Upadema

Ubiquitous Peripheral Awareness Display as an Everyday Memory Aid

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Submitted to the University of Limerick, 2004

Declaration

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This thesis is presented as partial fulfillment of the requirements for the degree of Master of Science in Interactive Media at the University of Limerick in the department of Computer Science and Information Systems, College of Informatics and Electronics. It is entirely my own work and has not been submitted to any other university or higher education institute, or for any other academic award in this university. Where use has been made of the work of other people it has been fully acknowledged and fully referenced.

Signature:

Martina Costello
03 September 2004

Dedication

This is to you Mam and Dad, thank you for everything.

And….. of course my brother Kenneth and sister Sinead

Acknowledgements

I would like to thank the class, all of Imedia 2003/2004, for one of the most entertaining, enjoyable and inspirational years of my life.

To all my friends and housemates for sharing the best times in my life so far, oh the laughs ….and madness…. Let the good times live forever

To my supervisor Prof. Liam Bannon for pushing the boundaries of my ability, keeping me focused and for providing help, optimism and guidelines.

To Mikael Fernstrom for providing me with tech advice and direction. Moreover for putting up with all my hardware queries.

To members of the IDC especially Mark Marshall who helped me with the electronic circuitry, Paul Gallagher for writing the Director Xtras and for helping me with all my RFID queries, Luigina Ciolfi, Marilyn Lennon and Krispen Ledyon for all their help, support and encouragement.

To Ann Murphy who deserves much gratitude for being the backbone in the IDC. Thanks for your patience and kindness Ann throughout the good times and the bad.

To my family, relatives and friends for their support, encouragement, belief and understanding.

Abstract

Title: Upadema (Ubiquitous Peripheral Awareness Display as an Everyday Memory Aid)

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The Upadema explores a novel way in which wearable, peripheral awareness and ubiquitous technologies might help to support everyday memory difficulties that we all experience in a subtle, non-intrusive and private manner. It involves seamlessly embedding digital information into a wearable device and personal items that are intended to augment human ability, by providing notification at the periphery of a user's attention, to prevent the loss and misplacement of selected personal items. The few notification devices and memory aids that currently exist on the market for this purpose utilise a series of beeping sounds as a means of notification and consist of a textual Graphical User Interface (GUI). When tested with a target user group the use of unsolicited sound for this purpose was deemed annoying and intrusive. In contrast, the Upadema investigates the use of subtle visual and vibro-tactile notification modalities and allows the user to have more control over the use of sound. The GUI consists of series of coloured LED's that aim to provide the same degree of support as a textual GUI. It also attempts to remove the undesirable social issues that are attached to comparable devices that currently exist on the market and aims to prevent distraction to other people in the surrounding environment.

For the purpose of this project the Upadema prototype takes the form of a wristband but the features it provides could be integrated into a wearable computer or watch. The project builds on knowledge drawn from previous research carried out in related fields and investigates a fresh design for memory aids and notification devices from a user interaction and social point of view. The Upadema also demonstrates the strong future potential for devices that hide the technology and make room for aesthetical user preferences and in turn paves the ways for further research and development.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

"Memory and forgetting are two sides of the same coin. Indeed, each provides the presupposition for the existence of the other. Remembering everything is as impossible as having no memories at all. To remember everything would mean that one would be in a state of total chaos and similarly completely forgetting would create an equally undesirable blank. Instead, it is the possibility of forgetting that makes it possible to remember certain things and vice versa"

Yiannis Papadakis, (1996), The Politics of Memory and Forgetting

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1.1 Introduction

This thesis aims to utilise technology in a subtle, private, non-intrusive way to support a real world problem. The real world problem that it addresses is memory difficulties that we all experience on a daily basis due to leading a hectic lifestyle. The most frustrating everyday memory difficulty that people experience was initially researched. The results of this proved that the most annoying memory difficulty that is experienced on a daily basis is forgetting or misplacing personal items, such as a phone, wallet, keys and glasses.

Few memory aids and notification devices already exist on the market for supporting this type of everyday memory difficulty, however those that do exist notify a user of the loss and misplacement of personal items through the use of a series of beeping sounds. These devices also utilise a series of beeping sounds for locating the lost personal items. When tested with a target user group these sounds have proven to be an intrusive and annoying means of notification. These sounds are also similar to those used in mobile phones and pagers and it is often difficult to identify which device or when used in public, whose device the sound was emitted from.

Another problem with the existing memory aids and notification devices is that they are rather obvious and as a result can cause a lot of embarrassment to a user when in public. They can also be quite disturbing to other people nearby, as they do not have an interest in the notification cues generated by other peoples devices but however are drawn to them regardless (Tarasewich, 2002). They also involve a visually intensive textual GUI, which in turn demands a significant amount of attention and refocusing from a user. Mnemonic and non-technical techniques such as to-do lists and post-it notes also fail to provide the correct

degree of support for this type of memory difficulty and in general are usually forgotten, not visible or ready at hand when memory support is required. The Upadema attempts to provide notification of the loss and misplacement of personal items though the use of more subtle information sources such as light and colour and tactile cues such as vibration that appeals to a user's peripheral awareness. It allows the user to have control over these sounds by deciding if and when they instigate the lost personal item to beep.

The idea here is to design a device that provides the correct degree of memory support to a user, is not too distracting and does not interfere with a user's normal daily discourse. Furthermore, the Upadema attempts to move towards a design that hides the technology, accommodates users aesthetical preferences, poses as a piece of jewellery and prevents disruption to other people in the surrounding environment.

There are several underlying issues that a project such as this could address however the main focus of this thesis is to investigate a novel design for a memory aid and notification device from a user interaction and social point of view. There are two different designs to consider in a project such as this, namely the memory aid itself and the tags that are attached to a user's personal items. This project concentrates mainly on the design of the memory aid however the design of the tags were also addressed but to a lesser degree.

1.2 Motivation

One of the most frustrating problems that I have observed over the years is forgetfulness, namely prospective memory difficulties that we all experience. I have always been interested in memory and the way it works and in turn, the way it affects us all differently. We all experience memory difficulties everyday as a result of leading busy lifestyles and we require some means of overcoming them, whether it be as simple as writing a to-do list. So therefore I decided to take the opportunity to use my technical and creative skills to design a device that supports users with their most common everyday memory difficulty in an effortless, non-intrusive and personal manner.

In the preliminary study phase of this project I initially began researching possible ways of augmenting real world objects with information in order to assist people with memory

difficulties they experience on a daily basis. I began researching possible ways of implementing this concept in a natural manner, which led to exploring ubiquitous and calm technologies. As these technologies have different forms of input and output that could be seamlessly integrated into a user's everyday lifestyle.

However, before determining the form the memory aid was going to take and the modality it was going to use, the type of everyday memory problem that the display was going to support needed to be established. Extensive user studies were conducted in order to find out the most frustrating things either tasks or items that people generally forget. The results of these user studies lead onto an understanding that the most frustrating memory difficulty that people experience is forgetting or misplacing personal items, such as a phone, wallet, keys and glasses. The results also highlighted that if the device was to be useful and provide the correct degree of personal memory support, it had to be with the user at all times and to be in the form of a wearable. A watch or wristband was eventually decided upon.

The results from the user studies proved that users liked the thought of being subtly reminded of something through the use of lights, colours and tactile vibrations. Users felt that an auditory modality was annoying and intrusive. Previous research carried out in this field also noted similar user preferences and proved that an auditory modality has a high degree of publicity and that subtle public notification cues are more effective and in demand (Hansson, and Ljungstrand, 2000; Hansson et al. 2001; Bhimdi, 2004).

However an auditory modality was required in order to help a user locate a personal item. It was not deemed to be intrusive for this purpose, as the user had more control over the use of sound and could instigate it on demand. All the ideas from these user studies, some participatory design sessions and research were then transformed into a possible design solution for the Upadema.

1.3 Research Objectives

The overall objective of this thesis could be described as providing a solution to the following problem statement: "How can technology be used in a more subtle, non-intrusive and private manner to help people with their everyday memory difficulties." This overall

objective can however be further broken down into four main research objectives that are as follows:

1. To gain an insight into the most common memory difficulties that people experience on a daily basis mainly as a result of leading a busy lifestyle.

2. To utilise these findings to design and implement a conceptual prototype of a memory aid that supports a user with the most common everyday memory difficulty they experience, in a more personal manner and way that is more suitable for a social setting.

3. To drive the design and evaluation of a prototype: based on user feedback; in relation to comparable memory aids and notification systems that currently exist on the market and knowledge drawn from previous research carried out in related fields.

4. To investigate a novel way of designing notification devices and memory aids that: allow a user to have more control over the use of sound; appeals to a user's peripheral awareness and provides for further research and development.

1.4 The Projects Phases

The following phases are used as a framework for describing this projects development process: preliminary study, concept creation and design, implementation, testing and evaluation.

The preliminary study phase involved the use of four user-centred design techniques in order to gather an initial set of user requirements. Firstly, informal conversations and questionnaires were employed in order to investigate the degree to which people experience everyday memory difficulties and to determine how people felt about the concept of using some form of invisible technology to combat these memory difficulties.

Following on from this further qualitative information was required, so a 'probe' style approach initiated by the CRD Research group at the Royal College of Art (Gaver et al, 1999) was engaged. The probes were designed to provoke inspirational responses in order to gain an understanding of what common items, tasks and things people forget on a daily

basis. A web log was also set-up at this stage in order to share the designers' personal experience and thoughts on the design and use of the Upadema. Furthermore, an appropriate user group was chosen at this stage.

The concept creation and design phase involved the translation of the ideas and from the preliminary study into a sensible combination of opportunity, context of use, feasible technology and design direction determined by users' needs. This phase involved the use of some participatory design techniques in order to articulate the further user requirements and the device requirements.

The implementation phase was fuelled by the knowledge gained from the user group in the design and concept creation phase. It also involved a significant amount of research into the available hardware and software technologies that could be utilised to develop both a full implementation of the Upadema and a conceptual prototype. A working prototype was then developed that simulated the real world use and possible design of the Upadema

The evaluation phase involves a series of empirical studies and tests on the Upadema prototype exclusively and in comparison to a newly released high-tech device that serves the same purpose, but notifies a user through the use of text, sound and vibration. The results of these tests were then analysed in order to determine the overall usability, subtly, publicity, user interaction and control of the Upadema.

1.5 Ubiquitous Computing Criteria

Ubiquitous Computing (Ubicomp) pushes the boundaries of computational ability from the desktop into the environment and everyday objects in both novel and transparent forms. Research in Ubicomp introduces several challenging issues for computer science overall and successful research in ubiquitous computing requires the development of applications and devices that can survive everyday use. Ubicomp is experimental in nature and good quality research should satisfy the following criteria (Abowd, 1999a).

- There should be a motivating application. In the words of Mark Weiser, applications are the whole point of ubiquitous computing (Weiser, 1993).

- The system built should address some notion of scale. Scale in this case can refer to the physical space covered, the number of people involved, the number and variety of devices supported or the amount of time over which an application is run.
- The system should be subjected to real and everyday use. This characteristic is especially important because of the next criteria.
- The use of the system should be evaluated to determine its impact on the user group.

All of the above was adhered to in the development of the Upadema and accomplished through the use of rapid prototyping. Prototypes were developed where possible and feedback was solicited from the representative user group.

1.6 Universal Design

When designing any device it is important to take into account that every individual has a unique range of abilities and disabilities. There are more people living with disabilities now than at any time in history and the number is continually increasing due to longer life spans and greater survival rates for people with injuries and illnesses.

So therefore in reality an "average" group of people does not exist so care must be taken to ensure that the design respects human diversity and inclusion of all users, including children, older adults, people with disabilities, people of atypical size or shape, people who are ill or injured, and people inconvenienced by circumstance (Story et al, 1998). This approach is known as universal design. Universal design can be defined as,*"the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design."* (Mace, 1997)

However it is important to recognize that it is improbable that a device, could be used by everyone under all conditions and therefore it is important to treat universal design as a process. The principles of universal design were adhered to in the design of the Upadema as it is intended to be usable by everybody. Users of varying ages, abilities, disabilities, profiles and backgrounds were involved and considered from the preliminary study phase right through to the evaluation of the final prototype. The modalities used (light, colour, vibration, sound) allow for language independent notification. These modalities also cater

for hearing and visually impaired individuals and therefore meet the requests of universal usability.

1.7 Thesis Overview- Introduction to each chapter

Chapter 2 discusses the research domains that relate to the Upadema conceptual framework. It provides a summary of the projects carried out and concepts outlined in each of these domains.

Chapter 3 provides an overview of the type of memory difficulties addressed, namely prospective memory difficulties. It highlights the valuable knowledge that was gained through this research and the issues that were considered in the design of the Upadema.

Chapter 4 details the methods that were used to gather the initial project requirements. These methods included informal conversations, questionnaires, the use of probes and a web log.

Chapter 5 discusses the participatory design techniques that were used to formulate the conceptual design of the Upadema.

Chapter 6 investigates the possible hardware and software technologies that were initially considered as a means of implementing a wireless functional version of the Upadema and a feasible working prototype.

Chapter 7 details how the Upadema conceptual prototype was eventually implemented. It outlines how a balance was eventually found between the user and device requirements and technological limitations.

Chapter 8 provides and overview of the final empirical studies that were carried out on the Upadema prototype. It outlines how the results of these studies were used to determine the viability of the Upadema and if the objectives of this project had been met.

Chapter 9 is a concluding discussion and overall evaluation of this research.

Chapter 2 Literature Review

"Memory is the most important function of the brain; without it life would be a blank. Our knowledge is all based on memory. Every thought, every action, our very conception of personal identity, is based on memory...Without memory, all experience would be useless."

William Edridge-Green (1863-1953), Colour-Blindness and Colour-Perception

2.1 Introduction

A ubiquitous peripheral awareness device was decided upon as it has the possibility to achieve all of the prerequisites of a subtle memory aid, by providing notification on the periphery of a user's attention. The Upadema takes the form of a wearable such as a watch or wristband and exercises the concept that everyday objects can be seamlessly embedded with computational power so as to extend usefulness. Therefore it suggests that technology can be integrated into our everyday lives through an emerging breed of wearable fashion accessories, lifestyle augmenters and other transparent forms.

The requirement to create a non-intrusive device that provides relevant memory support to a user and that moves beyond the confounds of conventional Graphical User Interfaces (GUI's) into the physical environment, demands extensive reference and analysis of many new and promising research domains. These include ambient/peripheral displays, notification systems, and wearable computing all of which reflect the Ubiquitous Computing[1] (UbiComp) and Calm Technology concepts pioneered by the late Mark Weiser, former chief technologist at Xerox's PARC (Palo Alto Research Center) and his colleagues.

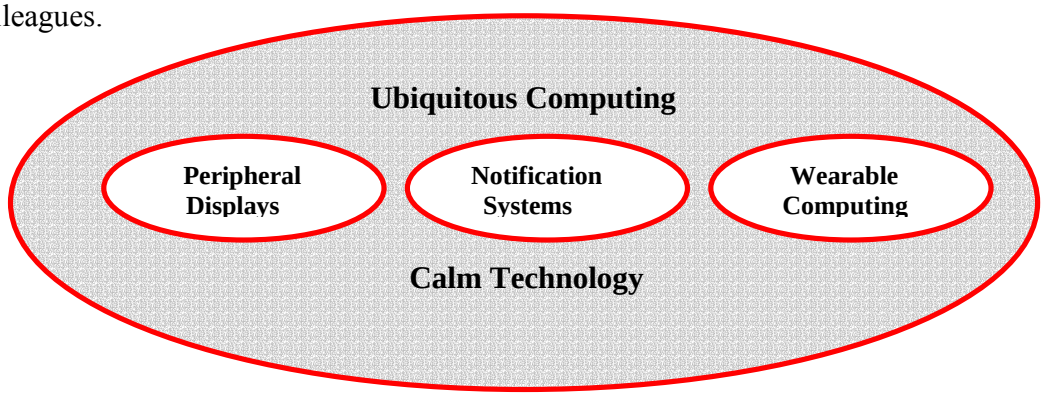

Figure 1: Relative Domains

[1] **"**Ubiquitous**"** as "Present or appearing everywhere; omnipresent" – The Oxford English Dictionary

The following is a review of the projects carried out and concepts outlined in each of the research domains outlined above (Figure 1). These domains also provided fundamental support and guidelines and much of the base theory on which the initial ideas for this project were founded. These domains have also dedicated some research time to providing support for memory difficulties through the use of ubiquitous technologies, all of which will be discussed here where possible.

2.2 Ubiquitous Computing

In the renowned article "*The Computer for the 21st Century*", Weiser introduced the supposition of ubiquitous computing and explained that it arose from contemplating the place of today's computer in actual activities of everyday life (Weiser, 1991).

In his vision, UbiComp is a means of liberating computational ability from inside a box or personal computer, as we know it and then embedding its ability in everyday objects throughout our physical environment. Weiser and his colleagues refer this process of removing computers from their electronic shells as 'embodied virtuality'. Computers will therefore recede from our awareness and become invisible in the sense that they will no longer be perceived as computers.

Weiser outlines that the personal computer is not a good tool as it is actually a hindrance and gets in the way of work whereas a ubiquitous computer provides smart support to user without forcing the user to change behaviour **(**Weiser, 1993). *"Machines that fit the human environment, instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods."* (Weiser, 1991) In this statement Weiser compares ubicomp to other technological movements and outlines that it can be thought of as the opposite to virtual reality whereby the user is forced to enter a computer generated world.

The Upadema revolves around this notion of augmenting everyday objects with information that is germane to a user's needs and its purpose is to serve as a novel mnemonic means of extending human ability. It incorporates the ubicomp ideas of dispersing computational ability throughout our environment in a way that does not

consume the full capacity of our perceptual attention like a personal computer but rather in an invisible form that blends seamlessly into our lifestyles.

Ubicomp technology involves cheap, low-power computers that include convenient displays and have the capability to communicate with other such devices. They require no revolution in artificial intelligence just the correct implanting of technology that can identify with one another, all of which could be used to best describe the design of the Upadema.

2.2.1 Tabs, Pads and Boards

Weiser and his colleagues at PARC developed a series of embodied artifacts that capture and portray information, which he called tabs, pads and boards. He took his inspiration from the physical affordances of everyday objects found in offices and homes namely paper, pictographs, clocks, labels on controls, thermostats and other symbolic information conveyers that come in different shapes and sizes (Weiser, 1993).

Figure 2: Xerox PARC Tab (Weiser, 1993).

The tab is the smallest component of embodied virtuality (Figure 2). It is the most relevant of the three artifacts to this project, as it closely resembles the size and form of interaction addressed by the Upadema, which is similar to that of a watch. The tab further emphasises mobility and Weiser's main message of the transparency of the interface that determines a user's perception of digital technologies, two affordances that are also present in the Upadema (Ishii, 2004).

2.3 Calm Technology

Calm technology aims at reducing the amount of information the user is required to process by letting them decide what information is at the centre and what is at the periphery of their attention. Weiser and Brown, who coined the term calm technology, envisage that calm technology will not only relax the user but by moving unneeded information to the edge of

an interface, will allow more information to exist ready at hand when it is required. Calm technology is also one of the driving forces behind peripheral awareness devices as it enables a user to sense and control what immediately interests them while retaining peripheral awareness of other information that the user can call upon at any time (Weiser and Brown, 1995).

The difference between calm technology and most information technology is the way it engages our attention. *"Calm technology engages both the centre and the periphery and in fact moves back and forth between the two"* (Weiser and Brown 1995). Weiser and Brown suggest that this happens in two ways. Firstly, it moves the information smoothly from the center of our attention to periphery and back. Secondly, it may heighten our peripheral reach by placing extra information on the periphery. They also state that the periphery gives us an essential gift called, "locatedness" meaning that we can remain in a comfortable natural state whilst in tune with a multitude of desired information.

Weiser (1991) states that, *"the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."* It is envisioned that as the future of calm technology unfolds an increasing quantity of ubiquitous information will be available throughout our surroundings, the computer as a dedicated device shall disappear, there will be more intuitive interfaces and more implicit information processing. This information is perceived to be easier to use, however this type of technology is only in its experimental and research phase and as of yet it is unclear as to whether this paradox fully holds true (Friedemann, 2004).

The requirements and concepts inherent in calm technology are addressed in the Upadema namely, providing information in a non-intrusive way by appealing to both the centre and periphery of a user's attention. This in turn presents the users of the Upadema with weiser's proposed gift of 'locatedness.'

2.4 Ambient and Peripheral Displays

People often want to keep awareness of information that has personal meaning and is not extremely vital or relevant to their primary task, so it therefore can be displayed in a non-

intrusive manner outside the scope of one's primary focus. This type of information can be referred to as *"awareness information"* (Miller and Stasko, 2003). Examples of such awareness information include email, calendar, stock, traffic, news and weather etc. In order to access this information it requires that a user open several programs and websites. This is a rather time-consuming process and forces information to the foreground of a user's attention taking precedence over their primary task.

Ambient[2] and Peripheral[3] displays aim to provide awareness of personally meaningful information by taking advantage of human perceptual and peripheral cognitive processing capabilities (Day, 2003). They are ubiquitous computing devices that transmit information, often in the background or periphery of a user's awareness without demanding their full attention (Ishii et al. 1998a). Information displayed in this way blends seamlessly and elegantly into a user's lifestyle by providing consistent awareness of the information they desire. The effective design of these displays is believed to revolutionize human-computer interfaces as they are more intuitive and take advantage of the human ability to perceive peripheral information with little effort (Buxton, 1995; Ishii et al. 1997)

They have previously been employed to present several types of peripheral information such as on-going status of data, notifications (Czerwinski et al. 2000), warnings, and suggestions. They have different means of input and output for example they can receive input from a program, webpage, sensor or camera and display output through changes in light, sound, colour, smell, movement, temperature or form in an environment (Carter and Matthews, 2002).

Although ambient and peripheral displays generally require a back-end service delivery infrastructure and draw information from a wireless network the Updaema does not. The Upadema relies on a different form of technology such as Radio Frequency Identification (RFID) and draws its information from users' activities and a real life situation. It presents

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2 Ambient \Am"bi*ent\, a. Surrounding, encircling, encompassing, and environing.
-Oxford English Dictionary

3 Peripheral \Pe*riph"er*al\, relating to or situated on the periphery.
-Oxford English Dictionary

a novel use for peripheral awareness technologies that mimics concepts inherent in ambient and peripheral displays.

The main concept the Upadema borrows from ambient and peripheral displays was the notion of abstracting data in its raw form and presenting it through natural peaceful sources such as light, colour and vibration. All of which is deemed to provide effortless memory support to a user that enables him/her to carry out their daily discourse as usual without being too demanding and distracting. As a result the Upadema aims to provide a much richer multi-sensory experience of notification than traditional forms of representation used in GUI's, augmented reality technologies and other visually intensive media (Ishii et al. 1997). The Upadema also contains the three different ambient and peripheral displays interaction zones namely; the ambient zone; the notification zone and the interactive zone (Rafique, 2003).

