on personal professional development, potential impact on the organisation, resonance of individual's experience, impact on the overall learning sector.
- **The future:** future impact on personal and organisational learning and programs, impact on organisational ITC infrastructure, suggestions to explore.

1.5 Evaluation plan

Each of the areas identified required separate and overlapping evaluation methodologies.

1.5.1 Technology evaluation

Target: technical experts, learners, resource developers or adaptors, workplace trainer and assessors.

Focus: impact of hardware and software utilised on learning and assessment activities, resource development process and integration of learning/ assessment activities with work tasks.

Aspects:

- hardware; memory capacity, operating system, peripherals.
- software; range available, specific applications for set purposes, conversion processes.
- resource development models; conversion of learning objects to handheld platforms, speed and ease of development and adaptation of materials, documentation/ support available.

1.5.2 Trial development process

Target: learners, workplace supervisors, trainers and assessors, enterprise representatives, pilot managers.

Focus: initial perceptions of handheld technology, level of interest from trial participants.

Aspects: ease of materials conversion to handhelds, initial training in use of handhelds for trial participants.

1.5.3 Trial evaluation

Target: learners, workplace supervisors, trainers and assessors, enterprise representatives, pilot managers.

Focus: drivers for and barriers against sustained use of handhelds for learning.

Aspects: integration of handhelds into workplace activity, types of learning and assessment activities suited to particular industry sectors, difficulties experienced and solutions discovered.

1.5.4 Learning evaluation

Target: learners, workplace supervisors, trainers and assessors.

Focus: impact on the quality of the learning and assessment process.

Aspects: engagement with learning activities, assessment (evidence gathering and generation), perceived value of various learning activities, participation in reflective activities (for example, journaling), shift in perception recognising informal learning as part of work activity, appropriateness of handhelds as a tool for workplace observation recording by both learner and assessors.

1.5.5 Future impact evaluation

Target: learners, workplace supervisors, trainers and assessors, enterprise representatives.

Focus: ongoing impact of PDAs on organisation and individuals.

Aspects: future impact on personal and organisational learning and programs, impact on organisational information and telecommunications infrastructure, suggestions to explore.

2 The trial sites

2.1 The Royal Tasmanian Botanical Gardens (RTBG), Hobart, Tasmania

Situated at the Queens Domain, Hobart on the banks of the Derwent River, the Royal Tasmanian Botanical Gardens offers visitors a wonderful opportunity to explore a range of experiences from the vast collection of unique Tasmanian native plants through to the many temperate and cool climate exotic exhibits. It is the home of the world's one and only Subantarctic Plant House where, unlike a typical hot-house, the temperature is kept very cold (around 7 to 9°C). This temperature is perfect for the types of plants living inside it.

There are forty staff based at the gardens with twenty-five of these assigned to field duties ranging from nursery production to landscape construction and maintenance. Additionally, there are management and research staff and one education officer.

The gardens provide educational tours, classes and demonstrations as well as a range of plant interpretation services for interest groups, schools and other educational bodies.

2.2 Enterprise partnership

The development of the enterprise partnership between the RTBG and the Institute of TAFE Tasmania, Natural Resources program has been an ongoing and mutually beneficial initiative encouraged by both parties.

The New Practices in Flexible Learning project has provided a catalyst that has increased and strengthened this relationship through providing opportunities for staff within both organisations to work together on common goals. This has enhanced staff members' understanding of cross-organisational work practices and exposed them to new and interesting concepts in team and project work.

The following feedback was provided by Richard Symmonds, Manager Botanical Estate, in a mid project report:

> …Clearly defined project descriptions and timelines, coupled with regular on-site meetings and training, has enabled the project teams to gain a number of benefits from being involved in this project. The benefits so far have been:
>
> - a strengthening of the RTBG partnership with TAFE Tasmania
> - exposure of the organisation to new technology
> - training in software dealing with presentations (PowerPoint® and Front Page™), which staff have since used in other areas
> - an increase in the basic personal computer skills of the staff involved in the projects (file sharing, working in different software, saving in different formats)
> - each project has created an opportunity for long term novel learning approaches in terms of how the RTBG presents its educational program, and
> - discussions and interest in the RTBG's own hardware and software requirements.

Evaluation of the project's process has provided evidence of the benefits arising from the project partnership and its application within the enterprise. Both informal and formal evaluation has been conducted. Participant feedback has indicated that, as a result of practices initiated by the project, there have been clear immediate and longer-term benefit to themselves and to the organisation.

The project has demonstrated that it is possible to provide personal development strategies for staff in both organisations simultaneously and that such strategies can be designed and targeted for a mixed audience comprised, for example, of managers, teachers, ground staff and apprentices. This approach proved popular with participants and allowed for networking and socialisation outside of their normal working groups.

A mutual management and decision-making process was encouraged from the very beginning of the project. This involved the RTBG director at the time (initially Steve Corbett and later Mark Fountain), the operations manager (Richard Symmonds) and sectional managers. This process was open and transparent, allowing all sides to operate as one and encouraging all to take ownership of the project's direction.

In the early stages of the partnership, staff were invited to a two hour project presentation and technology workshop where they were introduced to the equipment and what it could do. More than thirty-five staff members attended, a large proportion of the overall staff at the Gardens.

Interest was high throughout the presentation, with many already contributing ideas and thoughts on PDA usage within their traditional work routines. As a consequence of the interest shown within the workshop, participants were asked to document and submit their ideas for potential inclusion as project trials for the RTBG. A one-week deadline was agreed for the return of the initial proposals. More than twenty four project proposals were submitted to the Operations Manager, Richard Symmonds, making this one of the largest expressions of interest the gardens management has ever seen in response to any staff personal development exercise previously delivered.

Over the following week, the proposals were reviewed by RTBG management and New Practices in Flexible Learning State Project Manager, Marcus Ragus. Most were found to be of a high standard. It was obvious that the staff had put in a lot of their own time and effort into developing the proposals, ensuring that the ideas were valid and of practical organisational application. It was determined that the project could not accommodate all of the submitted ideas, as it would be logistically very difficult to complete all of them within the time allowed and because of restrictions on the amount of hardware that was available (that is, only six PDAs at that stage).

Four project proposals were identified as being the most suitable to continue as trials, with eleven of the successful individuals being asked to return for a proposal review and planning session the following week. All staff that had contributed proposals were given the option of attending the scheduled technology and software training sessions programmed within the development stage of the project.

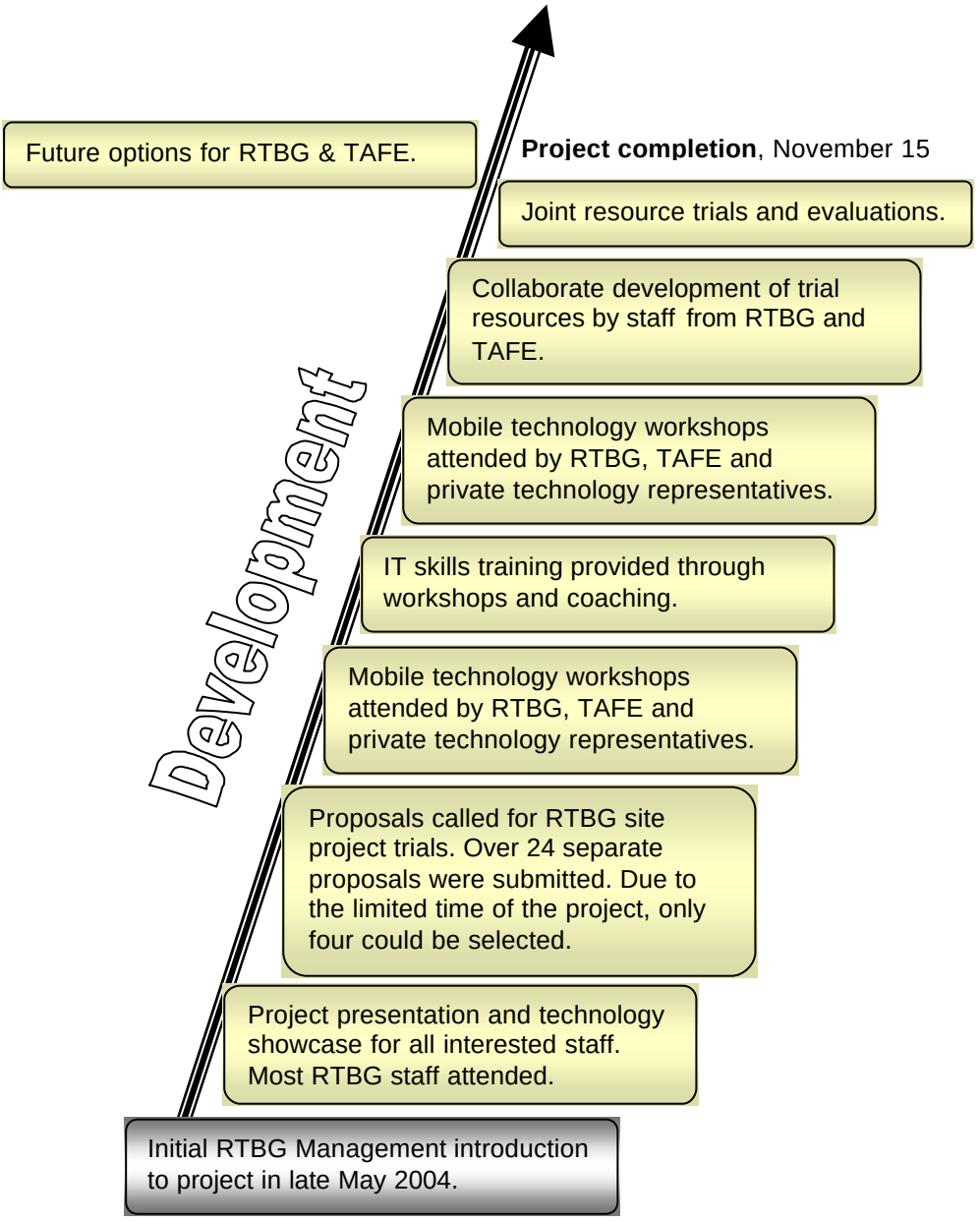
The four successful proposals were:

- *Pete's Vegie Patch*, an information resource based on the vegetable garden and legume patch development work of well-known gardening guru, Peter Cundall.

- *Catalogue of Tree Disorders*, a resource that provides the user with written and pictorial details of tree disorders found within the gardens.

- The *Foreshore Walk*, an electronic, virtual tour-guide for use on the RTBG foreshore walk.

- *Plant Adaptations*, which provides an interpretive and interactive resource for the learner as they make their way through a series of plant environments including fernery and rainforest, subantarctic, alpine and desert.



Project development sequence

Following the selection, proposals underwent a review process that clarified content and structure, as well as identifying the prospective learnings envisaged by the trial activities. At this stage, RTBG staff were also brought together into individual sub-project teams with each team working on developing one trial.

This action alone proved a significant change in daily work practices within the organisation with individuals who were previously unaccustomed to working together, subsequently coming together to work towards a common organisational goal. This was recognised by RTBG management as an important and positive move for the organisation and one that may not have eventuated if not for the New Practices in Flexible Learning project. Richard Symmonds, Manager Botanical Estate stated;

> In general, the creation of small project teams to tackle each project has developed stronger teamwork skills and created a focus on planning and the implementation of

work programs. A sense of being involved in cutting-edge technology has enthused participants and brought an awareness of how the RTBG can integrate technology into its workplace environment.

The RTBG staff, as content specialists, had the industry-specific knowledge needed to develop their proposals. Although two staff members were identified as having higher than base level IT skills, only one had a formal instructional learning background. It was obvious by the content of the proposals that instructional knowledge and IT skills were needed and that these were lacking amongst the trial team participants.

