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Keeping Connected in Care: Development of technology to stimulate social interaction among older people in care facilities

A Thesis submitted to the
University of Dublin, Trinity College
for the degree of
Doctor of Philosophy

Ronan McDonnell
School of Computer Science and Statistics
Trinity College Dublin

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Declaration

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Publications

Ronan McDonnell and Jane Grimson - Identifying requirements for communication systems in elder care settings - iHCI 2010 (Irish Human-Computer Interaction Conference 2010) - Dublin, Ireland - September 2010

Ronan McDonnell and Jane Grimson - Identifying requirements and features for communications systems between older people in care settings - The 23RD IEEE International Symposium on Computer-Based Medical Systems - Perth, Australia - October 2010.

Designing a Touch Screen Communication Device to Support Social Interaction amongst Older Adults - Julie Doyle, Zoran Skrba, Ronan McDonnell and Ben Arent - HCI 2010 -Abertay, Dundee - July 2010

Ronan McDonnell and Jane Grimson - Keeping Connected in Care: Development of technology to stimulate social interaction among older people in care facilities - Proceedings of the AAL forum 2010 - Odense, Denmark.

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Abstract

Care settings for older people, such as nursing homes, can have low levels of social engagement. Social interaction has been shown in many studies as being crucial to both the mental and physical well-being of older adults. Furthermore, increased social interaction has been shown to have a positive effect on adjustment in institutions for the aged. Technology can potentially provide an outlet for older people, allowing them to contact friends and family as well as use online resources to perform activities they previously undertook but no longer can, due to impairment or geographic separation. However, previous studies designing this sort of technology have focused on older people who are not in receipt of care or are quite cognitively impaired, rather than individuals who are in care settings and require some level of care on a daily basis, but are not significantly cognitively impaired. The needs of these latter individuals may be quite different to those who do not need care at all.

This thesis describes the design and implementation of communications technology to provide activities and engagement while potentially increasing levels of social interaction among older people who are resident in care facilities. Using a user-sensitive inclusive design process from the earliest stage possible, domain experts, followed by staff and residents of a care centre in the Leinster region of Ireland were interviewed about daily life, activities and engagement levels inside and outside the centre. Residents reported a lack of engagement and activities that catered for their needs, with many preferring to stay in their rooms. Furthermore, some of these residents were not able to leave the centre due to illness or impairment, and as a result could not get access to information and resources to occupy themselves, with many reporting boredom.

Analysis of these interviews provided a series of ideas that were described to residents using storyboards, with the most popular ideas forming the basis of the system developed. Based on resident responses to these storyboards, it was decided to start a book club, where residents were provided with a device containing an e-book, with a book club group meeting held once a week to discuss it. Furthermore, videos, newspaper headlines and an activities calendar were also provided on the device to afford additional interactivity. Finally, a messaging and calling system was developed so residents could communicate with each other as well as their friends and family outside the care centre. Following the analysis and selection of the hardware and software to build these features with,

they were iteratively developed on an iPad in conjunction with residents using techniques such as the think-aloud protocol and interviews in order to ensure that they were usable and met the needs of the group.

Three trials were then undertaken with the developed system, with interviews and analysis taking place after each one. The first two shorter trials took place in one care centre, with the third longer trial taking place simultaneously in two care centres with 4 residents (2 residents in each) in order to compare and contrast the experiences of both groups.

After the final trial, all participants reported increased activity levels and enjoyment while using the system, using it especially when no activities were taking place in the care centres. The majority of participants also believed that they had become closer to some of the other participants as a result of the weekly meetings and bonding over the shared experience. Some also had increased communication with their family through the system.

This study shows that technology has a role in facilitating social interaction and engagement, by providing activities in an individual's personal time that can be used as the basis for a group discussion. Furthermore, it can provide access to information and resources that can allow an individual to maintain contact with the outside world. However, care must be taken when designing technology so that it does not reduce or replace such interaction as may be already taking place, however limited. This study identifies such technology as an accompaniment to face-to-face social interaction, rather than replacing it. Furthermore, the critical involvement of staff in the design process and the importance of contextual factors (such as the best place to locate such technology), as well as the potential of touchscreen systems as suitable for novice older computer users in care to learn on are discussed.

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1 Introduction

The ultimate aim of this thesis is to specify, design, implement and evaluate a process for researchers to design communications technology for older people based in care settings, such as nursing homes. Technology can have a role in facilitating social interaction and engagement that previously may not have been possible due to an individual moving from their existing community into care. Furthermore, it can provide access to information and resources that can allow an individual to maintain contact with the outside world. However, care must be taken when designing technology so that it does not reduce or replace such interaction, however limited, as may be already taking place. This study identifies such technology as providing activities as an accompaniment to face-to-face social interaction, rather than replacing it.

To date, the design of communications technology for older people has been aimed at individuals still living at home [1] [2]. While such technology is certainly relevant to this thesis, there may be differences between those resident in care settings and those still living at home without care - people in care settings usually suffer from a variety of impairments that may be medical, physical or cognitive in nature. It can also be difficult for researchers from a non-medical backgrounds to gain access to care settings, as higher levels of ethical approval are needed as well as the backing of a consultant medical professional, at least in an Irish context.

Furthermore, while programming and software development skills are crucial for this type of research, a wide range of skills traditionally not used by computer scientists (such as qualitative research methods and assessing residents for cognitive suitability) are needed

to provide a complete solution. This thesis provides guidelines to perform similar studies, and ultimately design communications technology for this group, namely relatively healthy older adults in care, with at most mild cognitive impairment.

As well as examining the social aspects of designing communications technology for older people, this research also examines some of the technical aspects of designing for these older people as well. Older adults can struggle to use modern technology, partially illustrated by the fact that people over the age of 65 in the United Kingdom are generally the least likely age group to be connected to the internet [3], though this is repeated in other counties too. With increasing amounts of services (such as customer support and banking) based online as well as internet only sales, those without internet access or the computer skills to use it may be at a distinct disadvantage. As a result, identifying strategies and processes to design with and for older people in care, as well as the applicability of existing processes for older people not in care to this particular group is another important part of this research.

1.1 Ageing Population

By 2050, approximately 2 billion people (one third of today's population) are expected to be over 65 years of age. As such, there will be an increased proportion of older individuals and fewer numbers of people of earning age. More than ever, there will be a focus on keeping people healthy for as long as possible, as prevention is better (and potentially much cheaper) than cure. Eliminating factors that increase the risk of illness and disease is crucial to this. Depression has been linked to an increase in illness and physical

decline in older people [4], including such conditions as cardiovascular disease [5]. By reducing the risk of depression, older people can live potentially healthier lives for longer, potentially meaning a better quality of life. Several factors can influence quality of life measures but social isolation (a "lack of meaningful and sustained communication") and loneliness (the "subjective counterpart to the objective measure of social isolation") are both linked to reduced quality of older peoples' lives [6]. There is a difference between social isolation and loneliness though, as a person can be considered socially isolated and not be lonely, while conversely another could be considered well socially connected and still feel lonely. Residents in care settings can be at particular risk of both social isolation and loneliness [7].

1.2 Older People, Technology and Care settings

As people get older, their social networks tend to reduce in size. This places them at a higher risk of social isolation, which can have an adverse effect on their health, manifesting itself both physically and mentally. The onset of depression and poor physical health has been linked to major social change in a person's life [8]. Older people who are resident in care homes (and, through this, potentially being removed far from their family and local community) can be particularly at risk of developing depressive symptoms when initially moved from their home [9]. Depression in institutionalised adults increases the likelihood of death by 60% in the year after it first appears. [4].

The benefits of a socially active life have also been written about in many studies, including being linked to a lower risk of Alzheimer's

[10] and cardiovascular disease [11], as well as better self esteem and emotional health. Furthermore, increased social interaction has been shown to have a positive effect on older people upon moving into care institutions [9].

Technology can have an important role in enabling social interaction among people who are geographically separated, as well as promoting new social connection. Furthermore, several studies have espoused the benefits of internet usage, with senior friendly sites "seem[ing] to reduce feelings of social isolation and loneliness" [12]. Another study showed a reduction in symptoms of social isolation and loneliness after 5 months of internet and computer training in a residential home [13].

When designing technology for older people, an examination of previous research has shown that any such development should involve older people at all stages of the design and development process, from planning through to the final product [14] [15]. This 'user-sensitive' inclusive design process allows for the creation of technology tailored towards the specific needs of older people. User involvement is considered extremely important when designing anything that involves human interaction, but is especially important when designing for the older user. Several papers have described in detail the differences that designing for older people entails, such as differences in lifestyle (lack of exposure to technology) and impairments (reduced eyesight and hearing) [16] [17] [18].

However, previous interventions to study the effects of social isolation have typically used "off the shelf" technology, either with computer classes or simply training the user to use a computer [13] . There have been many studies into designing software with older

people but these have traditionally taken place with older people still resident at home [18] [19].

Social isolation, loneliness and boredom are common issues in care settings. Many individuals long to keep in contact with friends and family, as well as take part in activities and events that they used to before entering care settings, but can no longer due to medical reasons or geographic distance [20]. In the research presented in this thesis, interviews and observation of the activity levels of older adults in care was analysed, and technology was developed in conjunction with these older adults to address some of the issues arising from this data. Finally, it was tested over a number of months in two separate nursing homes in the Leinster region of Ireland.

1.3 Research Questions

As stated previously, very few studies have examined the design of communications technology in care settings with individuals who are in care, but not significantly cognitively impaired. This thesis examines this in-between group. As such, a number of research questions arise:

- Research Question 1: How can a technology-based communications system contribute to an improvement in the psycho-social well-being of older people in residential care settings?
- Research Question 2: What sort of features should such a system contain?
- Research Question 3: How can such a system be successfully designed and to what extent does the approach required for

older people in residential care setting differ from that required for older people living at home?

- Research Question 4: What types of technology are the most suitable for older people in residential care settings?

These are the questions this thesis intends to address.

1.4 Designing Technology in Care Settings

Several studies have reported that older adults can experience low levels of social engagement in care setting [21]. They may be unable to attend activities that they used to, and many of the activities provided in the nursing home are at too low a level for them (as they cater for the entire spectrum of patients), resulting in them not attending. Accordingly, they report long periods of boredom, spending the majority of their time (with the exception of meals) alone in their rooms. Furthermore, impairment and geographic distance prevent many of the residents from leaving the nursing home, meaning that they are unable to access resources and materials such as books and newspapers that are not located in the nursing home, adding to the boredom [20].

Previous research in communications technology has focused on individuals still living at home [1]. However, there is a significant difference between those living at home and those living in care. As yet, there have been few studies that have looked at introducing technology in care settings, and none have introduced specifically designed communications technology in care settings.

This study used a 'user-sensitive inclusive design' [22] process as a

starting point, adapted for use in care settings. As stated above, this research provides an approach for introducing and designing technology in care settings for older people, with a potential impact on levels of social engagement.

1.5 System

The final system created was developed for the Apple iPad, a touch-screen tablet made by Apple Corporation. The functionality of the system was designed based on user interviews and feedback, but revolves around two separate but interlinked themes - providing activities that residents in care settings can undertake in their own time, that would then provide the basis of group discussions. The choice of the iPad was based on a mix of participant feedback in the interviews, where participants reported difficulty carrying and using standard keyboard and mouse based computers, and a literature review indicating that older people could successfully use touch-based technology [23].

Developing the system allowed an evaluation of the design process, which was undertaken on a case study basis in two separate care centres.

1.6 Contribution

A system that can be used by older people in care settings with mild physical and/or cognitive impairment has been specified, designed, developed, implemented and tested. It allows for contact both inside and outside the care setting, while providing activities to keep

residents engaged.

This system has been tested with a number of participants in 2 different nursing homes for a number of months and feedback from these users has been extremely positive.

The work presented aims to provide both a process for designing technology-based communications systems for older people in care settings, as well as potential features of any such technology, which will be evaluated through the implementation and testing of a system designed using this process and containing these features. Furthermore, it aims to identify the specific requirements of those in care when it comes to using technology to enhance social interaction and maintaining existing relationships, as well as the type of technology that may be suitable for use by this group. Finally, it may initially examining what effect such a designed system has on feelings of loneliness and social isolation.

As well as the contribution to the design process, the application of this process led to the development a system for use by older people in care settings. This system, encompassing technology as well as non-technological elements, was evaluated in two care settings in the Leinster region of Ireland. The feedback, results and analysis of the use of the system in a real setting on residents in care which are reported here and which could be used as the basis for further research in the area, potentially on participants with more significant impairment than those in this study.

This research could potentially be applicable to a wider group than just those in care. Other studies, such as the Building Bridges Project [1], examined the use of a common experience to stimulate discussion and increase interaction among older people, and

this thesis adds another strategy to such research. The suitability of touchscreen devices as a first device for inexperienced, older computer users is also suggested; the learning curve of the participants in this study was such that they used more features beyond those originally provided to them, despite initially feeling that they may never use the system.

1.7 The Structure of this Thesis

This thesis is divided up in several chapters, each concentrating on a particular aspect of the process.

Chapters Two and Three of this thesis will deal with the state of the art, encompassing a review of relevant literature relating to social isolation in the elderly (especially those in care), the use of technology by older people and research that has looked at the intersection of both areas. Related work in the area, specifically communications technology for older people, is also included. Furthermore, technology design processes, both in general and specifically for older people, are examined, as well as studies that have used these design processes to develop technology for older people.

Chapter Four describes the methodology used in greater detail, with qualitative interviews with domain experts providing much of the early research data. Following this, staff interviews, participant interviews and observation of activities/daily life of older people in care provide early design ideas, which are then explored with participants through storyboards. From these storyboards and participant feedback, a set of features that can be implemented in software/hardware are proposed.

Chapter Five deals with the iterative development and implementation of a prototype system, based on the interview, observation and storyboard feedback from Chapter 4. Descriptions of the underlying technology used and the system architecture are described in detail. The feedback (both quantitative and qualitative) of participants on the early software prototypes are presented, analysed and discussed, as well as particular problems relevant to system design for older people. For example, while guidelines exist for computer application development for older people, no specific touchscreen guidelines exist, so the existing guidelines for non-touchscreen devices were modified, using those that could be considered relevant.

Chapter Six deals with the evaluation undertaken, comprising of two smaller trials (Trials One and Two) and one main trial (Trial Three). These were undertaken in 2 separate care settings in the Leinster region of Ireland. It describes the scales used and quantitative and qualitative results are presented, such as usage data, scales and pre/post interviews.

Finally, Chapter seven provides a discussion of the work, addressing whether the evaluation validated the approach undertaken. Based on the evaluation, a process for designing technology for older people in care is presented, the features such technology should contain, as well as other issues such as contextual factors not directly related to the software or hardware, such as where to locate such technology. Finally, future opportunities for further research, including in different care settings or residents with different impairments, are suggested.

2 State of the Art - Older People, Social Connection and ICT

This chapter, which is a review of literature, is divided into several sections. The first section looks at the physical, social and mental effects of social isolation on older people, as well as the potential benefits of social engagement, without any particular focus on technology. The second section examines the issues affecting older people using technology, such as physical constraints, a fear of technology and a lack of experience with computers and more modern technology in general. The final section deals with previous uses of technology to increase levels of social engagement among older people, noting the lack of studies that have looked at nursing homes or retirement centres. The majority of these studies have taken place in the home, or in non-care settings.

2.1 Older People and Social Isolation - General Introduction

As stated previously, older people can be at a higher risk of social isolation than other groups, which can negatively affect their health in a number of ways. Social isolation has been linked with a decline in various physical health metrics. Examples include links between social isolation, depression and coronary heart disease in middle aged women [24], an etiological link between social isolation and cardiovascular disease [5] and an increased risk of re-hospitalisation among veterans [25]. This association occurs across the entire age spectrum, but is particularly prevalent in older people, where there is evidence linking meaningful and sustained social interaction to

reduced risk of diseases and conditions such as dementia [26] and coronary disease [11]. There is even enough evidence to suggest that older people with an active and socially integrated lifestyle may be protected against Alzheimer's disease [10].