2.4.1 Tangible Media Group

The Tangible Media Group at MIT provided much of the inspiration for the type of ambient and peripheral display utilised in the Upadema. Their conceptualisation was mainly drawn from ubiquitous computing (Weiser, 1991), augmented reality (Wellner et al. 1993; Feiner et al. 1993) Graspable User interfaces (GUI's)(Fitzmaurice et al. 1995) and the notion of background and foreground (Buxton, 1995).

Their 'Tangible Bits' project developed a test bed called the 'AmbientROOM' (Ishii et al. 1998b) that explored how architectural space could be used to move information to the foreground when it is required whilst leaving irrelevant information residing in the background and vice versa.

The room further inspired the design of standalone 'Ambient Fixtures' such as a waterlamp, pinwheels and spline (Dahley et al. 1998) that exploit the idea of using 'ambient media' in an augmented space. They were used to determine what kind of interaction ambient media really supports and how it can be designed to encourage efficient human interaction, rather than hinder it.

Figure 3: Ambient Picture Frames (Chang et al. 2001)

The majority of the Tangible Media groups' experimental prototypes that rely on visual modalities have several alternating information states, which utilise different colours, lights or forms and source information from a computer. However, one example developed by this group that is more comparable to the Upadema is the interactive, colour-changing picture frames that lets people inform loved ones far away that they are thinking about them (Chang et al. 2001) (Figure 3). It is more similar in concept to the Upadema as it presents only one coloured information state that is triggered solely by human activity in a real world situation.

Figure 4: Ambient Watch

Figure 5: Ambient Fob

Figure 6: Ambient Pen

Other developments that illustrate novel uses for ambient displays similar to the Upadema include: an ambient-equipped watch (Figure 4), on which prescription-related icons light up at doctor-recommended medication times; an ambient fob (Figure 5) that shifts colors based on user-specified traffic information (congestion, accidents, etc.) and an ambient pen (Figure 6) that changes colour when user-defined associates voicemail the user. Other applications for ambient displays include health care, where it is being considered as a way of monitoring weight, daily exercise or depression symptoms from a distance.

This group have formed a company called 'Ambient Devices' in partnership with Motorola, Accuweather, Hyperfeed Technologies, CustomWeather, Pollen.com and Yodlee whereby their mission statement is *"to embed representation information into everyday objects such*

as lights, pens, walls, watches and wearables"(Ambient Devices Inc, 2001). They take advantage of a cognitive psychology phenomenon called pre-attentive processing whereby humans can process several streams of background information without any foreground cognitive loading. They concentrate on representing information that is neither worthy of interrupt (push), nor worthy of investing time (pull). Examples of push and pull information include the status of a portfolio, the health of an aging parent, upcoming weather or the score of a game. They continue to state that this type of information should be glanceable and ambient, like a clock or barometer.

The Tangible Media Group also developed 'Personal Ambient Displays' to further emphasise the physicality of ambient displays. Personal Ambient Displays are *"small, physical devices worn to display information to a person in a subtle, persistent, and private manner."* (Wisneski, 1999). They are wireless wearable displays that are small enough to be carried in a pocket, worn as a watch or some other form of jewellery (Figure 7), all of which reflects the form of the Upadema. In Wisneski's experimental prototypes the information is displayed in the background of a user's perception through the use of tactile modalities such as heating, cooling, movement, vibration and change of shape.

Figure 7: Personal Ambient Display Key Chain (Wisneski, 1999)

Earlier work on ambient displays has concentrated on using visual and auditory modalities whereas this work only uses the sense of touch, which is a relatively new direction in ambient displays. The Upadema attempts to extend beyond familiar interface concepts by employing this relatively unexplored channel of interaction in ambient displays. It is perceived that a tactile modality can overcome the demands of intrusive technical devices by reducing the amount of visual and audio attention required to interpret computational feedback. A tactile modality is discreet and can effortlessly be amalgamated with human activity yet in the case of the Upadema it is not intended to completely replace the visual notification modality but rather to complement and support where necessary. For example

if a user is in a busy environment they may not see the responses from the Upadema and in turn may leave a personal item behind. The Upadema tactile modality is similar to the current pagers and cell phones that employ a tactile display of notification. Furthermore, the 'vibrate mode' does not take cues from a previously computerised interface experience, it takes them from a real life situation.

2.4.2 The Ambient Displays Research Group

The Ambient Displays Research Group at the Computer Science Division Office in the University of California, Berkeley have outlined three key issues that are based on a survey of existing peripheral displays and cognitive literature. These include abstraction, notification and transition (Carter et al. 2003). They have also devised a set of ambient and peripheral display guidelines and evaluation heuristics all of which are of utmost importance to the Upadema and were adhered to where possible in the development process.

2.5 Notification Systems

Concepts borrowed from notification systems make up the third layer in the Upadema conceptual framework as they are used in any divided-attention, multitasking situation and their purpose is to *"provide reaction to and comprehension of valued information in an efficient and effective manner without introducing unwanted interruption to a primary task."* (Chewar and McCrickard, 2002b)

In this context the Upadema could be described as a notification system as it is worn to notify a user of the proximity of personal items. A system such as this necessitates insightful design and demands that a user can carry on in a normal fashion with their daily discourse of activities without interruption. Notification systems in the form of ubiquitous computing devices such as the Upadema are relied on to provide all types of ready at hand information at a glance and include wearable computers, vehicle information systems and handheld devices.

This paradigm dispatches numerous implications for information design that is ingrained in cognitive processing and human attention limitations. Chewar and McCrickard (2002) have presented many challenges for these circumstances as user goals are difficult to predict and often conflicting. For example, users may want to maintain awareness of the information

over time in order to spot particular information states but they may not want to be interrupted from their primary task. Other usage scenarios include the situation whereby users may wish to be alarmed about information and attracted to some form of interaction.

Their work has highlighted that platform capabilities may only cater for minimalist information representation and that there is a need for usability evaluation methods that are adapted specifically for notification systems. They have continued to conduct an empirical study in order to re-evaluate the design guidelines for emerging computer interfaces within these constraints (Chewar and McCrickard, 2002a**)**. Their work shows that Cleveland and McGill's (1984) guidelines for use of visual attributes do not hold for dual-task situations and they have identified design parameters or notification system classifications that were useful for the Upadema such as *Interruption, Reaction* and *Comprehension*. Other members of their group investigated perceptual issues relevant to the design of peripheral and notification displays (Tessendorf et al. 2002), which were also relevant for this project.

Campbell et al (2003) argue that there is a need to simplify information representation in notification systems. They conducted an experiment that evaluated the performance/size trade-off of notification devices ranging from two LED's to nine LED's. The results proved that twenty-seven messages could be conveyed with high recognition accuracy using only three LED's that map the messages through the use of colour and position. They proved that micro level form devices could be designed to display effective notifications through the use of light and patterns. Choi et al. (2004) extends these parameters by addressing the contextual awareness of a notification system. They designed a system called the "Gate Reminder" that proves that an effective reminder should have both messages and signals that can sense the correct moment to remind a user, all of which was considered in the design of the Upadema.

2.6. Aware Home Research Initiative (AHRI)

The AHRI project began in Georgia Institute of Technology to investigate the challenges facing the future of domestic technologies (Irfan, 1999). Their research relates to this thesis as they have designed some non-intrusive interactive experiences that involved the development of memory aids plus sensing and perception technology that monitor human activity in physical environments.

They built a smart home (Abowd, 1999b) that incorporates several devices that are of particular interest to this thesis: a cooks collage with a new concept of déjà vu displays (Mynatt and Tran, 2003); a memory mirror (Mynatt et al. 2004) and a system for finding Frequently Lost Objects (FLOs), such as keys, wallets, glasses, and remote controls. The system uses small radio-frequency tags attached to each object the user would like to track and a long-range indoor positioning system to track these objects (Lanzl and Werb, 1998).

2.7 Wearable Computing

Wearable computing and ubiquitous computing present new alternative ways of augmenting human capabilities with computers. However they differ in some respects, ubiquitous computing augments the surrounding physical environment with a network of machines and sensors while wearable computers attempt to augment a user directly in a personal manner with a mobile platform. Weiser (1991) discusses the merits of ubiquitous computing while Mann (1997) argues in favour of mobile, personal audio-visual augmentation in his wearable platform. However the Upadema attempts to cleverly adapt concepts and guidelines from the two routes in order to create a device that seamlessly augments human memory.

It is called wearable computing as it is envisaged that they will become an integral part of our every day outfit, permanently operational and capable of assisting us in dealing with a wide range of situations. However before this vision becomes a reality wearable systems must overcome a number of limitations that currently deem them unsuitable for extensive use. The personal aspect of ambient displays can learn many lessons from past and current work in wearable computing. Several research groups have formed and people working in this field have iterated through a number of design exercises that will aid in the development of new personal devices (Tan and Pentland, 2001; Healey et al.1997; Awhney et al. 1998; Dorsey and Siewiorek, 2003). Two groups in particular namely, the Wearable Computing Group at MIT and Carnegie Mellon offered some relevant and useful research for the Upadema.

2.7.1 Wearable Computing Group at MIT

The Wearable Computing Group at MIT has concentrated mainly on the technical issues related to wearable systems however they have paired up with IDEO Product Development

to address the human side of wearable computing. Their main project is called ‘MIThril’ and they suggest that it is the next generation research platform for context aware wearable computing. The MIThril team are constructing novel forms of computing environments and developing wearable prototype applications for health, communications and just-in-time information delivery. They have developed several experimental prototypes that relate, in some respects, to the Upadema. These include: The Memory Glasses (Corey et al. 2003); DyPERS, 'Dynamic Personal Enhanced Reality System' (Jebara et al. 1998); I-Sensed (Clarkson and Pentland (2001) and “The Remembrance Agent” (Rhodes and Starner, 1996).

2.7.2 Wearable Group at Carnegie Mellon

This group is an interdisciplinary team of researchers from the Carnegie Mellon University. They have conducted a decade of research into the architectural and interface requirements of wearable systems and are now entering a new phase of research in the area of pervasive computing. They have examined the comfort of wearable computer designs that consider functionality, device location and user gender (Bodine and Gemperle, 2003)

This group has also carried out some research into the use of touch as a background channel of interaction. They state that a tactile modality allows a user to be more efficient and to concentrate on real world tasks. Their tactile stimulation is used to translate visual or audio information similar to that employed in the Upadema.

Their research concluded that Vibro-tactile methods were the most promising because of their small size and weight and low mechanical and electrical requirements (Gemperle et al. 2001). Similar supporting research on the use of tactile feedback in wearable computing and mobile interfaces was carried out by Tan and Pentland (1997), who state that a tactile display is easily interpretable even for first-time users; and by Maruyama et al. (2002) who add that tactile methods incur some feasibility and human factor limitations. Maruyama et al. along with (Buxton, 1995;Billinghurst et al. 2002) have devised some requirements that the optimal mobile tactile display should satisfy.

2.7.3 EuroPARC (Euro Palo Alto Research Center)

An example of a wearable computer that serves as a memory aid similar to the Upadema includes, the “Forget-me not" system developed at EuroPARC by Lamming and Flynn (1993). Forget-me-not is designed to help with everyday episodic memory problems, for example forgetting where you left a document.

Figure 8: Forget-me not System

The application was presented on a PARC Tab as it is small enough to be worn on a watchstrap, belt or in a pocket (Figure 8). The system collects information about selected aspects of the user’s activities, and organises this data into a personal biography so that it can be retrieved on demand.

2.8 Conclusion

Collectively these domains have supplied knowledge that has been gained through years of experimentation with users and evolutionary technologies that could not have been concluded solely. Furthermore, these domains have supported this project conceptually and have provided both the necessary guidelines and evaluation techniques to allow a possible prototype of the Upadema to be implemented in an efficient and effective manner. However, there were numerous unique concerns and limitations that the prototype of the Upadema conquered alone and with the help of extensive user participation.

Chapter 3: Everyday Prospective Memory

"If any one faculty of our nature may be called more wonderful than the rest, I do think it is memory. There seems something more speakingly incomprehensible in the powers, the failures, the inequalities of memory, than in any other of our intelligences. The memory is sometimes so retentive, so serviceable, so obedient; at others, so bewildered and so weak; and at others again, so tyrannic, so beyond control! We are, to be sure, a miracle every way; but our powers of recollecting and of forgetting do seem peculiarly past finding out."

Jane Austen, (1775 - 1817), Mansfield Park

3.1 Introduction

This project is concerned with supporting prospective memory difficulties that we all experience on a daily basis. Before designing to support prospective memory some background research into this field was necessary in order to gather a richer understanding of its fundamentals. Fortunately several important aspects of prospective memory were identified and in turn provided the exact quantity of theoretical information to complement the development of a non-intrusive personal external aid such as the Upadema.

3.2 Prospective Memory (PM)

Prospective memory (PM) refers to the processes and skills required to support the fulfilment of an intention[4] to carry out a specific action at some point in the future without any prompting in the form of explicit recall instructions (Brandimonte et al. 1996; Elvevåg et al. 2003). It can be defined in many different ways. The most widespread definition seems to be the common element among the following: *realising delayed intentions* (Ellis, 1996), *intention memory* (Goschke and Kuhl, 1996), *remembering intentions* (Ellis and Kvavilashvili, 1996), *memory for future actions* (Einstein and McDaniel, 1996; Mäntylä, 1996), *remembering that something has to be done* (Maylor, 1996), *a person's list of things to do* (Roediger, 1996).

Prospective forgetfulness is one of the most frequent types of forgetting failure that people experience on a regular basis. Everyday examples include forgetting to buy milk on the

[4] A volitive desire to perform an action in the near or distant future; we believe that we are able to do it and that we will do it.

way home from work, forgetting to return phone calls, forgetting your phone or glasses somewhere.

During our everyday life we have many plans and intentions that we want to perform in future. These plans and intentions are referred to as goals and prospective memory is required to carry out such goals. Prospective memory is a rapidly growing area of research perhaps due to its importance on a practical level as it relates to meaningful behaviour in our everyday lives (Brandimonte et al. 1996; Kobayashi 1996; Koyazu and Umeda, 1998; Mizuno 1998a). Performance of a PM task typically includes the encoding of an intention, retaining the information and then executing the intention (Mizuno, 2001).

The main factors that affect the processes of prospective remembering intentions, include: motivation, time, a heavy workload, an increased cognitive load, distractions and stress. Leiman and Meacham (1982) made a distinction between two kinds of prospective memory: episodic and habitual.

3.3 Episodic Prospective Memory

Episodic prospective remembering involves intended actions performed infrequently or in different contexts. It relates to events or episodes that are to be carried out at some future point, for example remembering that you have to attend a meeting or remembering a dentist appointment.

3.4 Habitual Prospective Memory

In Habitual prospective remembering the intended action is engaged in frequently and consistently. Examples include bringing your keys with you, putting your wallet in your pocket when leaving the house and locking the door. Leiman and Meacham argue that habitual prospective remembering is more successful than episodic remembering, because it is supported by extra environmental cues or events that are linked to the intended actions.

3.5 Prospective and Retrospective Memory

Prospective memory difficulties that we all experience on a daily basis also correspond to retrospective memory (RM) difficulties. Retrospective memory refers to remembering past information for example soneone's name or in the case of this thesis where you have last seen or left your personal items. The social consequences differ for prospective and

retrospective remembering and this has been claimed to be the main distinction between them (Meacham 1988). Blending prospective memory tasks with the needs and wishes of other people makes it important socially as forgetting can be embarrassing (Morris 1992). A further social corollary is the tendency to say that a person is unreliable if his/her prospective memory fails; yet if retrospective memory fails, one is inclined to say that this is due to poor memory (Munsat 1966, cited in Winograd, 1988).

When people complain about their memory they usually are more concerned with prospective rather than retrospective memory failures (Meacham, 1977). Old people and patients with frontal lobe damage are considered to be particularly vulnerable to prospective memory failures as they apparently lack the self-initiating processes involved in prospective remembering (Craik, 1986). Therefore, it is not surprising that ageing has been a major focus in prospective memory research.

3.6 Effects of Age on Prospective Memory

Despite considerable progress in the last decade of research on prospective memory some theoretical controversies have also been produced, which relate to the effects of ageing on prospective memory retrieval processes. Extensive research has been conducted in this field, some studies reporting no deficits for older adults (Einstein & McDaniel, 1990; Einstein et al., 1992) whilst others observed significant age-related differences (Einstein et al. 1998; Maylor, 1993, 1996a, 1998; Craik and West, 1999). However a more recent study shows that there was no statistically viable difference between younger adults and older adults in the age band of 60-70. The study only illustrated differences between younger adults and older adults between the age bands of 70-80 (Cockburn et al. 2002).

These findings have several important implications for this project. Firstly, they highlight that a decline in prospective memory in old age starts at a relatively late point than previously conceived. Secondly, it emphasises that older adults should not be treated as a homogeneous group. Finally it explains the possible reasoning for the discrepancy in results in different studies with respect to age effects on prospective memory, thus supporting this researchers findings and the conjecture that people in their twenties suffer the same amount of prospective memory difficulties than people in their sixties. Ultimately this proves that the Upadema is suitable and required by people of all ages.

3.7 Classes of Prospective Memory

A further theoretical controversy revolves around the precise number of classes of different retrieval processes in prospective memory. According to Einstein and McDaniel (1990) there are only two distinct types of prospective memory tasks: time-based and event-based tasks.

3.7.1 Time-Based PM Tasks

This requires that the person perform an action at a certain time for example meeting somebody at an appointed time or after a period of time has elapsed for example take food out of the oven in 10 minutes.

3.7.2 Event-Based PM Tasks

This requires that the person perform an action when some external event occurs for example giving a friend a message when you see him/her. A further example of this that relates to the Upadema would be forgetting to bring your phone with you when you are leaving a friends house.

However, according to a model proposed by Ellis and Kvavilashvili (1996) one should also distinguish between activity-based prospective memory tasks.

3.7.3 Activity-Based PM Tasks

This relates to remembering to do something or executing a prospective memory task after finishing a certain activity. For example, remembering to do the laundry after going to the shop which, unlike event and time based tasks, does not require an interruption of an on going activity and therefore should be easier to remember than event and time based tasks.

Einstein and McDaniel (1990) have drawn an important distinction between time-based and event-based PM tasks, with the former placing heavier demands on self-initiated retrieval process in comparison with the latter. This is because in time-based tasks, such as remembering to make a telephone call at seven o'clock, one has to monitor time effectively in order to respond at the correct moment and furthermore there are few environmental triggers. In contrast, in event-based tasks such as remembering to bring your wallet with you when leaving the house, one can rely on the target event itself acting as the cue to instigate PM performance. By definition PM places a heavy demand on self-initiated

retrieval process in the absence of any external prompts or cues from the environment (Brandimonte et al. 1996).

3.8 External and Internal Aids

Retrieval cues can help the act of remembering and can be either external or internal. External aids include shopping lists, calendars, the reminder feature on your mobile phone, notes and anything that interrupts the normal occurrence of events. For example leaving your umbrella by the front door as a reminder to take it with you in case in rains.

Internal cues involve linking tasks with routine activity for example calling to the shop on the way home from work or mentally rehearsing the list of items one intends to purchase. Leiman and Meacham (1982) showed that there was a significant positive effect of external memory aids (Coloured tags on key chains) on remembering to mail post cards back to the experimenters at predefined dates. The subjects used external reminders rather than internal cues.

External memory aids are useful in most circumstances however the following two situations are outlined: (Mizuno, 2001)

1. When there is a lengthy time interval between encoding of the prospective memory task and carrying out the task
2. Where internal aids cannot be trusted.

Studies have proved that external aids are more reliable and easier to use than internal aids. One interview study investigated the extent to which people use memory aids by asking children what strategies they use to remember to bring their skates to school. It was found that the majority said they would rely on external cues rather than cognitive strategies (Flavell et al. 1982).

A more recent study conducted by Keane (2003) investigated the use of external aids or mnemonic techniques as they are otherwise known, such as post-its, informal notes, message boards, to do list and the use of external space. All of these techniques involve

writing or typing something on paper but have proven to be unsuccessful for most people due to their temporal notwithstanding nature. Moreover, they are sometimes mislaid, not visible or at hand when memory support is needed. Quince (1996) also suggests that in order to be of use for prospective remembering, external cues need to be visible at the time of remembering to carry out the task.

3.9 Conclusion

Research into prospective memory has provided significant conjectures for the nature of the Upadema as an external aid. Firstly prospective memory tasks are often important and there are several possible contributing factors, therefore anything that acts as a reminder can be of use. The nature of the Upadema effectively relates to habitual prospective remembering since the intended action of checking for and bringing personal items is engaged in frequently. The intended action of remembering to bring your personal items with you when departing a specific location could be described as an event-based prospective memory task, as the act of departing should pose as the cue to instigate PM performance. The Upadema also provides support for the retrospective memory component of remembering where you have left personal items in PM performance.

Furthermore, research suggests that an external aid must be visible in order for it to be of use when the user needs prospective memory support. All of the above has been considered in the design of the Upadema, as it is in the form of a watch that can be worn and glanced at by a user at all times.

Chapter 4:Methodology

"Memory is, among the faculties of the human mind, that of which we make the most frequent use, or rather that of which the agent is incessant or perpetual. Memory is the primary and fundamental power, without which there could be no other intellectual operation."

Samuel *Johnson* (1709-1784), *The Idler #44*

4.1 Introduction

User Centred Design (UCD) was adopted at all stages from the preliminary study phase right through to the evaluation of the final prototype. UCD is a broad term to describe design processes in which eventual end-users influence how a design takes shape. It is both a philosophy and variety of methods that can include activities such as observing users' practices as part of gathering system requirements, to using psychologically based user modelling techniques, to including user representatives on the design team. (Albas et al. 2004).

The User-centred design approach that was utilised throughout the Upadema development process was based on four principles set by Gould et al. (1985). These principles include: early focus on users and tasks, forming a user group, empirical studies and iterative design. They were however adapted slightly to resemble the nature of this project.

The following is a timeframe pattern (Table 1) that illustrates the techniques used to determine the requirements and design of the conceptual prototype. The findings from each of these methods were then used to drive the design.

Timeframe	March	April	May	June	July	Aug	Sept
Brainstorming							
Informal Conversations							
Questionnaires							
Probes							
Web Log							
Early Design Ideas							
Design Formation							
Low fidelity Prototypes							
High fidelity Prototypes							
Usability Studies							

Table 1: Timeframe pattern

The secondary and territory users, the people who will be affected in some way by the use of the Upadema were also considered in the design: as the device emits radio waves that cause interference to radio communications and also in order to examine if the modalities of the device are confusing and distracting when used in a social setting.

This chapter deals with the first two principles presented by Gould et al. (1985). It will introduce the different methods namely informal conversations, a questionnaire and the use of probes[5] that were used to solicit the initial set of requirements from a representative target user group.

4.2 Informal Conversations

Several informal meetings were held in the preliminary study phase of this project. The first meeting was held with Thomas Waldmann, a lecturer of Manufacturing and Operations Engineering here in the University of Limerick. Waldmann has carried out extensive research in ergonomics, experimental psychology and work psychology. The second meeting was held with Kieran Walsh, a PhD student who has carried out several experiments in conjunction with Waldmann in relation to the decline of memory and ability thresholds in older people (Waldman and Walsh, 2002).