The strategy to assist the trial teams for the development of their resources focused on:

- provision of short training sessions in Microsoft® FrontPage® and Microsoft® PowerPoint® which were contextualised to provide participants with basic skills for creating PDA specific resources
- mobile technology workshops
- coaching and review sessions, that introduced learning design and basic resource design concepts such as storyboarding
- provision of specialist development (multimedia designers)

2.3 Timelines

RTBG PDA Project calendar

Event	Date	Time	Venue	Who
Assessment: informal discussions	26-Jul-04	12-1 pm	Library	Team leaders only from each project
Intro to PDA for projects	28-Jul-04	3:15-4:15	Library	*Pete's Vegie Patch & Catalogue of Tree Disorders* projects
Intro to PDA for projects	29-Jul-04	3:15-4:15	Library	*Plant Adaptations & Foreshore Walk* projects
Microsoft® PowerPoint® training	3-Aug-04	9-1 pm	Clarence Campus (includes lunch)	All project members
Assessment: informal discussions	4-Aug-04	12-1 pm	Library	Team leaders only from each project
Microsoft® FrontPage® training	24-Aug	1-4 pm	Clarence Campus (includes lunch)	All project members
Review of each projects progress	10-Aug		Library	Further details closer to the time
Trialing of PDA projects in the field	1-Sep-04			Further details closer to the time
Evaluation	4-Oct-04			Further details closer to the time

2.4 Project leaders and teams

Project title	Project leader	Project team
The Foreshore Walk	**Natalie Papworth**	Richard Symmonds, Caleb Pedder, Lyndel Holton
Pete's Vegie Patch	**Megan Brown**	Anne Griffin, Jai Thorpe, Chris Mac
Plant Adaptations	**Jean Gray**	Margot White
Catalogue of Tree Disorders	**Natalie Papworth**	Alan Mac, Alistair Hodgman

3 Case study 1: *Catalogue of Tree Disorders* trial

3.1 Participants

Natalie Papworth (Horticultural Botanist) and Alan Macfadyen (Manager Plant Collections).

3.2 Project

- The RTBG contains approximately 1500 trees over 5m tall.
- The health of the trees needs to be monitored on an annual basis to maintain the ongoing health of the collection, determine strategies for canopy replacement and threats to public safety.
- In the past this has been done by the Botanical Resources team inspecting each tree and recording details on paper for a number of parameters relating to condition and health.
- This information is then transferred to a computerised map and database.
- This transfer is a step that, if eliminated, would make the whole transfer more efficient.
- Many of the assessment parameters need to be streamlined so that a comparative scaled assessment of tree health can be used to prioritise tree work.

3.3 Proposal

The use of a PDA would streamline the existing procedure and would:

- be tied to the development of a more objective tree evaluation system with a range of measurement fields that simply require a check-box entry to assess:
  - structural integrity
  - disease status
  - pest status
  - risk potential
  - need of review by a trained arborist
- Allow for the development of the first stage of a pictorial and descriptive catalogue of pests, diseases and structural problems common to the RTBG to be viewed while assessment is undertaken. For this project this will feature:
  - a pictorial and descriptive slide show of *Armillaria* root rot
  - a pictorial and descriptive slide show of green spruce aphid
  - a pictorial and descriptive slide show of canopy imbalance.

3.4 Process

The early concept for this proposal was the development of a resource that provided detailed, up-to-date information on common tree disorders specific to the RTBG and that was suitable for mobile use in the field. It was envisaged that this information could be immediately updated in the field by expert field staff and provided to general staff, apprentices, students and other interested persons as required. The initial objective

was for the design of a PDA resource that would provide a database platform with straightforward interactive interface that allowed data entry such as text and images in the field. The RTBG staff also required the database to be able to actively sync information back to a centralised desktop computer program such as Microsoft® Access® and visa versa, therefore allowing staff to either enter information at the desktop or on the PDA in the field.

As the resource development progressed, it was determined that there would be a need within this project to separate the learning resource from the database. This was due primarily to the limited time aspect of the project and with a view to connecting the two at a later date, separate to the project.

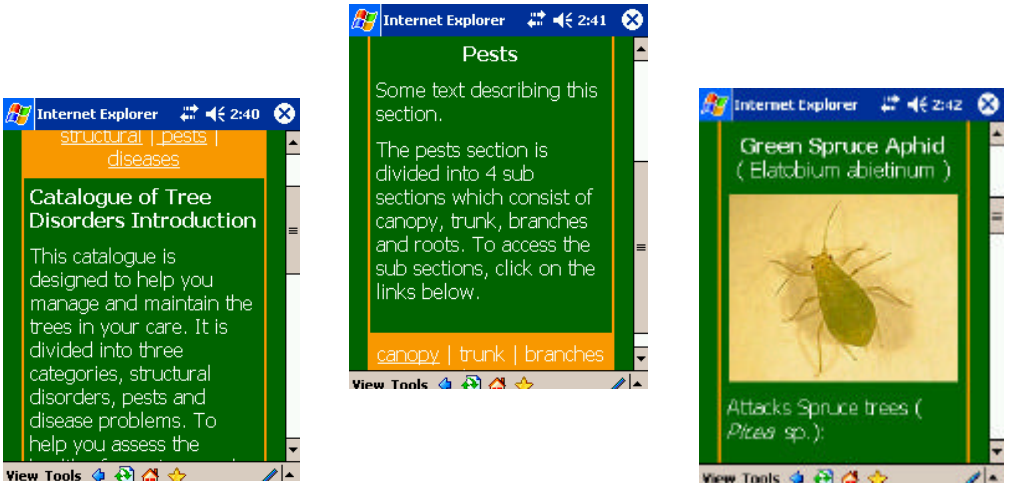
The resource development proceeded through a series of stages beginning with the production of the content and the identification of the platform and format. Natalie and Alan attended the technology and software workshops. The information they gained proved very useful in the development of the early prototypes of the resource.

They chose to detail the concept of their learning resource by storyboarding the outline through the design of an interactive Microsoft® PowerPoint® presentation. This was later used by Adam Maxwell, one of the multimedia designers of the Tasmanian New Practices in Flexible Learning project, to complete the html-based final product.

The initial storyboard version included hyperlinks and action buttons which provided an understanding of how the resource may behave if it was PDA based. This, they feel, gave them a greater appreciation for their concept than could have been realised through the traditional static, written storyboard.

Example screen shots of the original Microsoft® PowerPoint®

The ongoing development produced a series of three versions of the final html-based resource with each gradually being reviewed and refined by the project team. What has resulted is a partially populated resource, based on four common pest, disease and structural disorders found within trees located in the RTBG.

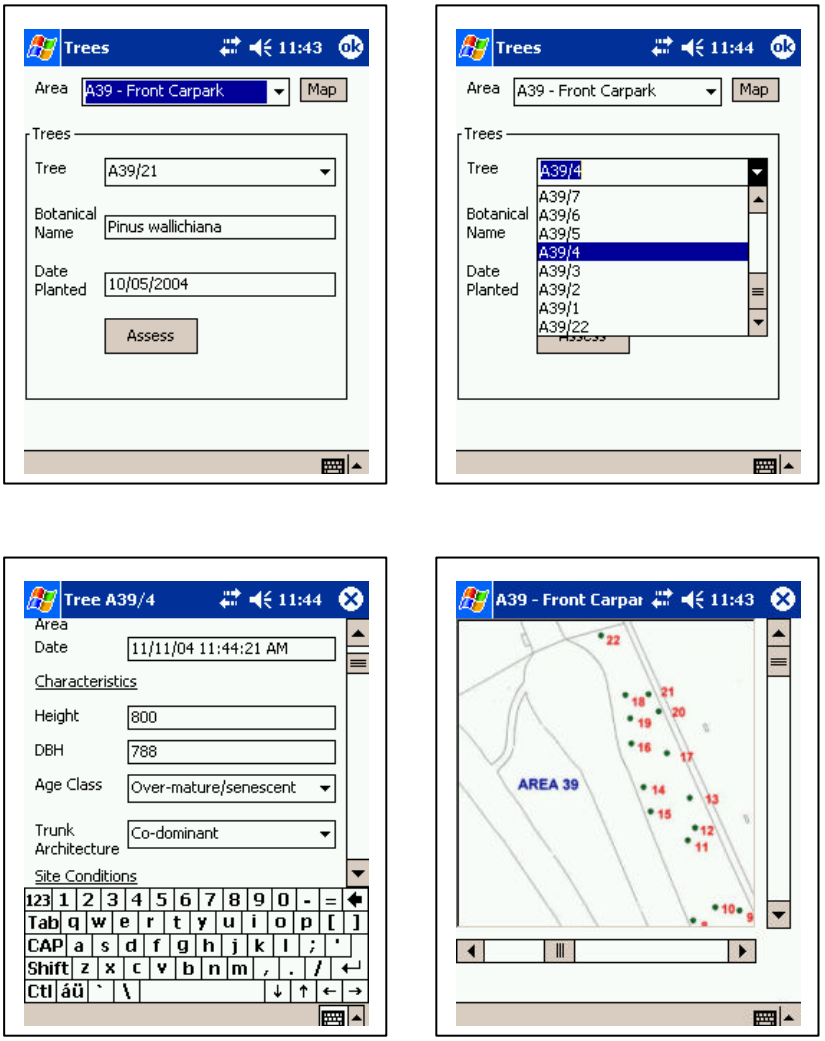


Example pages from the *Catalogue of Tree Disorders* resource

The second aspect of this resource was the production of a tree disorders database that was based on the hardcopy tree evaluation records currently used by staff. The existing practice had involved manual entry of information on a record sheet in the field which was re-entered into a computer database back at the office.

The new process required a database that effectively interfaced with Microsoft® Access® as this was the RTBG's most readily available database platform. Currently, there are no Microsoft® Access® versions for PDAs. However, there are a number of PDA database programs that provide bi-directional synchronization with Access®. One such program identified early in the development phase and regarded as a good option by the project team was Pendragon® Forms™ www.pendragon-software.com. Pendragon Forms was considered a good option primarily due to its ease of use and operational functionality. However, its primary limitation was that it was only available for Palm® operating systems and not for Pocket PC®. In addition, it was at the high end of cost for PDA software, retailing for around AUD$360.

Alternative cost effective products were researched and another option was eventually produced using open source Visual Basic® code. The final product was developed by the project's software and IT specialist, Stephen Brain, in conjunction with advice involving the specific tree data templates provided by the RTBG team. The resultant database effectively had very similar functionality to that offered by the commercial software, as well as ongoing potential for adding additional applications if desired. It was reasonably straightforward process for a designer with an understanding of Visual Basic® to produce the database. (See attachment in appendix).



Example *Catalogue of Tree Disorders* resource

There is a strong RTBG management focus to continue the development of this resource after the project's outcomes have been finalised as it is seen as an attractive model for knowledge management and resource sharing within the gardens.

3.5 Resource trial evaluation

Three of the RTBG apprentices, Jai Thorpe, Chris Macfadyen and Alistair Hodgeman were used to trial the *Catalogue of Tree Disorders* resource as it was felt they would be the main users of this type of learning package. The trial evaluation indicated that the package had ongoing potential as a resource for new and upcoming workers within the organisation. Feedback included:

> I would like to use the activity or something similar again because you can carry it out in the field and (because it) would make the identification of plants and pests in the field a lot easier.
>
> As a learning tool, the finished program would benefit me.
>
> If the chance arises to use it in our arbor team, it would be great.
>
> Have not seen Spruce Aphid before, have now!