Social contact is also seen as crucial to mental and psychological well-being. In a study of the relationship between social network type and depression over time, those with low levels of social integration were more likely to be depressed than those with high levels [27]. Furthermore, major life events in old age (such as moving to a care home) can be less stressful emotionally if a person remains in contact with their existing community [9]. It has also been stated that social support is "most important" in stressful circumstances [28]. Studies have also shown that increased social interaction can have a positive effect on adjustment to care institutions for the aged [9].

The studies that have focused on older people have looked at social interaction in a wide variety of locations, including in the home, hospital, care home and different types of institutional accommodation. This "environmental gerontology" has "progressed our understanding of the ways in which older people respond to and manage the environments in which they live" [29].

Older people who are resident in institutional care settings are particularly at risk of social isolation, as these settings are sometimes "bereft of high levels of social interaction and social activity" [7]. When relocating to an institutional care setting, those who maintain contact with their old community "show the least emotional distress" [9].

A study by Harper Ice in 2002 showed that among the residents in

a care centre that they observed, 65% of their time was spent doing little or nothing, and just 12% on social activities [21], re-enforcing the notion that care settings can suffer from a lack of engagement [7].

There have been many investigations into increasing social interaction among older people, as well as several reviews into these interventions in order to identify the common features of the most successful ones. Cattan [30] performed a review of 21 different interventions for their effectiveness, which showed that successful interventions typically:

- are group interventions providing social support;
- target specific groups
- have an educational or training input;
- should be within an existing service or evaluate that service;
- use validated measuring tools to evaluate the intervention;
- Allow participants some level of control

Those interventions that were considered unsuccessful were one to one interventions or were conducted in the homes of the subject. They were "unable to demonstrate a significant effect in reducing social isolation and loneliness" [30].

Findlay also conducted an examination of the evidence for 17 interventions to reduce social isolation among older people [12]. It was found that involving older people in the planning, implementation and evaluation of interventions makes them more likely to succeed. Many of the recommendations for successful interventions

present in Cattan's review were also repeated. These findings and recommendations are reflected in the protocol that are used in this research.

Within these studies, some were not using technology as the basis for the research. However, there were a significant number that did use technology, such as a phone or other system as part of their research. Care must be taken, however, when introducing technology into the lives of older people. Many studies have shown that simply giving older people a computer does not necessarily have any impact on their wellbeing [31].

2.2 Technology and Older People

Computer use has increased access across the world in recent years, and across all ages. There are significant attempts around the world (such as in Ireland with its National Broadband Scheme, a government sponsored initiative which began in 2008 and aimed to bring broadband to parts of Ireland where it was previously unavailable) [32] to make internet access available to all and the UN has proposed that internet access become a fundamental human right [33]. Finland has also made 1mb internet access a legal right, becoming the first country in the world to do this [34].

Internet access however is useless without devices and applications that can access and use it. With the advent of technology such as video calling (Skype [35] and Facetime [36] being examples of this), computers can potentially have an important role in enabling social interaction among people who are geographically separated [30], as well as promoting new social connection.

However, not all age groups are experiencing the same level of growth in internet usage, especially the over 65s. There are studies that have examined this 'digital divide', or more specifically the 'grey digital divide' [37], referring to the fact that older people are the least likely age group to be connected to the internet [3]. Increasingly, many services are provided on the internet, such as online banking and shopping, customer care via forums and social networks. With people older being the least internet-connected group in the UK, and web content developed for and by younger users, older people are generally not catered for, putting them, in some cases, at a financial disadvantage [38]. There are now online-only sales that take place, such as the American 'Black Friday' - computer access and experience using the internet is essential to take advantage of this.

There is also a feeling among older users that the internet is not relevant to them, and may not perceive the need to use it as a result, coupled with fear and insecurity that older people commonly feel when learning to use computers [39]. This fear and the associated stress that may accompany it can impair the performance of older people using computers [40].

Several studies have looked at designing applications for email and web browsing (which are discussed later in this chapter in section 2.2.3) as well as changing the web itself, such as providing a stripped-down version of the internet. However, providing a limited version of the internet may still exclude older users, and, as such, an alternate approach is to teach older adults to use the internet and computers as the majority of people use them. A significant number of older people learned to use computers in training programs and classes [39].

However, older people suffer from other issues beyond inexperience with modern technology, and as such, care needs to be taken when introducing technology, both in terms of the type of technology, as well as how it is designed. As stated previously, older people are less familiar with technology than most other demographics [3], but may also suffer from physical impairment as well as trying to adapt to technology not specifically created for them.

2.2.1 Physical impairment

One of the main barriers preventing older people from using computer technology is "the complex nature of application user interfaces" [16]. Much of the focus of research into computer use by older adults has focused on creating newer, simpler versions of existing computer applications, as "difficulties for elderly people often arise, not so much because they do not know how to use the systems, but because the designers of individual services have not been thoughtful enough to consider the cognitive, sensory and physical limitations that so many potential users will suffer from" [41]. Specifically relevant to this research, those in care settings are typically more impaired than those who are not, which means that the impairments that affect many older people could in fact be magnified for those in care.

The majority of the limitations that would affect older people are either physical or cognitive; for example, even simple issues such as colour choices can interfere with viewing text through an elderly eye lens, while pointing and clicking at smaller icons can be very difficult for those with muscular tremors [41]. Examples of this work on making computers accessible was the development of an

email interface called 'Simple Mail', which had a "bold, clear design that made the important features stand out and made it clear where the user should click to activate an action" [16]. This user-centred design allows a more customised version for older people, enabling use of an application without reducing the available features.

There is evidence, therefore, that with modifications to the training and interfaces, computers can be successfully used by older people. Care needs to be taken into account with training, and by including older people in the design of the training and design of the system itself, there is a greater chance of developing a system that is "senior friendly". It is suggested by some researchers that a main focus is to design a technology that is inclusive (i.e. that can be more than just the target group) while also ensuring that is usable by the target group [42], in this case older people.

2.2.2 Lack of exposure to technology

As well as the impairments to which older people are more prone, a lack of experience with more modern technology is a major barrier to usage. It is suggested that researchers use devices that do not look like traditional computers in order to avoid the preconceptions older people may have about them [42].

A review of computer usage by older people was also conducted. As of 2011, use of Information Technology of any type by older people is generally lower than the population average. For example, a 2007 OFCOM (Office of Communications) paper showed that the use of the internet by older people in the United Kingdom is only 28% compared with a national average of 57% [3]. An earlier study

carried out by the National Council on Aging and Older People in 2002 showed that only 13% of older people in Ireland use the Internet as a frequent means of accessing information related to health, social care and welfare services, compared to 80% using printed media (newspapers, leaflets etc.) for this [43]. This is despite the fact that over one third of the participants in the study stated that they either owned or had access to a computer [44]. The reasons for this are complex. For example, studies have shown that merely being older is not necessarily a barrier towards Internet usage, with other barriers including perceived usefulness, ease of use and complexity of navigation [45].

In recent years, a new branch of technology, called "gerontechnology" has evolved as a combination of technology and gerontology. It has been defined as "harmonizing two separate developments in present society; the increasing number of older persons, called the aging society, and the technological innovation of products and services, called the digital era" [46]. This union is "aimed both at better methods and instruments for understanding aging and at improving environments in which people age" [47]. There is now an international Journal devoted exclusively to the field of gerontechnology which has been published for over 6 years [48].

It is apparent from many studies that merely having a computer in the home of an elderly person does not improve their 'well-being'; Anna Dickinson and Peter Gregor from the University of Dundee concluded that there is "no evidence that computer use improves well-being among older adults" and cited many different reports from authors around the world for their contribution "to a technocentric view of aging that is not justified by the available evidence" [31].

2.2.3 Lack of custom designed software for older people

There have been a number of studies that have examined the development of technology specifically for use by older people. Some examples include Senior Mail [18], Cybrarian [31], Simple Mail [16] and the Building Bridges Project [1]. Each project is noted for its use of a user-centred design process (or variation thereof). Sayago and Blat state that the first 3 were designed to take into account "age related changes in functional abilities and the lack of experience with technology" [49]. However, they also state that there should be much more investigation into how such technologies are used and integrated into older people's lives. Dewsbury et al. suggest various techniques in order to design technology "inclusively and acceptably to the people who are to receive it" [42].

There were several applications that looked at email application design for older users, as studies have stated that it can be the most frequently used internet application by older users [31].

Senior Mail [18] is an email system designed specifically for older users. The researchers reported the older users actively asking for the "dumbing down" of the system so they could learn it. Experiences of the designers during the development of the application included the importance of involving older users throughout the design process, and that it is better to limit the universality of the application (and in doing so, potentially making the system more difficult to use for advanced users) in order to cater specifically for the needs of older users. This system used MS Windows with a standard keyboard and mouse, as the research "started from the assumption that most older users are currently using MS Windows", but acknowledges the limitations of this system.

Cybrarian [31] is an email system designed for older users with no previous experience of computers, in order to connect them to the internet. Results from the evaluation with older users showed that it was preferred to commercial applications and was considered easier to use, while Simple Mail [16] was another email client which aimed to understand better the user interface requirements of older users of e-mail, while emphasizing the importance of involving older people from the outset in the development of such applications.

It is noted that the applications and research presented above use standard computer input and output devices, such as a keyboard and mouse. The lack of exposure to technology is not purely an issue of software, as other issues such as how to use a mouse or a keyboard, even what all the buttons on a keyboard mean are also significant issues for older people. Dickinson et al. [50] ran a computer course for older people using standard computers with modified software (such as enlarged targets to click on) but participants struggled to manipulate the scrollbars in the system with the mouse. They also became confused when they pressed the right-button in a mouse and it did not select something.

Recent devices, such as the iPad, offer alternative input options, using just the finger or a touchscreen as the solitary input device. Older users have been shown to use touch-based devices successfully previously [23].

Building Bridges [1] was a project that focused on designing communications technology for older people still at home, using a modified version of the design process used in this research, as it was focused on a different cohort (but of a similar age). The idea was to use a common experience (in this case, listening to a radio show on the de-

vice, and participating in a group discussion afterwards) to promote social engagement. Participants could also call and send messages to each other. Those still living at home are typically less impaired then those who are not, and do not usually live close together like in care settings, so while the research was relevant, it was not directly applicable. A touchscreen system (which older users used successfully) was used instead of a keyboard and mouse. The design process used in the Building Bridges Project is described in detail in chapter 3, but the involvement of users at all stages of the process was a key finding and of major importance throughout the research. The use of touch screen technology was interesting, although there were issues with it in terms of responsiveness of the screen used and of the size and weight of the device. These findings are key for the research described in this thesis.

2.3 Studies on increasing interaction in Care

There is potential to use resources and activities as a way of increasing levels of engagement. Burge et al. [51] attempted to increase levels of social engagement in a care setting by creating memory books for residents, which were filled with memories of their past. These residents suffered from mild to moderate cognitive impairment. Staff were trained to stop and look at the book with the resident. They report that as a result of the intervention, communication between staff and resident was improved and it increased the amount of time other residents and visitors spent talking with target residents.

There have been limited studies looking at using technology to enhance the lives of older people in care settings, such as designing

activity management systems [52]. A recent study in 2010 by Otjacques et al. [2] looked at designing a system to support the daily life of older people in a care home. The system, called Sammy, allowed participants to register their intention to participate in activities, read a newsletter or some news headlines, and order their meals. The system was accessed via an RFID tag that each participant wore and was placed in the lobby, which some of the participants cited as a reason for not using it (inconvenient location), suggesting that the location of a device can have an impact on its use. There is also a need to take into account the differences in population in a retirement home, according to the researchers. It is interesting that the researchers chose this particular type of care setting, as opposed to hospital settings or at home, as these have been widely studied. This intermediate stage, where residents are neither too ill to be in hospital, but still need several hours of care a day, is a group that has been little studied when it comes to designing communications technology. They also focus more on less impaired adults as opposed to those with significant health problems.

2.4 Conclusions

This chapter has shown the potential negative effects of social isolation (and conversely, the benefits of social engagement) on older people, as well as the potential role that technology can have in keeping people connected for longer. However, the majority of studies to date have focused on older people still living at home, who are generally healthier and more active, and with higher levels of engagement than those who have moved into care. Furthermore, specifically in the case of moving into care settings, keeping in contact with friends and family can be particularly important.

It is possible to increase the level of social interaction in care settings using resources like books as a common ground to promote discussion [51], and technology can potentially provide greater access to this sort of information and resources. While previous studies have examined using technology to provide opportunities for individuals still at home to meet and connect over the internet [1], it may be easier and more suitable to connect residents in care settings face-to-face while using technology to provide activities, which may ultimately be a preferred option.

However, in some situations face-to-face communication may not be possible, as friends and family can be located far away. Technology may also have a role in connecting individuals separated geographically [1]. In the case of the care settings that this research was undertaken in, many residents had family outside Europe who could either not afford or were not well enough to travel. Modern technology such as video calling could enable them to see each other, even though they may be thousands of miles apart.

It is also evident that careful consideration must be given to type of technology chosen, which covers both hardware and software. Older people are generally more apprehensive and use technology such as computers less frequently than any other age group. As such, hardware and software should be designed with older people in mind, taking into account impairments such as poor eyesight and lack of dexterity, as well as a lack of experience with computers.

Finally, those in care settings may be more impaired than those at home, with less access to communications technology such as a telephone. As such, they may have different needs and wants to other groups. While there have been several studies into communications

technology for older people, the majority have taken place in the home, or have not focused on a particular location, but on the technology itself. Very few studies have taken place in care settings, and those that have are more focused on helping manage daily life as opposed to increasing levels of engagement.

3 Review of Literature - Design Methodologies for Older People

3.1 Overview

This chapter examines the various design techniques and methodologies that may be suitable for use with older people, as well as existing systems that have used these methodologies or have a similar function to the type of system designed in this research.

The importance of the involvement of users in the design of technology has been known for many years. Techniques such as user-centred design and participatory design are both based on the premise that the users (or in the case of participatory design, the stakeholders) are significantly involved in the design process [53]. This is to ensure that the product designed as a result of this process is usable by that group, as well as incorporating the needs of the group into the design of the end product.

However, the majority of devices and systems are often designed by those who may not have an appreciation for the difficulties that older people face when using technology, such as impairment and a lack of experience with technology [49]. Furthermore, many people are excluded from using products as a result of designers not taking account of the end user's functional capabilities [54]. As such, it is important to gain a good understanding of the problems faced by older people when designing for them.

There are a variety of methods that have been employed to design for older people or those with disabilities, such as universal design, inclusive design and accessible design.

However, in addition to the needs of older people being catered for in the technology itself, the methods used to assess these needs must also be tailored for older people. Issues such the length of interviews, attendance, question design and terminology used during interviews and requirements gathering need to particularly well planned when older people are involved [55].

This chapter is organised into several sections. The first section is a general introduction to technological design methodologies for older people. The second section focuses on methodologies for designing communications technology for older people, while the third section examines methodologies for communications technology and related work for patients or older people who are in receipt of care.

Finally, an analysis of this review is presented that shows where this research is situated.

3.2 Section One - Design Methodologies that involve the user

The importance of involving users throughout the design process, whether that be through user-centred design, participatory design or other design processes which recommend involving users has been widely reported [56] [57].

User-centred design describes a variety of processes where users influence how a design takes shape. It places the user not as part of the team, but as a voice communicated to the designer through the researcher [58]. Abras et al. [57] state that there may be a number of ways that that the users can be involved but the important point is that users are involved, such as consulting them about their needs

via interviews or making them partners in the design process.

There are many reported benefits to the use of user-centred design. The "ultimate test" of a product's usability depends on measuring users' experience with it [59]. The approach can ensure a system "will make the most of human skills and judgement, will be directly relevant to the work in hand or other activity, and will support rather than constrain the user" [56]. User-centred design is beginning to gain widespread acceptance in industry too, with a recent survey reporting that companies spend around 10% of their project budgets on its use [53]. However, while user-centred design can help ensure that a product is suitable for its intended purpose, the main disadvantage of it is cost, both in financial and time terms, as it takes a significant period of time to research, gather and analyse the data that informs the design. Furthermore, while user-centred design teams benefit from a multidisciplinary group including psychologists and sociologists who can understand user requirements and explain these to the technical part of the team [57], this can incur extra financial costs.