The third meeting was held with Ken Keane, a former Masters in Interactive Media student, who carried out numerous studies in relation to memory difficulties for his dissertation entitled "Hygeia- An exploratory study into an augmented Medication Support System for elderly people." (Keane, 2003).

These meetings were held in the hope that sufficient information and requirements for the proposed project could be gathered. The outcome of these meetings provided solid information and guidelines, which further redirected the focus of this project and eventually led to the notion of the Upadema. Upon meeting with Keane and after extensive reading of his dissertation and other material, a realisation that more specific requirements and a participatory design approach was required for such a project.

[5] Probes are packages containing an assortment of tasks, which can take the form of maps, postcards, cameras, booklets and other creative stimulating materials that can be used to gather inspirational information from people (Jørgensen et al, 2002)

Following on from this, numerous conversations were held with people of all ages in order to investigate the different types of everyday memory difficulties that people experience. These conversations took place over the course of a couple of weeks as the basis for this project was being established. These conversations are labeled informal, as they took place at social outings and in residential areas without any previous arrangement to meet. Family members, housemates, relations, neighbours and friends between the age groups of seventeen and eighty-seven talked in general about the everyday memory difficulties they experience, some even told stories.

4.2.1 Findings

An understanding of the differentiating attitudes towards memory loss between young and older generations was gathered. Out of all the people that were conversed with the younger generation, namely students under the age of thirty-five, seemed to experience more everyday memory difficulties than the older generation. It was suggested that younger peoples' active lifestyles, unorganised manner, carefree attitude and reliance on technology could have a lot to do with this.

Some of the younger people realised that their memory was poor but discussed their episodic memories of forgetfulness in a comic strip manner and found consolation in naming a friend that experienced more memory difficulties. They did however express some concern about the extent of their memory lapses, as they get older. The older generation on the other hand, seemed worried and embarrassed about their everyday memory difficulties and linked it to the fact that they were increasing in age.

4.2.2 Conclusion

Today's younger generation experience the same amount of memory difficulties as the older generation, if not more. A memory aid that supports everyday cognitive difficulties is required for all types of people regardless of age. Therefore it is necessary to form a user group that includes representatives of all ages.

4.3. Questionnaire

A questionnaire (Appendix A) was created and distributed in the preliminary study phase of this project so as to obtain qualitative information from a large number of people.

4.3.1 Goals

The underlying goals of this user research method were set out initially in order to ensure that important issues were not overlooked. They were as follows:

1. To obtain an understanding of the frequency of trivial memory difficulties that people experience on a daily basis;
2. To find out peoples general experience with technology;
3. To find out how people felt about the concept of using some form of invisible technology to combat everyday memory difficulties they experience;
4. To find out the mode in which people would like to be reminded or notified.

It was decided that an open format was required in order to achieve these goals, solicit rich subjective data, allow people the freedom to make comments and express honest opinions.

4.3.2 Participants

Twelve questionnaires were distributed in person to suitable participants of varying age groups ranging between seventeen and eighty-seven, namely colleagues, family, relatives and friends.

4.3.3 Results

Seven of the participants stated that they occasionally forget a specific task; the other five stated that they very seldom forget a specific task. When the participants were asked how do they eventually remember about a specific task, seven of them stated that something they would see or do would remind them, two stated when they are lying in bed thinking back on the day, two stated that other people usually remind them and one said that walking alone or in a quiet place usually helped.

Only three of the participants had trouble remembering to turn off an electrical appliance. All twelve of the participants stated that they regularly forget where they have left something. Eleven of the participants stated that they regularly leave something behind at home or elsewhere. Four of the participants occasionally forget important conversations and appointments. As regards experience with technology, four of individuals claimed they had none, three had a reasonable amount and five had a large amount. All of the participants liked the concept of using some form of invisible technology to combat

memory difficulties. Ten of the participants stated that they find repetitive sounds used in technology annoying. In relation to the mode of notification, five of the participants stated that they would like a combination of colour and sound, four would like the use of light, two would like something to change or move in their environment and one user left it blank but explained later that he liked all modes depending on the situation.

4.3.4 Conclusion

The following conclusions were drawn from the results and considered to be of valid substance for the project. The fact that people generally found that they remembered things better when they were in a quiet or relaxing place either, out walking or in bed, suggests that peaceful and calming media conceptually complements everyday memory difficulties. Forgetting a task, misplacing something and leaving something behind somewhere were the most common memory difficulties experienced. The majority of the participants find the use of repetitive sounds in technology annoying. Furthermore, the most popular means of notification were colour, sound and light.

4.4 Probes

A set of materials known as 'probes' were utilised in the preliminary study phase of this project in order to expand on the conclusions drawn from results of the questionnaires. The purpose of these probes was to extract intimate information in an open ended, unobtrusive manner from a target user group. The guidelines and schedule for probe design activities outlined by Clarke et al in 2002 were followed namely planning; assembling probes; recruiting participants; deploying probes and retrieving and analysing the probes.

4.4.1 Goals

The underlying goals of this research method were as follows:

1. To get a deeper understanding of people's everyday memory difficulties;
2. To establish the initial set of requirements;
3. To establish a user group.

4.4.2 Planning

There was a significant amount of planning involved in this method in order to ensure that all three goals were achieved. Time was spent drafting up the possible forms, the functional aesthetics and designs these probes could take so as to obtain relevant information from the

participants. It was decided that deploying the probes in participants' lives for a course of one week should be adequate to gather enough data. The number of materials and tasks involved in each pack was kept to a minimum as it was felt that users would not remain enthusiastic if it resembled work. It was decided that only one of the materials could live in the pocket of the individual for the week, the rest of the materials could be filled out at any stage over the course of the week.

Figure 9: Probe Packages

4.4.3Creating and Assembling the Probes

For the purpose of this project, four different provocative materials with underlying tasks were created and assembled into packages (Figure 9) namely two cards, a diagram of a house and a seven-day diary. An instruction sheet was also provided that outlined exactly how each material was to be used (Appendix B).

4.4.3.1 Cards

Within the probe packages, people found two cards that looked like postcards scattered among other materials. They were shaped like postcards, as *"Postcards are an attractive medium for asking these sorts of questions because of their connotations as an informal, friendly mode of communication"* (Gaver et al, 1999). The first of these cards had a question on the front asking, "What items do you forget?" and six images of everyday items that people carry (Figure 10).

Figure 10: First Card in Probe Pack

The second of these had a question on the front asking “What daily tasks and things do you forget?” along with some inspirational words and three images relating to common everyday tasks (Figure 11).

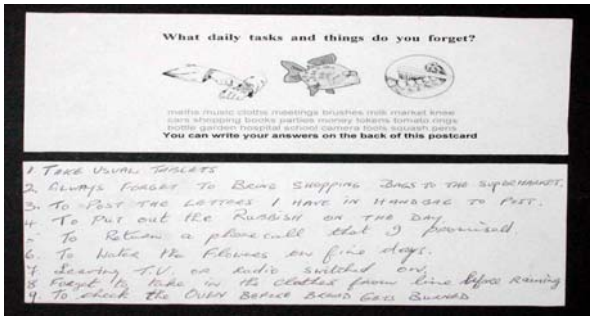


Figure 11: Second Card in Probe Pack

4.4.3.2 Diagram of Rooms in a House

The packages also contained a diagram of the rooms in a house. The participants were asked to associate a different colour with each of the rooms and to explain their reasoning behind their choice of colour (Figure 12).

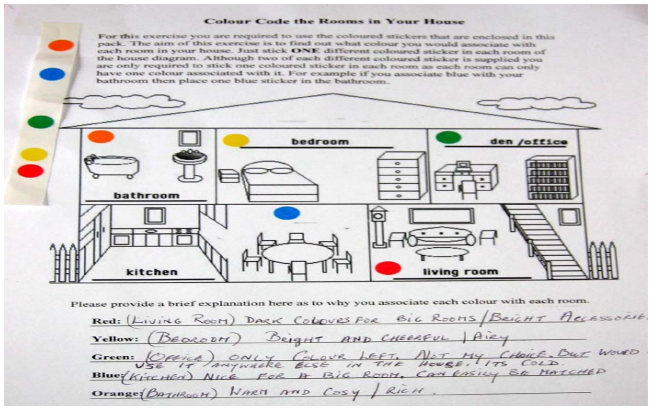


Figure 12: Diagram of Rooms in a House

4.4.3.3 Seven-Day Diary

Participants also found a seven-day diary in the form of a small pocket booklet (Figure 13). The participants were asked to record everything they forgot over the course of a week, starting Monday and ending the following Sunday. Personal comments were also to be included so as to measure the personal impact of forgetfulness. They were advised to carry this diary with them at all times to prevent the omission of valid data.

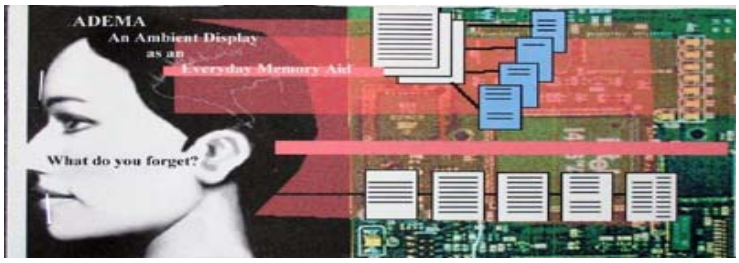


Figure 13: Seven-Day Diary

4.4.4 Recruiting the Participants

Twelve suitable participants with different profiles took part in this exercise. The participants varied in age, gender and occupation and comprised: a secondary level student (Aged 17); a third year chemical engineering student (Aged 20); a masters student (Aged 23); an unmarried mother (Aged 26); a mature student (Aged 30); a shop assistant (Aged 35); a housewife (Aged 40); an accountant (Aged 47); a company director (Aged 54); a retired guard (Aged 64); a retired nurse (Aged 78); a retired farmer and bus driver (Aged 87). It is also relevant to mention that one of these participants is slightly visually impaired and two of these participants claim to experience severe memory problems.

4.4.5 Deploying the Probes

The packs were distributed in person in order to explain the intentions of the exercise, to answer questions and to encourage a natural fun approach to the materials. Some of the participants were visited individually whilst the majority of them gathered as a group. Distributing the probes in a group turned out to be an extremely beneficial decision, as it generated the notion that they were part of a team that was on an exciting mission to determine how many things they forget. The overall approach was openly subjective, only partly guided by the objective of the problem statement (c.f. Section 1.3). Participants were assured that the data gathered from the probes was to be used for research purposes only.

4.4.6 Retrieving and Analysing Probes

Only ten of the probes were returned successfully the following week, as one of the participants ironically claimed that he was so busy that he totally forgot to fill in the diary each day and therefore did not complete the exercise. This was taken as a sign that he was occupied with his hectic lifestyle and in turn forgot, which is an important factor for design. A second participant claimed that he left it behind one evening in a bar. This proved to be a

further useful piece of data for design as it highlighted the type of scenario whereby one would need a memory aid.

The diaries and the cards of the returned packages were examined together. The results were noted in order to discover trends and common memory difficulties experienced. The most common memory difficulties identified related to misplacing or forgetting personal items and included mobile phones, wallets, keys, glasses, jackets, umbrellas, money and shopping lists. The colours the users associated with each room in the house diagram were then analysed. Each participant also had a totally different reason for his or her specific colour associations. The results of this exercise differed quite a bit from participant to participant, which highlighted the fact that everybody has totally different reasoning behind colour associations perhaps due to psychological, social and cultural factors. This data did not prove to be very relevant however it was just an experimental exercise with colour dimensions that was initially thought to be useful and interesting.

4.4.7 Debriefing Session

When collecting the probe packages a debriefing session was held with each of the participants. They were asked two specific questions:

1. What was the most frustrating thing that they forgot all week?
2. What was their over all comment on the exercise?

4.4.7.1 Results from the Debriefing Session

Overall the most frustrating thing for the participants related to misplacing and forgetting personal items such as their mobile phone, wallet, keys and glasses as these were of personal value. The participants continued to emphasise the amount of times these items have been stolen and misplaced along with the work involved or failure to replace their contents. Money was deemed to be replaceable and irrelevant when compared to the time and effort involved in replacing the other items.

The participants admitted that they did not realise that they forgot so many things but were consoled to hear that others involved in the exercise forgot as much. One participant went

as far as to say that she wished she had a robot or somebody with her always to remind her of things. Two of the participants admitted that they were conscious of their memory all week and were extra cautious every time they were leaving somewhere to ensure that they were not forgetting anything.

4.4.8 Conclusion

The debriefing sessions turned out to be an excellent means of gathering qualitative data as it highlighted the fact that a memory aid would relieve some of the stress and frustration attached to forgetting and having to remember things. Participants liked the idea of using some form of invisible technology that would be with them at all times to support them whenever they needed. Furthermore, a proactive means of preventing the loss of personal items was required.

4.5 A Web Log

A web log was also setup in this phase in order to share the personal experience of designing a subtle, non-intrusive memory aid (Figure 14). The web log viewers were encouraged to comment and it was hoped that design experts and eventual users with different cultural backgrounds would provide some useful comments. The requirements for the project had not been fully established and at this point the project was labelled ADEMA(An Ambient Display as an Everyday Memory Aid). This web log was then updated with information on the progession and stage of the project and people commented on each new suggestion that was posted.

Figure 14: Screenshot of Web log

4.5.1 Findings

The main piece of feedback that was gathered was in relation to the modality of the memory aid whereby it was suggested that a vibro-tactile means of informing the user should be considered. One commenter felt that it could be a useful optional feature on the

device but if used as a sole means of notification it could prove to be annoying and stated *"Remember a watch doesn't notify the user of the time at all times (excluding the hourly beep of a digital watch) and yet everybody that wears a watch can check the time whenever they wish."* Another commenter felt that it could be useful in several situations and highlighted the example of a day when you are travelling to the airport and you need to be constantly assured that you have your passport, tickets etc. on you at all times. Some excerpts of the web log are provided in Appendix C.

4.5.2 Conclusion

Further support for an auditory modality and the project as a whole was gained. Commenters liked the use of ambient light as a means of notification. Support was also gained for the use of a vibro-tactile means of notification as an optional feature that a user can turn on and off at their leisure. All of this was taken on-board in the design process.

4.6 Project Requirements Drawn from User Studies

1. Target Users

The memory aid should be designed in such a manner that it supports and is usable by people of all ages.

2. Form

The results lead on to an understanding that the ambient display memory aid had to be a form of wearable. Data contained in the probes such as participants behaviour and comments such as "I'd forget my head if it wasn't attached to my body" also indicated this conclusion (Figure 15)

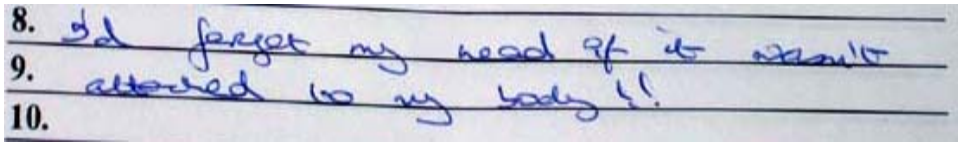


Figure 15: Comments in one participants' Diary

3. Memory Difficulty to be Addressed

The results proved that there was a need for a memory aid that prevented the loss and misplacement of personal items such as phone, wallet, keys and glasses.

4. Modality

The participants expressed a desire to be notified of a forgotten item through the use of colour, light, sound and vibration.

5. Colour Associations

Anywhere colour is used in the design, the users should have the option of personalising the device to suit their preferences.

4.7 Conclusion

Fortunately, all of the underlying goals of these user studies were achieved. Most of the participants agreed to be part of a user group for the entirety of this project. Moreover valid information was gained first-hand and most importantly the initial requirements were established and used to drive the design.

Chapter 5: Conceptual Design Formation

"Memory depends very much on the perspicuity, regularity, and order of our thoughts. Many complain of the want of memory, when the defect is in the judgment; and others, by grasping at all, retain nothing."

Thomas Fuller (1608 - 1661), Poor Mans College

5.1 Introduction

The initial set of requirements for the Upadema was gathered in the preliminary study phase of the project. However, more direct user involvement was required in order to form a clear concept with regard to the overall design. Moreover there were some peripheral and ambient display design guidelines and characteristics that had to be considered and incorporated into the design.

This chapter details the first two empirical studies that were carried out on the Upadema. These studies involved two different participatory design[6] (PD) approaches and introduced two low-fidelity prototypes of the Upadema. The first PD technique employed was a workshop that involved scenarios, role-play, envisionment exercises and paper prototypes. Its purpose was to envision the context[7] of use for the Upadema and to gather the device and user-centred requirements for a possible design solution. The second PD technique and method of prototyping employed was called the 'The Wizard of Oz' (WOZ). It was used as a communication medium to ensure that the results from the workshop were interpreted correctly and to further exercise the user interaction before progressing on to the implementation phase.

5.2 Participatory Design Workshop

A PD workshop[8] was chosen because it is highly productive and can involve numerous other creative PD techniques in order to ensure that the outstanding design requirements are

[6] Participatory Design seeks to involve users more deeply in the design process as co-designers by allowing them to actively partake in the design process. (Schuler and Namioka, 1993).

[7] Context *"is how computation can be made sensitive and responsive to the setting in which it is harnessed and used"* (Dourish, 2004)

[8] "A PD workshop *is one in which designers and users work together to design a solution"* (Gaffney, 1999).

gathered. It is also a quick means of reaching a design solution by pooling the best attributes of users and designers ideas together. Furthermore the individuality of the Upadema required a novel and collaborative approach to design rather than a rigid set of design methods.

5.2.1 Objectives

The underlying objectives of this workshop were:

1. To find out what form the users would like the wearable to be in either a chain with a pendant, watch, wristband, broach, belt-clip etc;
2. To determine both the device and further user requirements based on device- and user-centred design dimensions;
3. To envision the context of use for the Upadema.

5.2.2 Preparation

Some paper prototypes of the forms of the wearable as a chain with a pendant, watch, wristband, broach, belt-clip were made (Appendix D). Exercise materials such as a chain with a pendant, watch, belt, broach, mobile phone, paper and pens were gathered (Figure 16). A possible solution (cf. section 5.3.5) was devised from the user requirements gathered in the preliminary study phase and a scenario (cf. section 5.3.6) was drafted that detailed an example of the potential context of use. A detailed agenda (Appendix E) was also prepared that structured the workshop to ensure that there was sufficient user participation in order to achieve the objectives. The agenda followed some guidelines proposed by Gaffney (1999).

Figure 16: Materials Gathered

5.2.3 Participants

Four members of the established user group were present for this workshop. They were all of varying ages, genders and profiles: a masters student (Female, Aged 23); a mature

student (Female, Aged 30); a company director (Female, Aged 54); a retired guard (Male, Aged 64). One of these participants was slightly visually impaired.

5.2.4 Method

The method used followed the structure of the prepared agenda, which was as follows.

1. Introduction

Designer introduced herself first and welcomed everybody. Participants introduced themselves individually. The requirements gathered from the earlier user studies were outlined along with the prepared possible solution. Participants were provided with a copy of the workshop agenda and it was read aloud.

2. Objectives & Concepts

The objectives of the workshop were outlined. The concepts inherent in peripheral displays and usability were described.

3. Requirements & Issues

The requirements gathered from the preliminary study phase were outlined along with some issues in relation to the contexts of use.

4. Paper Prototypes

The prepared paper prototypes that suggest possible designs for the Upadema were presented to users and discussed.

5. Scenarios and Role-play

The scenario was read aloud to the users. The participants then role-played the part of the user in the scenario whilst wearing the provided exercise materials. The purpose of this was to determine where the user would like to look for notification of a misplaced personal item. A general discussion was held in relation to the users' personal choice of form by weighing up the pros and cons of each material. Feedback was noted.

The technical possibilities and constraints were not discussed in any great detail, although some device-centred design dimensions were addressed in this exercise in order to determine the device requirements. The first two of these design dimensions were adapted

from Goldthwaite et al (2004) however the others were specified to suit the unique requirements of the Upadema (Table 2).

Device-Centred Design Dimensions	Description
Device Interaction: User Prompting	Degree of proactiveness in alerting the user and the methods of alerts, Modality.
Device Mobility	Degree to which the device is mobile
Device Proximity	Range in which the device actively provides notification of a misplaced personal item
Device Personalisation	Degree to which the user can personalise the device

Table 2: Device-Centred Design Dimensions

6. Envisionment Exercises & Personal Scenarios

Participants were asked to envision the context in which they would use the device and to write a bullet point scenario describing where they would use it, when they would use it, when they feel they would find it most useful, etc.

7. Paper Prototyping

Participants worked in pairs (made up of one male and one female) to determine how a possible implementation of the Upadema should look taking into account several UCD dimensions extracted from Goldthwaite et al (2004) and translated to represent the requirements of the Upadema (Table 3). All of these take the ambient display characteristics of aesthetic quality, calmness and utility into consideration. Some paper prototypes of some possible designs based on the established wearable form were drafted during this exercise along with an explanation of the chosen designs.

User-Centred Design Dimensions	Description
Appearance	Pleasing design and aesthetical qualities
Burden on User	Routine effort required by user
Distraction	Degree to which the device is not distracting to the users daily routine e.g. calmness, subtly
Ease of Use	Overall usability
Utility	Degree to which it provides something of interest and use
Design Simplicity	Simple design not intimidating or overwhelming

Table 3: User-Centred Design Dimensions

8. Combine Designs

Participants discussed the merits of their designs in relation to the design dimensions and ambient display characteristics. A possible solution was drafted and sketched by the designer based on this exercise.

9. Other Issues

Any further issues that were not addressed in the workshop exercises were proposed to the group informally and a general discussion was held.

10. Review

The objectives of the workshop were reviewed to ensure that they were all met. A possible design solution was presented to the users in order to ensure that their feedback was interpreted correctly.

5.2.5 A Possible Solution

The Upadema comes with different coloured tags that can be attached to a user's personal items. The user can decide what coloured tags to attach to and associate with each personal item. Once a tagged personal item goes outside a certain proximity (to be defined) from the user's body the Upadema will vibrate and a corresponding light will display.

For example if the user attaches a red coloured tag to his/her wallet and if the wallet goes outside of a three-metre proximity from the user's body the Upadema will vibrate and a red light will display on the wearable thus notifying the user. The user can then press the button beside the red light on the wearable. The Upadema signals the tags on the wearable to emit a series of harmonious sounds that lead the user to the tagged personal item. The user has the option of turning the vibrate mode on or off.

5.2.6 Scenario for Context of Use

The user has just purchased a new wearable peripheral display that will be used as an everyday memory aid to prevent the problem of forgetting and misplacing some personal items.

Step 1. The user decides what personal items are to be tagged, in this case a mobile phone and keys.

Step 2. Each item is then equipped with a different identification tag (coloured sticker). The user chooses to associate the colour red with his/her phone and the colour green with his/her keys.