Although some of the trial participants had some initial difficulties using the resource, they all felt it would become easier with more use. This certainly did not put them off the product or the equipment, with all participants confirming at the end that they would definitely use the resource for learning if they had the opportunity.

The *Catalogue of Tree Disorders* evaluation trials confirmed that the database was a practical and efficient solution for mobile data entry in the field. With further trials and use, it will be set up as a standard tree evaluation process within the gardens. Already there is interest in using the database structure for other recording practices in the organisation.

Natalie Papworth

> It could be adapted for auditing plant collections and other database-dependant work.

Alan Macfadyen

> Could be applied to plant disease assessment, stocktaking and mapping.

Although the trials were undertaken on a bright, sunny day, the screen was still very visible due mainly to the resource's dark text on a white background. Both participants found the resource easy to use with its drop down menus and keyboard data entry.

During the trial, a PDA shock and water resistant case was also trialed for prospective use in the field. The reinforced plastic case provides impact resistance if dropped from a height (guaranteed from a little more than 1m) and can be used in light rain or high moisture areas typical of the RTBG environment. The case trials proved successful and both participants were able to carry out data entry with ease while the PDA was in the case.

Some additional comments from the trial participants included:

Natalie Papworth

> Using the program developed so far already has allowed me to think of ways in which to improve the assessment set-up. The ability to input data that could then be transferred to a computer (desktop) database will save a lot of time. It will streamline current work practices and provide a record of tree health through time.

Alan Macfadyen

> The trial demonstrates this application will work well and quickly in the tree assessment program.

4 Case study 2: *Plant Adaptations* trial

4.1 Participants

Jean Gray, Education Officer and Margot White, Horticulturist.

4.2 Project description

The inspiration behind the development of this resource originated from an ongoing need by the RTBG to find initiatives to improve the delivery of information to visiting school groups. Due to staffing limits and the quantity of students able to move thorough the RTBG plant interpretive centre, visiting school groups had to be split into two before undertaking the tour. One group spent up to forty-five minutes with the RTBG education officer in the plant interpretation centre while the other group spent their own time investigating the gardens. Once this was completed, the two groups rotated.

The gardens required a learning activity that could keep the second group actively engaged with some form of 'assisted' self-paced learning. Consequently, the idea of mobile learning resources proved very attractive.

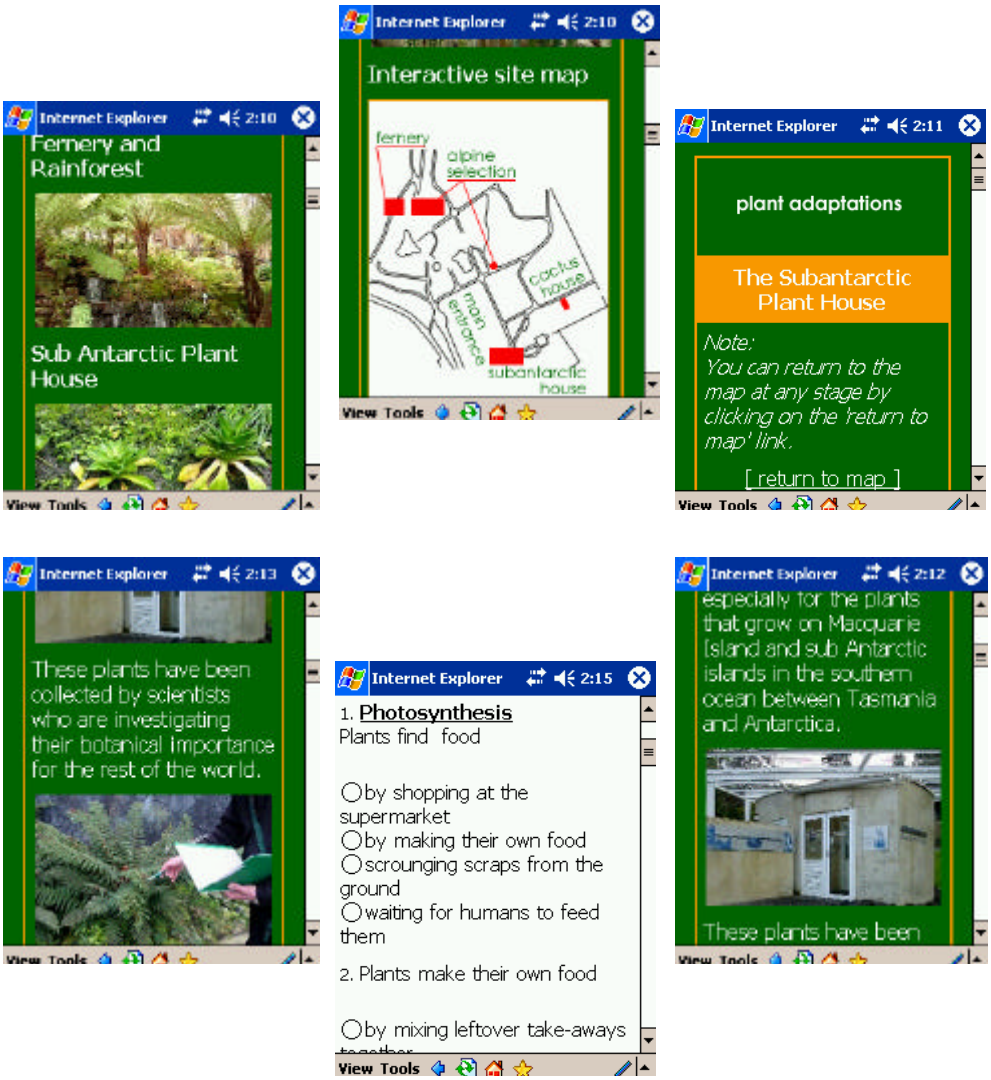
4.3 Process

Jean Gray, the education officer with the RTBG, originally proposed the idea of a PDA resource that could be used by students or visitors as they tour the gardens, essentially acting as a virtual tour guide or teacher. This resource would be designed around the topic of plant adaptations and would incorporate information, images, activities and a ten-question quiz. The proposal developed into reality with the information and design being planned through initial storyboard diagrams before being presented as a Microsoft® PowerPoint® storyboard by both Jean and Margot. The structure was further refined in conjunction with Marcus Ragus before being presented to Adam Maxwell for development as an html-based resource. The quality of the Microsoft® PowerPoint® resource has meant that it too can be used on a PDA as a self-paced resource through PDA presentation software such as Conduits® Pocket Slides™.

An outline of the PowerPoint® storyboard developed by the team

The html resource went through a series of three versions. Each time the resource was evaluated before recommendations for additions were made. The final production has resulted in an effective prototype that has enormous potential for the future addition of interactive elements such as voice over, sound and video. These were unable to be added within this project due to the time constraints of the schedule.

The RTBG see enormous potential in developing these types of resources and have proposed some innovative ways in which they could be provided to their visitors. For example, educational packages could be developed that are downloaded from the RTBG website and used offsite within the school, home or garden via a PDA device. It is envisaged that individuals could download a PDA tour/resource to their own device and then take the tour when they require 'anywhere, anytime'. The packages would also encompass additional notes and activities that could be completed outside of the gardens.



Example pages from the *Plant Adaptations* resource

4.4 Resource trial evaluation

The trials took place in the Royal Tasmanian Botanical Gardens and involved a group of grade four and five students and their teacher who were visiting from a Hobart school. The students were participating in the current series of plant discovery classes presented by the education staff at the gardens. The idea of the program is for students to be introduced to the various forms of plant adaptations by participating in practical learning activities as they visit various areas of the gardens.

After a brief five-minute introduction on the use of the PDA and the resource, the students were assigned to groups of three. Each group was then allocated a PDA.

Jean Gray

> The children commented that they would have liked a longer time to adjust to manipulating the program on the PDA before taking part in the trail. It was noticeable that the children all settled down after the first stop where they were more interested in

> the gadgetry than the message. All children understood the instructions and use of the software quickly and easily.

One member from each group was identified as the speaker. The speaker was given charge of the PDA and was responsible to read out the details of the resource to the others in their group as they progressed through the activities at each point on the trail.

The PDAs already had the resource pre-prepared with a link from a quick launch application on the front screen. The stylus had been replaced with a wooden skewer that was cheap, easily replaceable and yet effective.

Enthusiasm was very high amongst all of the students and all showed eagerness and engagement with the technology. One observer commented;

> It was amazing to see how easily the students were able to use the equipment. They navigated around the resource as though they designed it.

All appeared to find the technology easy to use. Links and scrolling seemed intuitive to them. If they went the wrong way, they always made it back without any assistance.

Jean Gray introducing the PDAs

Getting to know the PDAs

It was interesting to see the interaction and sharing amongst group members with each student taking turns at the various locations to become the speaker. All students actively participated in the activities presented in the resource.

Jean Gray

> The PDA was shared with three children. This seemed to personalise the lesson because they were in control of the learning. Other aspects came from this learning such as sharing and taking responsibility as a leader.

The student's attention was fully captured throughout the 45-minute trial with most of the students asking for more time at the end. Although the original trial was set for only 30 minutes, the interest and enthusiasm shown by the students for the resource meant that the time was extended.

Jean Gray

> The children's readiness to learn from this device surprised me. They were naturally drawn to manipulating the device in order to achieve learning. Why? School excursions always contain an element of novelty and learning is sometimes difficult to achieve when children are distracted. It is always tough for the teacher to gain their concentration under these conditions. A program on the PDA that provides a strong focus seemed to quickly settle the children into a learning mode.

They tended to work methodically through the resource, ensuring that they had finished the stage they were working on before they moved on to the next. It appeared that they did not want to miss anything.

Actively undertaking activities

Investigating the leaves of plants

At the end of the trial, the students were questioned about the activity. Their comments below illustrate their interest in this type of learning.

- We want more of this type of activity.
- It's easier to use.
- Rather use this than paper activities. More interactive, fun.
- We need more time, next time, to go through the stuff and look around.

The *Plant Adaptations* resource contains simple activities that get the students to interact with their surroundings when using the resource. Its design was successful in this instance and the addition of sound and/or other multimedia activities to this type of resource would not necessarily have made any additional contribution to the student's experience.

Jean Gray

All children thought it was fun to use and a valuable tool to learn from. They preferred a PDA from any book or paper handout. The extent of their learning was tested later in a teacher-led session and this group had retained the details of the plants in the trail (it was noted at one point that a child preferred the PDA to refer to, rather than the teacher who had prepared the trail). One child identified fungi using the picture on the PDA (this was) new knowledge.

5 *The Foreshore Walk* resource

5.1 Participants

Andrew McGown and Richard Symmonds.

5.2 Project description

The proposal stemmed from an existing foreshore regeneration program that had been a joint collaborative exercise between the RTBG, Claremont College Indigenous student stream and Caleb Pedder, Manager of Aboriginal Heritage with the Tasmanian Heritage Council.

It was originally proposed that the resource be targeted at providing a self-paced interactive product that could serve as a virtual tour guide for the foreshore area, essentially an electronic medium to enhance the overall experience.

It was felt that there could be a strong focus on the multimedia potential of the PDA handhelds (such as providing sound and video files) which would be included to provide a unique mechanism to describe the foreshore's significance from a cultural and evolutionary perspective. The concept was coined the electronic message stick, with the idea that examples of Aboriginal stories of life on the foreshore be included.

5.3 Process

In the early development stages, the concept ideas had focused on two main target groups for the resource; these were the students from Claremont College and visitors to the gardens.

It was also apparent that if the project were to include the Aboriginal content, it was imperative that Aboriginal input and approval for its design and content were obtained. The RTBG staff initiated correspondence with the representatives from the Aboriginal community through the Tasmanian Heritage Council. Unfortunately no one was available to contribute to the original concept proposal, although information was exchanged later as the project progressed.