Participatory Design is another type of design process that involves not just the user, but focuses on involving all stakeholders, such as workers and management in the research process as there may be different goals for each group, even if some of the groups are not end-users of the product. Participatory design first appeared in the 1970s in Scandanavia in reaction to the neglect of workers' interests in the introduction of systems into the workplace [60]. In Participatory Design, the user "becomes a critical component of the process" [58]. Workshops, lectures and courses are used alongside techniques from the ethnographic world including interviews and observation [60].

However, as stated previously, care needs to be taken when using these processes to design technology for older people, as they present much greater challenges than traditional user groups [61] and there can be differences such as a greater occurrence of impairments in this group. For example, 65% of those with visual impairments are over the age of 50, despite this group only accounting for 20% of the population [62]. Furthermore, older people may have different needs and wants and may operate in a different environment to other age groups, and as such a standard piece of technology may not be suitable for them [15]. In an effort to encourage more understanding of the needs of older people, there are studies and techniques that have tried to mimic the impairments and constraints of older people. These include simulating visual impairments in software so designers can experience the impairments for themselves [63]. Other examples include the "Third Age Suit", developed by the Ford Motor Company to simulate reduced joint mobility so designers understand what it feels like to be older [64], while Hitchcock et al.[65] designed wearable devices to address such limitations. However, it is important that these custom systems for older/disabled people can also interact with more mainstream technology. Shneiderman suggested that this universal usability (where more than 90% of all households successfully use ICT services at least once a week) contains 3 important issues: technology variety (wide range of hardware and software are supported), user diversity (wide range of skills, abilities and impairments) and bridging gaps in user knowledge [66], which can help older people use technology more easily and successfully.

The methodologies themselves may need to be adapted for older people as well, to take account of these impairments and lack of experience. Obtaining requirements from older people who may have very limited experience with ICT can be problematic [67]. It is also

key to ensure that a "great deal of effort" is made to recruit and nurture potential participants as older people are usually less mobile, live more isolated existences and therefore have to be actively recruited by approaching social groups, care homes and day centres [67]. Furthermore the length of interviews, questionnaires and focus groups should be limited as there can be communication, fatigue and attention problems among this age group when participating in such exercises [55].

3.3 Section Two - Design Methodologies Adapted for Older People

There are a variety of processes, such as universal/inclusive design and accessible design that have attempted to address the needs of older people and people with disabilities. Inclusive design can be defined as "design of mainstream products and/or services that are accessible to, and usable by, people with the widest range of abilities within the widest range of situations without the need for special adaptation or design" [68]. Accessible design is described as "usability for all users" but also includes interoperability with assistive technology or making products accessible to users with a wide range of functional limitations [69]. There are now laws which require websites and products to be accessible to people with disabilities [70].

There can often be a lack of understanding regarding the needs of older users, as they experience both impairment and a lack of experience with technology. The design processes described above have succeeded in bringing the needs of disabled users in product design, with many guidelines now available to help designers 'design for all'. However, there is the potential for these guidelines to contradict

each other [71]. While there are guidelines, such as the W3C web site accessibility guidelines [72], which "explain how to make Web content accessible to people with disabilities", studies have shown that simply implementing these sorts guidelines is not enough. As Milne et al. state, "these guidelines have not been successful enough in producing Web sites accessible to older people" [73], as designers often rely on automated systems to check the accessibility of a system, which can only check superficially, such as whether 'alt-text' (text description for non-text objects such as images) have been included, for example. They suggest a more sensitive and inclusive design using observation and interaction to gain knowledge about the particular group.

However, it is also very important that the needs of older people are considered and incorporated from the earliest stage possible. While user-centred design (defined as involving users in the design of a given system they will use) is considered the most appropriate design process in most projects or studies [53], it is not necessarily suitable for older people or those with disabilities.

Newell and Gregor have described many of the problems with using more mainstream techniques for designing with older people such as user-centred design, design for all and accessible design. They describe design for all as "a very difficult, if not impossible task", with the danger that by making products accessible to people with certain disabilities, it may make the product more difficult to use for those without disabilities or with a different type of disability. They proposed a further development on user-centred design, which they call "User Sensitive Inclusive Design" [71].

User Sensitive Inclusive Design differs from user-centred design in

a number of ways. Inclusivity has replaced the word universal, as inclusive design is more achievable than universal design due to the potential to alienate one group in attempting to design for another, while 'sensitive' replaced 'centred' as it can be difficult to obtain a proper sample user group due to recruitment difficulties [71].

As an example of where user-sensitive inclusive design is more appropriate, Gregor et al. [15] reported the use of a standard user-centred design methodology in the design of a web browser for visually impaired users, reporting that a more inclusive design (they recommended user-sensitive inclusive design) would have been more appropriate. In the designers' attempts to ensure a homogenous user group, they did not account for the diversity that exists in older population groups. As a result, the researchers stated that the designers were "genuinely surprised" that older users could not use the browser, even though "five minutes spent observing a visually impaired older adult trying to get going with the software would have made this clear" .

This design methodology seems more suitable for older users, but there are also specific techniques that must be adapted to allow technology to be designed using User Sensitive Inclusive Design. These include recruitment methods, including the choice of location so that it is accessible for people with mobility problems [71], or keeping information-eliciting techniques such as focus groups and interviews shorter as older people can have limited attention spans or may become tired more quickly [55]. Furthermore, carer involvement, or individuals such as medical experts who may not be users of the system but could have a valuable contribution and input into the research should also be included in the research process, should such involvement be deemed relevant.

Newell et al. state that rather than considering older people simply to be the subjects of experimentation, older people should be considered "as part of the development team". They also state that it is important to encourage researchers to develop an empathy for and relationship with the older people in the study [61]. Eisma et al. [67] examined the various components of the user-centred design process to see if they were suitable for an older user group. In-home interviews were found to be the best way to elicit requirements, as well as making sure any technology that would be introduced would be appropriate for the person, as older people "are more vulnerable to the negative effects ... of inappropriate technologies" [74]. They also found if terminology was made more understandable, as well as explaining the value of the opinions and input of the participants (especially in focus groups) then more successful data gathering would ensue.

A number of more recent studies have used various modified techniques and methods in the design of new technology aimed at older people. Rice et. al used 'forum theatre', where actors act out an example of a particular issue in a short scene to an audience of older people. This common ground promoted discussion and enabled the audience, many of who were technologically naive, to understand and discuss issues around the development of this new technology [75]. However, the likely significant cost to hire, train and perform such theatre may be beyond the scope of many projects. Other methods that have been successfully used for such requirements gathering and discussion include storyboards, where the scene is drawn and described by the researcher, rather than acted out [1].

3.4 Interface Design

As well as using modified methods to obtain requirements for such technology when designing for older people, it is just as important to take account of the needs of older people in the design of the actual system itself. Older people are usually one of the least experienced groups with computers and ICT [3].

A large proportion of systems are typically designed for younger, more able users, which can exclude a significant proportion of the population [76], which is steadily increasing as the world population continues to age.

As a result, guidelines for older people have been developed to help designers and are aimed at a variety of media, including the web. There are high-level guidelines, or heuristics, such as those by Nielsen [77] who recommends, among other things, error prevention and the incorporation of a minimalist design, while Shneiderman [78] advocates reducing the short term-memory load of users and offering simple error handling throughout the interface.

More detailed guidelines, which deal with more granular detail such as button sizes, font and text are also available. Kurniawan proposed a set of 38 guidelines for older and disabled users over 11 different categories which included text design, navigation and use of colour and background [79]. Other guidelines have been developed by the US Government [80] and the W3C for web accessibility [72].

However, developers can often have a lack of experience with developing for older and disabled people, and as a result do not have a conceptual framework in which to place these guidelines [81]. Fur-

thermore, several studies have stated that guidelines developed for these groups can be difficult to use for developers [82] and not necessarily good for end-users [73], as developers can struggle with trying to accommodate different types of impairment, whose guidelines may contradict each other, which can effect technology that people use to navigate the internet, for example.

As a result, it is important (but also difficult) that the team designing any technology for older people actually observe the evaluations and tests as they happen [81]. This can help younger researchers who can find it difficult to design for those in a different stage of life with different needs, wants and impairments [54]. This idea, where the users can inspire the designers as well as the designers inspiring the users is called 'mutual inspiration' and allows people to see the difference between what is reported by users and what actually happens [14].

Once the information has been gathered, requirements specified and development of the technology has started, the iterative process of showing it to users for feedback is crucial. Dickinson et al. [31] state that 'Think Aloud Interviews', where a user describes in detail their thought process as they use the technology, can highlight inconsistencies in the interface and can give "rich and interesting information, but will increase the cognitive complexity of the task". They recommended to start the protocol on the second run of using the system, especially for those with any cognitive impairment. They also recommend comparing any technology used to existing technology, as it can show the potential benefits of using the specially designed software as a "specially designed system is more usable and attractive than a commercial system" for older users.

Other techniques that have been used include logging the usage of a developed system for errors, iteratively changing the interface based on feedback and where users are encountering errors [1], [83].

3.5 Touch-Screen Interfaces

There is an increasing trend towards the use of touchscreen devices, with companies like Apple, HTC and Microsoft all using touch-screen specific devices and operating systems. But are they as usable as other more established interfaces?

Advantages to using touch-screen buttons include the ability to combine the display and input space, as well as dynamically displaying buttons and switches as needed [84], which is not possible with physical buttons.

However, there are some downsides to using touch screen devices. The lack of tactile feedback on touch screen devices can be a disadvantage [85]. Without this haptic feedback, the user relies on visual and audio feedback [84], rather than relying on the feeling the pressing of the button.

Furthermore, there are different types of touch-screens, such as resistive and capacitive screens, that respond differently and to different parts of the human body. For example, a resistive screen is more responsive when tapped with a fingernail, while a capacitive screen is activated by simple finger contact.

Lee and Zhai [85] studied the use of touch screen buttons, looking at these different types of screens (capacitive and resistive), as well comparing the use of a stylus to a finger and other experi-

ments. They report that resistive touch-screens (activated by a level of force) can be less responsive but may be useful when the buttons are very small. Furthermore, a stylus can be more easily used for smaller buttons but disadvantages include ease of access (such as pulling out the stylus versus using a finger straight away) and a propensity to getting lost, which can impede use of a system.

They also state that capacitive touch screens, on the other hand, were more responsive but more error-prone when using small buttons. Given that older people generally require bigger buttons and text due to eyesight problems, this may mean that a capacitive screen is more suitable for them.

As well as input differences between touchscreen and non-touchscreen devices, guidelines for standard computers do not necessarily transfer directly to touch-screen computers either. For example, the idea of the (double) click is not applicable to a touch-screen. However, many of the concepts can be adapted for both, and some have used the standard computing guidelines as a basis for their own touch-screen specific requirements [1]. Older people have used touch-based devices successfully in previous studies [23].

There are some touch-screen design guidelines specific to older people, which arose out of the existing guidelines for touch-screen systems not catering for this group [86]. Specifically, they state that older people are more accurate when they use buttons that are larger than those suggested by existing standards. They also suggest that spacing between buttons is important as buttons with no spacing resulted in the lowest levels of accuracy. Furthermore, the less dexterity a user has, the larger the buttons and greater the spacing should be. Others have recommended designing these interfaces for

use with one hand only and with a limited number of targets to press [87], and it is "important to reduce the cognitive overload if we want great performance for older people", indicating that a simpler interface may be most suitable for this group. This tangible, finger-based interaction can be easier to use for older people who may not have experience of computers, as mice, keyboards and other similar devices can "introduce a certain level of difficulty in learning for many elderly people" [88].

3.6 Studies

There are a number of studies that have used the specific techniques mentioned in the previous section in designing technology for older people at home, whether that be touch-screen based or otherwise. These include focusing on increasing social engagement with peers who are still living at home [1], increasing contact with their remote family [89], and email systems to aid in communication [16]. Other studies have used telephone befriending systems [90].

The Building Bridges Project [1] was one of the first studies to look at new interfaces (such as touchscreen devices) in the area of communication systems. Each participant listened to a radio show broadcast and participated in a group chat afterwards using the device. Participants reported enjoying the conversations and for the most part, successfully used the touch-screen interface, albeit with the help of a stylus on occasion.

These studies have reported increased levels of engagement and communication as a result of the introduction of their systems. However, these studies also took place with relatively healthy individuals still

living at home, and there is only a limited number of studies that have taken place outside the home, or in care settings. This can be due to a number of factors which include advancement in age, cognitive impairment and physical frailty [91]. There are also issues at administrative levels in nursing homes, with a questionnaire from 2001 distributed to nursing homes in Oklahoma showing that the majority of administrators felt that "little could be gained" by granting residents access to the internet [92]. However, a more recent study shows that this attitude has changed somewhat, with administrators in a different state reporting a much higher interest in introducing the internet into their care centres for client use [91].

This introduces the idea of including staff of a care centre in the design process. As stated previously, user-sensitive inclusive design recommends incorporating carers and other relevant individuals, even if they are not end-users of the system [71]. This may be crucial in care settings, where staff can help with access to potential participants, as well as provide insight into life in a care centre.

3.6.1 Studies outside the home

Traditionally, the majority of studies in this area have looked at older people still living at home [1]. Older adults who are in care can be quite distinct with different needs and issues, notwithstanding medical and other problems that they may face, as described below. It is not necessarily the case that studies undertaken in the home would be applicable in care.

For example, older people in care generally lead less independent lives, experience more severe impairment than those living at home,

and may be more isolated than those at home, though certainly that is not the case in all situations. Most older people are in care due to failing health [21], and it is fair to say that most people would not be in care if they did not have to be. As stated previously, moving into care can be stressful and puts people at risk of depression, which has been linked to increased mortality rates [4].

It can also be more difficult to gain access to care settings. Certainly, within Ireland, ethics from a hospital level board is required which can add significant delays to a project. This approval is also dependent upon a consultant to medically supervise the research, so access to such an individual is key for any research of this type.

Care settings also can and do have a larger range of individuals present, beyond just the residents. It is a workplace too for staff, whether they are medical or administrative in nature. Given that there are potentially more of these 'stakeholders' in care settings, such as nurses, doctors, consultants, administrative staff, inspectors as well as the residents themselves, it is recommended to involve all of them in the design process (and not just the residents), as they may have insights and feedback crucial to the project [71].

3.6.2 Lack of similar studies outside the home

Some studies have looked at computers, and communications technology in care settings. Tak, Beck and McMahon [91] reported a survey among nursing home administrators that showed while 88% of them were interested in making computers and internet access available for residents, only 14% actually had computers for resident use. They did also note that some residents were beginning

to bring in their own computers for personal use. While there are few studies that have examined increasing levels of social engagement and interaction through the use of ICT, there are studies that have looked at providing information and task management, such as Otjacques et al.[2], who looked at designing technology in a care centre in Luxembourg. White et al. showed a reduction in symptoms of social isolation and loneliness after 5 months of internet and computer training in a residential home [13].

However, as stated previously, the staff in care settings are also very important and constitute an extra 'stakeholder' that is not always present when designing for those still living at home. This fits into user-sensitive inclusive design [71], where it is encouraged to include relevant stakeholders, whether end-users of the product or not, in the design process. A recent study into technology in care have emphasised the importance of communication with all the stakeholders of any new system [2], as some of the procedures in the care centre worked differently to the way they believed they did.

A 2011 study in Taiwan [88] looked at introducing collaborative surface computer (a table with a computer as the surface, with a multitouch interface) to a retirement home, where residents sat around a table computer, recording or listening to messages from other residents. The purpose of this was to enhance their social interaction by providing an alternative communication technology. The residents responded positively to the system, and further work was underway to examine the potential social interaction benefits of the technology. This study is similar in nature to the research undertaken in this study, but seems to focus on a 'senior living community', which may not have residents who are particularly impaired. Furthermore, the study aimed to increase levels of social contact through the tech-

nology, rather than providing access to resources that can increase activity levels, and through that increase engagement opportunities. As stated previously, older people in care spend up to 65% of their time doing little or nothing [21].