Step 3. The user stores all the personal items on person. No coloured lights show up on the wearable ambient display so the user has clarification that all the items are either in his/her bag or pocket etc.

Step 4. The user then goes shopping so he/she actives the vibrate mode on the wearable. The user's phone rings in the changing room and he/she answers it. When the user is finished the phone call he/she leaves the phone down on the floor and continues trying on clothes. He/She then leaves the changing room and forgets to pick up the phone from the floor. Immediately the wearable emits sounds, vibrates and a red light appears on the wearable. The user then glances at the wearable and realises that he/she has left his/her phone behind somewhere. So he/she presses the button beside the red light and hears his/her phone emit natural harmonious sounds in the distance. He/She follows the sounds and locates the phone.

5.2.7 Results

All of the participants preferred to glance at their hand, as this was already a learned skill. They felt that the Upadema would be more wearable if it was in the form of a watch or wristband. It was found that a chain with a pendant, broach and belt clip were not placed in a highly visible part of the body. The male participants added that they would not wear a broach or a chain with a pendant. So to suit gender preferences a watch or wristband was most suitable.

As regards user prompting, all of the participants liked the fact that the information source was in the form of light. Overall, the vibro-tactile mode was liked and deemed to be extremely useful for the visually impaired participant and also for somebody with hearing difficulties. Participants felt that the use of sounds as a means of notification was

unnecessary as they hear enough annoying and confusing sounds everyday. The use of harmonious sounds for the second function (helping the user locate their personal items) was deemed pointless as due to the current mobile phone usage and different sounds in the air, the user would not hear them. It was suggested that these be replaced with a series of beeps.

All of the participants felt that if the Upadema was in the form of a watch or wristband then the device design dimension of mobility did not have to be considered as it was already in a mobile form. As regards proximity, a three-metre minimum range was decided upon as this would allow the user to be relatively flexible in their everyday actions without being notified of the location of a personal item. The maximum range possible was deemed to be most suitable.

In relation to personalisation, participants liked the idea of choosing the different colours themselves to suit their preferences. One of the participants suggested that he would like if he could set different audio sounds, similar to the ring tones on a mobile phone. Another suggested that she would like if she could alter the proximity that a user's personal items were going to be monitored in depending on the context of use.

As regards the appearance of the Upadema, participants felt that it should be a fashion icon or else they would not wear it everyday. Participants brought the tags into question and stated that they would like each to be as small as possible and easy to attach to personal items. Participants felt that if the Upadema was in the form of a watch or something on your hand then routine effort was not a factor as you glance at your watch naturally on a regular basis anyway.

In relation to the distraction of the Upadema, the participants analysed the use of lights and stated that they would prefer if the lights were not flashing as this could prove to be annoying. Static lights were deemed to be sufficient in most circumstances, as the vibration feature would overcome situations whereby the user required extra precaution. All of the participants thought the device was very useful as it can be applied to any personal items a user wants to monitor.

The context of use for the Upadema was examined in the scenarios the participants drafted. The Upadema was envisioned to be useful in a wide variety of everyday situations. Some photos of these scenarios are in appendix F. Finally, the participants added that because the device is to be worn at all times they should be able to turn the device on and off as there may be times when they are in a situation whereby they do not wish to be notified of the proximity of personal items. The following are some sketches of a possible solution for the Upadema in the form of a wristband and watch that were drafted by the designer at the workshop based on participants combined designs and feedback (Figure 17).

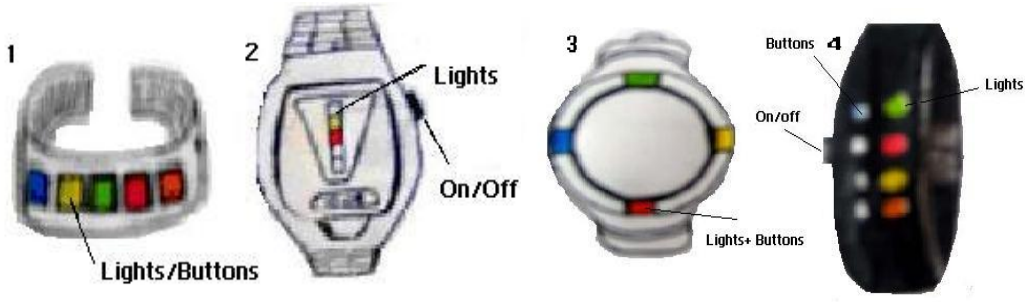


Figure 17: Possible Solutions

5.2.8 Conclusion

The PD methods proved to be extremely useful as the design was very evolvable to fit new needs, account for changes and incorporate new technologies. There were several advantages to using this approach. Firstly, it gave users a voice in the design process, which increased the probability of a usable design. Secondly, the culmination of workshop exercises served to determine the wearable form of the device and the device requirements. Thirdly, it was highly productive for providing a forum for identifying further user requirements, the context of use and other relevant outstanding issues that were important for a possible Upadema design solution. It also highlighted that the Upadema could potentially be embedded with sensors in order to be location aware and thus suitable for all contexts of use. Overall positive and useful feedback was gained from the participants. The objectives of the workshop were met and support was given for the interpretation of the initial requirements that resulted from the preliminary study phase.

5.3 Characteristics of Peripheral Displays

Peripheral displays have three different qualities that characterize them. These characteristics were outlined by Carter et al. (2003), after conducting a study on existing

peripheral/ambient displays. These include abstraction, notification and transition. In order to ensure that the device could be described as a peripheral awareness display it was necessary at this stage to review the design to ensure that it contained all three of these characteristics.

1. Abstraction

"Abstraction is the process of removing or extracting data so that the result includes fewer or different details than the original." (Mathews et al. 2003). The Upadema extracts numeric data on the location of personal items and if they fall out of a proximity of three-metres from the user's body, information is presented in the form of light and through the use of vibration. Therefore the information provided is easily understood by the user and requires less focused attention than analysing raw numeric data.

2. Notification

Ambient displays allow users to monitor changing non-critical data while performing another task and to be notified in some way when more important data arrives (Mathews et al 2004). The most critical information should be presented in such a way that it catches the user's attention and potentially demands action and the least critical information should be presented so that it does not attract conscious or focused attention from the user. Matthews et al. (2004) have identified five different notification levels: demand action; interrupt; make aware; change blind and ignore. The context and interruptability of the person receiving the information along with the information source determine which notification level to use.

In the case of the Upadema when there are no personal items outside of the predefined three-metre proximity from the user's body, the display corresponds to the ignore notification level, as no lights are presented on the display. When a user's personal items go outside of this proximity a light appears on the display and prompts the user to press the light on the display in order to locate the misplaced item in the environment, this refers to the demand action notification level.

3. Transitions

Transitions relate to how the information is displayed in order to grab the appropriate amount of attention from the user. Transitions stem from the notification level of the data, the modality of the device and the context meaning the noise level in the nearby environment. The Upadema has only one transition to consider, for example when a user's personal item goes outside of the three-metre proximity, the display transitions from a blank with an ignore notification level, to a display with a light or lights and the user will experience a slight vibration on their hand.

The evaluation of the Upadema will determine exactly how subtle or abrupt these changes should be on the display in order to grab the correct amount of human attention. However, the fact that this technology is so new, Laakso (2004) states that further research is needed to determine the best way to transition changed data in peripheral displays.

5.4 Peripheral Display Modalities

One of the key choices when developing a peripheral display is the modality chosen to map the information. This modality can be targeted at any one of the five senses but it is recommended that in order for it to be effective, the users situation or foreground task must be taken into consideration (Ishii et al, 1998). For example if a users foreground task is visually intensive then it is suggested that the background information be presented in an auditory form. Alternatively if a users foreground task is auditory intensive then a visual modality may be more successful. It was now necessary to ensure that the modalities of the Upadema established in the user studies and PD workshop correctly complement the users activities.

The users will more than likely be in a busy environment or on the move and therefore a coloured light that they can glance at along with the vibration was deemed to provide the correct degree of notification. Users deemed an auditory modality to be an intrusive and inappropriate means of notification in most use contexts due to the large number of sounds already in use. Unsolicited use of sound was also deemed annoying. A further rationale for the use of vibration is that humans can detect vibro-tactile stimuli five times faster than visual stimuli (Maruyama et al. 2002)

However once the user presses the button beside the glowing light(s) the misplaced personal item(s) will emit a sound so that the user can locate them/it in the environment. In this case however users thought an auditory modality was suitable and required, in order to locate the lost personal item. It was not deemed to be annoying or intrusive for this purpose as the user personally instigates the sound when they feel it is the right time and place. Vibration was also considered for this function, but the users thought that it was not suitable for locating a lost object as it could result in a very time consuming process. Furthermore, when the user presses the button on the Upadema he/she will be prepared to provide focused attention.

5.5 Wizard of Oz

Although the device interaction was considered in the PD workshop the user interaction was not analysed in any great detail. A deeper understanding of how the users respond to the notification modalities of the Upadema was now required. There was a further need to analyse how a user would interact and deal with the responses of Upadema if there was more than one personal item misplaced and to be located at the same time. In addition there was a need to determine if the device and user requirements gathered in the PD workshop were interpreted correctly. It was also deemed essential to test some of the wearable interface concepts in a physical form before advancing to the implementation phase. Therefore another PD technique was employed at this point in order to resolve these issues. It is formally called the Wizard of Oz[9] method of prototyping

5.5.1 Participants

Five of the user group in total participated in this exercise. It comprised of the same four participants that were at the PD workshop along with the third year chemical engineering student (Male, Aged 20). It was felt that there was a need to involve the same users from the PD workshop, as they were the only ones that could determine if the user and device requirements were interpreted correctly. Plus it was thought that the inclusion of one extra

[9] The Wizard of Oz technique *"is a form of prototyping in which the users appear to be interacting with the software, when in fact a member of the development team is responding to the users actions."*(Preece et al. 2002).

participant might illuminate any outstanding requirements that were not previously considered.

5.5.2 Objectives

The objectives of this exercise were to:

1. Establish whether the device and user-centered requirements were interpreted correctly;
2. To find out exactly how users interact with and respond to the notification modalities of the Upadema, when more than one personal item is misplaced at the same time;
3. To test some of the wearable interface concepts in a physical form.

5.5.3 Preparation

All preparations were made before the participants arrived. The same scenario from the PD workshop was utilised, as participants were already familiar with it. However there were some amendments made to this scenario (Appendix G). Firstly, the user had the freedom to attach whatever coloured sticker they desired to the personal items. Secondly, two personal items are misplaced so therefore the user has to deal with locating two personal items simultaneously. Finally the audio sound for the first feature was omitted and the end of the scenario was incomplete, as it was up to each user to determine what to do in order to locate the lost personal items. A very basic simulation of the Upadema that incorporated the user and device-centered requirements from the PD workshop was created. It comprised of a wristband and coloured stickers that simulated the buttons and lights (Figure 18)

Figure 18: Simulation of the Upadema

A video camera was set up in the corner of the testing location. Appropriate props were gathered in order to carry out the tests in the most realistic manner possible. They consisted of: two buzzers, which were used to simulate the audio sounds from the tags that helped a user locate the misplaced personal items; some examples of personal items (mobile phone,

keys, glasses case, wallet) and coloured stickers (red, green, orange and blue) that were to be attached to the four personal items in order to simulate the use of the tags (Figure 19).

Figure 19: Personal Items

5.5.4 User Briefing

When the participant arrived it was essential to give them a thorough briefing as the general procedure and objectives differed from the previous PD session. It was also explained that a video camera would be used to record the session but that this was solely for the purpose of data referral and analysis. The procedure was carefully explained to each user and they were assured that it was not their ability that was being tested rather their interaction with the Upadema.

5.5.5 Procedure

Each participant attached the four different coloured stickers to the four personal items. They then acted out the role of the user in the scenario whilst wearing the imitation of the Upadema. Once a user's personal items went outside the three-metre proximity the responses of the Upadema were simulated by placing the corresponding coloured stickers on the mock-up and users imagined that there was a vibration mode. The auditory sounds or beeps emitted from the tag when the user is locating personal items were simulated with the buzzers. How each user dealt with locating the two personal items was observed very closely. What was of particular interest here was: how they reacted to the lights on the interface; how easy or difficult it was for them to associate the lights with the correct personal item and how they reacted to more than one auditory sound.

Figure 20: Debriefing Sessions

5.5.6 Debriefing Session

A debriefing session was held at the end in order to determine if the simulation matched the device and user-centred requirements gathered in the PD workshop and to find out if there were any improvements to be made with the design of Upadema before it progressed to the implementation stage. Some photographs of this are provided in figure 20.

5.5.7 Results

All of the participants responded to the simultaneous notification of the misplacement of two personal items in the scenario in a similar fashion. Their first response was to press the lights and hear both the phone and keys beep in the distance to find out if they were somewhere in the vicinity. They then pressed one of the lights, listened and followed the sounds to locate the first item and repeated this process in order to locate the second misplaced item. One participant suggested that when locating a personal item it would be useful if you could keep lowering the set proximity to determine how close you were to the personal item.

Participants also questioned the situation whereby somebody nearby is also using a Upadema, how would they be able to determine if they were following the correct series of beeps and how would the device know to just monitor their personal items. The participants confirmed that the simulation represented the device and user-centred requirements that were identified in the PD workshop. The participants' comments confirmed that there was no problem with the interface and interaction.

5.6 Conclusion

Users were able to seamlessly interact with and deal with the loss and misplacement of more than one personal item. Several security measures and unique identification codes should be included in the design to prevent one user's Upadema from interfering with anothers. An understanding of the users' conceptual model was formed and all of the design requirements for the Upadema were established. The Upadema was now ready to progress onto its implementation phase. However the implementation of the Upadema now requires a clever balancing between the technological limitations and the established design requirements.

Chapter 6: Possible Means of Implementation

"What a wonderful faculty is memory! -- the most mysterious and inexplicable in the great riddle of life; that plastic tablet on which the Almighty registers with unerring fidelity the records of being, making it the depository of all our words, thoughts and deeds -- this faithful witness against us for good or evil."

Susanna Moodie (1803–1885), Life in the Clearing

6.1 Introduction

A significant amount of time was dedicated to researching and evaluating the available hardware and software technologies that were thought to be useful for implementing the Upadema as a wireless functional device namely Bluetooth, Infrared, PIC (Programmable Interrupt Controllers) Microprocessors and RFID (Radio Frequency Identification). However, it was discovered that there is a set of simultaneous constraints on electronics, software and mechanics facing a project such as this and further factors relating to power, range, size and cost, so therefore it was difficult to implement the prototype as a wireless functional device. However, due to the conceptual nature of this specific project, the relatively short project time frame, lack of available resources and expense of required raw hardware it was sufficient to build a conceptual prototype that simulated the use of the Upadema in a real-life situation.

Available off-the-shelf solutions could also be utilised where possible in the development of the Upadema prototype. However, it was difficult to satisfy the first function of the device, namely notifying a user of the misplacement of personal items through the use of colours, lights and vibration using only off-the-shelf componentry. Fortunately a suitable off-the shelf solution was found and utilised for the second function of the Upadema that enables a user to locate their lost personal items. Overall, the prototype required a large amount of custom design and programming through the use of available hardware, software and electronics.

This chapter provides an overview of each of these technologies and off-the-shelf solutions along with the reasons why they were initially considered, accepted or rejected.

6.2 Bluetooth

Bluetooth was considered as it is designed to be a low-power, short-range wireless technology. It can be applied to a point-to-multipoint connection such as that required by the Upadema, whereby several devices can connect to a single base station. There are several suitable small-scale Bluetooth chips available and a Bluetooth piconet can host up to eight active devices at any one time (Weidong et al. 2001).

However, there are several limitations with Bluetooth that resulted in rejecting it as a possible solution. Firstly it is a unidirectional technology and is slow in comparison to LAN speeds, the peak raw data is just 1 Mbit/sec. Secondly, it communicates using the unlicensed microwave ISM (Industrial, Scientific and Medical) band and suffers interference from other devices that also use this band therefore data may be lost as a result (PC Network Adviser, 2001). In the case of the Upadema if data is lost, it will not be able to function in the correct manner, thus the device will be unreliable.

6.3 Infrared (IR)

Infrared was considered as a possible means of implementing the Upadema, as it is a cheap, secure, low power technology that communicates using special Infrared LED's. It is used in a wide variety of applications including mobile phones, PDA's, organisers, laptops, cameras, notebooks, printers and other such devices **(**Reid, 2003**).** However it has numerous disadvantages that deem it as an unsuitable means of implementing the Upadema conceptual prototype. Firstly it can only communicate to one device at a time, it needs a clear line of sight and the device has to be kept stable when transferring data **(**Electronics Zone, 2004**).** Moreover, infrared devices operate at extremely high frequencies and are frequently sensitive to obscuration, heat, light, and orientation. (Raghu, 2004)

6.4 PIC Microcontrollers

PIC Microcontrollers are special purpose integrated circuits that are embedded inside some other device so that they can control the required features and functions **(**Brain, 2001). They were initially considered as a means of implementation because they are small low power chips, relatively cheap and can be used in low-power remote transmitters/receivers (Microchip Technology, 2004). However, there are some issues with basic PICs that

prevent them from being used in the Upadema prototype. Firstly, if the PICs were bought in large quantities, the cost can sometimes be just pennies, however it could work out to be relatively expensive to acquire a few small chips. Secondly, programming the controlling functions is a very time consuming process and unfortunately time is essentially what the complete implementation of the Upadema prototype is lacking.

6.5 RFID (Radio Frequency Identification)

RFID was deemed to be the most suitable technology for implementing the Upadema prototype and for implementing the Upadema as a wireless functional device. A more detailed explanation of an RFID system is provided in appendix H. RFID has several advantages over the other technologies that were researched. Firstly, several RFID tags can be read at same time and the read/write capability of an RFID system provides the ability to input unique identification codes that provide security for interactive devices such as the Upadema (Texas Instruments, 2003). Secondly, an RFID system will operate with no line of sight and the tags do not have to be oriented in any particular direction. Furthermore, the tags can be read through a variety of substances and surfaces such as cardboard, plastic, paint, snow, ice, fog and even grease and grime (Harty, 2003).

There are three main types of tags: passive, active and semi-passive. Both passive and active tags were utilised in the Upadema conceptual prototype. A brief explanation of why they were chosen to implement the prototype is provided here, however a more detailed description of their capabilities along with the current real world limitations and implications of using an RFID system is provided in appendix H.

6.5.1 Passive Tags

Figure 21: Smart Labels

Passive tags have a very short read range and are often referred to as “smart labels” (Figure 21). Passive tags were used in the implementation of the first function of the Upadema conceptual prototype as a long read range was not required. They are also the most suitable

resources available in the IDC (Interactive Design Centre). They required the use of the RFID system illustrated in figure 22, which includes a reader, external battery and a custom built antenna that extends the normal read range of just under one foot.

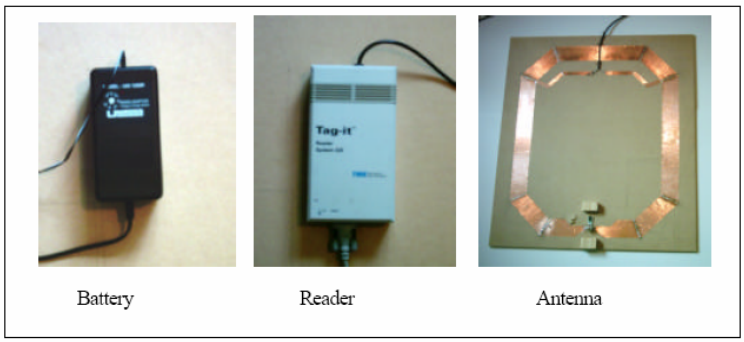


Figure 22: RFID System in the IDC

However they could not be used to implement the second function of the Upadema prototype or in the complete implementation of the Upadema as a wireless functional device for several reasons. Firstly, their read range is much too short. Secondly, the returned signal detection can be lost due to interference from other devices operating on the same wavelength for example RF barcode scanners, cell phones and wireless LANs to name but a few (Leydon, 2004). Furthermore, the RF transmitter/receiver unit can only detect which tags are within its detection range thus there is no means of detecting where the tags are outside of its detection circle (Adams, 2002).

6.5.2 Active Tags

Figure 23: Active RFID Tags

The active tag RFID system was deemed to be the most viable solution for implementing the second function of the Upadema prototype and for implementing the Upadema as a wireless functional device for several reasons. Firstly, they are powered by an internal battery which generally gives the tag a larger read range of up to hundreds of metres thus the proximity detector and read range of the Upadema could be implemented. Secondly, the active RFID tags (Figure 23) are small and can be read at extremely high speeds. However,

they can be very expensive when purchased in small quantities and hard to manufacture. Moreover, all the identification codes in the active tags share a common resonant frequency so therefore anti-collision algorithms are required. As a result, it was suggested that available active tag RFID off-the shelf solutions and products should be utilised where possible.

6.6 Available RFID System Solutions and Products

There are several available RFID solutions and products on the market today that could be hacked, reassembled and combined to bring about the implementation of the Upadema prototype. However a full understanding of how each of these solutions worked along with their specific features and functions was required so a significant amount of time was dedicated to researching and evaluating these solutions. The following section provides an overview of the some of the possible useful products and solutions that were researched and evaluated. All of these operate on 433MHz, which is the optimal frequency for global use of active RFID systems in crowded, multi-tag environments at present.

6.6.1 "Now You Can Find it" RF Wireless Electronic Locator

The most suitable device that was found was the "Now You Can Find It" RF locator (Sharper Image, 2004). It consists of a RF transmitter base, a mounting bracket and four individual coloured beeper RF receiver discs (Figure 24). A user can just attach a coloured disc to an object and the next time they need to locate it, press the matching coloured button on the portable base and the corresponding coloured disc beeps loudly. The base signals the disc to beep and the beeps lead the user to the disc (and object).

Figure 24: Base and Four Coloured Beeper Discs (Sharper Image, 2004).

It was used in the implementation of the Upadema as it contains the following relevant features and functions. It has four RF receivers that identify with the base RF transmitter

thus allowing the location of the receivers to be tracked upon request. Each of the colour coded receiver discs are a suitable small size at 5 cm across and run on a CR2032 lithium coin-cell battery, which is embedded into each disc The receiver discs and transmitter base will communicate within a suitable 35-foot range. Its functionality is similar to the second function of the Upadema, which enables the user to locate personal items if they are misplaced.

6.6.2 Child and Luggage Monitoring Systems

There are several other child and luggage monitoring systems on the market. Some examples include: The Kid Messenger (Blackridge Security and Safety Products, 2003a). The Child Guard Electronic Child Leash (Blackridge Security and Safety Products, 2003a); The Wrist Type Panda Series Personal Alarm (Y&S Technology Co.Ltd, 1996) and the Suresafe Luggage Monitoring Locator (Suresafe Technology, 1996).