During the initial phase of the development, the original RTBG working group for the foreshore project changed. Andrew McGown, interpretation officer with the gardens, took over the direction of the project. Due to time constraints, Andrew directed the focus of the resource towards the history and use of the foreshore and its existing and future development. He based the design around current and readily available information housed within the gardens resources. It was decided not to include sound and video within this prototype, although it was determined that this had potential to be introduced with an updated version of the resource in 2005.

The original intention of this resource was that it would be used through devices provided to visitors and students on a loan agreement. Due to the design of the resource, it could be used on cheaper low-end PDA models, thereby making the concept cost effective for the organisation.

Another delivery idea conceived by the project team was the downloadable resource. Potentially, the resource files could be provided through the RTBG website as a zipped, downloadable file. This would essentially allow anyone to download the resource to their own PDA and therefore allow its use anytime. This would also negate the need for the RTBG to have a large stock of hardware on hand for visitors. This concept has potential in all enterprises where interpretation programs are required; for example, museums, zoological displays, art galleries, etcetera.

The final resource prototype designed and developed by Andrew McGown is simple in structure and navigation making it an attractive resource. The time and commitment that he has made to the project is commendable.

The prototype is designed for use by persons walking along the foreshore walk. The trail has numbered, embedded markers that direct users to corresponding hyperlinks on the PDA resource where relevant information text and images are displayed. This text and image information could easily be added as a voice and/or video presentation that could be listened to via a portable headset. Results from the evaluations of this trial suggest that this inclusion would be justified.

Example pages of *The Foreshore Walk* resource

5.4 Resource trial evaluation

The resource was trialed on location at the foreshore walk and was assessed by a group from the Claremont College Indigenous student stream. The day presented well with sunshine and mild weather. This brought with it one of the first issues of using PDAs outside. Specifically, there were problems with viewing LCD screens in the sunshine. The project team had been presented with this issue before and had designed and planned its operations to limit this problem. However, it still is one of the biggest limitations of using a PDA outside (See *Hardware* in *Conclusion* section at the end of this document).

The trial also highlighted another issue of using technology for interpretation, particularly when the technology is attractive to the user. In this case, the users tended to focus on the technology more than on the surroundings. This was, in part, due to the fact that they were still getting to know the equipment and that the PDAs had lots of interesting information to provide. This issue also occurred during an impromptu trial run with a group of primary school students in the Subantarctic Plant House where the children were so fascinated by the devices and how they worked, it appeared they failed to appreciate what was around them.

An interesting related observation was noted by Andrew McGown:

> One observation is that using the device can be an Occupational Health and Safety risk as I noticed a couple of the participants trip while concentrating on the media and walking at the same time.

How could this be resolved? An interesting adaptation of the first trial on the foreshore may have the answer. When the PDA was provided to only one individual in a group of four, that individual took on the role of the tour guide.

As Andrew McGown explains,

> During the trials of the devices, the groups that enjoyed the tours the most were those that had only one PDA and the presentation was read aloud by one of the participants. It prompted discussion and questions and was excellent.

The group of students was asked to complete evaluations after the trial. The following points are an extrapolation of that feedback.

- Most students found the PDAs to be very attractive devices and all wanted to use them again on another occasion.
- All thought that they had learnt something about the foreshore and in a manner that was interesting and new.
- All thought the activity enhanced their overall experience.
- Many liked it because they could use it at their own pace; for example, ‘I like to be a self learner and you can go at your own pace’.
- Many were surprised and impressed by the amount of information the PDA could hold, as well as its usefulness as a device for learning.
- Comments included, ‘It was great I enjoyed it’ and ‘Great outdoor classroom’.

Some additional feedback from Andrew McGown, reflecting on the project and the trial, was that:

> If we had some form of Bluetooth® or IR markers that the PDA could detect as people approached, then we could have a self-running, individually paced product that allowed the visitor to look at the Royal Tasmanian Botanical Gardens and have relevant comments chime in once and a while with an invitation to find out more as in, ‘You are

now approaching the Canary Island Palm. Can you see it? It looks like a… Would you like to know more about Canary Island Palms?'

I think interactive audio is the biggest advantage of this media for interpretation, and can think of no other device that could deliver it in the same way. I am excited about those possibilities and the PDA's ramifications on the ongoing interpretive strategy for the Royal Tasmanian Botanical Gardens.

There is no doubt that for certain targeted user-groups, the options of sound, voice and video files would increase the effectiveness of the resources. This also identifies the need for headphones, particularly if used outside.

6 *Pete's Vegie Patch* resource

6.1 Participants

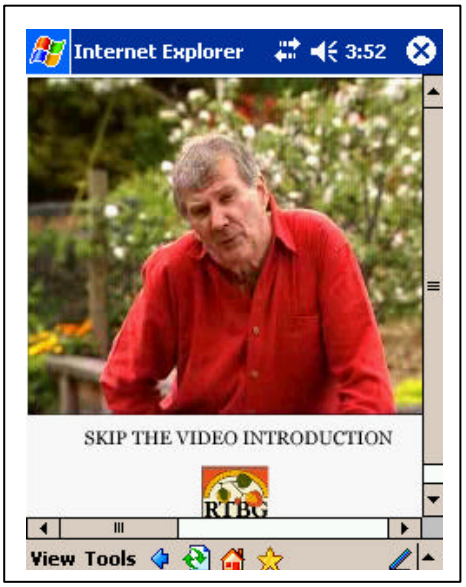
Anne Griffin, Megan Brown, Jai Thorpe, Chris Macfadyen and Alistair Hodgman.

6.2 Project description

As custodian of *Pete's Vegie Patch* (as filmed on the ABC's *Gardening Australia* TV series) since 1997, Anne Griffin has had the opportunity to assess the community need for information regarding the garden. *Pete's Vegie Patch* is one of the most visited sites in the RTBG and there is increasing community interest in establishing and growing vegetables in a similar way. The interest in organic gardening at home is undergoing resurgence, with all classes and talks provided by the RTBG dealing with backyard production being well patronised. The *Explore the Gardens* tour of *Pete's Vegie Patch* is one of the most successful of all the classes in the series.

The *Pete's Vegie Patch* has captured the interest of Australia's gardening public. The means of establishing a rotational planting system is always the aspect that most interests people and, unfortunately, one that can also cause considerable confusion.

To provide a simple learning tool using mobile technology that would outline this system was the objective of this proposal. This learning tool has the potential of becoming a wonderful ongoing asset for the RTBG.



Introductory screen: *Pete's Vegie Patch*

6.3 Process

The original proposal was to develop a resource that would encompass the six bed rotational planting within the garden and be aimed at enthusiastic visitors to *Pete's Vegie Patch* and TAFE horticulture students.

The process development stages started with the production of structured storyboards and the compilation of specialist content materials. This lead to the first stage of the project evaluation where it was determined that the content suggested at that time was too large and complex for the initial prototype being developed for the project trials. It was obvious that there was a need to reduce the content and concentrate on one aspect of the rotational plantings as a stage one development of the resource. Other details could be added at a later production date after the trials.

Example pages of *Pete's Vegie Patch* resource

One key element that the project team wished to benefit from was the use of gardening guru, Peter Cundall. His endorsement of the resource would certainly validate the quality of the content in the eyes of many and make the resource more attractive. The RTBG project team also wished to include some multimedia applications within the product with introductory and sectional video shorts of Peter Cundall. The project team approached Peter, explaining the concept and ideas of the project. He agreed to participate, volunteering his time for the production of the video.

As the development undertook its second stage, RTBG project team member Jai Thorpe started the development of a html-based version of the team's ideas for an early stage trial of the concept. As it progressed, various issues became apparent including the size of the product. Lots of detail meant that, when used on a PDA, there

was a large amount of scrolling required by users. This was not ideal and a better means of navigation to and from specific subject areas was required.

At this stage, Dr Robin Petterd, multimedia designer, was introduced to the RTBG project team. With an initial clarification of the team's objectives and an overall evaluation of the various media platforms available, a universal decision was made to develop the resource in Macromedia® Flash®.

The concept design was to be kept as simple as possible with navigation based on links from a set of primary pages that detail the rotational planting sequences. A self-analysis section was incorporated whereby users can assess their own garden conditions to determine the quality of their site for a vegetable garden and get helpful hints that will allow them to turn a difficult site into a vegetable paradise.

6.4 Resource trial evaluation

The evaluations took place in Peter Cundall's vegetable garden located on the eastern side of the Royal Tasmanian Botanical Gardens. The resource was trailed on people of varying age groups ranging from early twenties to seventy years of age, with all finding it interesting and relatively easy to use.

Anne Griffin noted that:

> They found it interesting and worked their way through it very competently! We asked them if they were familiar with the Internet. Response was, 'Yes, but not very good at it'. They loved the live Peter Cundall segment, were definite fans of the TV show and found it interesting to relate the plan to their own vegie patch at home. Overall, they seemed pleased that it was all so easy and confidently wrote 10 in the score for ease! We were with them for around half an hour.

Some found the links and functions a little difficult at first, but soon found it straightforward with a little practice. Once again, the screen proved a little more difficult to read in full sunlight and headphones were required for the introductory video. The need for headphones was due to some peripheral sounds that made the audio that was emitted straight from the PDA a little hard to hear.

Anne Griffin reported that:

> Our group was very pleased with the result, and particularly pleased with how the quiz/site planner was converted into a graph with click on suggestions. We had been stumped as to how to get it on a PDA, we just knew we wanted the quiz aspect but didn't know how to go about it. The colours were good, clear dark writing on light screen was presumably the most readable print. Ideally we would love to see more photographic content.

All were aware that the resource was a prototype and many mentioned that they would like to see an expanded version of the resource with additional content. It is the intention of RTBG to further develop this product in 2005.

7 The bar and beverage resource

7.1 Trial site

The Drysdale Institute of TAFE Tasmania, college of Food, Hospitality and Tourism.

7.2 Participants

James Oates, teacher of Food and Hospitality, Drysdale Institute of TAFE.

7.3 Project description

The project grew from a need to develop interesting, interactive resources for use by trainee bar and beverage staff in the workplace as just-in-time learning models. James' brief was to ensure that the resource could be easily put together by staff with limited IT skills (for example, a teacher) and that it could also be adapted or updated quickly. James describes himself as an enthusiastic user of computers for work, having good basic-level computing skills and a great candidate for this project trial. James attended the technology introduction workshops and received software coaching from the project team during the development of the resource.

It was also known that the food and hospitality industry was already introducing PDAs into restaurants and café's for work with wireless ordering systems. Additionally, the industry encourages workplace training, with many service managers preferring their staff to undertake training anywhere, anytime. Informal comment was provided to the project team by a food service manager who supported the need for his staff to have a learning package that they could 'pull out at a moments notice, in a break or quite period and undertake some study'. It was certainly easy to see that this concept could be integrated with an existing technological process (ordering with PDAs) that would, in turn, be very attractive to sectors of the industry.

From the start, the concept focused on using existing, cost-effective software options that did not require a great deal of training to use. It was also important to link the process to technology that was available to staff within the institute.