There does not seem to be a system, however, that has explored using technology-based activities that can be undertaken in one's personal time as a way of stimulating discussion and engagement in a group setting within care. The Building Bridges Project [1] examined using a collaborative group activity to increase levels of engagement using participants based at home, so while their research is certainly relevant to this study, the participant group they use is different (at home, potentially more independent and less impaired) and does not include staff of the care centre whose input and opinion are crucial. Furthermore, the participants in that study were not located in the same building (as they may be in care) so face-to-face collaboration was not possible. It is interesting to note that some of the participants did suggest meeting face-to-face after the study.

3.6.3 Telecare

There are a number of studies that have looked at the provision of care through ICT. There is a movement towards telecare, with the potential for this to support care that takes place in the home. Many companies are looking to explore this area. However, tele-care is more concerned with the remote care of older people, and as such is outside the remit of this research.

3.7 Analysis of Literature Review

The review of literature has covered a number of areas in a variety of disciplines:

- social isolation and a lack of engagement can have negative effects on (older) people. Conversely, there are physical and mental benefits to keeping socially engaged.
- technology can have a role to play in reducing levels of social isolation, but that it needs to be carefully designed for older people.
- older people can struggle to use modern technology, with some of the main difficulties including impairment and a lack of experience with computers.
- a number of interventions have been identified that have examined using technology to reduce isolation and increase engagement, with some success.
- The review has described some of the design processes that may be best suited to design technology for older people.
- the review has identified and examined examples of studies that have used these processes to design technology for older people.
- the review has identified the small number of studies that have examined technology in care settings, and studies that have examined communications technology in non-care settings.

An analysis of the literature on social isolation suggests that older people can be at high risk of social isolation, and that keeping active

and socially engaged can be beneficial to their health and well-being both physically and mentally, potentially lowering mortality rates.

Other studies have shown that major life events, such as moving into care and away from family, can increase the risk of depression. Older people in care settings are particularly at risk of social isolation, spending the majority of their time (up to 65% of their day in some cases) on their own doing little or nothing. This would suggest that there is an opportunity for increasing activity and engagement levels.

Some studies have looked at reducing this boredom and increasing levels of interaction through the introduction of non-technological interventions such as 'memory books' (scrapbooks with pictures of the past), which have a positive impact on communication and interaction levels. Using group activities and taking advantage of existing services are some of the features of previously successful interventions. However, with the advent of modern technology, there is an opportunity to explore this with new devices and systems.

There are a number of studies that have examined communications technology for older people, but these for the most part have examined healthy adults still living at home. There are some more recent studies in care but they have looked at retirement homes [88], or focused on co-ordinating activities systems within the care centre [2], but none that have focused on providing activities that reduce the boredom with personal activities and simultaneously increase engagement levels. The Building Bridges Project is a study with a similar goal, but examined individuals still living at home [1] which is a significantly different (and potentially much healthier and less impaired group) that have regular access outside and still live in

their original family home near friends and neighbours.

Previous research has showed the successful use of memory books and reminders of the past to simulate interaction, so perhaps attempting to recreate some activities of the past is an appropriate angle to take when developing such technology. As studies have reported a lack of activities and 'doing nothing' for large periods of the day, the use of past activities coupled with modern technology could solve two issues at the same time, namely activities for personal time to reduce boredom, and then using these activities as a way of promoting increased engagement with other residents in a care centre. The use of media from the past coupled with an informal discussion time could mean that residents could reduce their time sitting alone, but also have activities that they could undertake when alone. Therefore, any system developed should include activities to reduce boredom.

Any technology used in such a situation must be developed with the needs of older people in mind, and any features must be based on feedback from older people from the earliest stage possible. A user-sensitive inclusive design process seems the most suitable process for this research as it accounts for the needs of older people as well as incorporating the staff feedback, which is potentially relevant. Furthermore, age-related impairment such as declining eyesight and a lack of dexterity mean that any interface developed should have the minimum of controls needed to operate it and substitute usability before beautiful graphics. Therefore, careful design is necessary and continuing input of the elderly is essential.

Older people can struggle using standard computers, and with the advent of the touch-screen into mainstream devices over the last

number of years, it would seem appropriate to use touch-screen technology, as the devices are typically smaller than traditional computers and may be easier to carry for older people. Furthermore, one study described touchscreen devices as potentially more suitable for novice computer users, and therefore may be suitable for those in care. It may also be easier to iteratively change a touchscreen design due to the ability to easily change the size of buttons and input objects, which is not possible with physical input systems. However, this does not exclude any other types of systems, just that the potential to explore the area of communications technology in care with very modern technology is interesting, especially as others are using similar technology, albeit with a slightly different group [1]. Therefore, it is valid to examine the use of touch-screen technology, especially as it can hide some of the complexities of an operating system.

There are different types of touch-screens, such as resistive and capacitive, and a review of literature would suggest that a capacitive screen would be better for this type of research. Older people have used touch-based devices successfully before [23] and the responsiveness of the capacitive screen coupled with the exclusive use of a finger by creating bigger buttons may be more useful for them.

This combination of using user-sensitive inclusive design to design communications technology in care settings with modern technology for a group that has received little study is an interesting mix. Therefore, this research will provide some insight into what older people in care want from technology, as well as how it can benefit them, potentially increasing levels of social engagement.

3.7.1 Summary of Analysis

The system to be developed has the following characteristics -

- It should provide activities for residents in care settings, with the potential to promote discussion and conversation with people both inside and outside the care setting.
- It should be designed to take into account the needs of older people when using computers, such as impairments and a lack of experience with computers.
- it should promote group interaction rather than one-on-one interaction if possible
- A touch-based system may be suitable for this group

It will be specified and designed by using a user-sensitive inclusive design process and involving the staff, experts and residents from as early a stage as possible. From previous research, it seems the most suitable course to take, and potentially provides insight and at multiple levels into designing for this group.

It may first be necessary to interview a wide number of experts in the area so as to gain knowledge about the myriad of different types of care centres. This will also help cultivate potential consultant support, which is crucial when conducting research in care settings in the Republic of Ireland.

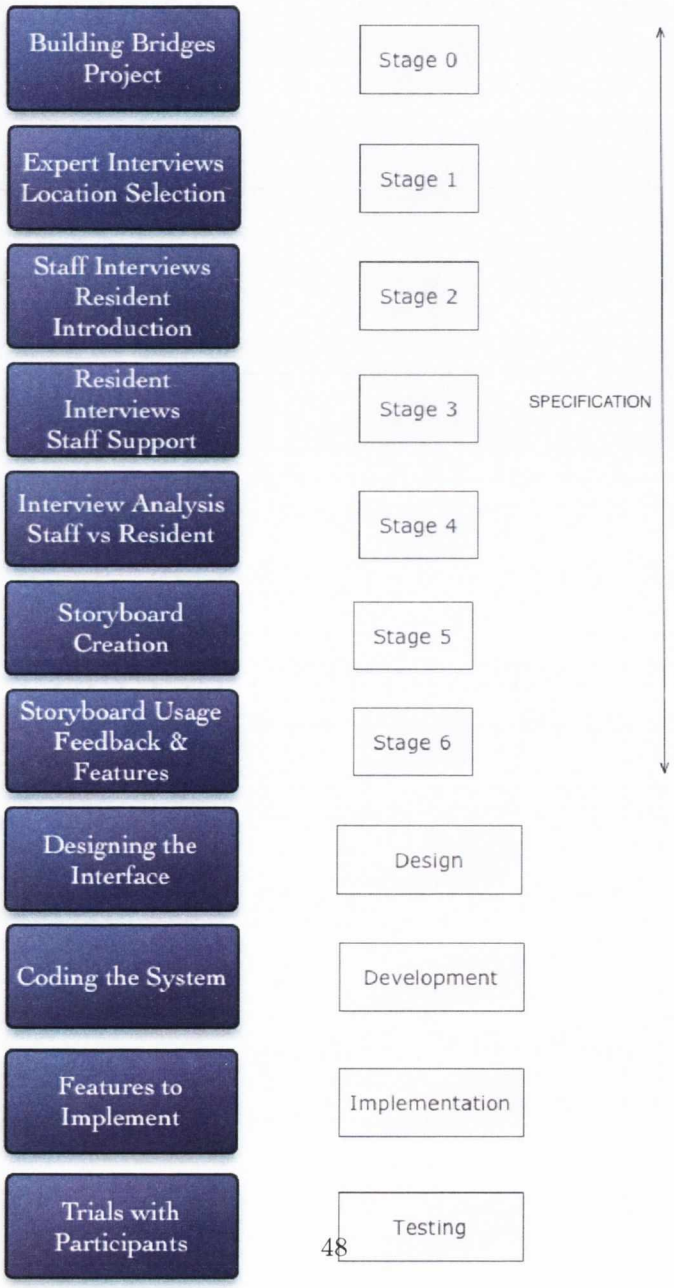
Research techniques, such as storyboards and interviews, will be adapted as required to take account of individuals who, for example, suffer from a low levels of concentration, but it is envisaged that

interviews with staff and residents will take place to gain an overview of the entire care centre and relevant information. Other techniques such as observation will also be used to achieve as clear a picture as possible of life in the care centre.

This research will lead to a number of ideas that can be implemented in a system. This system is still undefined at this point both from a hardware and software perspective, and while a thorough investigation of any and all potential systems will be undertaken, the recent introduction of the tablet and touch-screen device must be considered, and previous literature suggests that they can be used successfully by older people.

4 Methodology

Figure 1: The stages of the methodology, including the 6 stages of the specification (discussed in this chapter). The following design, development, implementation and testing stages are described in the later chapters of this thesis.



The system to be developed was outlined in Section 3.7.1. This chapter describes the methodology used in this research. Following an examination of relevant literature, a user-sensitive inclusive design approach (which was described in more detail in Chapter 3) was used in this research, incorporating as many different stakeholders as possible.

The methodology can be divided up into several stages, as shown in figure 1.

The first stage involved interviewing experts in the area of care of older people in order to identify the most suitable location to base the research, as there are many different types of care centers with different types of residents. The initial interviews with experts are presented in this stage.

Following these interviews and the selection of a suitable setting, stage two of the research concerned ethics permission and interviews with staff in the chosen care centre. Stage three involved early stage interviews with participants, as well as identifying any issues encountered during this process. Stage four analysed these interviews and compared participant and staff responses and thoughts.

Storyboards describing potential system features were created based on these interview findings in stage five, each following a very specific formula to encourage discussion of the feature, rather than technology that could be used. Finally, stage six involved showing these storyboards to participants and staff for feedback and opinions on these ideas.

From this, a clear series of features that were interesting to residents were decided upon. This meant that in the design and develop-

ment stages of the research (which follow from the methodology), these features could be developed into software applications, once the hardware and software for the system was selected, which was based on participant interviews and previous research in the area. The most popular ideas were then developed into software applications using iterative feedback. These applications were then tested and evaluated over a number of weeks with the participants in the care centres, which are discussed in later chapters.

4.1 Literature Review

As described in chapters 2 and 3 of this thesis, there has been a limited amount of research conducted outside the home [2]. However, there exist a variety of different care settings, each with several types of residents and patients with various levels of impairment.

Given the lack of research in the area and that there are many care centres that are neither hospitals nor home based, but somewhere in between, the first stage of the research involved interviewing a broad range of experts in order to get a wide understanding of the different types of facilities, in order to decide which were the most appropriate.

4.2 Stage 'Zero' - The "Building Bridges Project"

Figure 2: The Building Bridges System

Approximately 5 months into this study, an opportunity arose to work as an intern for 9 months with Intel Corporation, who part funded this research. During that time, a project called the "Building Bridges Project" [1] [83] was conducted, the aim of which was to explore new ways to maintain, stimulate and increase the social activities and interactions of older people through the use of both existing and new technologies. This particular project focused on developing communication technologies to reduce social isolation and promote social interaction for people at home, or who were members of active retirement groups but who could no longer participate due to, for example, illness. The author of this thesis was one of two software developers on the project and was involved at all stages of the design process, which was highly beneficial given that a similar

type of process was required for the research which is the subject of this thesis.

Initially, the entire team (composed of psychologists, medical doctors, anthropologists, software engineers and interaction designers) took part in several workshops in order to develop a list of potential features that could be part of the device. Any idea, no matter how unlikely, was given due consideration.

To supplement these workshops and ideas with research into how older people use computers, ethnographic studies as well as questionnaires and interviews were held with several older people who were computer users or wanted to learn how to use computers, in order to figure out how computers were fitting into their lives. These interviews proved particularly useful, as some of the problems they had with computers were taken into account when designing the system, as well as incorporating some of the positive aspects of computing that were mentioned.

The potential system features were narrowed down to 15 or so, based on the ethnographic interviews, feedback from individual experts who were present in the workshops, and what was technically feasible within the short timeframe.

Several focus groups, workshops and interviews were then held with older people. The author was present at these workshops and some of the interviews. Storyboards (depictions of users interacting with the device in different ways) of each of the potential 15 features were shown to the focus groups for discussion and feedback. The feedback was very interesting and a lot of the responses were different from what had been expected. As an example, it was thought in the researcher workshops that people would connect over a shared in-

terest (such as a liking of football), whereas in the focus groups the participants stated that a shared experience (i.e. went to the same football match/church etc) was much more conducive to forming a friendship. The same findings were repeated in each of the focus groups, giving greater credence to them.

From these focus groups, the 15 set of features were narrowed down three features: communication with friends and family via voice and text and communication with strangers using a shared experience to increase the rates of social interaction. An idea in the workshops was to have a 'broadcast' or radio show where users would listen to a show together and discuss it afterwards. This 'common ground' was intended to give the users a topic to start off the conversation. Simply just arranging a group call would not have resulted in increased social interaction, as conversations between strangers typically need a context to begin. The 'broadcasts' provide that context.

Once the features of the system had been decided, the next stage was to develop a prototype of the system.

Non-functional prototypes of the system were shown to a group of older people for feedback. These included depictions of some of the features that had emerged from the focus groups, for example the ability to contact their friends and family who were far away. This provided feedback on the interface choices and usability of the system.

At the same time that these prototypes were being shown, the software to enable communication behind the interface was developed. It was decided to use internet communications software to allow people to talk and for messaging between people. Examples of this sort of software include Skype [35] and Vonage [93]. Using these soft-

ware applications would be cheap, as only an internet connection is needed. Furthermore, if the software had an application programming interface, customised functionality and interfaces could be built on top of the software, allowing for rapid development, especially necessary given the time constraints of the project.

It was decided to use Skype as the communications software, as it had a robust application programming interface, with thousands of applications already created and a large community of developers. It is also one of the most ubiquitous VOIP (Voice Over Internet Protocol) applications at the time, with versions available for several operating systems, which was important given that the hardware had not been finalised.

A prototype was developed and shown to a group of older people for feedback, which was then incorporated into the design. This was designed using Flash, and allowed for interaction with the system, without any functionality. This was important as it allowed various prototypes of the interface to be tested independently, allowing development in other areas to proceed unhindered. It also ensured that the feedback received was exclusively on the interface, rather than what the interface allowed the user to accomplish. This process was repeated several times until a satisfactory version of the interface had been developed.

The device consists of a touch screen tablet PC running Windows XP mounted in a customized laptop stand (with speakers built into this stand) and phone with a cradle. Part of the design philosophy was to keep the device quite similar to already existing technology that people used, so the device is modeled (in design and function) on a radio and phone. 'Broadcasts' are played simultaneously to

each device at specified times, with 20 minutes of discussion time allotted afterwards, to establish the common ground for strangers mentioned earlier.

It also allowed people who had the device to communicate with each other, via voice and text. A touch screen keyboard allowed messages to be sent. This was developed with a Flash front end, and a C# back end which used Skype to route calls and messages. An XML serializer was used to translate between Actionscript and C#. Essentially, the Flash interface acted as a replacement for the Skype interface, simplified in order to reduce the cognitive load on users. It also meant that features such as 'broadcasts' could be incorporated into the design easily. In effect, a custom interface was placed on top of Skype, rather than trying to add features in to the existing interface, which would have severely limited the type of system that could be built.