All of these products use active RFID systems and consist of a child/luggage unit (receiver) and a main unit (transmitter) that alert a user with a series of beeping sounds if a child or luggage leaves a specified range. These products were initially deemed to be suitable for implementing the second function of the Upadema as they are small in size, contain an RFID receiver and transmitter, have a suitable 6-30 foot range and unique identification codes. However, they were not chosen to implement the second function of the Upadema for several reasons, however the main reason being that the parent unit can only track the location of one child/luggage unit therefore three of these devices would have to be purchased and the small wearable form of the Upadema would have to be sacrificed.

6.6.3 Other Possible Solutions

Car alarms and radio controlled toys and kits were also investigated. However, they proved to be an inefficient solution for implementing the second function of the Upadema.

6.7 Conclusion

RFID passive tags were used in the implementation of the first function of the Upadema prototype. RFID active tags could be utilised in the real world implementation of the Upadema as a wireless functional device. The “Now you can Find it” product was used in the implementation of the second feature of the Upadema Prototype as it contained RFID active tags and some relevant functions and features.

Chapter 7: Implementation of the Upadema Conceptual Prototype

" Memory … is the diary that we all carry about with us."

Oscar Wilde (1854-1900), The Importance of Being Earnest

7.1 Introduction

This chapter explains how the chosen hardware (outlined in the previous chapter) and software was utilised to bring about the implementation of the Upadema conceptual prototype. It reflects how the extensive research and proactive user participation in the earlier phases of the project resulted in a better interaction design and creation of a final working prototype that simulates the intended concepts of a full implementation of the Upadema.

7.2 Description of the Upadema Conceptual Prototype

As previously outlined, the Upadema prototype offers two main functions. The first function notifies a user of the misplacement of the personal item(s) through the use of colour, light and vibration. This requires that a user attach a coloured RF Passive tag (red, green, yellow) to the personal item(s) they want to track. Once any or all of the personal items are misplaced the corresponding coloured light(s) appear on the interface of Upadema (which consists of a series of LED's) and it vibrates.

The second function enables a user to locate the lost personal item(s) through the use of a series of beeping sounds. This requires that a user attach a different coloured disc (RFID active tag) to the personal item(s) they want to track. The user then presses the button beside the light (glowing LED(s)) and the disc attached to the personal item(s) emits a series of beeping sounds, which lead the user to the lost personal item(s). Two separate tags will not be required for each function in a full implementation (Figure 25).

Figure 25: Separate Tags on Personal Items

7.2.1 The Upadema Prototype Circuitry

Three LED's (red, green, yellow) and three buttons were placed on a small circuit board alongside the circuit board from the "Now You Can Find it" device. The three buttons were connected to the wires coming from the "Now You Can Find it" device. One end of a wire (two metres) was connected to the Upadema and it contained the three connections from the LED's and a connection from the base of the "Now You Can Find it" device. The other end of this wire was connected up to a FlowLog-lite device, which is a low-cost, flexible PC interface that was used to control the LEDs. Three resisters were placed on the wires that were connected up to the Flowlog-lite device to prevent the LED's from burning out as there were eight volts being emitted from the Flowlog-lite device and the LED's could only receive five of these volts (Figure 26). A block diagram of this is provided in appendix I.

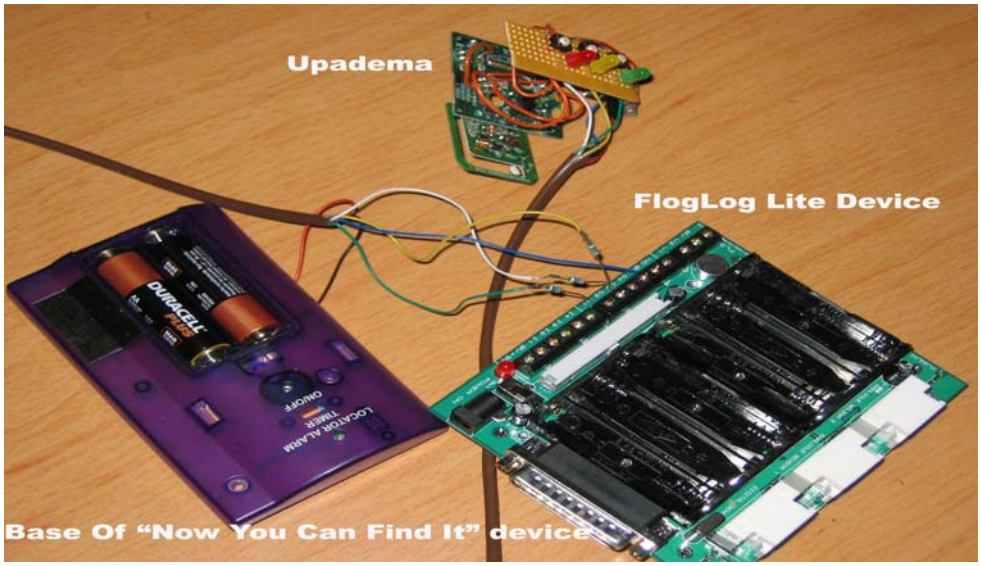


Figure 26: Upadema Prototype Circuitry

A vibro-tactile transducer was connected up to a stereo headphone jack so that it could be plugged into a speaker at one end and placed on the back of a user's wrist at the other (one of the most sensitive parts of the body). (Figure 27)

Figure 27: Vibro- Tactile Transducer

7.2.2 Technology Behind First Function

Each of the RFID passive tags is encoded with a specific number. A controlling program was custom written in lingo, Macromedia Directors programming language (Appendix J). It required the use of two software extentions "Xtras" and relative code (Flowlog-lite and RFID reader) which were previously written by Gallagher (2001). The controlling program works on the following basis. Once the RFID passive tag(s) attached to user's personal item(s)) go outside of the 7inch RFID reader field, the reader which is connected to the computer can no longer detect their presence (read identification numbers) and therefore the computer sends signals to the Flowlog device (connected to the parallel port) to turn on the corresponding LEDs on the Upadema. Each time this happens, the controlling program plays a .wav file (a series of sine waves) that is emitted out through the vibro-tactile transducer connected to the speaker port (Figure 28)

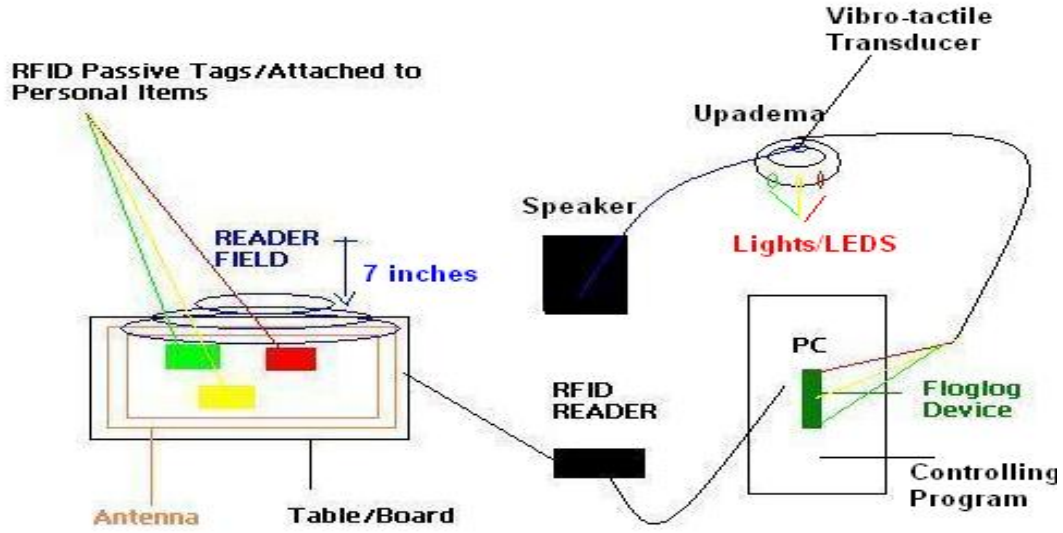


Figure 28: Illustration of First Function

7.2.3 Technology Behind Second Function

Once the user presses the button beside the glowing light(s) (in order to locate the lost personal item) signals are send from the Upadema to the base of the "Now You Can Find It" device. RF signals are then sent from the base of the "Now You Can Find It" device to the RF active tag(s) (attached to personal items). The RF active tag(s) activate an internal alarm/buzzer that emits a series of beeping sounds (Figure 29).

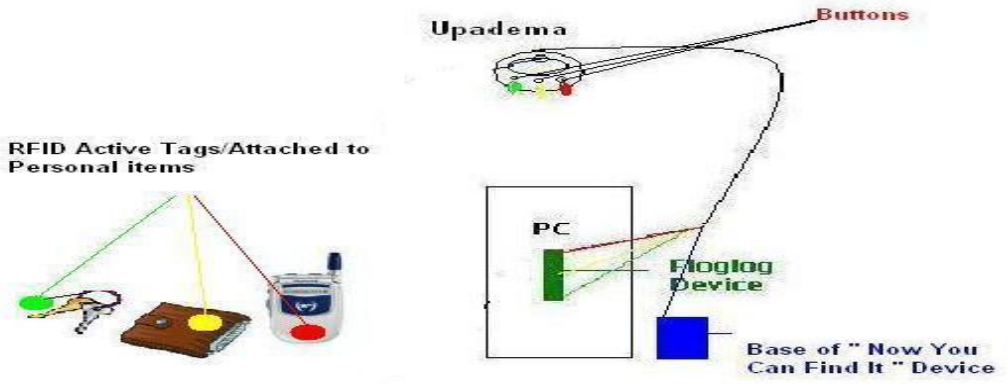


Figure 29: Illustration of Second Function

7.2.4 Appearance of Upadema Prototype

The Upadema prototype cover consisted of black textile material and velcro- straps. The interface consisted of three silver button covers and three coloured LED's. It resembles the fourth possible solution outlined in Figure17 (c.f. Section 5.2.7). It was informally tested with some users and proved to be too large and awkward to wear and the buttons were too big. The material was also liable to get wet, as it was not waterproof (Figure 30)

Figure 30: Design of Third Prototype

Following on from these important realisations, the circuitry was compressed down and a smaller, neater waterproof cover was made, which contained smaller buttons (Figure31).

Figure 31: Design of Fourth/Final Working Prototype

Chapter 8: Testing and Evaluation

"I shall remember while the light lives"

Algernon Charle Swinburne, (1837 - 1909), Erotion

8.1 Introduction

This chapter deals with the third and final set of empirical studies that were carried out on the fourth Upadema prototype. They involved a co-operative evaluation approach that employed a "thinking aloud" method. Two separate sets of tests were carried out using this method. The first of these tests examined the overall usability and user interaction of the Upadema prototype in comparison to the newest high-tech device on the market that serves the same purpose, called the FoolProof® device[10] (MRSI International, 2004). A more detailed description of the FoolProof® device is provided in appendix K. The second of these tests evaluated the design of the Upadema exclusively. The purpose of both tests was to obtain qualitative data from potential users.

Both of these tests also utilised scenarios that considered the use of the device(s) in two different possible use contexts; a home environment and a public environment. They were then followed by a quantitative method of evaluation, which involved the use of a questionnaire. Both the qualitative and quantitative methods of evaluation were used in conjunction with one another in order to achieve the following objectives.

8.2 Objectives

The overall objective of these empirical studies was to evaluate the users' attitude towards both the Upadema and the Foolproof device, which encompasses their perception, feelings and opinions on the following:

1. The use of light and colour (subtle visual) as a means of notification in comparison to textual and auditory modalities used in comparable products that currently exists on the market;

[10] FoolProof® is a monitoring device that notifies a user of the misplacement of their personal items through the use of auditory and vibro-tactile modalities. It also helps a user to locate the lost personal items through the use of visual (text-based) and auditory modality and consists of an LCD display and textual GUI.

2. Whether visual and vibro-tactile means of notification are more non-intrusive and private/personal than traditional auditory sounds used in memory aids and notification devices (relative to social setting and context of use);

3. The control of sounds in memory aids and notification devices, namely allowing a user to decide the appropriate time and place to instigate the lost personal item to beep (relative to social setting and context of use);
4. The usefulness, effectiveness and learnability of the Upadema in comparison to other such devices.

8.3 Participants

Twelve participants took part in the empirical studies. Six of these participants took part in the first set of user tests. They included the same five participants that were involved in WOZ session (c.f. 5.5.1), along with one other participant (Student, Male, 24) who was not part of the established user group. The other six of these participants took part in the second set of user tests and were also not part of the established user group. They included four males and two females (Aged between 21-56). The inclusion of the participants that were not part of the established user group and not familiar with the project was deemed to be relevant for providing an unbiased view of the Upadema.

8.4 The Thinking Aloud Method

The thinking aloud method of evaluation was employed at this stage as *"it can be very useful in interface design to give a clue as to why a given design feature is good or bad"* (Bannon, 2000). The general procedure requires that the participants are given a list of tasks to carry out and their verbal protocols are studied in order to get an insight into their mental process and perceptions of a design. The tester cannot prompt or help the participant in anyway; they can only prod them to keep talking aloud.

8.4.1 Preparation

The procedure the tests were to follow had to be planned in order to ensure that the objectives would be met. It followed the guidelines presented by Lewis (1982) but was adapted slightly to include the use of scenarios that exercised the use of the devices in a home and public (e.g. café) environment (Appendix L). Some appropriate café sound effects were made. All of which was thought to be useful for: setting the scene,

camouflaging the prototypical form of the Upadema, simulating real world situations, encouraging a more realistic form of interaction, allowing participants to express viewpoints and analysing the appropriateness of all the modalities in different settings. A suitable set-up that dramatised the scenarios was devised and created for the tests (Figure 32)

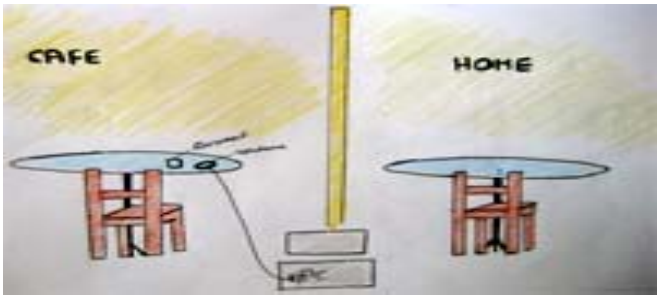


Figure 32: Illustration of Test Set-Up

A pilot study was then held that exercised this procedure, and proved that the use of scenarios complemented the thinking aloud method and served their intended purpose. Both sets of tests included these scenarios and followed the same general procedure. Therefore for simplicity reasons only the procedure for the comparison test will be described here.

8.4.2 Procedure

The participants were first presented with a consent form (Appendix M). They were instructed on how to perform the thinking aloud method and informed that a video camera was recording the session. They then moved firstly into the café environment set-up and the scenario was read aloud. They were then asked to act out the role of the user in the scenario using both devices whilst thinking aloud. The same procedure followed for the home environment. In order to overcome any influential factors, the comparison test on the Upadema and FoolProof® device were alternated, namely three of the users carried out the test on the FoolProof® device first and the other three carried out the test on the Upadema first.

A debriefing session was held with each participant after they had carried out the test. They were asked a number of questions in relation to both devices (Appendix N). The questions were asked in random order in order to prevent a sequence effect. The participant was then presented with a questionnaire (Appendix O).

8.4.3 Questionnaire

The questionnaire was adapted to suit both types of tests, namely the questions about the FoolProof® device were omitted for the second set of tests. Both contained: some demographic questions in order to gain a brief profile of each participant; three general questions in relation to the degree of publicity of auditory, light and colour and vibration notification modalities and up to nine specific questions in relation to the Upadema or FoolProof® device. Some of the questions were partially negatively formulated in order to prevent repetitive response patterns and a halo effect (Rubinstein & Hersh 1984 in Cushman & Rosenberg 1991). A Likert scale (Toner, 1987) was used in order to provide consistency among similar questions and to allow for comparisons.

8.5 Data Analysis

The following section firstly presents the results from the questionnaire. A discussion of the results from this quantitative method of evaluation is then provided that proved to achieve the first two objectives. A discussion of the data gathered in the thinking aloud method is then supplied and determines the outcome of the two remaining objectives. It concludes with issues that were raised in relation to both the qualitative and quantitative data gathered and some possible contributing factors, which may have affected the overall results.

8.5.1 Results from the Questionnaires

The following are the overall results from the two types of questionnaires that were distributed to the twelve participants after the thinking aloud method. Both of which were combined as they contain comparable questions in relation to either or both the FoolProof® device and the Upadema.

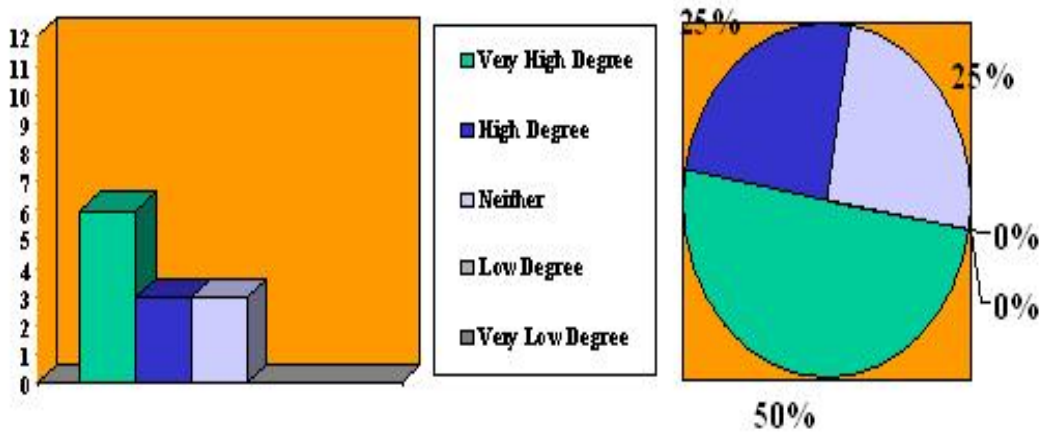
8.5.1.1 Demographic Questions

The results showed that participants that were not part of the established user group included four students, a waitress, an accountant and a software engineer. Therefore this meant that the data gathered represented the views of a wide range of people with different backgrounds.

8.5.1.2 General Questions

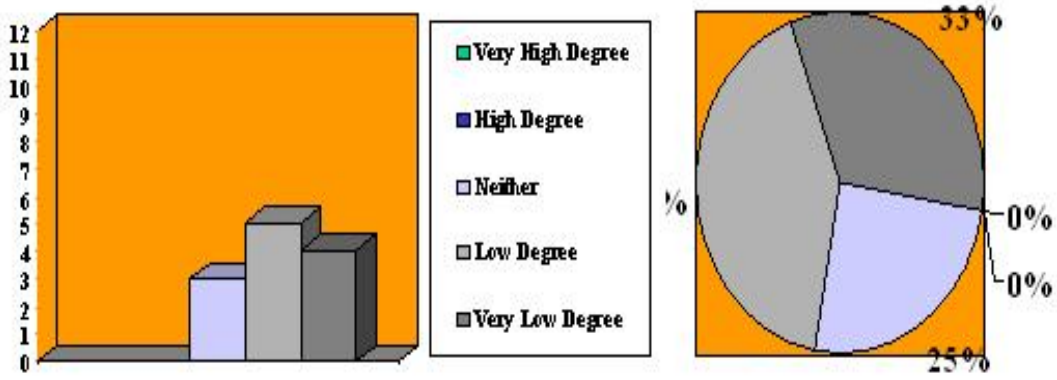
The following three questions were asked in order to get an understanding of peoples general perception of the modalities used, without any specific reference to either the Upadema or the FoolProof® device.

1. An audible means of notification has what degree of publicity?



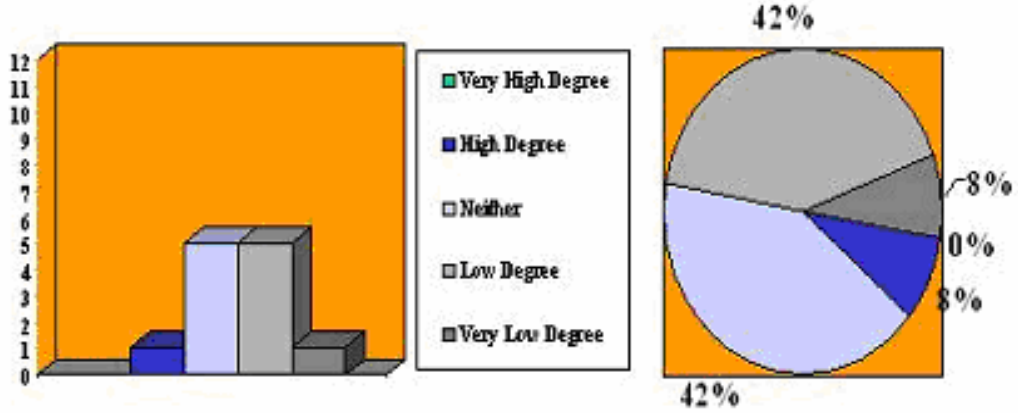
Half of the participants' felt that an audible means of notification had very high degree of publicity. Comparable results were produced for the options of high and neither high nor low degree. Overall the ratings ranked at the higher end of the scale, all of which suggests that the participant felt that an auditory modality has a high degree of publicity.

2.Vibration as a means of notification has what degree of publicity?



Five of the participants' felt that vibration had a low degree of publicity. Four felt that it had a very low degree and three felt that it had a neither high nor low degree. However a definite result was produced here and the statistics suggest that overall, the participants' felt that vibration has a low degree of publicity.

3.Light and colour as a means of notification has what degree of publicity?

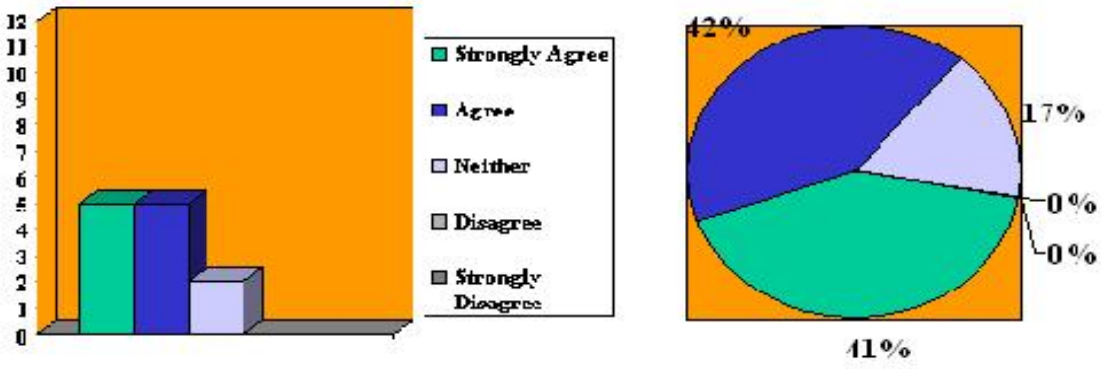


The rankings for neither high nor low degree of publicity and low degree of publicity correlate. The same applies for the ranking of high degree and very low degree. However a balance was found which suggests that light and colour as a means of notification has a medium degree of publicity.