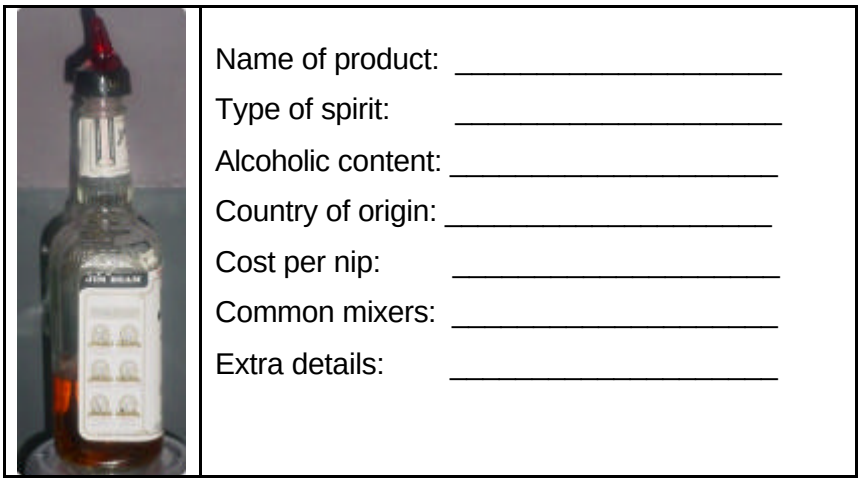
As the emphasis of this project was on practical bar work, specific subject-matter concepts were relatively easy to come up with. One that was quickly identified was the development of a resource that would assist bar staff with their product knowledge training — in this case, the identification of suitable liquors and mixers for use in a bar.

As learners within the bar course were required to recognise types of liquors by obscure characteristics such as the shape or pattern of the bottles, the colours of the glass or label, and differences in the bottle cap, images were identified as being an essential element of this resource. It was also important that the learners were able to have at least some interaction with the resource on the PDA, such as being able to add text or voice or to move between different brands.

After some initial research, the project group identified a range of useful software that would fulfil the objectives outlined above. Conduits® Pocket Album™ www.conduits.com was deemed the most functional and cost effective product. This product allows the user (in this case the teacher) to develop identification resources based on images, with the potential of adding text detail and voice or sound to each image.

Development of the trial resource required a range of 48 liquor and mixer bottle images to be taken and incorporated within the PDA resource. Once the images were transferred to the PDA through the active sync and filed within a pre-named folder, they had text and voice-overs added to them. It was found that it was better to add the text

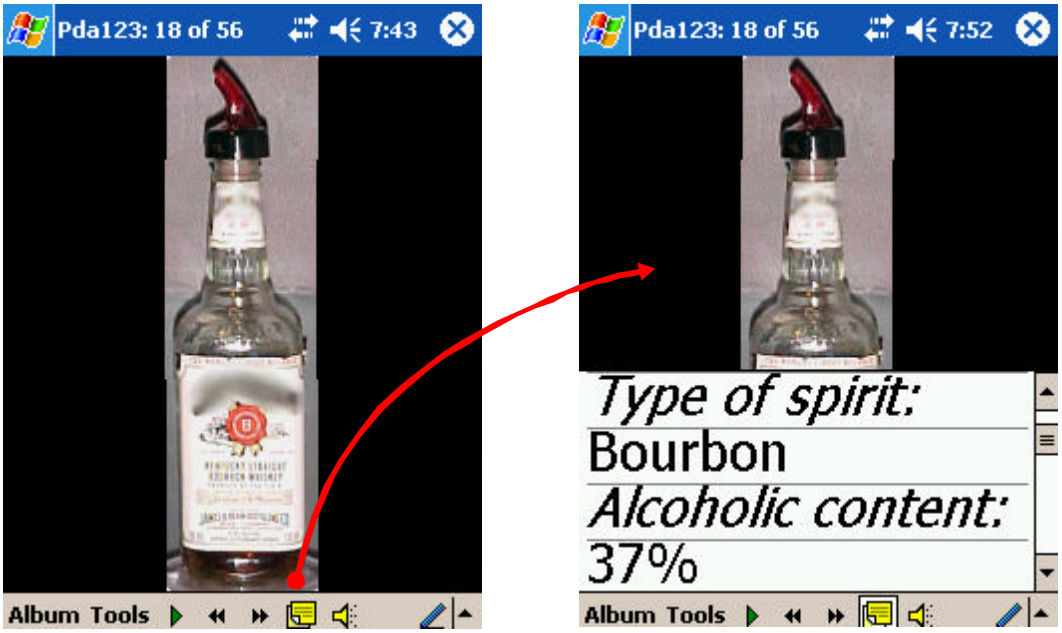
on the desktop in Microsoft® Word, and then to transfer it to the required image on the PDA, as this enabled more options for layout of text, fonts and font sizes.



Information detail for one example beverage

The resource was designed as a dual quiz and information activity. Two images of each bottle were taken with the first being a side view and the second a frontal view. The idea was that the student would look at the side view of the bottle and then complete the information on the text tag associated with the image. They would then move to the next slide to see the bottle from the front and read the correct information from the text detail, and/or voice over, provided with the image.

Pages from the student quiz of the *Bar Resource*, used with permission from Conduits®



Answer pages of the *Bar Resource*, used with permission from Conduits®

7.4 Resource trial evaluation

A trial of the resource was conducted with a small group of students, all less than 25 years of age, from the Certificate II Hospitality (Bar and Gaming) course within the public bar of the hospitality area of Drysdale College, Hobart.

The feedback was very positive from the trial participants. All participants thought the technology was attractive and most would have loved to use a PDA all the time for their learning if they had the opportunity. All found it fairly straightforward to use. Comments from the participants included:

Q: Did the activity enhance your overall experience?

> Kalinda: Yes, because the handheld computer is a 'fun' learning tool.
>
> Mo: Yes, learnt more about the origins of certain drinks, you can have a lot of information at your fingertips.

Q: Would you like to see more activities made available using this technology?

> Kalinda: Yes, because workplaces are now turning more towards technology based environment.

Trial participants found the resource structure simple and the content very good as a just-in-time product for the workplace. They were surprised by the fact that they could add text. Although they thought the ability to add text was a good idea, they did find that doing so was somewhat awkward and 'fiddley' as they had not done this before. They were all prepared to use the resource again if they could and all indicated that they would like to see more resources developed for use on these devices.

8 The Assessor trial

8.1 Location and background

The Horticulture and Agriculture team from the Institute of TAFE Tasmania provide workplace training and assessment to a range of learners across Tasmania. Their primary delivery can occur in a range of environments from the field to the farming shed. Therefore, it is imperative for them, and for the learner, that they operate with a high degree of flexibility in regard to the delivery of the learning and with respect to the materials and equipment they carry with them.

What flexible trainers like this are increasingly finding is that in today's learning bureaucracy, there is a required degree of accountability that can include issues such as signup in the field, workplace evidence collection, learner tracking and other management processes. These issues all add to the already complex logistics of delivery in the workplace. Consequently, such staff are always looking for innovative ways to more effectively manage their delivery process and they feel that mobile technology may provide a valuable option for them.

8.2 The trial

A handheld horticulture trial was developed with an emphasis upon designing a simple process that:

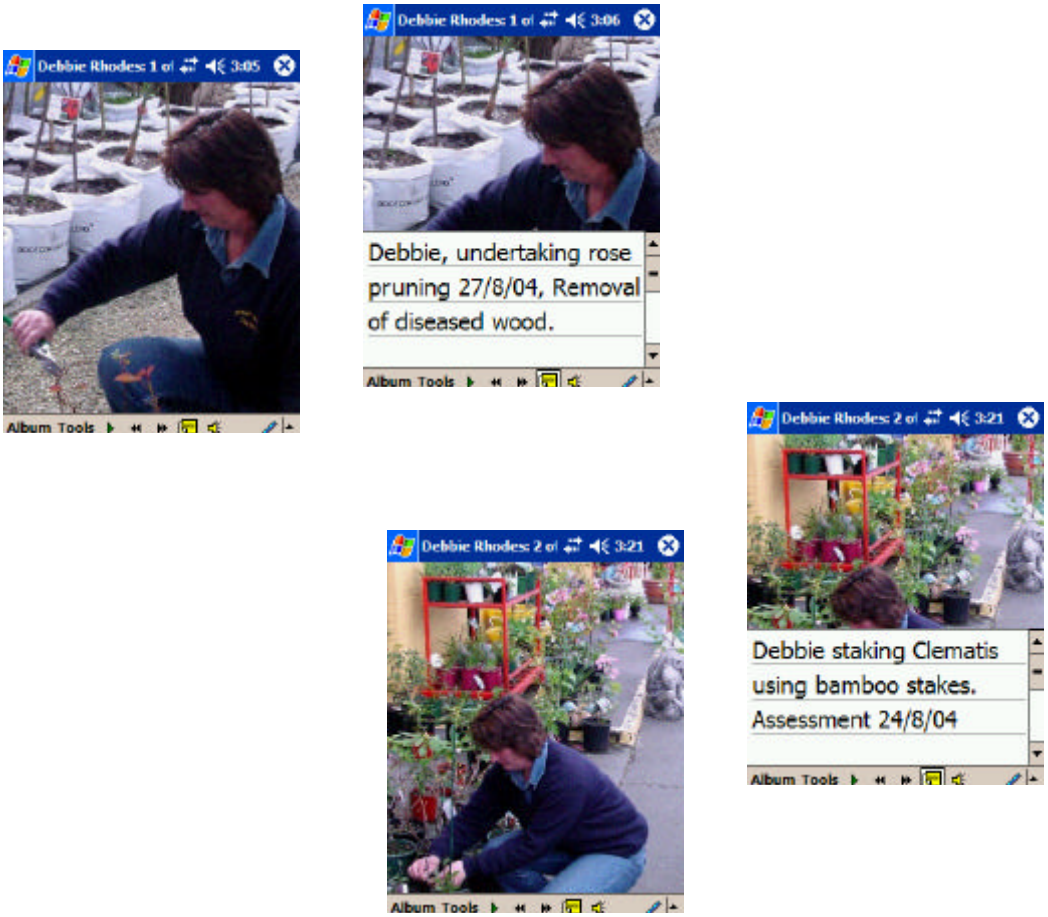
- used readily available and cost effective software, and
- enabled assessors to record assessment data in the field using a PDA and a plugin secure digital (SD) camera with imaging software incorporating voice and text.

This trial also included an additional trial where a learner, apprentice gardener Alistair Hodgeman, used the device essentially as an electronic diary to record tasks undertaken by him in the workplace.

Workplace trainer/assessors, David Eyles and Adam Churchill from the Natural Resources program area of the Institute of TAFE Tasmania, trialed the process with various learners in workplace environments for a two-week period. Both have limited computer and general ITC skills and regard themselves as novices in this area.

The software for the exercise was Conduits® Pocket Album™ and the images were taken with a peripheral, Hewlett-Packard® Photosmart SD mobile camera, attached to an HP® iPAQ Pocket PC® 1940. The images were compiled as a show, which could be a record of a particular visit, occasion or activity. Voice-over and text can be easily added to the images from within the program on the PDA. The files can then be stored to a memory card or transferred to a database on a desktop computer.

Standard image capture software HP® iPAQ Image Zone™ comes with the camera and this is also capable of presenting images as a show and has the option of voice-over and text addition.



Screen shots from assessment exercise using HP® Photosmart SD mobile camera and compiled in Conduits® Pocket Album™. Images used with permission from Conduits®.

8.3 Trial evaluation

Although both practitioners were initially sceptical about what the PDA could offer, by the end of the trial they were convinced of its usefulness to them. Comments included:

Adam Churchill:

> I was impressed with its capacity to store information and provide more tactile/experiential evidence of competence.

David Eyles:

> It is the best new equipment I have used for recording and storing information. I feel it will greatly enhance the process of assessment in the workplace.

File management was found to be very important and if not organised beforehand, it had the potential to get confusing. The images were first taken with the PDA camera and then transferred to the Pocket Album™ software.

Usually, a file was set up on the PDA prior to the start of the photo record session. The file was then named according to the type of visit or activity. All images from that activity were transferred to the corresponding file and then compiled into a show through Pocket Album™. Voice and text were added either during or after the activity. Having had limited experience with file management, both practitioners found this a little confusing.