This prototype was then piloted initially with 6 users (called a 'Friendly Trial' - essentially beta testing software) who did not know each other in order to work out any outstanding bugs. This was, despite being one of the smaller pilots undertaken, arguably the most difficult as there were a significant number of issues to work out because of the complexity of the software. However, it was hugely beneficial as it meant that a large number of issues were sorted and fixed before any of the pilots where data recording was necessary. It also allowed fine tweaking of the design of the interface and hardware before the formal trial.

Following this, it was piloted with 6 strangers (who did not know each other) and 6 members of an active retirement group (who did know each other) in order to measure the usability of the system, and

also as a comparison to see the different ways that different groups of people would use the device. Further bug fixes were required throughout these trials, but were greatly reduced in number (and severity) compared to the friendly trial.

Data on usage of the device was logged over the course of each pilot. This included the amount of time spent using the device, as well as the features that were used. Call and message data was also logged, but this was made anonymous, with a number used instead of names. Several papers have been published on the work [1] [83].

4.2.1 Summary of Stage Zero

The Building Bridges Project provided useful lessons to the research presented in this as it is intended that the current research will provide some insight into using modern intuitive technology in care settings for older people that aims to provide entertainment and engagement when no group activities are scheduled, while also potentially providing increased social engagement.

First of all, the current research is targeted at a specific group of individuals, namely those who are no longer at home and are in some form of care setting. Previous studies, such as Building Bridges [1] were targeted at those who are still living at home. Those at home are usually less impaired than those in care, and traditionally still live in the family home. As such, they may still be connected more regularly to friends and family.

Many lessons were learned from the Building Bridges Project that were applicable to the research presented in this thesis:

- Building Bridges showcased many of the challenges facing older people using technology, as well as the difficulties that designing for them entails. Many of these apply to those in care as well.
- Building Bridges also showed that it is possible to use a common experience to promote social engagement, and that idea is certainly applicable to this research.
- It showed that older people can use touchscreen devices, and that a process involving older people from the earliest stage possible can result in the successful development of technology.
- The process used in Building Bridges, gathering as many ideas as possible, presenting them to partipants for feedback and then picking the most popular to develop is an excellent way to narrow down possible system features.

The current work extends existing research in the following ways:

- A large research challenge to face is that people in care may no longer be living in their own communities, and therefore potentially geographically separated from their friends and family. It is not immediately clear whether it is would be more appropriate to increase engagement between friends, family, or whether to increase contact within the care centre itself with other clients, especially when technology is involved that can connect people remotely. There are differences compared to Building Bridges [1] as there are potentially contacts to be made within the same care centre, which is not an option Building Bridges had.
- The Building Bridges Project focused on individuals who were potentially isolated and/or lonely in their own community. Those

individuals were not in need of regular care and as such were most likely significantly more active and able than the group in this study. This research presented in this thesis focuses on individuals who are isolated/lonely as a result of being moved from their community.

- Building Bridges used a shared radio show to connect individuals who were not located in the same location. Logistically, it would have been much more difficult to connect these individuals face-to-face and conduct meetings several times a week. With individuals potentially all located in one care centre for this research, there are more opportunities for face-to-face engagement that was not possible with Building Bridges projects, so the techniques and activities used are potentially different.

- While similar research methods will be employed in eliciting information and interests for possible development (such as storyboards and semi-structured interviews etc) the proposed outcomes are likely to be markedly different. The addition of extra stakeholders such as staff mean that the research will include 'non-users' as well as users. For example, Building Bridges interviewed participants and conducted focus groups, but did not include carers or others with whom the participants might have had regular contact.

- While user-sensitive inclusive design advocates adapting research methods as appropriate (such as including other 'non-users', there may be some extra findings applicable to this group, especially as there is limited research in the area; existing studies (already mentioned) have looked at this for older people in the home [19].

- This research will involve the staff and management of care

facilities to a much greater extent than the Building Bridges Project did.

- Finally, there are other activities and events taking place in the care setting that are not typically taking place at home. There is also more opportunity for participants to engage face-to-face in care, given that they all live in the same building.

4.3 Stage One - Location Selection and Expert Interviews

The first stage was to identify a location in which to base the research. Interviews were conducted with stakeholders and experts in the subject area (all based in a variety of care facilities including hospitals and nursing homes, or inspectors of these settings). By visiting as many different care facilities as possible, the aim was to view a number of potential research locations which were compared in order to select the optimum location for the research, based on the characteristics of successful interventions, as described in Chapter 2.

The stakeholders and experts consisted of 3 Directors of Nursing, a consultant gerontologist, and a current and former nursing home inspector. Each stakeholder and expert was asked a series of questions (appendix ??), the purpose of which was to acquire as much information about each care setting as possible as well as the opinion and knowledge each expert had about a number of topics, such as engagement and levels of contact in care settings, activity levels, isolation, loneliness and the use of technology. The questionnaire was discussed with researchers who work in the area of communications technology for older people, in order to determine any other areas that should be discussed as part of the research. Other questions

included more practical topics such as the cleaning of equipment and use of mobiles in the rooms by residents. Furthermore, the type of person (e.g. what kind or level of illness or impairment) typically resident in each location was examined. Each expert was asked the same general questions, though the interview was allowed to focus on other relevant topics, should they arise in the course of the interview.

The ideal facility would include residents who were in care for medical reasons, but not so impaired that they would not be cognitively able to take part in the research or sign consent forms. There needed to be consultant and management/staff support as their input and expertise are critical to research in care settings.

A nursing home for a religious order, a hospital especially built for older people, a mixture of a hospital and nursing home, and a nursing home with psychiatric wards were visited over a number of weeks, and interviews conducted with the senior management of these facilities. Interviews with a government inspector of these facilities also took place, in order to get a more national view of care settings. It was intended that this would cover a large spectrum of the types of facilities present in Ireland, from facilities where residents were mildly impaired right through to psychiatric and serious impairment, such as in the hospital. There were two centres (a nursing home for the religious order and a second centre) that had a mixture of residents with varied levels of impairment. In total, 6 interviews were held with different experts and stakeholders.

The senior manager at the hospital for older people was interested in the research but queried whether the patients there were medically well enough to take part in the research. He noted that out of a

population of 200, only 4 or 5 at most would be even capable of taking part, let alone interested. He suggested a setting with less impaired residents, which was consistent with recommendations in other studies [2] .

The management of religious order nursing home were again interested in the research, but wondered whether the residents themselves would be interested. He noted that the residents did not normally use the computers, apart from asking the staff for crossword solutions. During the course of a tour around the facility, it was discovered that there was one priest who would take handwritten notes from some of the other residents and type them up on the computer. Many of the residents were quite impaired in this care centre too, so it would not have been the most suitable location.

A nursing home/hospital in county Wicklow was also visited. Again, the management were very keen on the research, but there was a number of problems, namely the impairment of some of the residents, the facilities available for use by residents (most had no phones in their rooms, and there was a pay-phone in the corridor and some mobiles used for communication). While there was clear interest in the research, it was also significantly further away than the other care centres, which would have made any technical problems more difficult to diagnose and fix in any trials. The rural location also meant that broadband and internet access may have been very difficult to gain access to.

Finally, a consultant gerontologist was interviewed, who suggested another facility in Co. Dublin. He was also willing to clinically supervise the research (a requirement for ethical approval for research of this type in the Republic of Ireland), and bring it through the

medical board of the care centre as well. He was confident that there would be sufficient interest and capable residents living there to take part.

This care centre in County Dublin was selected. Ethical Approval was granted on September 10th, 2009 from the Research Ethics Committee of the Adelaide and Meath Hospital, Tallaght, Co. Dublin. Ethical approval had already been granted by both the Medical Advisory Board and the Full Board of the Care Centre where the research was to take place.

It will be discussed in more detail later, but a second nursing home (in Co, Meath) was selected for participation after a resident in the original nursing home moved there. A further amendment to the ethical approval was granted in March 2011 to incorporate the second care centre. The age limit was also lowered from 65 to 55, to incorporate an extra participant. However, it was felt that at nearly 60 years old, this individual met the main criteria to participate.

To summarize, the study was conducted in two care centres. One centre, in the Dublin region in Ireland, contained two participants, with another two participants in a care centre in Co, Meath. Both these centres have a mix of residents, including patients with dementia, nursing home residents and psychiatric patients. The patients with dementia were not approached for this study, as previous studies have suggested focusing on the more able residents.

4.4 Stage Two - Interviews with Staff and Other Experts

Once the location had been selected, and ethical approval granted, the next stage was to approach and interview the staff of the nurs-

ing home, who were separate to the experts and stakeholders interviewed previously. In total, five staff interviews were conducted, bringing to 11 the total number of expert interviews, when including the care centre experts interviewed in stage 1 (section 4.3). Two occupational therapists, the activities coordinator, the director of nursing and a consultant psychiatrist were interviewed.

The purpose of the interviews was to elicit the expertise the staff of the home had, both in terms of their many years of experience working in care settings, as well as their knowledge of the residents of the care centre. Furthermore, it was important that the knowledge of the staff was incorporated into the research, but also that the staff were aware of this.

The questions (appendix ??) were based on some of the questions that were asked to the experts (described in section 4.3), with some additions to incorporate the fact that the staff in this centre were working directly with potential participants. The questions also focused around their experiences of levels of engagement and activity in the care centre, as well as technology use and anything relevant to the care and activity levels taking place in the care centre. The questions were modified slightly depending on the type of staff member or expert interviewed: for example, the inspectors were asked about general trends in care centers regarding activities and engagement, while the activities co-ordinator was asked about the activities he arranged and how he went about this. The questions were also shown to other researchers in the subject area for feedback and to ensure that the most appropriate questions were being asked.

Before the interviews, a presentation was made to the staff and management of the care centre, in order to inform them of the research

and to request interviews with them, if possible. While most of the staff were happy to be interviewed and were interested in the project, some were not. This was due to them believing that the research would not be suitable for the residents that they looked after, as they were not cognitively suitable.

The staff were interviewed about several topics, which included their own insights regarding resident activities, the different types of residents and effects of social isolation. These were then compared against the participant interviews.

4.4.1 Recruiting Participants

It would be have been particularly difficult to recruit participants without the help of the staff in the care facility. They facilitated and encouraged many residents to come to an initial presentation where the aims of the research were discussed and participation requested.

Furthermore, care centre staff can act as gatekeepers to the residents of care facilities; they work with and for the residents on a daily basis, and have already established relationships with them. In a situation where researchers do not have a medical background (such as in this case), staff can recommend and introduce suitable residents. This proved invaluable in this research. Interviewing the staff allowed the researcher to benefit from the knowledge that they have about the residents, as well as daily life in the care centre.

It was also important to ensure that the staff were (and felt) involved in the research - the centre is a working area for the staff as well as a home for the residents. Interviewing the staff can also provide valuable insights and potentially an alternative viewpoint from the

residents themselves, as well as corroborating what the residents may say.

Following the staff meetings where several potential participants were identified, it was decided that staff would approach a number of selected residents, based on inclusion criteria that had been provided to them.

A resident meeting was scheduled to be held in the care centre, and the researcher was afforded the opportunity to present the study at this meeting. An information leaflet (Appendix ??), separate to the consent form (Appendix ??), but based largely on it, was created and distributed by staff to the residents. This leaflet encouraged residents to attend a meeting where some more information would be provided. It also described the research as an exploration of communication and how people did it, but was clear to indicate that computer knowledge was not needed as it was a general interview, rather than a test of their computer skills.

However, it was also noted that staff felt certain residents, who may be interested in the trial, would not like to attend such a large gathering. As a consequence of this, it was decided to also approach several of the residents individually.

The first meeting with residents involved 7 residents, 6 of whom were residents in the nursing home and were at least 60 years of age, while one was a resident of the psychiatric ward and was under 45. While some of these residents (such as the resident under 45) may not have been suitable, any interest was considered initially as it was difficult to make an immediate judgement on suitability. Also in attendance were the director of nursing, a ward nurse and an occupational therapist. The purpose of the meeting was two fold

- to discuss the creation of a residents committee, and to introduce the research to the residents. It was also noted that several residents were unwilling or unable to attend, but were happy to be approached individually. Some residents did not take part much in the activities of the care centre and as a result were unwilling to attend the talk. Others were unwell or were out of the centre at that particular time.

The nature of the research was explained to the residents, as well as the importance of their assistance and input in making the project a success. The researcher stated the general aims of the project, or what any system that was designed could do, but was not very specific as the research was in its early stages at this point.

During the course of the meeting, more precisely the discussion around the creation of the residents committee, it was suggested that there could be an opportunity for inclusion of that in the research. At the end of the meeting, residents were invited to approach the researcher directly, or if they wanted to take some time to think about it, to let a member of staff know who would pass on the information to the researcher.

Two residents expressed an interest in participating in the research from this meeting, and both were provided with consent forms to read and sign. Another individual who was spoken to indicated that he did not speak to many people, and therefore would not find the research of benefit to him. On discussion of this with the nursing staff, one stated "the problem is that he doesn't communicate enough with others". This shows the benefit of involving the staff in the research process, as while communication was one of the areas examined, it would not necessarily be a large component of the system developed, which at this point was undefined.

As well as the residents who had attended the meeting, the staff had suggested several other residents who would be interested in the research. They suggested these residents as they believed that they would be cognitively suitable or would benefit from participating in the research. These residents were approached and the researcher was introduced by the Director of Nursing, the Occupational Therapist or one of the staff in charge of the ward. The researcher then explained the nature of the research and asked if the resident would be interested in participating. In most cases the residents were interested, for a number of reasons. Some indicated their interest in learning more about technology and computers, as well as recounting problems they currently have with technology. Others did not give a reason but were willing to participate.

There were several residents who decided not to participate. There were several reasons given for this; one individual felt that it was 'beyond her abilities' to take part in such research, another decided that they did not have time to participate. It was suggested to some of these residents that even if they did not want to take part in the entire research project, perhaps they would be interested in taking part in the early stage discussions revolving around their social activities, use of technology etc. In almost all cases, this was agreed to.

Consent in a number of cases did prove difficult to obtain. Some individuals in care may be conscious or believe that their mental abilities may be declining, and thus can be very sceptical about signing anything. It meant that high numbers of participants were difficult to attain, as even if the individual was willing to take part, they would not sign anything. In practice this meant that they could not take part as proof of consent is very important in this type of

research.

4.5 Resident Participation

It did prove quite hard to get sufficient numbers of residents to take part in the research, quite apart from the participant loss that occurred due to illness. A resident became a participant when they signed a consent form (Appendix ??), which was mandatory as it was a requirement of the ethics application. Regular meetings were held with residents who did not sign the consent forms but were interested in the research, even several months after the research had begun in the nursing home. New participants were recruited during this time too.

Several reasons were given by residents as to why they were not interested in participating.

- A belief that computers were 'beyond them'/"I can't use computers": some residents felt that they were unable to understand computers, that they had tried in the past but had not succeeded. Computer classes were available for residents, but the staff noted that they were concerned about what they would access, as well as being unable to get to grips with the mouse and keyboard input system. Many had tried and failed, and had computers or laptops gathering dust in their cupboards.

  As a result, the computer rooms were largely empty. They were also not located in an easily accessible spot in the care centre, which previous studies have mentioned as important [2]. However many residents stated that they would like to know more about computers and learn how to use them.

- There was a lack of understanding of what computers could do, but also a curiosity among many residents to learn more about them.
- A lack of interest in learning about computers; There were some residents who simply had no interest in computers, with a common response being "They're not for me".
- Fear of technology - There was a fear relating to technology in some cases too. Residents were afraid that they would be the victims of fraud using computers as they were not familiar enough with them.
- Belief that they would have to pay for the technology - Certain residents repeatedly stated that while the technology was 'interesting', they would be unable to afford the technology, and thus were not interested in taking part in the research. This was despite the fact that residents were repeatedly re-assured that they would not incur any financial cost for taking part in the research, in addition to the formal statement in the consent form.

  > "Section 5 - Risks: There are no financial or unusual health risk associated with participation in this study. Whatever technology is developed, it will be completely free to use."

  It is difficult in such situations to convince someone, who despite explaining to them repeatedly that you are not, believes that you are simply there to make money.