8.5.1.3 Specific Questions

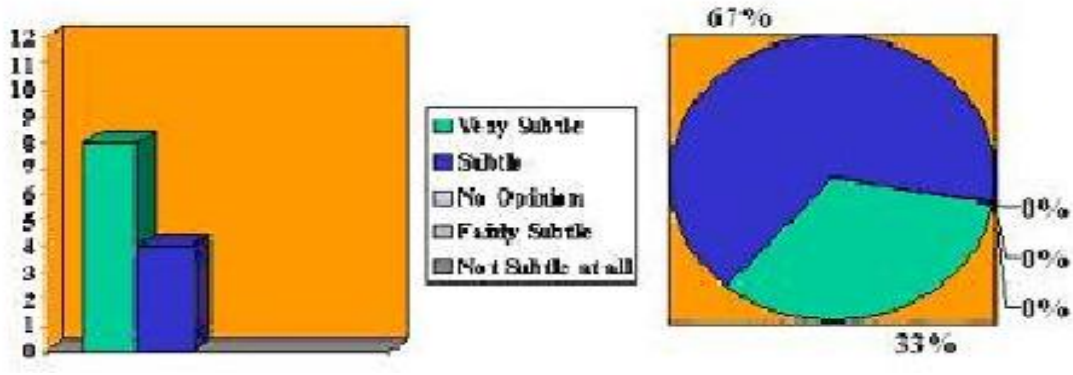
The following questions were used to make comparisons between the modalities of the FoolProof® device and the Upadema. They were the most significant contributors in determining if the project had achieved its overall objectives.

1.The notification modalities (light, colour, vibration) of the Upadema provide sufficient memory support?



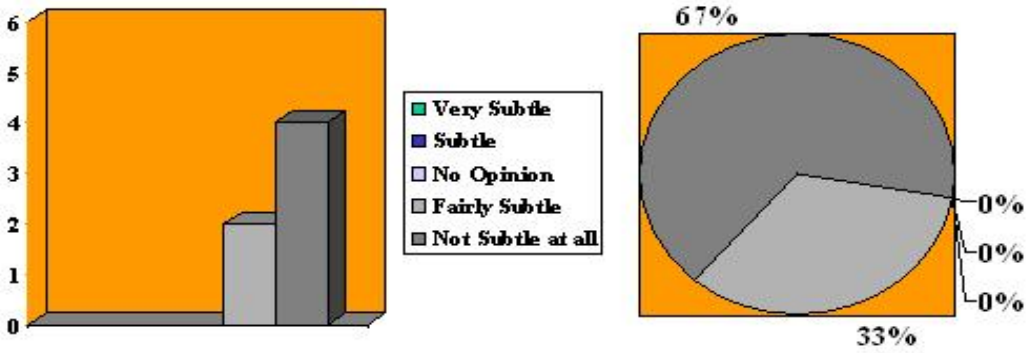
The most comparable results can be found at the higher more positive end of the scale suggesting that the notification modalities of the Upadema provide sufficient memory support. The results from this question proved that the Upadema serves its intended purpose.

2. The notification modalities (light, colour, vibration) of the Upadema are? (In relation to subtly)



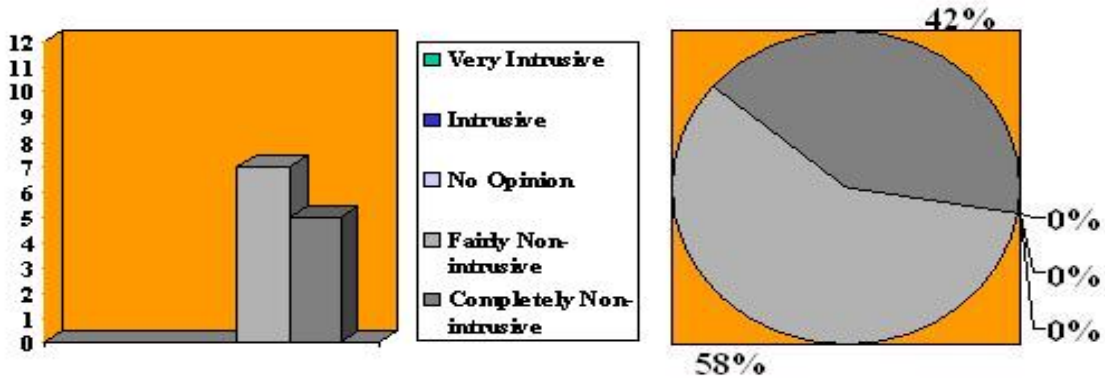
Two thirds of the participants' felt that the notification modalities of the Upadema were subtle and one third felt that they were very subtle. This concluded solely that the notification modalities used in the Upadema are subtle.

3. The notification modalities (text, audio, vibration) of the Foolproof are? (In relation to subtly)



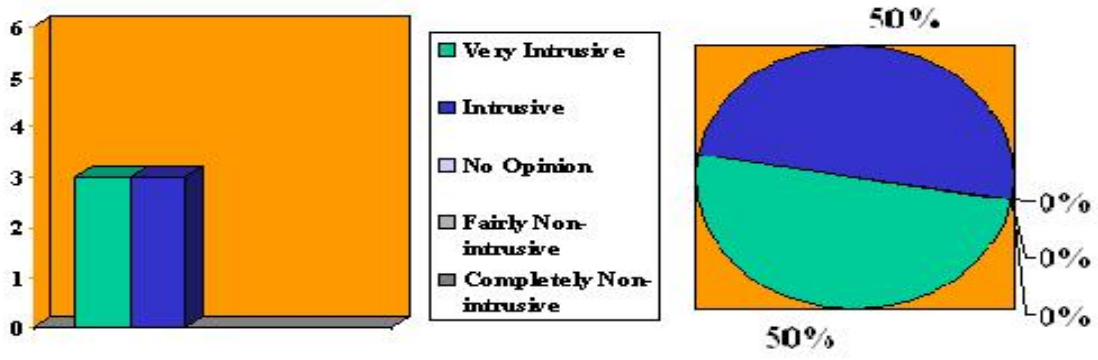
Two of the participants' felt that the notification modalities used in the FoolProof® device are fairly subtle. However, the majority of the participants' felt that they were not subtle at all. Both the results from this question and the previous question were compared and proved another one of this projects objectives (the first objective of this study) that the notification modalities of the Upadema are subtler than comparable products that currently exist on the market.

4.The notification modalities (text, audio, vibration) of the Upadema are? (In relation to intrusiveness)



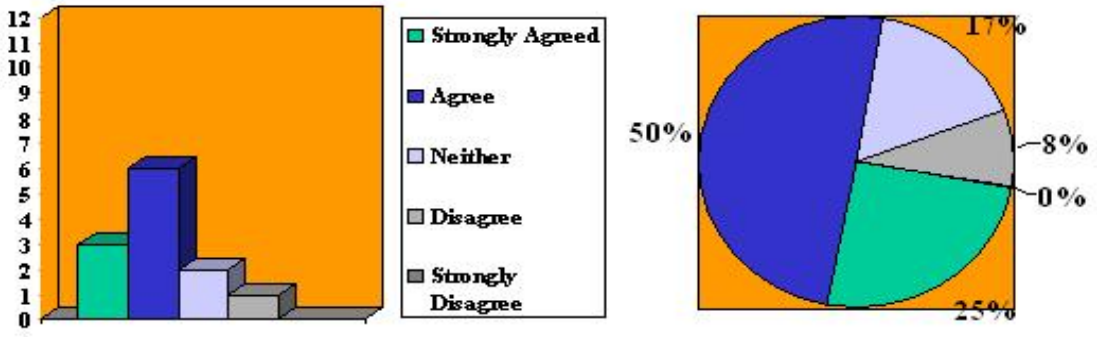
Seven of the participants ranked the notification modalities of the Upadema to be fairly non-intrusive and the other five felt that they were completely non-intrusive. Overall the results suggested that the notification modalities of the Upadema were non- intrusive

5.The notification modalities (light, colour, vibration) of the Foolproof are? (In relation to intrusiveness)



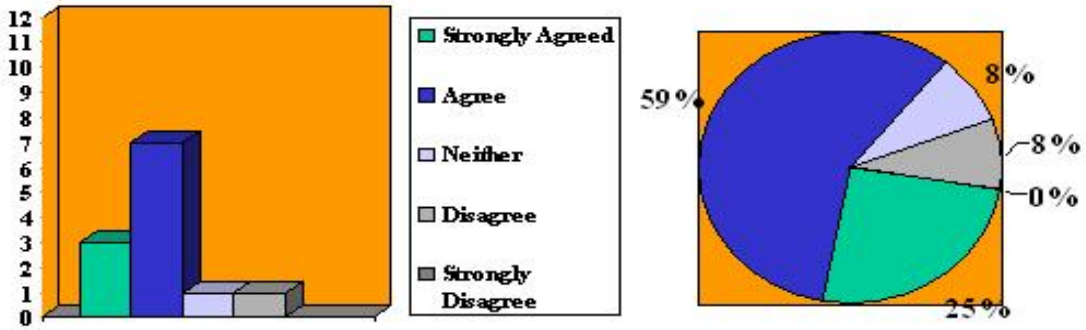
All of the participants ranked the modalities of the FoolProof® device at the higher end of the scale. Three of the participants felt that they were very intrusive and the other three felt that they were intrusive. The results of this question and the previous question were compared and proved to determine the result of the second objective of this study that the notification modalities of the Upadema are more non-intrusive than comparable products that currently exist on the market

6.The Upadema has the potential to become a part of ones everyday outfit?



Six of the participants agreed that the Upadema has the potential to become a part of ones everyday outfit and three of these strongly agreed. However one participant disagreed and two neither agreed nor disagreed. These results were later compared with the results from the thinking aloud session. It was discovered that the participant that disagreed declared that he does not wear anything on his wrist not even a watch, he uses his phone to check the time. The other two participants that remained undecided had proposed that the functions of the Upadema should be part of a watch, as they would not wear anything else on their wrist. Overall the statistics show that Upadema has potential to be worn as part of ones everyday outfit and the functions it provided also have the potential to be integrated into a watch.

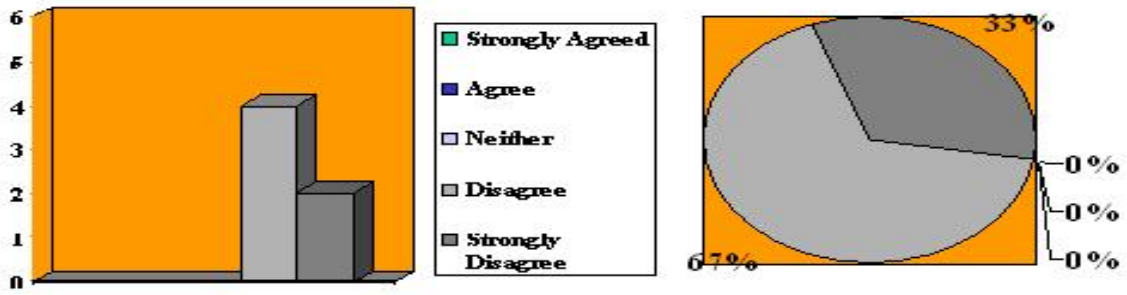
7. The Upadema is suitable for a social setting?



The majority of the participants either agreed or strongly agreed that the Upadema is suitable for a social setting. However one individual disagreed and one neither agreed nor disagreed. The two negative results were again compared with the data from the thinking aloud session. It was discovered that these two participants would like control over all modalities used in the Upadema so that the user could adjust them in accordance with their

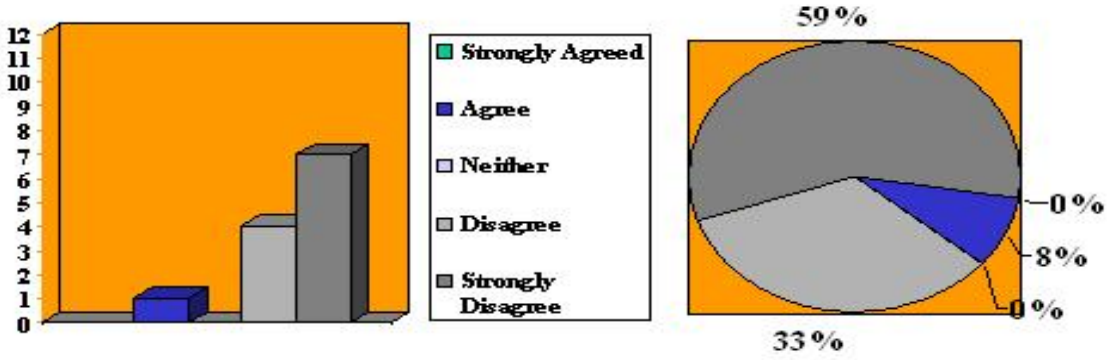
social context, all of which was considered as a possible future development. Overall there is significant statistical evidence here to suggest that the Upadema is suitable for a social setting.

8. The Foolproof device is suitable for a social setting?



All of the participants either disagreed or strongly disagreed that the FoolProof® device was suitable for a social setting. The results from this question were then compared with the results from the previous question and served to prove positive results for another one of this studies objectives and an overall project objective, namely that the Upadema is more suitable for the social setting than comparable products that currently exist on the market.

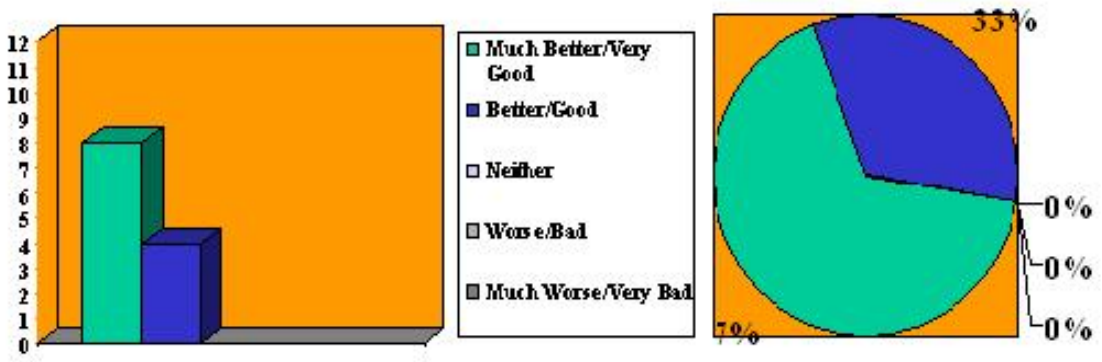
9. There is not a major benefit to using the Upadema device over the Foolproof device? (six of the participants were asked this question in relation to the Upadema Only)



The majority of the participants either strongly disagreed or disagreed with this statement. One participant agreed with this statement but this data did not correlate to the data contained in the participant's thinking aloud session, as he provided all positive remarks. It was felt that the question might have been misunderstood as the participant was of French nationality and due to the fact that it was negatively phrased it might have caused some

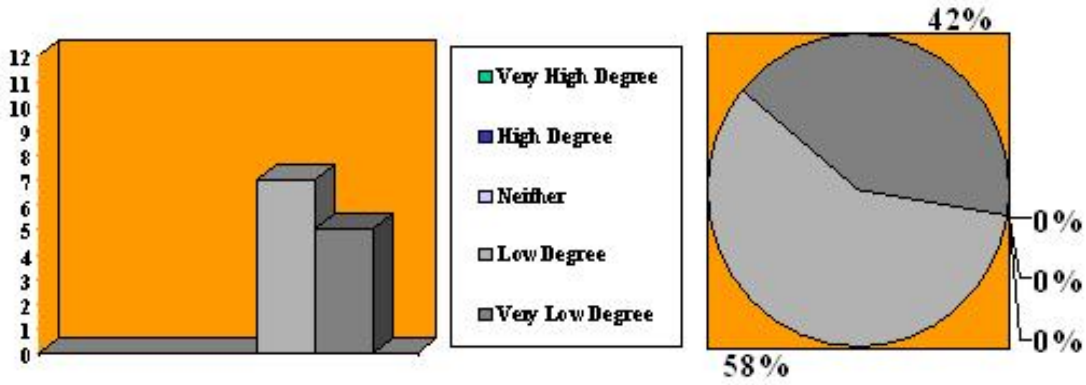
confusion. Overall it was interpreted that there is a major benefit to using the Upadema over the Foolproof and the Upadema in general.

10.Do you think the interaction with the Upadema device is_____ than the Foolproof device?



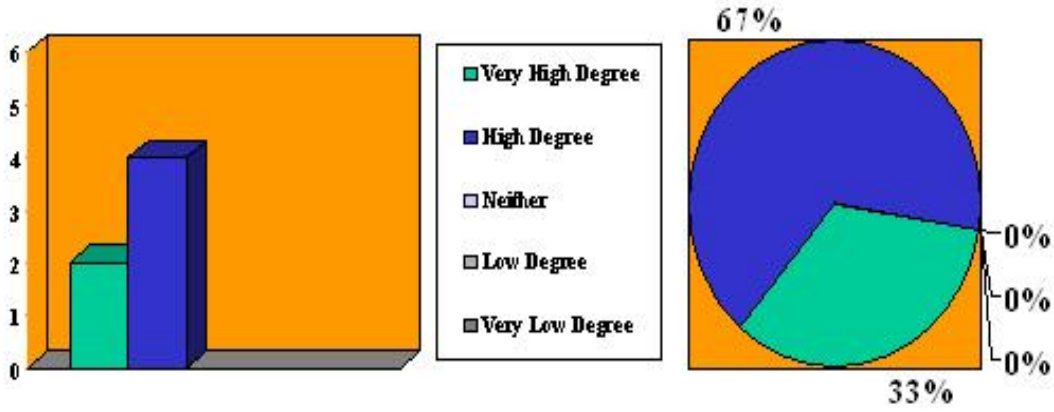
The majority of the participants' felt that the interaction with the Upadema was much better and the remaining two felt it was better than the FoolProof® device. This question was phrased differently for the six of the participants that took part in the second set of tests. They were asked what they thought of the interaction with the Upadema. Four of these participants' felt that the interaction with the Upadema was very good and two felt it was good. Overall the results proved that the interaction with the Upadema was very good and much better than the FoolProof® device.

11.What degree of publicity do you think the Upadema has?



Seven of the participants' felt that the Upadema had a low degree of publicity. Five felt it had a very low degree. Overall this proves that the Upadema has a low degree of publicity.

12.What degree of publicity do you think the Foolproof device has?



Only six of the participants were asked this question. Four of these participants' felt that it had a high degree of publicity and two felt that it had a very high degree of publicity. The results of this question were then compared to the results from the previous question and proved that the Upadema has a lower degree of publicity than comparable products that currently exist on the market, another one of this project's and studies' objectives. It was then translated to support other objectives of this project, namely that the Upadema is more personal/private, is more suitable for a social setting and would prevent disruption to other people in the surrounding environment.

8.5.2 Results from Qualitative Method

The data gathered in the questionnaires was successful in determining that the first two objectives of the empirical studies. The qualitative methods were then analysed in order to establish if the two remaining objectives that relate to the control of sound, usefulness, effectiveness and learnability of the Upadema were achieved.

All the participants liked the way they had control over the auditory modality and some gave examples of situations where they would find it useful e.g in lecture and meetings. Two participants added here that they thought that the user should have control over all modalities as mentioned earlier. Some of the participants' felt that it would be better if the auditory sounds for the second feature were removed, but could not think of anything else that would be efficient enough to enable a user to locate a lost personal item. They also highlighted that you need a quiet environment to hear the sounds. They did not like the

auditory modality in the Foolproof product what so ever. The Foolproof device frustrated all the participants with its constant beeps and vibrations. The participants had no control over the modalities of the device and could not interpret the meaning of them, as the device would beep and vibrate even when they had all the tags in their hands.

The participants' thought the Upadema was very user friendly as it contained very little functionality and few buttons. No problems were observed in relation to the buttons, all the participants pressed the correct ones straight away. Participants remarked that lack of complexity was also one of reasons that they would wear and use the Upadema. All six of the participant could not use the Foolproof device. They all failed to complete the task of retrieving the lost personal item, they looked for the correct button on the master unit, but could not find one. One user got so frustrated that she stated "take it away from me."

In relation to learnablity, the participants' thought that they would not have to learn how to use the Upadema that one participant stated "even a child could do it, three buttons, three lights, simple". In relation to the FoolProof® device users said that it could take up to several days to get used of the device or require extensive reading of a manual.

All the participants' thought that the Upadema was very useful and comments at the end of the questionnaire also proved this, as one participant said "I need one, it would be very handy". In relation to the users interaction with the device in both the home and café environments the general consensus was that the first function was not really required in the home as it may prove to be annoying. In relation to the overall aesthetics users felt that the Upadema should look like a watch, the tags should be tiny like a dot, as some users said that they would not attach anything larger than a button to their phone.

They did not like the appearance or form of the FoolProof® device in comparison to the Upadema and thought that the tags were much too heavy and were unattachable to small personal items like keys. They preferred something that they worn on their body. All participants liked the way that there was no text or computer screen on the Upadema and declared that it was a refreshing change from traditional devices and user interfaces. The

expanded on this by saying that as a result it did not look like a piece of technology. All of which were excellent remarks for this proving that the Upadema conceals the technology.

8.5.3 Issues Raised from Qualitative and Quantitative Methods

Vibration has a low degree of publicity but has to be kept close to the body. The use of light and colour were considered public to a certain degree but however useful as they did not have to be kept close to the body and have a larger potential to evolve into new wearable forms that could be placed outside of a users' clothing etc a chain, bag, broche. All the modalities were thought to complement each other. The Upadema needs to work well and adjust to the wide range of environmental conditions and situations.

8.5.4 Possible Contributing Factors

The factors that may have affected the overall outcome include:

1. The aesthetics of the Upadema in a prototypical form (wires etc.) required that the participants envisioned the prototype as a watch or wristband;
2. The fact that the designer carried out the tests participants' may have felt a certain degree of empathy, which may also have affected the overall results.

8.6 Conclusion

The empirical studies carried out in this phase of the project were successful for evaluating the Upadema prototype in comparison to a similar product that currently exists on the market, namely the FoolProof® device. They were also successful for evaluating the Upadema solely. All of the objectives of the studies were met and remarkable results were produced that prove that the design of the Upadema complies to usability standards and provides the correct degree of memory support to a user, in a more subtle visual, non-intrusive and personal manner. It has also been proved that the Upadema provides more efficient and pleasant user interaction and that it is more suitable for a social setting than comparable products that currently exist on the market.

Chapter 9: Conclusion

"In memory's telephoto lens, far objects are magnified"

John Updike (1932 -) Poems/Short stories/Plays/Prose and Plays

9.1 Introduction

This research began by addressing a real world problem, namely memory difficulties that we all experience on a daily basis. A series of methods of collecting data from potential users such as informal conversations, a questionnaire, and the use of probes were carried out in order to determine the most common everyday memory difficulty experienced. The results proved that forgetting and misplacing personal items was experienced most on a daily basis. A user group was formed at this point that participated at every essential and opportune stage in the design process.