Participants also found it a little difficult to add text at first until they determined which method of text entry suited them and then practiced the process.

Adam Churchill,

> It was getting easier each time I did it (use the PDA).

Additionally, participants found that that, due to the slow shutter action, the camera and PDA needed to be kept very still when operating the shutter mechanisms. Participants usually braced their arms against their body and used the stylus to press the capture button.

Participants were impressed by the activity and thought these devices would be beneficial to them and their delivery areas.

David Eyles:

> At the end I missed having it, I had to hand it back.

David also used the PDA as a diary organiser, which he found very useful, and suggested this could also be used to assist with student reminders, updates and tracking.

David Eyles,

> I would not hesitate using it instead of my standard diary.

Apprentice, Alistair Hodgeman, used the device to record a journal of activities undertaken by him in the workplace. He used the PDA and camera to record text, voice and images, essentially documenting evidence that can be given to the workplace assessor through email, swapping memory cards or beamed via IR or Bluetooth® to the assessor's PDA.

Although Alistair initially struggled with the technology, particularly the plug in camera and software, after a couple of days he became confident with its use.

Alistair:

> Initially, with some experimentation, I found the PDA quite easy to use.

Alistair was impressed by the fact that the PDA had a camera and thought this would be a real advantage and time-saver when it came to recording his evidence. He would have liked to use it for a longer period of time and was of the opinion that it could quite easily become part of his general workplace and study routine.

Once again, like the other users, this participant was impressed by the organiser capacity of the PDA and its ability to set times and dates for recall and reminders. He felt that he would be more inclined to use it than a standard written diary.

Alistair thought the idea of using the PDA to store and use learning resources was one of the major benefits for him. He stated, 'I would really like to use it as a device to assist my learning.'

9 Using a Palm® handheld for informal, reflective learning and knowledge management.

Case study by Kirsty Sharp

9.1 Introduction

Kirsty sharp is a Flexible Learning Manager with the Institute of TAFE Tasmania. She has been part of the management team for this project and has agreed to case study her use of a PalmOne™ Zire™ 72 for remote blogging.

9.2 Background

A key part of my knowledge management and reflective practice this year through my Flexible Learning Leaders (FLL) project has been the establishment and maintenance of a weblog. This website has served as a location for posting plans, ideas, reflections, links to interesting resources and so on. It has the advantage over paper that it can be easily searched. Just two days ago, I was looking for something that I knew I had photocopied from a text. I came across several other articles I had stashed away in a filing cabinet over 18 months ago. This was in pre-blog days. Nowadays I aim to digitise my notes and reflections. When it comes to report writing this saves me time because I can copy and paste text or images before refining. But most importantly, I can search on keywords and phrases.

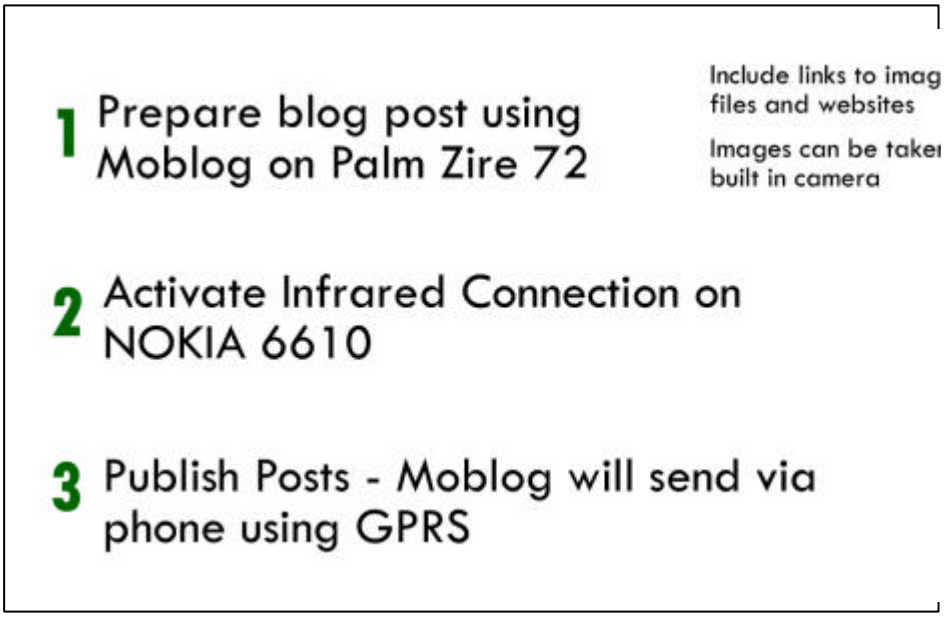
9.3 Portable knowledge capture tools

Through my FLL project, I have been supported to visit institutes and organisations beyond Tasmania. The portability of a handheld computer has been essential. In a conference session, I can hook up my PalmOne™ Zire™ 72 to a wireless keyboard and type my notes directly. There are some distinct advantages over a laptop — the battery life is more than double, both the Palm® and keyboard can fit in my handbag and other features like a built-in voice recorder can capture morning tea conversations (of course with the agreement of those participating!). In the evening, I can hook up the Palm® to my Internet-connected computer and upload my day's notes to my blog. Photos can enrich the experience and capture great PowerPoint® slides as well. It is possible also through an infrared connection to my mobile phone to do the same using a piece of software called mo:Blog, www.tektonica.com then follow links to mo:Blog. The only thing stopping me from using this more is the cost contrast between a local call dialup when I hook up a laptop in a hotel room, and the 'per byte' charging that applies to using the mobile phone. I have used it though — several entries in my blog were loaded via the phone.

9.4 Workflow

Software and hardware used:

- PalmOne™ Zire™ 72
- Nokia® 6610 with GPRS enabled — give your phone company a call to check associated charges and set up processes
- mo:Blog software, available at www.tektonica.com. There is a limited trial version available which means you get to test it with your equipment
- blog powered by MovableType™.



Sample summary of blog posting

9.5 Issues

One of the issues I still face is a reticence in myself to take the Palm® and keyboard out of my bag and use them in a small group setting. I feel quite comfortable in a large meeting or workshop or conference session. Maybe this has less to do with the technology than what I perceive as my role in the different settings.

10 Issues for people with a disability who wish to use a PDA in an educational setting

Case study by James Newton

10.1 Introduction

James is an Adaptive Technology Consultant & Trainer. He lost his sight at age 21 in 1996. Since then, he has gained expertise in operating a wide range of adaptive technologies. He has incredible insight into the worlds of blind and partially sighted Internet users, and has the almost unique perspective of how empowering accessible and inclusive practice can be.

James has worked in the private and TAFE sectors, providing educational and workplace accommodations for people with disabilities. He has consulted on digital document accessibility and useability in distributed or distance education and on hands-on adaptive technology training. In addition, he has been involved in web accessibility and useability testing for over 3 years.

As a person who has no formal web development qualifications, the approach James has taken is to work with the web developers. In this way, the coding knowledge and experience of the developer is utilised along with James' knowledge and experience of adaptive technology. The outcome is that web accessibility and useability for blind and low vision users is maximised.

Whilst the primary focus of his accommodations is vision loss, James does have general experience in other disabilities — experience which he drew on during his question and answer sessions with each user trial. Surnames of users in the trial have been omitted by request.

In relation to the report, James has not divided the references by disability. This is because he believes in matching tools to tasks, rather than tools to disability.

10.2 The users in the trial

To get an understanding of some of the practical barriers to access, limited user testing was undertaken. Twelve disabled users participated.

- Michael: a blind user with memory difficulties.
- Valerie: a user with a visual impairment.
- Angela: a user affected by a visual processing disorder.
- Daniel: a user affected by dysphonic dyslexia (an auditory processing disorder) who was a visual learner.
- Jade: a deaf user.
- Allan: a user with a hearing impairment.
- Stefan: a user with slight manual dexterity problems.
- Eric: a user affected by Lesch-Nyhan who suffered significant mobility impairments affecting the use of his hands.
- Brian: a user with mobility impairment, which significantly affects his ability to carry the add-ons.
- Billie: a user with Multiple Sclerosis, which significantly affects her ability to carry the add-ons.

- Tanya: a user affected by cerebral palsy who suffers significantly mobility impairments and speech impairments.
- Michelle: a user affected by dysgraphia and memory difficulties.

10.3 The process

This report is intended to assist educational technology specialists understand the practical issues of personal digital assistants (PDAs), otherwise known as palmtops or handheld PCs. The acronym PDA will be used throughout to describe this type of device.

The main focus of this case study has been on accessibility and useability issues related to the functionality of PDAs and the way those with disabilities may find the devices helpful or difficult to use due to the way the devices are designed. This case study presents the findings and recommendations arising from an evaluation of the degree to which PDAs are useful to students with specific disabilities in education.

PDAs are becoming increasingly popular, not solely for business and personal use but also for use in education. At all educational levels, PDAs are being used in the classroom for increasing students' organisation, fostering collaboration, and maximising portability of technology.

PDAs are well suited to these tasks. There are thousands of applications available (many of them free) that support a full spectrum of activities and academic disciplines. PDAs are also fiscally appealing to educational entities with most models being much cheaper than desktop computers.

In many ways, PDAs would appear to have the potential to provide benefits to individuals with disabilities. For example, people with learning disabilities or cognitive disabilities could benefit from the PDAs' organisational and task management functions. Also, some people with mobility impairments could benefit from the PDAs' small size, lightweight, and portability. **However, despite these benefits, PDAs are currently not accessible to all users.**

10.4 PDA accessibility: evaluation criteria

For the purpose of this research, I spent two hours with each disability (see following summaries of aspects that affect those with disabilities), using the Hewlett-Packard® iPAQ Pocket PC® h2210, and evaluated it against a set of accepted measures ('heuristics').

1. **Body** (size, shape and weight). PDAs should ideally fit easily into the average sized hand and be easy to hold. Tactile grips could provide greater support for those with manual dexterity problems.

   Ideally, PDAs and their peripheral devices should not be too heavy and should remain easily portable. Unfortunately, with respect to this research, most of the add-ons were fiddly to connect and can not be considered very robust.

2. **Touch screens/displays.** Users were required to interface with the iPAQ Pocket PC® using a small stylus for input and a small screen for output. People with visual impairments and those with reading difficulties found that coping with text on a small PDA was problematic. Additionally, this device was not accessible to individuals who were unable to use the stylus or who were unable to see the screen.

   Screens should ideally have a good quality resolution, a reasonable colour depth and clear screen lighting. However, as with all computer monitors and text that scrolls down or across a screen, it is a question of testing the tools in as different

environments as possible. In respect to this research, it was found that a dark area needed a bright screen and that the monochrome nature of the iPAQ Pocket PC® chosen did not suit some users when daylight faded.

3. **Switches/buttons.** These are used to execute functions such as cursor/focus navigation, quick start buttons for applications and power switches.

   People who had lost some sensitivity in their fingers, had manual dexterity problems or who were vision-impaired would benefit from better designed buttons and switches with clear markings and tactile additions, such as those offered on some mobile phones. In this evaluation, these tended to be at the bottom of the body of the iPAQ Pocket PC®, small and conspicuously lacking in tactile detail. Buttons should ideally be raised or clearly identifiable (both visually and by feel) and be in ergonomic positions. Sadly, some required far too much fiddly scrolling or direction twiddling to produce actions on the screen without offering the alternative of a jog dial (often easier to use) at the side of the device.

   Providing good support for hardware buttons to allow those operating PDAs with limited movement (perhaps manual dexterity problems or single-handed) would increase a PDA's useability.