  On further discussion, one particular resident (who would not sign the consent form and as such did not participate in the research) noted that they had experience of friends losing money

through scams specifically aimed at older people, and as a result she was unwilling to sign any forms or take part in the research.

Two other residents also expressed concern at signing consent forms. One felt that she was unable to read it properly, giving the relative complexity of the language used, and as such was nervous about signing such a consent form. The consent form is submitted as part of the ethics application form and is difficult to reduce in size with any ease.

Another resident was more than willing to take part, but simply said "I won't sign anything". Reassurance from the senior manager of the care centre convinced him to sign up.

4.6 Stage Three - Participant Interviews

4.6.1 Recruitment Difficulties

Over the course of the study, over 15 residents were approached, each after being introduced by a member of staff to the project. These residents were considered by the medical staff to be cognitively suitable to take part. Of this group, 7 signed the consent form and agreed, at some level, to take part in the research.

As the study continued, participant loss began to become an issue. One individual initially agreed one day to take part in the research (even signing a consent form), but subsequently withdrew the very next day, reducing the participant numbers to 6. Another participant left the nursing home, ostensibly because the activities offered that were not the activities he wanted. He felt that they were "at too low a level" for him, and as a result he did not participate regularly.

He moved to a care centre outside Dublin, in some part because he liked that the facility had a wide range of activities. This further reduced the participant numbers to five.

Two other participants only took part in the interview stage of the research, but one more was recruited at a slightly later stage, meaning four participants took part up to the implemenation stage. However, one individual in particular suffered from a quite rapid decline in cognitive function just before the first trial, and left the care centre. It was felt that as this participant was no longer a resident of any nursing home, he would not be considered for the project, leaving three participants for the trials.

4.6.2 Focus Groups

Initially, this part of phase 1 was to involve gathering the participants together for focus groups. However, it proved extremely difficult to gather the participants together for a meeting, and it was therefore decided to have individual meetings. While there have been studies that have shown focus groups to be a useful way of gathering ideas [1] impairment and illness are a significant problem for those who are in long term care, making it very difficult to get a common time that would suit everyone.

Six interviews in total were held with each of the different participants. Four individual meetings were held in most cases, in the participant's room with the door open for staff and other residents to come and go. In two other cases, interviews took place in the canteen area of the care centre. They typically lasted over 30 minutes, with several topics being discussed. Staff and expert interviews had

identified many of these topics as specifically important for residents (such as meal times and activities). The interviews were recorded using a computer with a microphone and were transcribed for later analysis.

The following topics were used to guide the discussion (the interview sheet used is contained in appendix).

- General background/past - so as to 'break the ice' and make the participant comfortable;
- The daily activities of the resident inside the care home - ranging from a description of a typical day, what times they had meals, social activities etc.;
- What activities they took part in, both personal, group and organised by the care home.
- External activity - what visits/trips the resident went on, how they communicated with people who were not in the care home and how often;
- Their experience with technology, what technology they currently used, any problems they had and so on.

4.7 Stage 4 - Analysis Of Interviews

Under each topic, each participant was asked to compare their current activity levels to their activity levels before entering the care home. Every participant interviewed noted a drop in one or all of their activity levels, and while some had maintained their levels of activity, there were no cases where activity levels had increased.

This was due to a number of factors including impairment and illness which precluded leaving the care centre, as well as a lack of activities that interested them. The remoteness of the care centre also played a part in this. The participants all seemed eager to continue with their activities from the past, they were just unable to do so.

After 2 or 3 individual interviews with the participants, common themes began to emerge, highlighting differences between what the staff and management of the care facility thought regarding activities, and what the residents themselves thought. As discussed later, residents felt that it could sometimes be difficult to find out how to formally communicate with the staff regarding food or concerns they had, while the staff felt that the residents could speak to any staff member in confidence at any time. The formation of the residents' council in the Centre was specifically to address this.

All of the participants seemed to feel that there was a lack of communication and engagement in the care centre, matching with many of the studies before that had reported this [7] [21]. Confirming the statements made by some of the care professionals interviewed in the previous stage, mixing of residents with dementia and those without any cognitive impairment was common, but was a source of frustration for many of the participants who were cognitively sound. As one resident stated, "there's no point in communicating with someone who's way off the beam", but "with ordinary people, there is a slightly cold front, that they don't want to communicate with you, so you don't bother communicating with them". Another participant complained at the slowness that accompanied having those with more cognitively impairments participating in games, which prompted them to withdraw from activities altogether.

This researcher speculates that this "cold front" may be due to the fact that there is an expectation among the more able residents that every other resident is quite impaired, and therefore unable to communicate with them. Having interviewed many participants, all of whom were judged in consultation the staff to be cognitively able and suitable to take part in the research, this was a common theme throughout the interviews. The majority of the participants are even based in the same ward. But beyond meal times and activities (if they attend) they do not seem to interact. There was a distinct lack of regular interaction between residents, with one example that during the researcher's time in the care centre, residents did not seem to interact with each other outside of meal times at all, unless it was related to the research.

4.7.1 Confirming findings from first interviews

After the interviews were completed, transcribed and analysed, there were a number of outstanding issues that required further clarification, such as statements made at the time that perhaps warranted further exploration. The researcher approached the participants after some of the interviews to confirm the meaning or request clarification of some of these statements, or to confirm points that the researcher felt that participant was making in the earlier interviews. These are reflected in the findings below.

4.7.2 Activities and Contact Inside the Care Centre

The majority of the participants interviewed did not take part in any of the activities provided by the care centre, with the excep-

tion of day trips outside the care centre. There were several reasons given for this, but the main reason (given by the participants who did not attend activities) was that the activities were set at too low a level and therefore were not of much interest. The staff, conscious that they would not want to force a resident into activities they did not want to do, were keen to allow the residents the freedom to choose their own activities, with one stating, "if they don't want anything, if they prefer to read newspapers in the room, and prefer to spend time in their room watching TV, that's ok". The Health Information and Quality Authority, an independent authority overseeing the health service in Ireland, has published a document entitled "National Quality Standards for Residential Care Settings for Older People in Ireland," [94], which stresses that residents are not coerced into activities. The staff felt that the main opportunities for socialising were meal times and activities.

Staff noted that while activities are separated by impairment (e.g. those with dementia or with psychological problems have specific activities) there was no further separation. One participant noted how games would take too long to play as the other players would regularly fall asleep during the game (in this case, Scrabble), or were not able to play the games to the same level that he could. This frustrated him greatly and as a result he no longer took part in activities.

Observation of some of the activity sessions took place on several occasions. It was noted that a number of residents were actually asleep during some of the activities, corroborating what residents had reported previously. It did not seem specific to any game, as ball games, board games and poetry sessions all had similar issues.

4.7.3 Activities and Contact Outside the Care Centre

There were three participants interviewed who were able to leave the home to go to the shops or to visit relatives. One acted as a assistant for many of the residents, taking a shopping list every day when he went out, to buy food, magazines, cigarettes or anything else other residents asked him for.

However, there were three participants who were unable to leave the centre on their own at all, usually due to illness or a lack of mobility. One of the other three participants who did leave regularly "was very fortunate in that way that [they're] not tied to the place", as he had a car, while the other participants used local bus services or a taxi. Furthermore, while a sizable number of participants went outside the care centre for large parts of the day, and many had friends and family that they kept in touch with, there were some participants who had no contact with anybody outside the centre, and while they went on visits outside whenever they could, weather or illness regularly hampered this. In an effort to provide the residents with contact to the outside world, the care centre ran a weekly outing to a park, or to the theatre. They also held activities in the grounds of the care centre to encourage residents to leave the building.

There was also an interest in doing other activities such as learning about or using computers. However, like much of the research before it, many were afraid of using computers, saying that they were "not for me". One individual gave an example of holding down one of the keyboard buttons while they tried to spell their name, succeeding only in spelling out the first letter of their name many times. This put them off computers, believing they were too complicated.

4.7.4 Common Ground to Promote Discussion

The Building Bridges Project used the idea of a shared experience to promote discussion in their research [1], where participants listened to a radio show at the same time and joined in a group conversation together afterwards. A similar finding was found in the care centre in this research, where friendships had developed out of shared experiences.

In one case, a love of boats and "a lot of great stuff" was one of the main things that made two participants friends, as one had been working at sea most of his life. However, as neither really participated in activities, many of their interactions took place at meal times, backing up the staff opinion that meal times were crucial for social engagement.

One participant spoke about the idea of having more discussions, citing a lack of interaction between many of the residents beyond simple greetings. He also remarked on a theatre group that was organized by a former staff member, but that it had not continued once that staff member left. It had been attended by many of the participants who did not take part in other activities, suggesting that a facilitated group activity, based on a shared experience, could work for a group. However, while such an activity could be quite well attended, it would not necessarily alleviate the boredom that exists between activities.

It was noted that each participant who did not take part in activities spent a significant period of the day in solitary activities such as reading and listening to music. Other studies in different care centres have also reported this [21]. However, while this was enjoyed

by the participants, they also felt that they did not have access to as many resources and information as they would like, usually due to an inability to leave the care centre. One participant stated that he read "whatever I'm given" (on occasion a staff member was kind enough to drive to the library), and longed for a library where he could access and read more books, recounting that he spent a lot of time in them before he went into care. He also mentioned that he used to read several newspapers every day, but since he had moved to the care centre, he could only read one newspaper (that staff brought in every day) and got up early every morning so he could have access to it before everyone else and read it at his leisure.

The key issue for these non-cognitively impaired residents seems to be providing activities that allow for both solitary engagement and group interaction within the care setting, thereby reducing the long periods of boredom between activities (if they are attended) and meal times - as one participant put it, "it's just sitting here bored out of your mind a lot of the time". Another said (on mentioning that she only spoke to one other resident regularly) "I've no one else to talk to". This could potentially be achieved by providing activities that could be undertaken on a personal level, but provide for discussion on a group level or through activities. As residents already experience issues in accessing resources and information for their own activities, technology could have a role in providing this access.

4.7.5 Communicating Problems to Staff

Participants felt that there was a lack of communication and engagement in the care centre, matching previous studies. Confirming the

statements made by some of the staff during their interviews, mixing of residents with some cognitive impairment and those without any cognitive impairment occurred, but was a source of frustration for many of the participants who were in a sound state of mind. There was also a feeling that there was no formal way of communicating problems to staff beyond mentioning it to a staff member when they met them.

4.7.6 Attempts at computer use by residents

Computer usage is limited in the care centre, but several classes have been held in the past. There is a computer room in the home that residents can access, but not without staff assistance. Many of the participants interviewed had heard of it but had not visited it themselves, and some did not even know it existed. The staff noted that these computers were sometimes used for long distance communication (using Skype, an internet phone service), but residents required assistance to use the computer, as they "get lost in the process". In short, the resident would sit in front of the monitor and talk to their relative/friend, but would never interact with the computer themselves, as the staff member would handle the computer interaction. As a result, if there was no staff member available at the time, then the residents would be unable to make the calls.

Some participants owned laptops, but do not use them as they could not understand how to. Most do not use computers at all. Staff also stated that a lack of understanding of computers lead to a fear of using them (in one example, a resident didn't want to use the computer in case they accidentally accessed pornographic material) - "it was too difficult for them to learn, so we stopped".

4.7.7 Summary of Findings

From analysis of the interviews conducted, it was felt that one way of increasing social engagement was through collaborative group activity based on a common experience, which is similar to what the Building Bridges project reported [1]. Specifically, this group-based activity would need, quoting one of the participants, to promote "more discussions".

Furthermore, there seems to be an opportunity for the use of communications technology within a care setting to increase engagement on an individual, group and organisational level. At the start of the project, using technology to enhance communication between a resident and their family and friends was thought to be a key feature, and to an extent this is supported by some of the data from the resident and staff interviews. However, increasing engagement in the care centre is more important, and catering exclusively for family communication could potentially exclude several participants from using any technology developed. Some people do not have friends and family outside that they wish to contact, and while those who do have family outside would like more communication, they appreciate that their friends and family have independent lives and may contact them already as regularly as they can.

These more able participants want mental stimulation and social interaction, and feel that the current activities, designed to cater for as wide an audience as possible, do not provide that for them. Their physical and medical impairments may mean that they are restricted, and this is what has caused a reduction in their social interaction and engagement.

Clearly, it is very difficult for a care centre to cater to every single person in a centre with hundreds of residents. Furthermore, in a similar way that by designing for one group another may be excluded and by catering exclusively for this small group, the care centre may have excluded a far greater number of residents whose activity needs are different.

The findings from the interviews with participants can be summarised in the points below.

- some participants want to communicate with staff or the nursing home more easily - whether that be complaints/compliments or requests for changes;
- some participants wish to communicate more easily and cheaply with their friends and family - via phone or email/messages;
- most participants want more activities and resources for their personal time - such as newspapers and books or at the weekend when no activities are scheduled in the care centre;
- participants want activities that promote discussions through shared experiences, such as watching movies or reading;
- participants are interested in using computers, but are uncomfortable using standard computers for a variety of reasons including confusion and fear and a lack of experience with them.

4.8 Stage 5 - Developing ideas and Storyboards

The findings in the previous section are quite general, and needed to be developed into more specific ideas that could be shown to

residents in the form of storyboards. It was decided to create storyboards based on a combination of the general concepts identified in the interviews coupled with observation of activities, as well as activities that the participants stated that they did or used to do. These would then be shown to participants for feedback. Previous studies have used storyboards [1] and story telling through the medium of theatre [75] to elicit feedback on ideas.

The following ideas were developed out of the interview findings, observation and the general concepts identified.

- Book Club;
- Library Link - allowing participants access to books, potentially over the internet;
- News Reading and Sharing;
- Phone Calls;
- Residents Council;
- Messaging;
- Activities;
- Comment box;
- Multiplayer games conducted remotely.

Each is discussed in more detail below, including how it arose out of the findings and what it involved.

Several other potential features of the system were identified. These were all based on interview data from the participants and staff, whether that be activities that they do or once did, things they

would like to do but couldn't (due to cost/impairment) or based on common themes that ran throughout the interviews, such as the need to have more conversations or more personal activities. Each feature is described in more detail below with the interview data that prompted it.

4.8.1 Book Club

The participants stated in the interviews that they wanted "more discussions", as well as more information and resources for activities in their personal time, separate to the activities organized by the nursing home. They also requested more stimulating activities that would keep them more engaged, which they felt was very important to their health and well-being. Technology can potentially have a role in promoting engagement and increasing interaction among this cohort, while also providing the mental stimulation that they desire.

Furthermore, as a way of promoting shared experiences and discussion, the Building Bridges Project [1] broadcast a radio show together followed by a group discussion as a way of promoting shared experience.

It was decided to use a similar concept to the Building Bridges Prokect, but modified for a group that wanted more access to resources and was located close together, so could potentially meet face-to-face. Furthermore, if remote communication was required (such as taking part when sick or in another care centre), this could be incorporated.

The goal of this feature involved using the system as a way of organising and running a book club, providing access to books as well

as information available for the users such as who was attending, what book was discussed that week and where the meeting was. A computer system could be specially designed with and for this group that would allow individuals to read, discuss or recommend books to each other, as well as suggest group meetings where discussion could take place face-to-face. If an individual was unable to attend due to physical impairment, he or she could use the computer system to 'virtually' attend. It could also be generalized quite easily so as to be used for almost any activity, making the system more viable for use by other groups.

4.8.2 Library Link

This idea arose out of the interviews, where many of the participants stated that they both read a lot and expressed a great interest in reading, but some had difficulty in accessing new books to read. This was due to them being unable to leave the care centre because of impairment and the distance of the care centre from shops and services. Books were brought in by the activities co-ordinator on occasion, but the participants were generally dependent on the activities co-ordinator to do this. There were also a number of books available in the canteen area.

This idea involved using some sort of computer system to link in with the library, where users could browse and 'check out' books, and have them delivered right to the door.

The interface would be simplified so that the experience would be as seamless as possible. Other features this involved include recommending/rating books that they've read.

This idea could also link in well with a 'book club' based activity, similar to the one specified earlier.

4.8.3 News Reading and Sharing

This idea developed from interviews and observation of the participants.