Extensive research was carried out in relation to possible ubiquitous technologies and possible solutions that had the potential to move the technology into the background of a user's attention, thus allowing them to carry on with their daily discourse without distraction whilst still providing them with sufficient memory support. Research in to the type of memory difficulty that this project addressed was conducted, which provided some relevant and supporting issues for the design of an external memory aid.

A significant amount of problems were also found in memory aids and notification systems that currently exist on the market and this project refocused its objectives in order to address them. This research and user involvement sparked the design and implementation of the Upadema prototype that serves as a novel mnemonic means for providing notification of the loss of personal items by appealing to a users' peripheral awareness.

9.2 Achievement of Objectives

The overall objective of this thesis could be described as providing a solution to the following problem statement "How can technology be used in a more subtle, non-intrusive and private manner to help people with their everyday memory difficulties." The results

from the empirical studies prove that a viable solution to this problem statement was found in the Upadema. These statistics prove that the Upadema provides a user with sufficient memory support through the use of more subtle visual and vibro-tactile modalities. The statistics also provide evidence that the Upadema enables a user to obtain a more private and personal means of notification on the loss and misplacement of personal items, in a way that does not distract other people in the surrounding environment.

They also verify that the Upadema allows a user to have more control over the use of sound by allowing them to decide the right time and place to instigate the lost personal item to beep. The Upadema has proven to be more suitable for a social setting than comparable products that currently exist on the market. All of which confirms that the objectives of this research were achieved.

9.3 Future Recommendations

Both the second and third set of the empirical studies carried revealed some particularly interesting and exciting results that emphasise the future potential for a device such as the Upadema. However, the following are some issues that need to be addressed.

There is a need to enable a user to program the range in which they wish to have their personal items monitored, and possibly a means of lowering the distance to determine how far or near you are to the lost item. Provisions could be made in the design to allow a user to have more control over all modalities and to enable them to set them based on personal preference and context of use. There is a need to enable a user to terminate the vibration once they have received notification perhaps by pressing the button a second time.

The use of sound for the second function of the Upadema needs to be more pleasant or even replaced if a more suitable modality that be found, without the need for an LCD display. A means of enabling users to personalise the tones for the second feature in a similar fashion to the polyphonic ring tones used in mobile phones is also recommended. The context in which the Upadema is used can change frequently and therefore the modalities must be aware of a user's location and cognitive state and thus react appropriately, without taking control away from the user.

Furthermore, the functions and features of the Upadema need to be incorporated into a watch or some other wearable form that is worn in a visible part of the body (Figure 33).

Figure 33: Possible Future Designs

9.4 Further Studies

If the Upadema were integrated into the current PDA and mobile devices, its entire conceptual form and purpose of providing a subtle and non-intrusive means of notification may be jeopardized. Furthermore, adding more functionality to the device might increase the need for user interaction and result in a more demanding device. Therefore the tradeoffs between subtly, intrusiveness and functionality need to addressed and studies need to be carried out in order to determine the correct balance between them.

The ubiquitous aspect of the Upadema also needs to be addressed. However if it was expanded upon numerous problems may be introduced. For example, embedding it with sensors so that it is contextually aware and acts accordingly may take a significant amount of control and privacy away from a user. Studies need to be carried out in order to exercise the use of such a device in a real world situation.

9.5 Conclusion

Overall this research presents the complete design process of the Upadema that employs what has previously been described as a "*bricolage* approach" (Bannon, 2000). It was approached from a user interaction and social point of view. The positive and encouraging

results from the empirical studies suggest that there is great potential for the Upadema and other wearable technology that is designed in this manner, as it provides a more pleasant, usable interface to a user. The possible future applications and devices that the features and functions of the Upadema could be incorporated into are endless; any product a user desires could be designed to include them. The results suggest that users' prefer and are drawn to more natural, less demanding forms of information presentation and notification. They exemplify that participatory design approaches are an excellent way of ensuring that a novel design successfully fits potential users' requirements. They confirm that technology can be embedded seamlessly into familiar objects that users currently wear everyday in a subtle, non-intrusive and personal form to overcome everyday memory difficulties. This suggests that if technology in this form can be applied to memory difficulties, it can also be used to overcome other real world problems.

Furthermore, this research has produced a working prototype that embodies the concepts inherent in ubiquitous computing. It has succeeded in moving towards a design that hides the technology, accommodates users' aesthetical preferences, poses as a piece of jewellery and prevents disruption to other people in the surrounding environment. It verifies that the concepts inherent in the Upadema break down some of the barriers to technology that take control away from a user and thus prevents them from interacting with computers in an efficient fashion. The Upadema demonstrates positive results for the third wave of computing; it is a step in the right direction and paves the wave for future research and development.

The End

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Appendices

Appendix A

The following questionnaire was distributed to twelve suitable participants of varying ages and profiles.

1. How often do you forget to do a specific task e.g. everyday, occasionally etc.

---

2. How do you eventually remember? Explain

---

3. How often do you forget to turn off an electrical appliance?

---

4. How often do you forget where you have left something?

---

5. How often do you leave something behind either at home or elsewhere?

---

6. How often do you forget what you were doing? Give a brief description

---

7. How often do you forget important conversations & appointments?

---

8. Do you have much experience with technology?

---

9. How would you feel about invisible technology placed in your home that would in some non-intrusive way remind you of something?

---

10. Do you find the repetitive sounds used in technology annoying?

---

11. How would you like to be notified, with lights/colours/icons/shapes/sounds or change and movement in your environment?

Appendix B

The following instruction sheet was provided in the cultural probe packages that were distributed to twelve participants in the preliminary study phase of the project.

Instructions for Cultural Probe

This pack is a cultural probe, which is used to gather information about people's everyday short/medium term memory difficulties. These packs are distributed to people of all ages and backgrounds in order to get a general consensus of the types of things that people forget. The data collected from these cultural probe packs will be used for research purposes only, namely to dive the design for a Masters project called **ADEMA** which stands for **"An Ambient Display as an Everyday Memory Aid."** ADEMA is a piece of calm/invisible technology that will be placed in a home environment to help one to remember the everyday things that they forget.

N.B. The information you provide is entirely up to you. You shall not be judged on the information you provide. However, it is required that you spend some time filling out the enclosed contents.

This pack contains:

1. A Seven-Day Diary
2. A Postcard that asks "What items do you forget?"
3. A Postcard that asks "What daily tasks and things do you forget?"
4. A Diagram of each room in your house and coloured stickers
5. A Comment Card

1. A Seven-Day Diary

You are required to start the seven-day diary this Monday and to fill in the different items, appointment, tasks etc. that you forget for each day right up until next Sunday. It is advised that you carry this diary with you each day so as to accurately record the different things you forget. Personal comments can also be written into this diary.

N.B. Everything you forget is relevant; although some things may seem insignificant they are important to you and your life style and could provide valuable information for the ADEMA project.

2. A Postcard that asks, "What items do you forget?"

This postcard can be filled out at any time over the seven-day period. You are required to write down any item in general that you frequently forget. Please note that you can write on the back of this postcard.

3. A Postcard that asks, "What daily tasks and things do you forget?"

This postcard can be filled out at any time over the seven-day period. You are required to write down any task or thing in general that you frequently forget to do. Please note that you can write on the back of this postcard.

4. A Diagram of each room in your house and coloured stickers

This involves associating and placing a different coloured sticker in each room of the house diagram. Further instructions are provided on the sheet itself.

Appendix C

The following web log was set up in the preliminary study phase of the project in order to obtain information from people from different cultural backgrounds. It was then updated as the project progressed.

Upadema Web log

MONDAY, JUNE 14, 2004

An Amient Display as an Everyday Memory Aid (ADEMA)

I am a Interactive Media Masters student at the University of Limerick in Ireland. I am currently about to commemce the design of an ambient display as an everyday memory aid. This ambient display will be used to combat everyday prospective memory difficulties that we are face namely forgetting an item, a task, appointment etc. For example how often do you forget to return a phone call to a friend or forget to buy milk on the way home from work. As you can see above, I called this project ADEMA.

Just incase you do not fully understand what I mean by an ambient display here is a very broad definition: An ambient display is an abstract and aesthetic peripheral display that portrays information in the background or on the periphery of a user's attention. This information can then be brought to the foreground when it is required.

So I was just wondering in general what you forget or what information you would like an ambient diplay to provide in order to remind you to carry out some task or do something.

All opinions are useful and very welcome
posted by Martina @ 9:53 AM

Stephen-IDC said...

> It sounds like the Sense-Cam device - mentioned here - might be of interest to you. Obviously, it's more of a device for information collection rather than display.
>
> One of the uses for the SenseCam mentioned on the BBC site was as an aid to help people remember where they left their keys etc. One of the primary user groups is people with memory disorders or brain damage. It also ties in with the Life Bits project.
>
> I also seem to remember an i-media project from last year that used an interactive painting to track environmental changes in a room. If you wanted to take the idea a bit further, there's been a fair bit of development

on wearable displays. There was an interesting discussion on Slasdot about recycling old LCD screens with a few interesting comments.

1:02 PM

cyberviking said...

What would make this project really interesting is if you dare to try auditory display as well. So far, the best successful (for a while) example is Cohen's Out-To-Lunch system... It would also make an interesting contrast to previous work as sound has very different attentional properties to vision. Call in some day and I'll tell you what I know about this (or email me)

4:21 PM

Martina said...

Due to extensive user studies the form of the project has now been established. The ambient display is now in the form of a wearable and as a result I have renamed the project UPADEMA.It explores the concept of using a wearable ambient display to notify a user of and support a common everyday memory difficulty. For the purpose of this project the wearable ambient display takes the form of a wristband but the features it provides could be integrated into a wearable computer or watch. The interface allows the user to monitor the location of personal items such as a mobile phone, keys, wallet, glasses etc. It ensures that they are never forgotten or misplaced. The project builds on knowledge drawn from previous research carried out in related fields and investigates a novel use for wearable ambient displays that provides for further research and development.

NAME: WADEMA (Wearable Ambient Display as an Everyday Memory Aid)

Interactivity/Functionality: The user scans in/registers all the personal items equipped with tags and identification codes that they want to carry at all times i.e. mobile phone, glasses, keys and wallet into
the wearable. A different coloured light on the wearable ambient display represents each item. When the users personal items go out of a certain proximity (say 3 metres- to be decided upon) a corresponding light on the wearable will light up. For example if the coloured light associated with the users mobile phone is red and if the users phone goes outside the 3 metre

proximity, then the associated button on the wearable will light up in red. The user can then press this red button and it will in turn cause the mobile phone to make some form of noise, hence helping the user to locate where it is in the nearby environment.

Any comments what do you think. Would you find this useful?

1:23 PM

Martina said...

Mikael suggests that the wearable could vibrate as well as light up when the users personal items go outside the 3 metre proximity. He feels that this could be a good and more direct way of notifying the user. He suggests that the vibration be a light tickle on the users hand.

Alternatively the vibration could be a setting that you turn on yourself when you are in a crowded area or busy.

Any comments , what do you think of this? Would you prefer to be notified by the light on its own or would you prefer to be notified by light and a vibration on your hand. Would you like vibration to be optional or standard ?

1:39 PM

Enda said...

With reference to the Vibration concept, I think that the feature, although useful could prove to be an annoying feature especially if the user is quite mobile within the location of the objects.

It might be better to provide the feature as an optional utility which can be switched on and off according to the user's preference. In terms of the project at hand it might be better to leave it as a future recommendation in order to increase feasability for the project.

The device is intended to be an aid for the user, it's not meant to notify the user of any changes. If the user wishes to look for an item they can then view the displayed light on the ambient display. This way it's left up to the user's discretion. Remember a watch doesn't notify the user of the time at

all times (excluding the hourly beep of a digital watch) and yet everybody that wears a watch can check the time whenever they wish.

2:30 AM

Enda said...

sorry I put the same comment in twice as it did not appear on screen probably due to last nights downtime...that I just noticed...oh well
Best of luck anyway martina

2:50 AM

Emma said...

Re: the vibration on the UPADEMA, I think perhaps having it on all the time would be counterproductive, as Enda suggested, and may put users off utilising the memory aid altogether. If you have a constant vibration every time you let something out of your immediate proximity, it would mean you'd be getting little shocks most of the day, and would definitely not be an option I would want. However there are situations where the vibration option may come in handy, for example when travelling to the airport, you need to be constantly assured that you have your passport, tickets etc., on you at all times, so perhaps in that situation the vibration would be beneficial. The ability to turn on and off the vibration feature would improve the product, if it were on all the time, it would make it less useful.

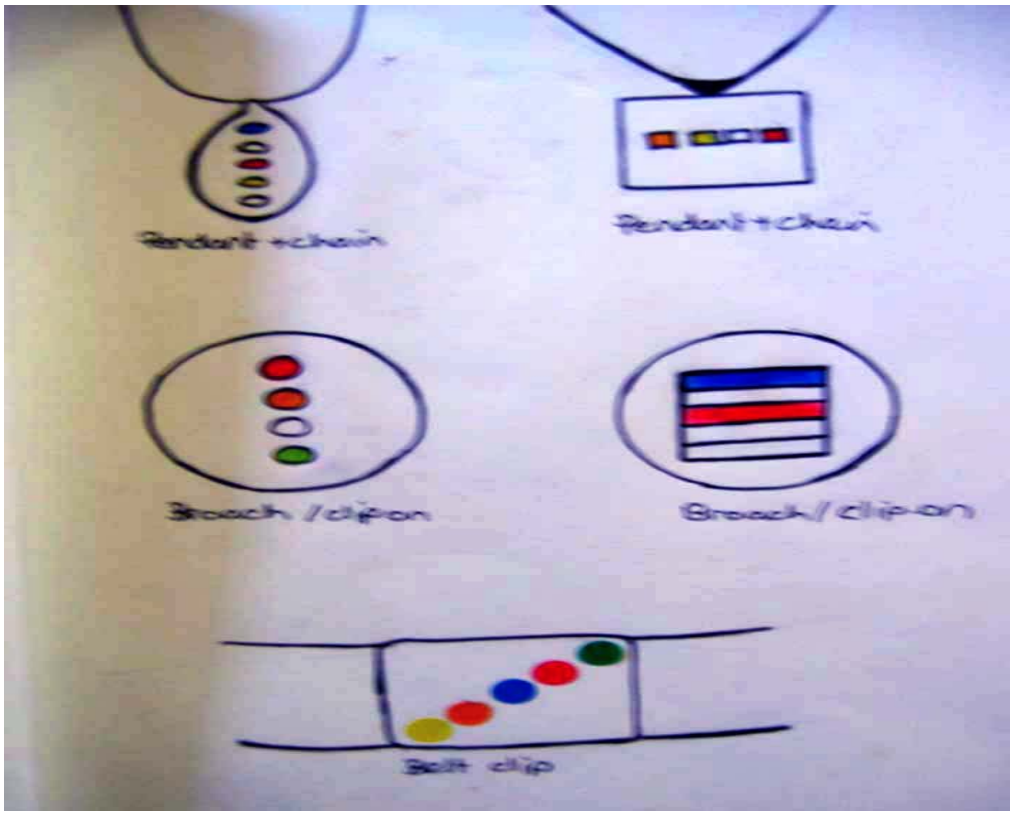
7:20 AM

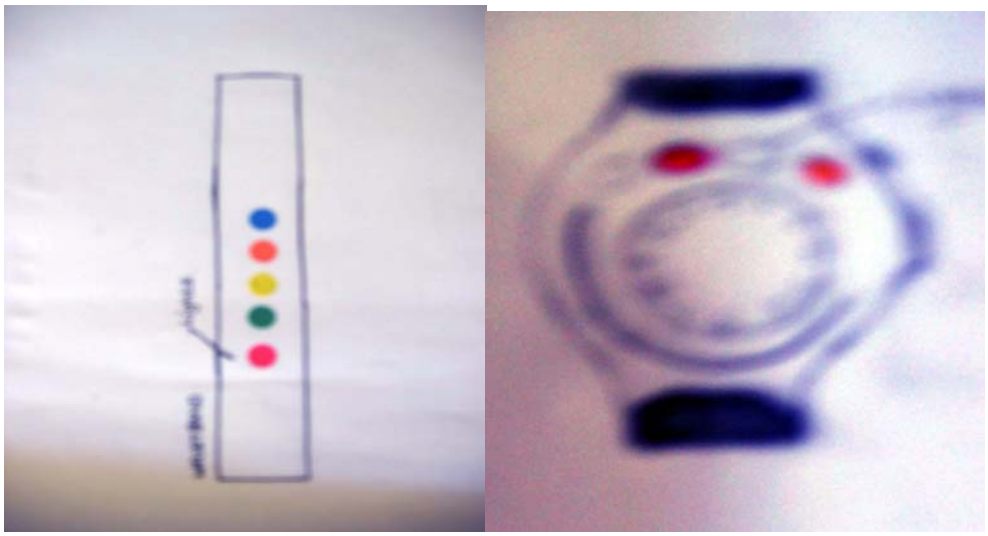
Post a Comment

<< Home

Appendix D

The following are the paper prototypes that were prepared for the PD workshop.





Appendix E

The following is the agenda for the participatory design workshop

1. Introduction

Designer introduces herself first and welcomes everybody. Participants introduce themselves individually. The requirements gathered from the earlier user studies shall be explained along with the prepared possible solution. Participants shall be provided with a copy of the workshop agenda and it shall be read aloud.

2. Objectives & Concepts

The objectives of the workshop shall be outlined. The concepts of the ambient display and usability shall be described.

3. Requirements & Issues

The requirements gathered from the preliminary study phase shall be outlined along with some issues in relation to the user interaction, interface and contexts of use.

4. Paper Prototypes

The prepared paper prototypes that suggest possible designs for the Upadema shall be presented to users and discussed.

5. Scenarios and Role-play

A copy of the scenario shall be given to each user and the designer shall read it aloud to the users. The participants shall then role-play the part of the user in the scenario whilst wearing the provided exercise materials. The purpose of this is to determine where the user would like to look for notification of a misplaced personal item. A general discussion shall be held in relation to the users' personal choice of form weighing up the pros and cons of each material. Feedback shall be noted.

The technical possibilities and constraints are not to be discussed in any great detail in this exercise although some device-centred design dimensions shall also be addressed in this exercise namely user interaction and prompting, mobility, proximity and personalisation. The first two of these design dimensions were adapted from Goldthwaite et al (2004) however the others were specified to suit the unique requirements of the Upadema (Table 2).

Device-Centred Design Dimensions	Description
Device Interaction: User Prompting	Degree of proactiveness in alerting the user and the methods of alerts
Device Mobility	Degree to which the device is mobile
Device Proximity	Range in which the device actively provides notification of a misplaced personal item
Device Personalisation	Degree to which the user can personalise the device

Table 2: Device-Centred Design Dimensions

6. Envisionment Exercises & Personal Scenarios

Participant will be asked to envision the context in which they would use the device and to write a bullet point scenario describing where they would use it, when they would use it, when they feel they would find it most useful etc.

7. Paper Prototyping

Participants shall work in pairs (made up of one male and one female) to determine how their ideal Upadema shall look taking into account several user centred design dimensions extracted from Goldthwaite et al (2004) and translated to represent the requirements of the Upadema. These dimensions include appearance, burden on user, distraction, ease of use and design simplicity. All of which take the ambient display characteristics of aesthetic quality, calmness and utility into consideration. Some paper prototypes of some possible designs based on the established wearable form shall be drafted during this exercise along with an explanation of the chosen designs.

User-Centred Design Dimensions	Description
Appearance	Pleasing design and aesthetical qualities
Burden on User	Routine effort required by user
Distraction	Degree to which the device is not distracting to the users everyday routine e.g. calmness
Ease of Use	Overall usability
Design Simplicity	Simple design not intimidating or overwhelming

Table 3: User-Centred Design Dimensions

8. Combine Designs

Participants shall discuss their merits of their designs in relation to the design dimensions and ambient display characteristics. A possible solution shall be drafted and sketched by the designer based on this exercise.

9. Other Issues

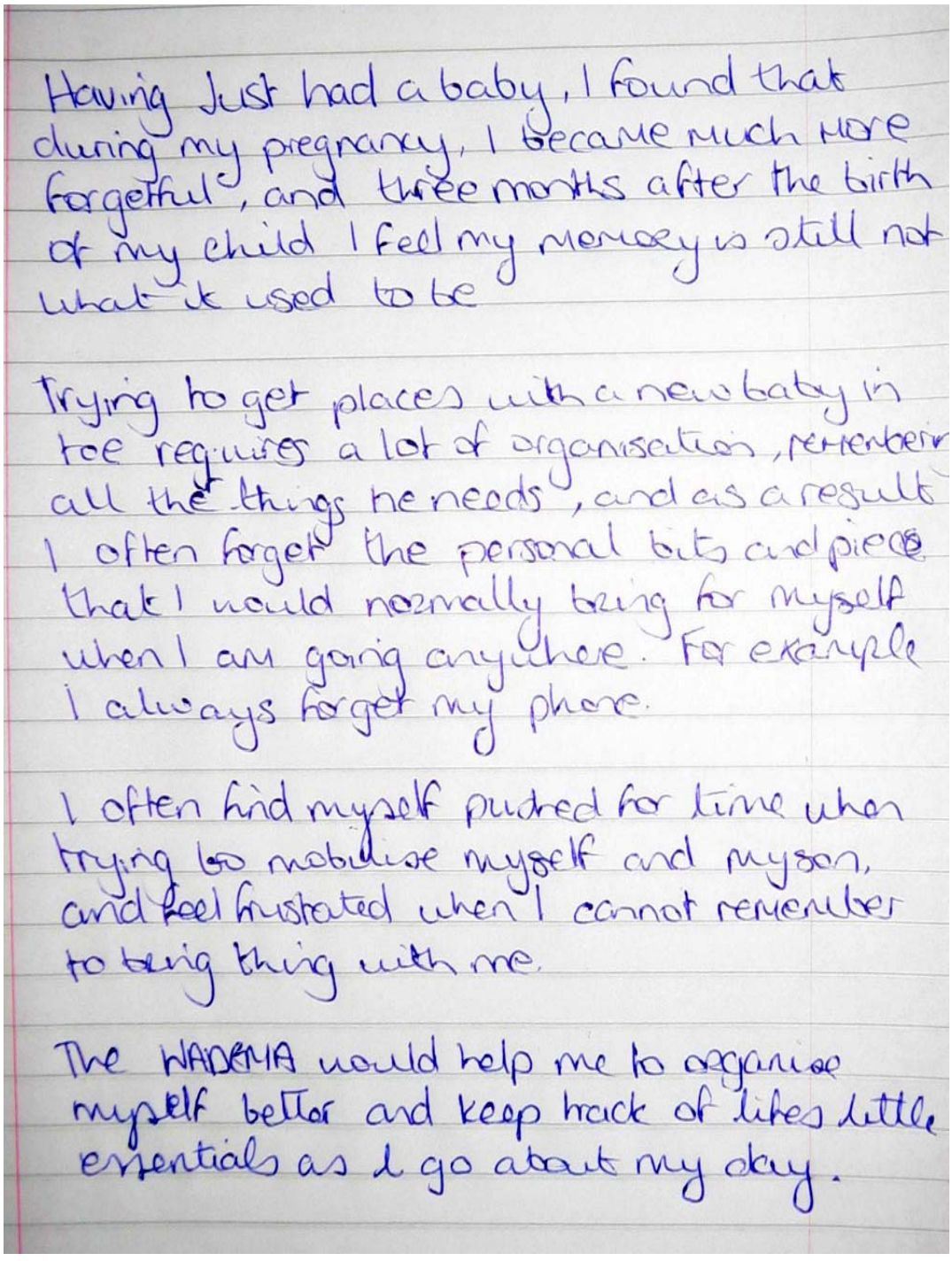
If there are any further issues to be addressed that were not identified throughout the workshop, they shall be proposed to the group informally and a general discussion shall be held.