4. **Operating Systems/GUI**. People with visual impairments had problems reading the text and graphics on the display as well as identifying the functions of the hardware buttons. They may benefit from the ability to resize text or magnify graphics and to change the colour or contrast of a display. External keyboards with shortcuts for navigation as well as an external magnifying glass may also be necessary. However, it has to be accepted that these devices may not be accessible or useable unless they have been especially designed for the purpose; for example, the PAC Mate™ by Freedom Scientific® www.freedomscientific.com then follow link to PAC Mate™. Pulse Data® are also providing a Palm® application that connects Braille Notes™ to Palm® PDAs (via a serial cable) so that a user can show a sighted person what they have been writing in Braille.

   People with specific learning difficulties and dyslexia found some of the complex graphical interfaces provided on the iPAQ Pocket PC® confusing; for example, cramped toolbars and menus with long lists. The small screen tended to result in a lack of 'white space' and there was little chance to choose a favourite font. Once again it may help to resize text or graphics and change the colour or contrast of a display.

   People with hearing impairments did not have any difficulties with the graphical user interface (GUI) and operating system. However, for those who tended to communicate in sign language and/or who found English difficult, the PDA language was confusing.

   People with mobility and dexterity difficulties did not have any problems looking at the GUI interface, but when they tried to access it via the iPAQ Pocket PC® stylus, small button or keyboard, issues of manipulation arose. With the options for mouse or switch access being limited, remote control, IR or Bluetooth® may be the way forward. In fact, those with very major mobility and communication difficulties have been using GUI interface communication aids for a long time, although these are often larger than the usual PDA. Examples of the Cassiopeia® with speech output and a simple interchangeable grid system can be found at Sensory Software International® www.sensorysoftware.com then follow links Computers and accessories for communication > Windows CE Computers.

   Ideally, the GUI should be intuitive, have user-friendly navigation and functionality and a clear, readable, uncluttered visual design that can be resized or enlarged.

The operating system should support large enough graphics to allow easy viewing and stylus control.

5. **Batteries.** The longer the battery life, the better. Most students will be at university or college for up to eight hours a day and will have different usage needs. As most are dependent on an AC charger, it can help to choose a model that does not require a cradle for charging (see below).
6. **Docking stations and Synchronisation cradles.** These are provided with the device to allow for data to be transferred between a PC and PDA. While some manage this through IR, Bluetooth® or a single cable, the iPAQ Pocket PC® requires the body of the PDA to be slotted into a cradle that is linked to an AC adaptor in order to recharge the battery.

   As has been mentioned, the difficulties that tend to arise with this aspect of using a PDA are related to dexterity and being able to slot the PDA into the fitting. Plugging in cables and setting up the synchronisation through the hardware button or software synch program on the computer or PDA was fraught with frustration when things did not go smoothly. Most of the time these tasks were fiddly. It is recommended that a few cradles are tried out and that their type of connection checked before purchasing the PDA.
7. **User alerts.** The means of alert for these PDAs was through a speaker. This created problems for people with hearing impairment. A suggestion would be for a vibrating alert to accompany an alarm. In addition, the auditory alarm should have a variable pitch and volume to allow for people with different hearing ranges.

   Visual alerts, such as a flashing light emitting diode (LED) or flashing display screen, help users with visual and/or hearing difficulties as well as those who do not wish to disturb others, such as when in a library. However, flashing display screens affect people with seizure disorders.

   It should also be kept in mind that the means of alert, such as the sharp tone given when user errors occur or the LED for visual stimuli, also causes problems for those with disorders such as Asperger Syndrome. This is due to the severe discomfort caused for these people by either loud, low frequency or sudden noises and by bright or flashing lights.

10.5 PDA accessibility: evaluation findings

10.5.1 Blind and vision impaired

As has been said, people with a visual impairment found that using a PDA was problematic mainly because of the size and clarity of the display. They also found the layout of hardware buttons on the PDA difficult to distinguish and use.

Features of the iPAQ Pocket PC® that hindered accessibility were:

- small screen size
- low screen resolution
- small standard font size
- short sentence wrapping distance
- small touch screen sensitivity areas
- poor screen contrast control
- poor (front, back or side) lighting for the screen
- buttons with low tactile quality

- buttons with small labelling or symbolism.

Further:

- 'live' Text-To-Speech (screen reading and document reading) could not be installed
- speech recognition (both text transcription and for 'actioning' commands) is unable to be installed
- no attachment for an external screen magnifier
- not all keyboard commands had navigational prompts.

10.5.2 Specific learning disabilities

People with specific learning difficulties found that some of the accessibility features (mentioned in the blind/visually impaired section above) also applied due to the fact that some had a visual-processing deficit or were ‘visual learners’.

Features of the iPAQ Pocket PC® that hindered accessibility were:

- un-intuitive layout of hardware buttons that action functional commands (for example, mal-aligned hardware)
- buttons for cursor navigation control
- un-intuitive location or actions of fixed on-screen buttons
- poor use of symbolism/icons and visual representations of actions or commands
- lack of true multimedia options
- poor quality calendar or diary functions that could be invaluable for those with short term memory difficulties.

Further:

- 'live' Text-To-Speech (screen reading and document reading) could not be installed
- speech recognition (both text transcription and for 'actioning' commands) is unable to be installed
- graphical navigation was not simple
- menu structures are not wholly clear.

10.5.3 Deaf/hearing impairment

Many of the difficulties that deaf users encountered have already been mentioned and are often the same issues that arise when using mobile phones.

Features of the iPAQ Pocket PC® that hindered accessibility were:

- alerts which are purely auditory (for example, a sharp tone given when user errors occur)
- complex use of PDA specific language.

10.5.4 Manual dexterity

A person with manual dexterity problems may find manipulating or using a PDA in their hands cumbersome or difficult. They may lack the dexterity needed to simultaneously coordinate holding and using a PDA. The iPAQ Pocket PC® has a touch screen and the GUI can be activated by touch.

Features of the iPAQ Pocket PC® that hindered accessibility were:

- holding a PDA for 'in hand' use
- type of force or fine touch required to action buttons or other physical controls
- small size and/or non-ergonomic shapes of buttons
- where stylus or touch screen controls are the only option
- small thin, hard to grip styli
- poor operating system support for hardware accessories (for example, additional keyboards).

Further:

- speech recognition (both text transcription and for 'actioning' commands) is not able to be installed.

10.5.5 Mobility impairment

A person with mobility impairment (that is, who may have difficulty in moving from place to place due to a physical or medical constraint) may find the portability of the iPAQ Pocket PC® useful. On the other hand, gross motor impairments cause operational difficulties.

Features of the iPAQ Pocket PC® that hindered accessibility were:

- the 'handheld' nature of PDAs, often not ruggerised
- a heavy weight to carry
- battery life requiring charging.

Further:

- speech recognition (both text transcription and for 'actioning' commands) is not able to be installed.

10.5.6 Speech and language difficulties

A person with speech or language difficulties may find it hard to cope with complex technical language and may prefer to use symbol or graphic-based communication systems.

Features of the iPAQ that hindered accessibility were:

- poor use of symbolism/icons and visual representations of actions or commands.
- poor speech output from written text or picture grids (that is, audible text to speech)
- poor quality built-in speakers
- lack of true multimedia options.

Further:

- 'live' Text-To-Speech (screen reading and document reading) is not able to be installed.

The keyboard for a PDA is compact and folds up. I have been unable to determine whether there is a more suitable one available that has the keys spaced at an appropriate distance for someone with motor skill limitations.

There is no screen magnification or screen reading for PDAs unless you go to a PacMate™ TNS [keyboard version] by Freedom Scientific®. This has no display and uses the JAWS® screen reader to access the PDA. The VoiceNote™ is another PDA for people who are blind or visually disabled. It uses a different access approach to get to

the applications. Which one would be most suitable for someone with a visual impairment requires further investigation. For further information on PacMate™ TNS, see www.freedomscientific.com then follow link to PAC Mate™. For further information on VoiceNote™: QT (QT stands for Qwerty keyboard, which is the standard keyboard for computers), see www.pulsedata.com then follow links Products > VoiceNote™

Viewing Flash® on a PDA is difficult as the image is quite tiny. Someone whose visual acuity or functional vision is low would not be able to see Flash®. The other issue is that Flash® doesn't translate well to the PDA environment.

Generally, Flash® is not scalable so it does not adjust itself to the size of the display. Also, even though they have been able to create accessible Flash for three years now, most people still don't do it. The biggest issue on a PDA though is scalability and useability. Unless material has been specifically designed for a PDA, it most likely will not display well.

Currently, Adobe® Reader® for PDAs is not accessible on either the PacMate™ or the VoiceNote™. Microsoft® PowerPoint® again will be quite small and there is no access to it on either the PacMate™ or VoiceNote™.

I have also found out that the Nokia® 9210 mobile phone doubles as a PDA, and although it is useable for the blind or visually disabled, its usage is limited. The Nokia® 9500 mobile phone that is due out November, 2004 will be better, although torques for such a device will not be available until 2005.

Alternatively, I would suggest consideration of a slate tablet like the Motion Computing® M1400 (www.motioncomputing.com then follow links Products and services > Tablet M1400) as an alternative to the PDA. Although the slate tablet has the look of a PDA, a more normal sized keyboard is available and since the monitor is larger, someone slightly vision-impaired would be able to see the screen. This alternative should be able to be used as long as an application hasn't been developed to only run on a PDA. People with a visual impairment find slate tablets more useful than a PacMate™ or VoiceNote™ because they can use full applications. Currently no screen magnification works on the slate tablet, but it can be used with the JAWS® screen reader.

PDF and Microsoft® PowerPoint® are not accessible on either the PacMate™ or VoiceNote™, which is why I suggested the slate above. For someone with a visual or motor disability who is trying to see the controls on a standard PDA, they will probably find this process frustrating. If they use the slate/M1400, they can use its larger display area. Adobe® Acrobat® 6 has a *Read Out Loud* tool and you can install JAWS® on the slate. So far, screen magnification software is problematic on the tablets. However, you can use the All Programs > Accessories > Accesibility > and the built in Magnifier and Narrator™ if you just need minimal support.

If a student has a visual disability, there is no adaptive technology for standard PDAs, which is why Pulse Data®, Freedom Scientific® and now VisuAide® developed handheld devices for people who are blind or visually disabled. The VisuAide® product should start shipping late October 2004, although it is a Braille interface and will be using the small PDA keyboard which doesn't help those with motor skill issues. For further information, see the product description at www.visuaide.com/index.en.asp then link to Maestro.

Unfortunately, none of the available adaptive technology can be installed on a standard PDA and since the whole concept of a PDA is to tap on the screen, the needs of people with disabilities appear to have been overlooked thus far. Devices such as the iPAQ Pocket PC® from Hewlett-Packard® use the Pocket Windows® operating system which, although looks similar to your desktop, again depends on tapping and functions slightly different to Windows® XP. The iPAQ Pocket PC® is the base for the PacMate™ and has successfully had a version of JAWS® added to it. This version of JAWS® is

dependent on the BNS or TNS architecture and therefore it can not be installed on a standard iPAQ Pocket PC®. The VoiceNote™ uses a Pulse Data® screen reader called Keysoft™ and provides a different approach to screen reading on a Pocket Windows® handheld.

Both the PacMate™ and the VoiceNote™ can also provide access to a talking global positioning satellite (GPS) tool and a digital audio information system (Daisy) reader. A version of Daisy is the standard for accessible textbooks in the US. These two additional tools for the note-takers provide improved access to information.

An external style sheet can be used to format content for a PDA. WML is being deprecated in favour of XML for PDA devices. This means that the current method of formatting and structuring content for PDAs is being replaced by XML because XML allows the use of content on several platforms instead of creating individual iterations of content for each device. Flash® should not be used as a content container.