As well as reading books, many of the participants spoke about reading many different papers, as well as many of the different supplements. Some participants had papers brought into them, but most relied on the papers that were supplied by the staff. In one case, a participant had read "a variety of papers" before he was in care, but due to impairment was now not able to get access to them. In another case, a staff member recounted how she regularly delivered the health supplement in one of the papers to a female resident.

Out of these findings, the idea of using a reader to display and share news from a variety of sources was developed. This had been used in previous studies [19] and would most likely not be the core feature, but could still be an important part of the system, allowing participants access to information and news that they would otherwise not have.

4.8.4 Phone Calls

Some of the participants used their phones to call people outside the care home, such as friends as relatives resident in Ireland. Some also called friends and family abroad, but did not do this as frequently

due to the cost involved.

The staff recalled that some residents, with help from a staff member, made calls using Skype, either for the cost or so as to have access to video calling. However, this required a staff member to set it up, as many of the residents were either unfamiliar or uncomfortable with computers. Given that many residents had family abroad, they could only contact them when there was a staff member to help, which may have been at inappropriate times for calls to take place. This idea allowed residents to use a device to call when they wanted in the privacy of their rooms.

4.8.5 Resident's Council

Participants had stated in the interviews that they did not always know how or whom to talk regarding problems, requests or concerns they had about anything in the care centre. This idea involved using the system as a way for the members of the residents' council to communicate, sharing minutes from meetings, arranging meetings, commenting on suggestions etc. They could also contact the staff members using it as well if they needed to communicate with them. At the time, the care centre was in the process of setting up a resident's council so it would tie in neatly with the formation of the group.

4.8.6 Messaging

Some of the participants have mobile phones, but struggle to use a large part of the features available, such as calling and text messaging, meaning that in effect, they don't use them. This was similar

to the problems with computers that they reported.

This idea involved using the system to send messages to family members, relatives and friends. It would be able to send these messages to other computers, so that people external to the care centre may not need any new technology - the system would communicate with existing technology rather than attempting to replace it.

4.8.7 Activities

There have been studies that have looked at designing activity management systems for people in care centres [2]. Many of the participants interviewed in the research presented in this thesis reported having an interest in some of the activities, but not really knowing when they were on, or forgetting when they were on. The purpose of this feature would be to remind the participant that certain activities were on.

4.8.8 Comment Box

This feature involved the participants giving feedback to the staff via the system, on topics such as food or activities.

4.8.9 Creation of Storyboards

Having identified several features, the next stage was to turn each of these features into storyboards and ask the participants what they thought of each feature, in order to identify the most popular ones.

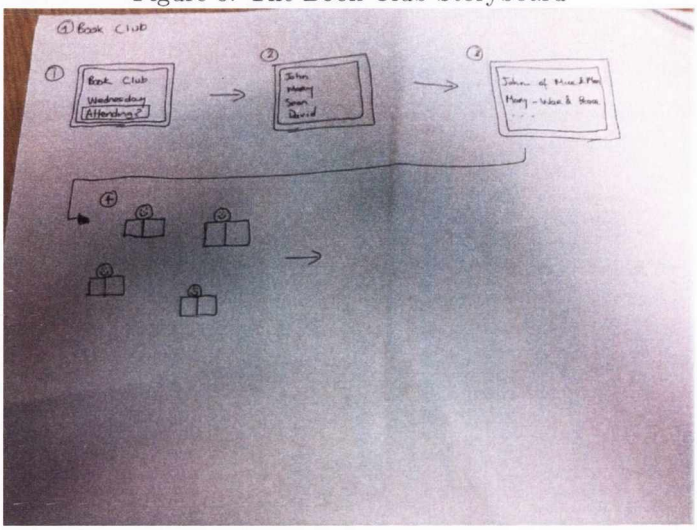
The potential ideas and features that were developed out of the interviews and observation needed to be presented to the participants for their opinions and feedback. However, it was important at this point that the focus was clearly on the idea, and not the technology that would distract participants. One way of displaying these ideas is through storyboards.

Storyboards are representations of a particular sequence of events [95]. Typically, they reflect limited information about the interface that will be used, focusing more on the benefits of using the technology, as they are used at an earlier stage than the development of the interface - it is important to get the right design before getting the design right. Leaving the final technology out of the storyboards meant that there was much more of a focus on the merits of the idea/feature rather than the technology itself. This type of focus can be applied to storyboard design at all age levels, not just older people. But it has particular importance when designing for older people as they can already possess negative attitudes towards technology which could cloud their opinion of the proposed feature. Furthermore, the sketching of the storyboards, rather than pixel-perfect drawings, suggests that they are ideas rather than features that will definitely be implemented. This promotes discussion of the idea rather than reaffirming it.

The potential ideas and features were each developed into storyboards. These were based on the findings described in the Summary of Findings section. The intention was also to incorporate activities that the residents were doing, or wished to do. Each storyboard consisted of 4 - 5 images, with the first image describing the individual and his particular problem, and the last image describing the benefit of the technology in solving this problem. The other images

described the individual using the feature to achieve this benefit. An example is shown below.

Figure 3: The Book Club Storyboard



As stated previously in section 4.8, nine storyboards in all were created, covering a broad range of topics. Each storyboard followed the same format as described above, with 4-5 slides and describing a scenario involving the feature being discussed. These are included as appendix ??.

4.9 Stage 6 - Second Meeting with Participants - Showing the Storyboards

All six of the participants who were interviewed originally were approached to show them the storyboards. One participant was no longer suitable for the research (he had become ill) and two more did not want to take part beyond the interviews, so 3 participants in total out of 6 were shown the storyboards.

Each participant was met separately and, in sequence, was shown the storyboards one by one. The researcher explained the scenario in more detail and then asked the participant for their thoughts on the feature. Follow up questions were asked by the researcher when appropriate. In most cases this was to ask for further clarification as to why a participant liked/didn't like a particular scenario.

On occasion, a participant would ask about the type of technology that would be used for such features. The researcher stated that it was not decided at this time what type of technology would be used, and as such it was better to focus on the idea rather than how it would be implemented.

The scenarios also prompted discussion about other topics not immediately present in the storyboards . One participant noted that a common ground was needed to start some of the discussions, stating "nobody discusses anything in here".

There was far more interest in the social aspects of any feature that was described, specifically activities that would lead to face-to-face interaction, than any others. Two-player remote gaming was not of interest to any of the participants who were shown the storyboards, all of whom stated that they were either not interested or felt they would lose the "social aspect" if games were screen-based only. They wanted the technology to facilitate interaction, not replace it. While it is clear that if there is no chance of face-to-face engagement, technology is potentially a worthwhile replacement, such as when talking to friends and family far away, physical contact is preferred over virtual contact.

As a result, the messaging and calling of friends and family was well received among those participants who had friends and family to

contact. One participant stated that he made no calls in or out of the care centre and as a result such a feature would be useless to him, but appreciated that it would be useful if he was making calls on a regular basis.

Similarly, the idea described in the Residents' Council storyboard was also poorly received. Many felt that the frequency of use of such a feature would be too low. Residents' Council meetings take place in the care centre every month, and while they are well attended, it was not considered particularly interesting and not of interest to the vast majority of participants. One participant suggested that a daily notification of any issues could be useful, but not beyond that.

The newspaper storyboard was considered interesting if it supplied different newspapers to those already provided by the care centre. This backed up the finding that many of the participants wanted access to more resources, as stated in the interview analysis section (Section 4.7).

The Book Club storyboard was well received on an individual basis, with all three participants having previously stated that they read a lot, but did not have the ability to access books beyond what the staff brought into them. They also said that it would promote more discussions, and that potentially it could be combined with the library link.

The responses to the storyboards from the three participants were quite consistent. Generally speaking, the most popular storyboard feature was the book club and the least popular were the comment box, the game playing and the Resident's council storyboards. They could be placed into two groups:

The positively received concepts were the following (ranked from most popular):

- Book Club
- Library Link
- News Reader
- Calls
- Messaging

and those that were not as well received:

- Resident's Council
- Comment Box
- Games

It may be possible to group some of these concepts, as the book club, library link and news reader are activity based while the phone calls and messaging are communication based, further suggesting that activities and communication are two important features in designing this kind of system. Those that were not well received were related to the nursing home, or lost the social aspect of activities (such as in the case of two-player games).

The most popular feature among the participants was the book club feature. The storyboard for this feature described an individual reading a book on a device, which also informed the individual when the next book club meeting was on, the book they were reading and who was attending. The storyboard then depicted the individual

participating in a book club meeting where a number of individuals who also had a device met and discussed the book as a group.

Some participants suggested a number of improvements for the positively received features. For example, one recommended adding DVD and CD searching to the 'Library Link' idea. Another recommended using 'Skype' for the calling system, as he had relatives who used it, and would like to use it as it cost him a lot of money to call them because they lived abroad. Even though this was technically about an implementation of a feature, the focus was on the cost benefits of Skype, rather than the technology itself.

It was also suggested that the book club was modified to use books from the 'Library Link' idea. Participants liked the idea of access to lots of books and it would combine nicely with the book club idea, providing plenty of information and resources for discussion.

Examining the less-well received ideas, the comment box and residents' council ideas were considered too infrequent to use, and also prompted one participant to say that he would feel obliged to use the system if it was used as part of the residents' council, rather than wanting to use it. Furthermore, he described it as "not practical in a place like this", as he didn't want to be sending messages back and forth, but a message each day about what was going on in the care centre would would not be a bad idea.

The computer games concept was also difficult to adjust as the participants felt it would detract from the games they did play. Furthermore, the cost and time in developing a custom game, which might only constitute a small part of the overall system, was simply not feasible given the time and cost constraints.

A number of staff were also consulted on the features as well, and reported that they felt the features were suitable for this group, although they did also express surprise that the games were not more popular.

The storyboards were a very useful way of gathering feedback and data on the ideas shown without clouding the discussion with how these ideas would be implemented using technology. Furthermore, they were useful for confirming some of the original findings with the participants as the most popular ideas were those that provided activities and promoted discussion. Ideas that only provided one or the other were not as popular.

It was unfortunate that some of the early participants who undertook interviews were not available to take part in the storyboard phase of the research. There was initially concern as to whether this would affect the research; however the combination of participant and staff feedback meant that a number of opinions beyond end-users were taken into consideration. Furthermore, it was clear from the storyboards that the same features were the most popular among each participant that they were shown to.

4.10 Final Decision on Which Features To Develop

On the basis of an initial presentation, 6 participant and 5 staff interviews, talking with staff and the storyboard feedback, it was decided that the book club combined with the library link concept would be a main feature of the system. It allowed for a common ground, as the majority of the participants interviewed already read a great deal. Furthermore, the Building Bridges Project noted that

participants did not liking being committed to turning up to many scheduled events [1] - it was decided to run the book club meeting on a weekly basis, as it gave participants time to read the book themselves, but provided activity and engagement in between the weekly book club meeting. This facilitated discussions and promoted face-to-face interaction, two of the main requests by participants.

Other features that were popular among the participants were the ability to contact friends and family using the device by voice and via email (though it was described as sending messages), a device that allowed users to read and share newspaper articles from a variety of sources, a calendar system that displayed when events were happening in the care centre, and a library link, where an individual could access, search for and read books via a device. It was decided to incorporate these as sub-features of the system, as they would provide further opportunities for social interaction through family and friends, as well as potentially alleviating boredom.

The features that were not popular were those that replaced face-to-face interaction with computer-to-computer interaction, such as playing games with someone else using technology, the comment box and sending messages to members of the resident's council. In these cases, participants remarked that they preferred to interact with people directly if possible, rather than through a computer. One participant stated that he had a small group that he played card games with on a semi-regular basis and that the interaction during the game was better than the game itself. He felt changing that interaction to a computer screen would have a negative impact on his enjoyment of the game.

4.11 Conclusion

This chapter has described the techniques and methods used to design and develop a communications system for older people in care settings. Recent studies have focused more on those at home, or who are very ill or suffer from dementia in hospital. The methods used in this research are a modified version of previous research, and shows that while this approach is sound, it requires the involvement of more stakeholders. While very recent studies have examined communications technology in the context of a care setting, the author of this thesis notes that there is still a limited amount of research undertaken. There are adjustments that need to be made when designing technology for this group, which includes more stakeholder involvement than with those not in care settings. Staff must be included as they can provide valuable additional information.

Following the interviews with staff and participants, storyboard creation and their presentation to participants, a series of features have been identified that participants are interested in and feel can be of benefit to them. Furthermore, these features can be implemented using technology, once hardware and software systems are chosen. This will be discussed in detail in the next chapter.

The next chapter also discusses the hardware and software selection, which are of critical importance as the participants are part of a group that is the least familiar of any demographic with technology. Following this, the initial implementation of a system, including the creation of the prototype, development of working software and testing of the system before evaluating it in a real situation. This implementation is based on the approach and findings described in this chapter.

5 Design, Development and Deployment

This chapter describes the implementation of the system, including development, early stage usability testing and iterative feedback from participants. Early testing was undertaken with 2 users, (by this point, another participant had moved to a second care centre, and was not involved in this part of the research. He participated in the later trials once the second care centre was added) with the later addition of two more participants in a separate nursing home.

The implementation took place over a number of stages. The first stage, which involved hardware selection, was crucial, as it was not immediately clear what the best hardware choice would be. Older people can have difficulties with standard computers and issues around the weight and size of computers were reported by participants in the interviews presented in Chapter 4.

The participants and staff that had been interviewed also reported problems using the computers that were in the care centre. Furthermore, previous research has indicated that touch-based devices can be successfully used by older people [23]. Software selection was also important but would depend largely upon hardware choices, as some hardware only ran one type of software.

Once the software and hardware choices had been finalised, stage 2 involved the early design of a prototype, and with this, the initial development and iterative testing could begin. The iterative testing took place over 3 stages. First, the participants were shown a functional (but with dummy data) of the system and were observed using it.

Following this, a think aloud and scales measuring the usability of the system were taken, followed by a short one week trial. A longer 2-week trial with a book club meeting was also conducted along with an interview and more scales including Product Reaction Cards [96] (where a user picks 5 words from approximately 120 that they associate with the system and describe why they chose them) and the Intrinsic Motivation Inventory (which assesses "interest/enjoyment, perceived competence, effort, value/usefulness, felt pressure and tension, and perceived choice while performing a given activity, thus yielding six subscale scores") [97]. Finally, an 8-week trial was conducted with 4 participants in 2 different nursing homes with a think-aloud before and after, as well as scales (the two scales mentioned previously plus the USE questionnaire [98] (which measures usability)) and log data such as usage. The system was evaluated through a variety of methods including think aloud and usability tests.

Development of the functionality of the system, such as connecting to databases, designing and setting up the messaging features as well as any other necessary coding, was conducted in tandem with this design process. This is also described in detail in the chapter.

5.1 Hardware choices

The first stage was to select the hardware that the system would use. This was as important as the choice of software, as older people are more likely to suffer from a variety of impairments as well as a lack of experience with computers. Furthermore, impairments meant issues like weight and size take on an added importance, as many of the participants struggled carrying the computers they had, and it was

one of the reasons why they did not use them.

Many different devices and form factors were considered, such as netbooks, tablets and laptops. Several key features were required however: some were included as a result of findings from the interviews, as the participants were asked about their previous computer experience. Others came from the staff interviews.

5.1.1 Previous interaction with Computers

A summary of the ideal features any system would have are given below. These features were based on previous studies that had examined computer use by older people, as well as findings from the interviews with and observation of participants and staff in the care centre.

- Light - residents already had problems with laptops, as they could not carry them.
- Potentially touchscreen based - successfully used previously by older users [1] ;
- Responsive Touch Screen - an unresponsive touch-screen could cause confusion.
- Robust;
- Long Battery life - residents were concerned that they would forget to charge it;
- Simple, clean interface with no unnecessary buttons - more of a software issue but relevant to hardware as well - residents did not know even how to turn on the computers in the centre and

were scared of many of the buttons. This was also based on some of the literature published previously.

- Clear screen - eyesight and impairment is an issue with this age group;
- Connectivity - at this stage of the research, wireless internet connectivity was in one part of the care centre only. Furthermore, a lot of care centres do not have the facilities or the financial resources to create or extend a wireless network across their buildings. As such, it was important that the hardware chosen had multiple ways of connecting to the internet, potentially without using the connectivity in a centre.