10. Review

The objectives of the workshop shall be reviewed to ensure that they are all met. A possible design solution shall be presented to users in order to ensure that their feedback was interpreted correctly.

Appendix F

The following are two examples of the context of use scenarios that were drafted by users in the participatory design workshops.

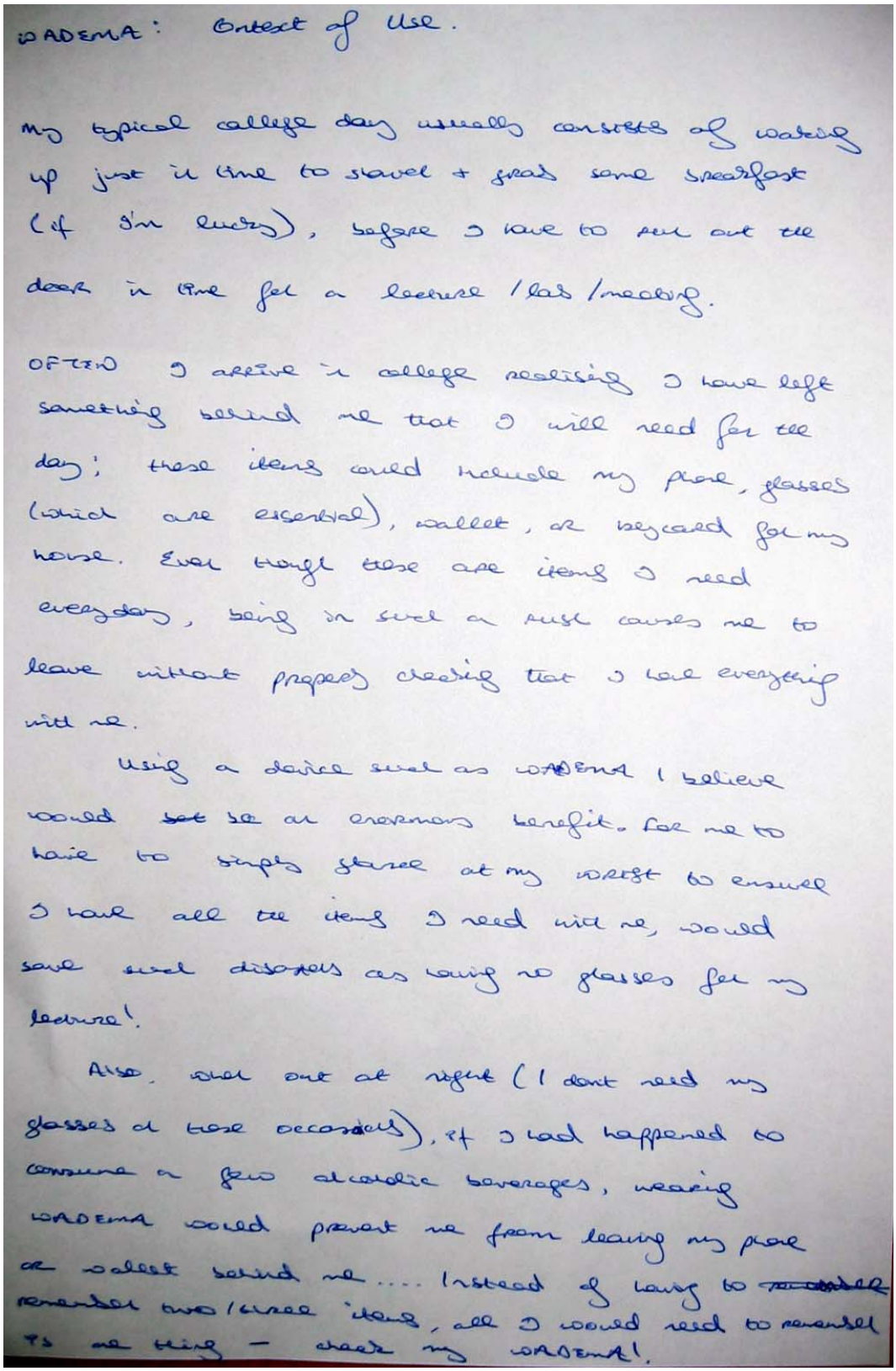


Having just had a baby, I found that during my pregnancy, I became much more forgetful, and three months after the birth of my child I feel my memory is still not what it used to be

Trying to get places with a new baby in toe requires a lot of organisation, remembering all the things he needs, and as a result I often forget the personal bits and pieces that I would normally bring for myself when I am going anywhere. For example I always forget my phone.

I often find myself pushed for time when trying to mobilise myself and myson, and feel frustrated when I cannot remember to bring thing with me.

The WADEMA would help me to organise myself better and keep track of likes little essentials as I go about my day.



UPADEMA: Context of Use.

My typical college day usually consists of waking up just in time to shower + grab some breakfast (if I'm lucky), before I have to run out the door in time for a lecture / lab / meeting.

OFTEN I arrive in college realising I have left something behind me that I will need for the day; these items could include my phone, glasses (which are essential), wallet, or keycard for my house. Even though these are items I need everyday, being in such a rush causes me to leave without properly checking that I have everything with me.

Using a device such as UPADEMA I believe would be of enormous benefit. For me to have to simply glance at my wrist to ensure I have all the items I need with me, would save such disasters as having no glasses for my lecture!

Also, what out of sight (I don't need my glasses at those occasions), if I had happened to consume a few alcoholic beverages, wearing UPADEMA could prevent me from leaving my phone or wallet behind me.... Instead of having to ~~remember~~ remember two/three items, all I would need to remember is one thing - check my UPADEMA!

Appendix G

The following is the scenario utilised in the Wizard of Oz method of prototyping.

The user has just purchased a new wearable ambient display that will be used as an everyday memory aid to prevent the problem of forgetting and misplacing some personal items.

Step 1. The user decides what personal items are to be tagged, in this case a mobile phone, wallet, keys and glasses.

Step 2. Each item is then equipped with a different identification tag (coloured sticker). The user can choose to associate whatever colour they wish with the personal items.

Step 3. The user stores all the personal items on person. No coloured lights show up on the wearable ambient display so he/she has clarification that all the items are either in her bag or pocket etc.

Step 4. The user then goes shopping in a large department store so he/she decide to active the vibrate mode on the wearable. The user's phone rings in the changing room and he/she answers it. When the user is finished the phone call he/she leaves the phone down on the floor and continues trying on a jumper. The user likes the jumper he/she has tried on and leaves the changing room and forgets to pick up the phone from the floor. He/She proceeds to the check out to pay for the clothing.

Step 5. He/She empties out the contents of their pocket to get their wallet and in turn drop their keys. The user was unaware that their keys fell on the floor and continue to leave the shop. Immediately the wearable begins to vibrate and two lights appear on the wearable. The user then glances at the wearable and realises that he/she has left her phone and keys behind somewhere. So he/she…. to be determined by user.

Appendix H

The following is a more detailed description of the RFID system, passive tags, active tags and their limitations and implications.

RFID (Radio Frequency Identification) System

An RFID system can comprise a number of components including tags, handheld or stationary readers, antennas, system software and an external/internal battery all of which are available in different shapes and sizes. It communicates via radio frequency signals that carry data either unidirectionally or bi-directionally. A reader contains a transmitter, receiver, control module and communication functions. An antenna is attached to the reader and is used to transmit and receive the radio frequency signal (Harty, 2003). The tags are used to identify objects and can be uniquely programmed with information about the objects.

Passive Tags

Passive tag units extract enough electricity to power their electronic circuitry from the signal transmitted by the reader, therefore they have no internal power source. The interrogator emits a radio frequency (RF), which powers the silicon chip on the tag when it is within range of the RF field. They provide virtually unlimited operational time but need to be powered by a higher-powered reader (Raghu, 2004). Their read range is much more limited than active tags and as a result they are less expensive, smaller and lighter. They are often referred to as "smart labels".

Active Tags

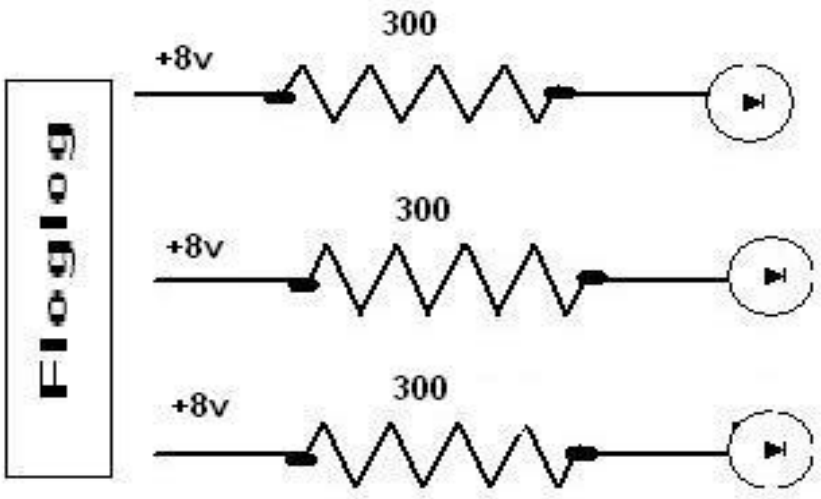
Active tags refer to RFID tags, which have their own power source, usually an internal or external long life lithium cell battery that can be activated by a transmitted RF field generated by the reader, or alternatively data can be transmitted at set timed intervals. They comprise a coil, a programmable silicon chip and a battery. They are more expensive than passive tags because of their size, sophistication and relatively high memory capacity. However, the battery life can limit the life of the tag.

RFID System Implications and Limitations

However there are some implications and limitations with the current RFID systems that the implementation of the Upadema as a real world device may face. Firstly, they are easily detuned which means that they are often moved to a slightly different resonant frequency by nearby metal and conducting objects including other tags (Leydon, 2004). Secondly, a human body can block the radio waves (as it is 90% water) as can metal shelving or a concrete wall containing any metal (Adams, 2002). They also operate at higher resonant frequencies and therefore are accompanied by more stringent legislation and health concerns (Leydon, 2004).

Appendix I

The following is a block diagram of the main components that were required for the first function of the Upadema prototype.



Appendix J

The following is the code that was written for the implementation of the Upadema prototype.

```
global FlowlogInst
global ReaderInstance
global portopened
global history
global iBlock


on OpenPort

  -- error trap for missing file Xtra

  if not ReaderInstance.objectP then
    alert "Reader Xtra missing"
    exit
  end if

  check=ReaderInstance.S6000OpenPort(1)

  -- Funtion: Opens COM port for RFID reader communication
(Port 1 or 2)
  if check = 1 then
    portopened=1
    --     alert "Port Open"
  else
    alert "S6000:Error Opening Port!"
    portopened=0
    exit
  end if

on startMovie
  ReaderInstance = xtra("Reader").new()
  History=1
  iBlock=0
  OpenPort

  FlowlogInst = xtra("Flowlog").new()

  --   error trap for missing file Xtra

  if not FlowlogInst.objectP then
    alert "Flowlog Xtra missing"
    halt
  end if

  check=FlowlogInst.Init()
  if check = 0 then
    alert "Init error"
    halt
  end if
  timex=0
  sound(1).queue(member("ColdCut"))
```

```
end

on ReadTag
  if portopened=1 then
    iBlock=0
    set valuelist=ReaderInstance.S6000ReadTag_SID(iBlock)
    check=0
    if valuelist[1] > 0 then
      num=valuelist[1]  -- number of tags
      repeat while num > 0 -- add all the tag numbers
        check=check + valuelist[num+1]
        num=num-1
      end repeat
    else
      check=valuelist[1]
    end if
    --        Function: Reads Tag block 0-7 returns value
in block or error
    if check = -1 then
      alert "No response"
      go to frame "NoTagPresent"
    else if check =-2 then
      alert "Bad response"
      go to frame "NoTagPresent"
    else if check =-3 then
      alert "Bad Checksum"
      go to frame "NoTagPresent"

      -- reads tag(s) number(s)that are inside the
detection range and turns on the
      -- light(S)that corrspond to the tag(s) number(s)
that are outside the detection
      -- range

    else if check =37 then
      go to frame "Object Missing"
      FlowlogInst.SetOutput(1)
      FlowlogInst.ClearOutput(2)
      FlowlogInst.ClearOutput(3)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])

    else if check =27 then
      go to frame "Object Missing"
      FlowlogInst.SetOutput(2)
      FlowlogInst.ClearOutput(1)
      FlowlogInst.ClearOutput(3)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])

    else if check =20 then
      go to frame "Object Missing"
      FlowlogInst.SetOutput(3)
      FlowlogInst.ClearOutput(2)
      FlowlogInst.ClearOutput(1)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])
```

```
    else if check =22 then
      go to frame "Two Objects Missing"
      FlowlogInst.SetOutput(1)
      FlowlogInst.SetOutput(2)
      FlowlogInst.ClearOutput(3)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])

    else if check =15 then
      go to frame "Two Objects Missing"
      FlowlogInst.ClearOutput(2)
      FlowlogInst.SetOutput(1)
      FlowlogInst.SetOutput(3)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])

    else if check =5 then
      go to frame "Two Objects Missing"
      FlowlogInst.ClearOutput(1)
      FlowlogInst.SetOutput(2)
      FlowlogInst.SetOutput(3)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])


    else if check =-4 then
      go to frame "NoTagpresent"
      FlowlogInst.SetOutput(1)
      FlowlogInst.SetOutput(2)
      FlowlogInst.SetOutput(3)
      sound(1).play([#member: member("ColdCut"),
#loopCount: 30])

    else if check =42 then
      go to frame "All Objects Present"
      sound(1).stop()
      FlowlogInst.ClearOutput(1)
      FlowlogInst.ClearOutput(2)
      FlowlogInst.ClearOutput(3)
    end if
  end if

end

on ClosePort
  ReaderInstance.S6000ClosePort()
end


on stopMovie
  ClosePort
  set ReaderInstance=0
  set portopened=0
  FlowLogInst.Uninit()
end
```

Appendix K

The following is a more detailed description of the foolproof device that was used in the evaluation phase of this project.

FoolProof® Device Description.

Remote (left) Master Unit (right)

FoolProof® *"is a monitoring device that will locate valued personal objects 24 hours a day, while continually performing system checks to ensure continuous reliability."* (MRSI International, 2004). The following is an interpretation of the Foolproof product description.

The Foolproof® device comprises a mobile master unit that can monitor the location of one hundred remote devices and can accommodate eight remote devices simultaneously. It may be worn on a belt and it is in a similar form to a pager. It consists of an LCD display and text based GUI that identifies which personal object is being removed. All the components of Foolproof® are small in size. Each remote is described as weighing about one ounce and can be attached to a user's personal objects. The user can personalise the device by setting individual monitoring zones, notification modalities (text, audio and vibration or text and audio) and object titles for each remote .It has three different monitoring zones, Zone 1:20-40 feet. Zone 2: 40-60 feet and Zone 3: 60-80 feet.

It operates on the following basis: if a user's personal objects are being tampered with or removed from inside the specified monitoring zone the user is notified through the use of visual (text-based), vibro-tactile and auditory modalities. An auditory modality is also used to help a user locate a personal object. For example if a remote is programmed to notify a user through the use of the audio and vibration, the master unit will vibrate first and if the user does not respond, it will then notify the user by an audible alarm.

Each remote device contains unique identification information that is identified only by its own master unit therefore ensuring security of the user's personal objects and preventing interference from other similar devices.

Appendix L

The following are the scenarios that were exercised in the thinking aloud sessions. In both cases the user had to play the part of the user and determine how to interact with the device in order to retrieve the lost objects

Scenario for use in a Cafe

Step 1. The user has just purchased a new device that prevents the loss and misplacement of his/her personal items. They then decide what personal items are to be tagged, in this case a mobile phone, wallet and keys.

Step 2. Each item is then equipped with a different identification tag.

Step 3. The user stores all the personal items on person either in his/her bag or pocket.

Step 4. The user goes to meet his/her friend for lunch in a busy café in limerick city. The user's phone rings as he/she answers it. Once they have finished on the phone they leave the phone down on the table. He/she eats their lunch whilst chatting to their friend and then goes up to pay for the lunch.

Step 5: On the users return he/she encounters some work colleagues at another table who are also having lunch. The user begins chatting to them and his/her friend comes over to join in the conversation. After a few minutes the users friend suggests that its time to get back to work, so both the user and his/her friend begin to leave the café.

Step 6: Just as the user and his/her friend push the door open to leave the café the device notifies the user that a personal items has been misplaced. The user then glances at the device and realises that they have left their phone behind.

Scenario for Use in a Home Environment

Step 1. The user has just purchased a new device that prevents the loss and misplacement of his/her personal items. They then decide what personal items are to be tagged, in this case a mobile phone, wallet and keys.

Step 2. Each item is then equipped with a different identification tag.

Step 3. The following day the user is sitting at home and decides to have a cup of tea, he/she puts on the kettle and opens the fridge to get the milk but realise he/she has none. He/She decides to go to the shop to get some milk.

Step 4. As he/she is approaching the front door they check to see if they have their wallet and car keys. He/she realises that they do not have either of these items on person so they turn on their new device and use it to find the keys.

Appendix M

The following is the consent form that was presented to participants prior to carrying out the "thinking aloud" session.

Upadema Consent Form

This study is being conducted to meet a course requirement of the Masters in Interactive Media under the supervision of Prof. Liam Bannon (061-202632), Interactive Design Centre, Dept. of Computer Science & Information Systems, University of Limerick. The purpose of the study is to assess the overall usability of two memory aids/notification systems. Many people have difficulties when using technology, and I am interested in understanding the nature of these difficulties in order to help design better devices and systems that are easier-to-use. Thus I am testing the technology, and not you, the user.

The particular technique that is going to be used here, is called the "thinking-aloud" method, which is followed by a questionnaire. It requires you to attempt to use the memory aids to accomplish specific tasks, and for you to think aloud as you do so. There is a facilitator available to assist you, if you are unclear as to what is required, but the intention is that you to try to figure out how to accomplish the tasks using the device(s).

In order for the interaction designer to be able to analyse the interaction between you and the device(s), we are requesting that you allow us to videotape the session. Then we can play it back to understand what has happened in the session. To ensure confidentiality, these videotapes will ONLY be used by the interaction designer and her supervisor for the purposes of this study, and you will not be identified by name.

You may, any time, for whatever reason, terminate your participation in the study and request the deletion of the videotape material. The main aim of this study is to evaluate some technology, remember you are not being testing! If you are interested in finding out the results of this study, please contact the interaction designer named below. Thank you for participating in this study

I (the participant) have read) and understand the information above, and any questions I have asked have been answered to my satisfaction. I understand that my participation is voluntary and I agree to participate in this research, knowing that I may withdraw at any time.

Participant's Name:.....

Participant's Signature:.....Date:.....

Interaction Designer Name:.....

Interaction Designer Signature: .....Date:.....

Appendix N

The following are the debriefing questions that followed the "thinking aloud" method.

Debriefing Questions

1. Did you think the Foolproof device was easy to use?
2. Did you think the Upadema was ease to use?
3. What did you like about the Foolproof device?
4. What did you like about the Upadema?
5. What did you dislike about the Foolproof device?
6. What did you dislike about the Upadema?
7. What improvements would you make to the Upadema?
8. What improvements would you make to the Foolproof device?
9. What did you think of the wearable form of the Upadema?
10. Did the Upadema look and feel natural like a watch?
11. Did you find the use of colour confusing?
12. Did you like the use of text in the Foolproof device?
13. Do you think it would take a long time to learn how to use the Upadema?
14. Do you think it would take a long time to learn how to use the Foolproof?
15. Do you think it would take a while to learn/get used of what colour you had attached/associated with each personal item?
16. Would you find a Foolproof device useful?
17. Would you find a Upadema useful?
18. Would you wear and use an Upadema?
19. Would you use a Foolproof device?

Appendix O

The following is the questionnaire that was presented to the users after the" thinking aloud" session.

Questionnaire

Thank you for participating in this study. Please take a few moments to complete this questionnaire. The purpose of this questionnaire is to get an understanding of your attitude, thoughts and opinions. Bear in mind there is no right or wrong answer. For each of the statements below please place a tick in the box that relates most to your personal opinion.

Personal Demographic Details

Male ☐ Female ☐

Age ☐

Occupation ☐

General Questions

1. An audible means of notification has what degree of publicity?

Very High degree	High degree	Neither high nor low degree	Low degree	Very low degree

2. Vibration as a means of notification has what degree of publicity?

Very High degree	High degree	Neither high nor low degree	Low degree	Very low degree

3. Light and colour as a means of notification has what degree of publicity?

Very High degree	High degree	Neither high nor low degree	Low degree	Very low degree

Specific Questions

1. The notification modalities (light, colour, vibration) of the Upadema provide sufficient memory support?

Strongly Agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree

2. The notification modalities (light, colour, vibration) of the Upadema are?

Very Subtle	Subtle	No Opinion	Fairly Subtle	Not subtle at all

3. The notification modalities (text, audio, vibration) of the Foolproof device are?

Very Subtle	Subtle	No Opinion	Fairly Subtle	Not subtle at all

4. The notification modalities (light, colour, vibration) of the Upadema are?

Very Intrusive	Intrusive	No Opinion	Fairly non-intrusive	Completely non-intrusive

5. The notification modalities (text, audio, vibration) of the Foolproof device are?

Very Intrusive	Intrusive	No Opinion	Fairly non-intrusive	Completely non-intrusive

6. The Upadema has the potential to become a part of ones everyday outfit?

Strongly Agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree

7. The Upadema is suitable for a social setting?

Strongly Agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree

8. The Foolproof is suitable for a social setting?

Strongly Agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree

9. There is not a major benefit to using the Upadema device over the Foolproof device?

Strongly Agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree

10. Do you think the interaction with the Upadema device is

Much better	Better	Neither Better nor worse	Worse	Much worse

than the interaction with the Foolproof device ?

11. What degree of publicity do you think the Upadema has?

Very High degree	High degree	Neither high nor low degree	Low degree	Very low degree

12. What degree of publicity do you think the Foolproof device has?

Very High degree	High degree	Neither high nor low degree	Low degree	Very low degree

Any other comments?