In the case where a program/course uses applications developed specifically for a PDA, students with disabilities may well face other issues. Being informed of any such issues would help the author of this report to source information that may help in such instances. However, if a program/course is using the PDA for standard content, there is no reason a student with disabilities should have difficulty using the slate as an alternative.

For students who have motor skill issues, the slate tablet would let them use their handwriting to enter information in instances when handwriting is easier for person concerned. Slate tablets have a much broader range of choice of input: for example, speech recognition, on-screen keyboard which they can tap, external keyboard which is more like a standard keyboard, or handwriting. The Windows® XP Tablet PC operating system is a sub-set of Windows® XP Professional, so does include Narrator™ and Magnifier™.

Students would also be able to use Adobe® Acrobat 6™ on a slate, which has accessibility tools for reading and magnifying http://www.adobe.com. Along with a 'how to' guide for Adobe®, there is the how to create accessible PDF which is on the 'create accessible content' page at Adobe®.

If Windows® XP SP2 is installed on the above mentioned tablet along with the latest version of ZoomText® screen magnification, the only remaining issue for screen magnification is the use of the pen for handwriting. If a user with poor vision uses the mouse, there is no tracking problem. However, when they try to write, there is a gap between the pen in their hand and the cursor on screen. Consequently, in instances where screen magnification is needed on a tablet, the user will need to temporarily turn ZoomText off and use the writing pad — which is a line at the bottom of the screen to write text they want to be converted.

ZoomText® has just released a new version and Windows® has the new service pack, so they are incrementally working toward each other.

MAGic™ screen magnification will now also work, again without synchronisation for handwriting.

You cannot install Dragon™, JAWS® or TextHelp™ on any model of an iPAQ Pocket PC®. You can, however, put a recording tool that comes with Dragon™ on the iPAQ Pocket PC® so that you can record and then take the recording file when you sync the iPAQ Pocket PC® to your desktop, and transcribe it on your desktop computer. If you want an iPAQ Pocket PC® with JAWS®, you will have to buy a PacMate™ TNS. Unfortunately you cannot put Dragon™, or even the Dragon™ recorder tool, on a PacMate™. Given these limitations and taking into consideration both visual and motor issues, a slate is still the best alternative.

The keyboards that you can buy for an iPAQ Pocket PC® are small and compact and for the disability issues described above, will not give easy access to the device.

Whilst the iPAQ Pocket PC® is an inexpensive tool, it will not (at the time of writing this report) run any adaptive technology. Consequently, students with disabilities (especially visual and motor disabilities) will not currently be able to use this tool effectively.

If a student with epilepsy sees screen flicker, then they should not use that screen. With regard to this present research, there were a few instances where students with visual disabilities saw screen flicker on computer monitors, although this was specific to their own eye condition. Since we know that there are blinking and flickering rates that can cause an epileptic seizure in people who don't have epilepsy, it is a good rule-of-thumb that if a student is affected by flicker, they should not use the particular device. Being able to see the flicker is not something that is measurable in an assessment except by word of the student. Once a person identifies that they can see screen flicker, they should be moved away from that monitor immediately.

10.5.7 Final thoughts

Upon further reflection, new scripts and languages would also be difficult for those with dyslexia, so keyboard input would be preferable. Making notes in a lecture situation would also present problems, as the PDA would have some trouble coping with diagrams being drawn beside notes, and thus would require more effort than when compared to pen and paper mind maps.

Also, users with a disability may not feel happy using their PDA in public, as people usually stare when a portable keyboard is attached or a magnifying glass is added on top of the screen.

The use of a PDA as an assistive technology seems to have barely been explored in the mainstream educational sector. Within the educational or supplier infrastructure, the expertise of the operating systems, software or accessibility features does not at present exist. I do note, however, that Hewlett-Packard® is making an effort toward improved accessibility of its product.

11 Creating digital PDA resources using Microsoft® PowerPoint®

During this project we have investigated the potential for using Microsoft® PowerPoint® for the development of simple interactive resources for PDAs with considerable success. The project's focus builds on the concept of digital coaching aids (DCAs) that were originally designed and developed by the Institute of TAFE Tasmania to enable staff to develop their own interactive digital resources using readily available 'common' software — in this case, Microsoft® PowerPoint®.

The design of most standard Microsoft® PowerPoint® presentations tends to be linear — one slide after another with navigation consisting of one slide forward and one slide back. The DCA concept diverges from the standard linear approach of presentations through creating PowerPoint® presentations that behave more like web pages with hyperlinks, hotspots and action settings.

PowerPoint® presentations can be played on most PDAs (both Pocket PC® and Palm OS®) using a PowerPoint® player. Microsoft® has decided not to develop a version of PowerPoint® for PDAs, instead allowing private developers to dominate this market with some interesting results. Currently there are a number of PowerPoint® players available with most providing at least basic PowerPoint® functionality on a PDA. During our research we reviewed the following three main players:

- Conduits® Pocket Slides™
- Presenter To Go®
- Clearview Presenter™

Of all three, Conduits® Pocket Slides™ http://www.conduits.com/home.asp provided the best functionality and conversion of PowerPoint® features for PDAs. By far the most impressive aspect of the software was its ability to convert hyperlinks, action-settings and sounds through to a PDA. As far as we can determine, it is the only software at the moment that can do this.

Hyperlinks and action settings (such as navigation buttons) can be activated in show view through the touch screen of the PDA. The Microsoft® PowerPoint® show is best used in landscape view. Using this option, the entire PDA screen becomes the resource view with no valuable PDA screen space being taken up by program frames.

Using Microsoft® PowerPoint® together with this software, it is also theoretically possible to develop resources such as Web Quests. Web Quests can be described as investigative action learning activities that use hyperlinks to link to resources on the web. If a PDA is loaded with this type of resource, it potentially could be used remotely via LAN or GPRS (mobile network).

One of the main benefits of using Microsoft® PowerPoint® is that it is a relatively easy program to use. The simplicity of its transfer to a PDA will make this concept a viable option for resource development for PDAs and mobile phones.

We have successfully trialed a number of fully-featured interactive digital coaching aids on PDAs. Based upon the outcomes of our tials, we believe that this concept has enormous potential.

We have developed a Microsoft® PowerPoint® template that can be used as a base to create PDA resources. Some examples are provided following.

Example resource created using the template

Minimum font sizes of 22pt have been found to still provide good readability on a PDA screen, although larger font sizes may be required for mobile phones depending on screen size.

12 Conclusion

12.1 Acceptance

Feedback from the trials indicates a broad acceptance of handheld technology for use as a tool for learning within the workplace. The majority of participants indicated that, if provided with the opportunity, they would like to continue using the PDAs for work and as part of their ongoing learning practice. There was high enthusiasm for the diary and organiser capabilities of the PDA, with all participants indicating that such was an improvement on their current personal organisational methods.

Younger learners found the devices exciting and really enjoyed the experiences. Most wished that they had regular use of this type of technology for learning.

12.2 The devices

When participants first encountered the PDA, although some had some initial hesitation (particularly those with limited IT skills), most found the technology intriguing and were attracted to it. However, once they had used them for a period, even those who were initially hesitant eventually became attached to the devices.

This project has identified that there are distinct limitations with these devices for those with disabilities. It can be said that presently, as an individual unit, the PDA does not meet all accessibility standards. Although there are options for adding or using peripheral equipment that will increase the useability and accessibility of these devices, presently the present cost of these does not make this a viable solution. Further developments that will improve accessibility to mobile technology are therefore needed.

As presented earlier in the report, the poor visibility of the screen in high light environments was one factor limiting the use of the PDA devices outside. Strategies that the project team have found to limit the impact of this factor include:

- being aware of colour usage when designing resources. Dark text with a light background was found to be most effective, although some greens also proved satisfactory. The effectiveness of dark text on white background was highlighted in the trials of the *Catalogue of Tree Disorders.*
- use of anti-glare screen protectors
- use of the PDA in shaded areas when outside
- use of more sound and voice files in presentations.

When using the sound function of the PDA (either inside where the impact on others is an issue, or outside where other external sounds would interfere with the experience), we would recommend the use of headphones. This would significantly improve the quality of sound-based presentations.

12.3 Software

Participants encountered some technical difficulties with the use of the equipment and with the design and layout of the operating systems — in this case Microsoft® Windows® for Pocket PC® 2003 Premium. Additionally, some of the software used (such as Conduits® Pocket Album™) proved difficult for some without some initial and follow-up training. This was possibly due to the process used by the software to set-up a 'show', which relies on the selection of images from specific folders. This meant that users had to have some understanding of file management on the PDAs — something that proved awkward for the more novice computer user. It should be stated, however,

that the software was not originally designed for the purpose that we had put it through. Also, it is presently only in its first generation release. Future editions will be awaited with anticipation.

The project team found that the addition of the open-source software program, Launcher, significantly improved the useability of the PDA, particularly if it was being used for the first time. Launcher provides links or shortcuts on the front or 'today' screen of the PDA device that enable the manager of the activity to set up the today screen with only the links to the various programs the user would need to see. Launcher is a very useful program when running a learning activity using a series of digital resources. Each resource can be linked from the today screen, eliminating the need to search for the files in file explorer. For more information on Launcher, see http://www.scottandmichelle.net then follow the links 'Scott's Site' > 'CE stuff'' (link on left of screen) and then scroll down to 'Launcher'.

Most new users to the PDA had some difficulties with adding text or using the text recognition options of the device. New users all found this awkward at first, with most taking a while to get to a stage where they could enter text at a reasonable speed. By the end of the trial, some of these users were entering text almost at the speed of conventional handwriting.

The best entry modes when using the Microsoft® Windows® software were through the pop up 'key board' and the 'letter recogniser'. Other entry modes were more difficult to use and required more practice.

12.4 The camera

The plugin Hewlett-Packard® Photosmart Mobile Camera was regarded as a valuable tool by all participants who were exposed to it. Its ease of use, coupled with the fact that it is small and portable, makes it a very versatile plugin camera. There is an increasing trend by manufacturers of handhelds to amalgamate the camera and the handheld within one unit. One definite benefit of this is that the expansion slot of the handheld will be left free so that memory cards and other peripheral equipment can be used.

Limitations encountered during trials with the Hewlett-Packard® Photosmart Mobile Camera included:

- the need to keep the camera very still at the time of taking the picture, usually by bracing the arms against the body, otherwise the picture could easily blur
- not having a built in flash. When participants used it in relatively low light environments, the pictures were too dark to use even if the programmable light settings within the camera were appropriately set. Consequently, participants all indicated that a flash-type camera would be their preferred option. Plugin camera models such as the LifeView® FlyCAM-CF™ and CF Camera have built in flash.

12.5 Resources

While most participants within the trials found the PDA resources useful, all participants felt that the resources had enhanced their overall learning experience.

When the project groups formulated the concepts and designs for the learning resources, the project team was very conscious of the need to keep them as functional and easy-to-use as possible with easy links and a one-click return to a main navigational page from anywhere in the resource.

Some points relevant to the development of PDA resources that have been highlighted by these trials include:

- limit excessive scrolling, by incorporating more links
- awareness that sound and video can be useful for some interpretive and ‘anywhere, anytime’ resources. When using sound and video, the availability of headphones will provide a more effectual experience for the user
- awareness that resources do not need to be have a high degree of multimedia function to make them useful or attractive to users. All they require is some form of interactivity, which could be as simple as a descriptive action including a question such as, ‘Crush the leaf in front of you. What does it smell like?’, and
- awareness of how colours, font types and pictures affect the quality of the resource when it used in differing environments, such as indoors and outdoors.

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