5.1.2 Touchscreen input vs standard input (keyboard)

There have been several different studies on the most appropriate way for older people to interact with a computer, whether it be the keyboard, mouse, stylus or other input device.

Standard input, such as a keyboard and mouse, can be used by older people. However, there are studies which have shown touch-based devices can be used by older people, regardless of their physical or cognitive weaknesses [23]. There can be problems with touch-based devices too (such as touch-screens), and care must be taken with their selection. One of the problems with some touchscreens is that may not be responsive enough for users, or work better with a stylus. This usually occurs in resistive touch-screens. Capactive screens on the other hand, are more responsive, but less accurate and require bigger buttons [85].

During the Building Bridges Project, many participants used a biro

or chopsticks to interact with the device. The system was designed to be used by the finger only. This may indicate that users found the screen inaccurate, but it could also be related to the touch-screen technology used in the system, which was not as responsive or as usable as more modern screens, such as those on the iPad.

Many different types of hardware systems were considered. Each is discussed in turn below.

5.1.3 Desktop

Participants reported many problems using standard desktop computers, and the staff also stated this. They can be quite large in size and would most likely not be portable in any way. Furthermore, a touch-screen is only sometimes an option on such devices.

5.1.4 Laptop

A standard laptop was considered initially, however these are typically not successfully used by older people [1]. Furthermore, several of the participants noted that they already had laptops but could not figure out how to use them, so they gathered dust in their drawers.

One participant also noted how he was unable to carry his laptop around as it was too heavy for him, so he could not bring it to the main dining area, where the wireless network that the care centre provided was set up. He could also not figure out how to use it either so he gave it away.

During the Building Bridges Project, a majority of the participants in that study did not put their device in the main room that they used, but usually in another side room due to space concerns. While people living at home may have many rooms in their houses, residents in care may only have one room, such as in the case of the participants in this research. As a result, the size of a laptop may present problems both in terms of space, weight and interacting with it.

Furthermore, some participants had issues around the safety of the device, expressing concern that it may be stolen, which did not arise during previous research, either in Building Bridges or other research projects.

This feedback was very insightful as previous research [1] focused on a device that was designed to stay in one place and not be moved. For this group, it seemed that a more mobile device was required. In this first care centre, the residents had a movable desk that was used to eat dinner on (when they did not eat in the dining hall), and as such, space was very limited, meaning that a smaller device would be preferable and that did not necessarily require a surface to rest on. The ability to use the device to read also meant that it would be better if the device could be held.

5.1.5 Tablet PC

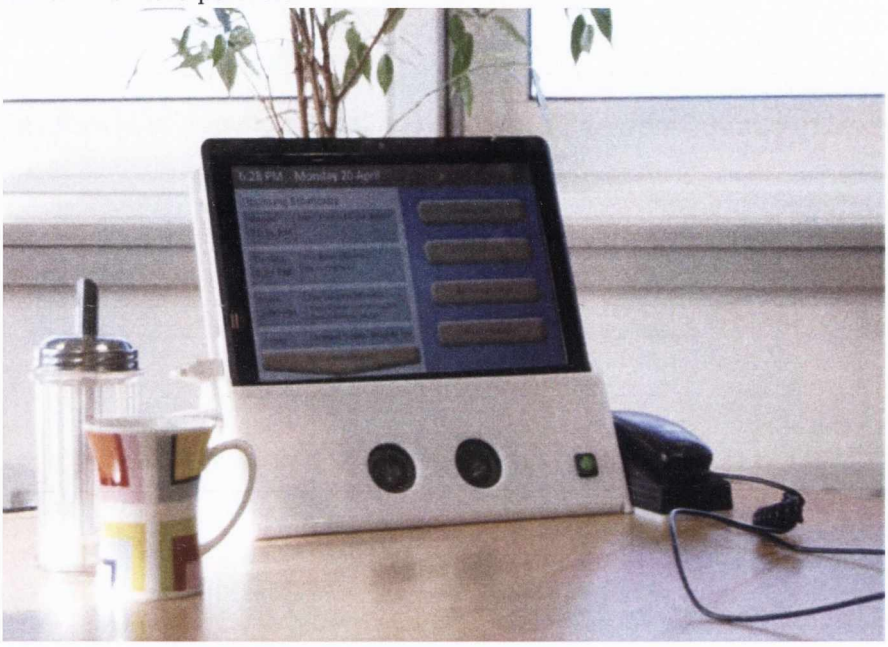
The next type of device considered was a tablet PC. Tablet PCs are hybrid devices, as they look like a laptop computer, but the screen can be folded down turning it into a touchscreen device. This is important as there are some studies that have shown older people

find touch-based devices easier to use [23]. However, tablet PCs suffer similarly to standard laptops in terms of weight and size.

Furthermore, the majority of tablet PCs use software not exclusively designed for touch-based interaction. While more modern operating systems, such as Microsoft's Windows 7, have touch support built in, many buttons are still quite small and can be difficult to press with a finger. This may mean that participants would have to switch between mouse and finger interaction, which is not a good solution and may be confusing to them.

As an example, the Building Bridges Project used a modified tablet PC in their research, but one of the problems was the size of the system which meant that it could not be easily moved. Given the space constraints for those in care settings, a large system that was difficult to move would be a problem for them.

Figure 4: The Building Bridges System. The size of such a system might be a problem for those in care with limited space. The hardware was chosen in 2008, so at that time it was the right choice of hardware. Modern technology is thinner and more portable.



5.1.6 Netbook

Netbooks are smaller versions of laptops with screens which are typically 11 inches or smaller in diameter. They usually use the keyboard and trackpad as the input system. While they are portable and light, they were not felt to be suitable for the research as some of the participants already had netbook sized computers but did not use them as they could not figure out how to work them, and already struggled with the full-size keyboard or mouse, meaning that the smaller input devices may cause even more problems. A common complaint with netbooks can be the small size of the keyboards and

mouse.

It would be possible to modify a netbook to have a touchscreen, but it would be very roughly and poorly put together rather than properly integrated and would be more prone to failure.

Netbooks were better than PCs and Tablets weight wise, but seemed worse in regard to input methods. They did not seem suitable for the project as a result.

5.1.7 iPod/iPhone

The iPod and iPhone, both developed by Apple, are 3.7 inch touch-screen devices. They rely on finger input to use them, and are designed specifically for this purpose.

While Apple have been praised for the ease of use of their devices, the iPod and iPhone may be too small for older people to use, especially those with impairments, such as those in care. Dexterity is a major issue for older people and with a screen size of 3.7 inches, it would be very difficult to design and implement an interface suitable for older people. Furthermore, the screen size would mean that it could be difficult to read for older people with sight impairment. The iPhone screen is smaller than most netbook screens so would be potentially worse to use for the participants.

5.1.8 iPad

The iPad, developed by Apple, is a 10 inch touch-screen device, essentially a bigger version of the iPod Touch/iPhone. It is operated

exclusively by using the hand to touch the screen, as the screen is sensitive to electrical impulses that the human hand emits. It could be considered a tablet, however a distinction between it and tablet PCs must be made as it is thinner, lighter and has a reduced operating system compared to a tablet PC.

There could be some negative impact in using an iPad however. First of all, Apple exerts quite strict control of the operating system, making customisation extremely difficult. For example, creating a system akin to the Building Bridges Project would not be possible on the iPad, as Apple prohibits (nor does it provide any other mechanism to do so) the use of 3rd Party Application Programming Interfaces.

Furthermore, linking different applications together would also prove difficult. Apple has designed each of their applications (called 'apps') to run standalone. Feedback from the storyboards indicated that reading books and then hosting a book club would be of great interest to the participants. Apple have developed a book reading application, called 'iBooks', which allows users to store and read hundreds of books on their iPad.

This seemed like the ideal book reading device, however it would be very difficult, if not impossible, to integrate iBooks with any software developed as part of the research. For example, it would not be possible to load a book within any application developed by the researcher. It would also raise copyright issues. It would not be a technical hurdle, Apple would simply not allow it. As a result, the books would need to be kept in a separate application to the rest of the software developed.

5.1.9 Connectivity

One of the problems in care centres in Ireland today is that of connectivity to the internet. While there are some centres who have installed site wide internet access, many cannot afford it. Furthermore, there are security and safety questions, as well as the need to install a separate line for casual internet access, as the nursing staff require internet access for medical reasons.

5.1.10 Final Device Choice

As described previously, netbooks, laptops, and several other devices were considered, but it was decided to use the iPad, developed by Apple Corporation. The iPad is a 10 inch, 3.5 pound touch-screen device, which represents a suitable trade off between size and weight. It is operated exclusively by using a finger(s) to touch the screen, so could potentially be used successfully by the participants. Furthermore, the software included on the device, called iOS, is designed exclusively for finger based interaction, unlike any of the other operating systems examined.

From a development standpoint, the iPad development systems are set up for designing touch-screen interfaces. Using the Application Programming Interface, Cocoa Touch, developers can access tools such as buttons, switches and navigation items designed specifically for use with the finger.

The iPad is technologically positioned between a mobile phone and a laptop, and is not necessarily designed to act like a standard computer, but more closely to a device that is a lower functioning device

that provides features and functionality most people use daily, such as reading books or magazines, using the internet browser, sending email or writing small documents, watching movies or playing games. This is reflected in the operating system that Apple developed for the iPad - it is a stripped down version of their Desktop operating system, but with an entirely new user interface built in to cater exclusively for touch-screen development (Cocoa Touch). Applications developed for the iPad/iPhone cannot run on a computer and vice-versa, and this is very much intentional as the interface and usage patterns may be completely different for each platform.

The easy access to a large collection of media, such as books, movies and games via an iPad was also very important to this research, as the book club would not necessarily work well if there were few books to choose from. Apple has also developed a book reading application (called iBooks) which allows users to store and read hundreds of books on their iPad. Apple also developed the 'iTunes' store, which provides a large range of movies and games for use on the iPad. Finally, the internet phone application 'Skype' is also available for the iPad, which allows users to call other Skype users for free. This would allow for remote communication, something potentially useful for participants to contact their friends and families via voice or messages.

5.2 Software choices

As well as all of the above features, consideration had to be given to the software that would be running on the system.

Many modern operating systems, while not exclusively designed for

touch interaction, support it to some degree. Microsoft's latest operating system, Windows 7, supports multi-touch interaction. However, many of the operating systems features were not designed for touch screen devices, such as the buttons, scrollbars and other manipulation devices are not designed for finger input and many users struggle with them. Given that older people suffer much more with these input gestures, it is highly unlikely that they will be able to use them successfully.

Another issue in software focused around confusion among the users. The majority of non-iPad devices may have required significant changes to the launching of the system. For example, issues around startup and ensuring that all applications launched successfully and that system error messages would not arise when an application didn't launch could have confused the users.

A big issue was around the media (books and movies) applications and how to integrate them into one application. No matter what operating system or hardware that was used, integration would most likely not be feasible. As a result, it was important to have a very consistent user interface if at all possible. If the iPad had not been chosen, participants would potentially have needed to use a keyboard and mouse, or navigate from a touch-based user interface into a mouse-based one, with no guarantee that they could use this properly. It would have been very confusing for them.

There were very few, if any, alternatives in the lightweight tablet market at the time the hardware was chosen (2009). It was felt that the software that the iPad uses and the touch screen interaction could be successfully used by older people. Furthermore, iOS seemed to support the development of all of the features described in the

storyboards. Other operating systems did not necessarily support them all, nor did they have the media support built in like the iPad does with 'iTunes' and 'iBooks' (or similar competitor applications).

There was no other operating system available at the time that was exclusively built for touchscreen interaction, contained a number of touch-based media applications, and required little, if any, customisation to the operating system. Furthermore, many of the features of a PC operating system are hidden when using an iPad (like the BIOS or file system). Older people can struggle with locating files in the file system [50]. Combined with the hardware benefits such as size and touch-screen based, the iPad seemed like the clear choice for this study.

5.3 Connecting the various software pieces

Having identified the features to implement and decided to use the iPad as the hardware system (and through that, using iOS as the software platform) the design of the system could begin.

However, a complete system required more than just an iPad. Messages needed to be sent and received, newspaper articles downloaded, and contact lists stored and saved. Clearly this required significant amounts of development, such a database to store this information and providing connectivity to these databases between each individual system. Furthermore, logging of usage was also important so as to see what people actually used compared to what they reported they used, though this might not be possible in all circumstances, as usage data of the third party applications may not be available.

5.3.1 System Design: Overview

Figure 5: The overall system design. Essentially, 4 applications were used - 3 which were already on the iPad system (YouTube, Movies and Kindle) and one which was developed as part of this research. This application contained 5 sub-features: calling, news reading, information on the book club, a calendar of events taking place in the nursing home and a messaging feature for contact friends and family.

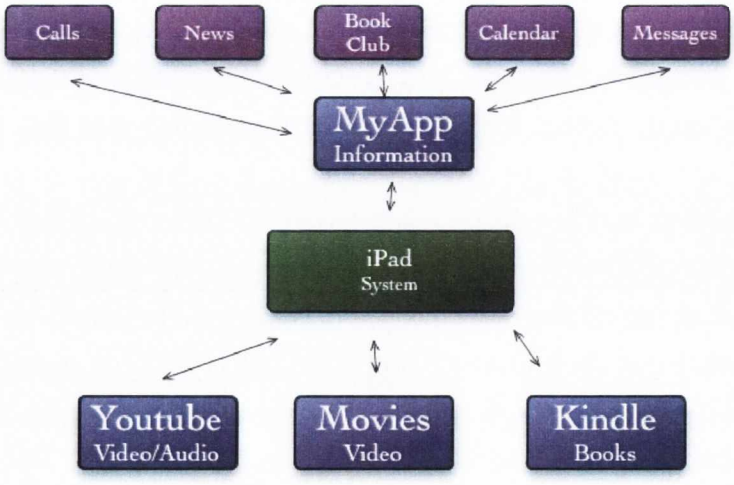
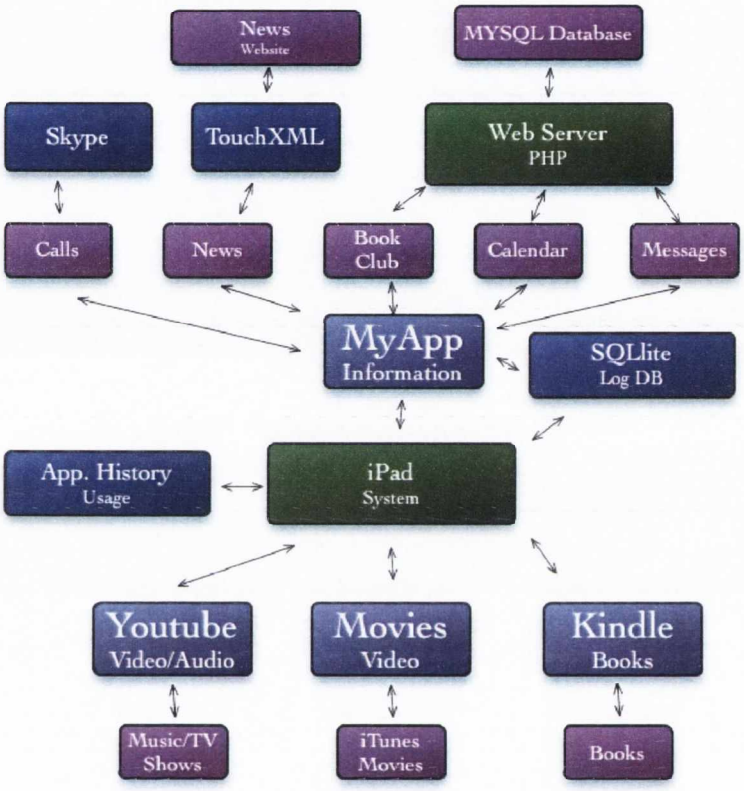


Figure 6: The overall system design. Each feature is shown with the technology and software necessary to make it functional and usable. The description of this technology is described in detail in section 5.4.2.



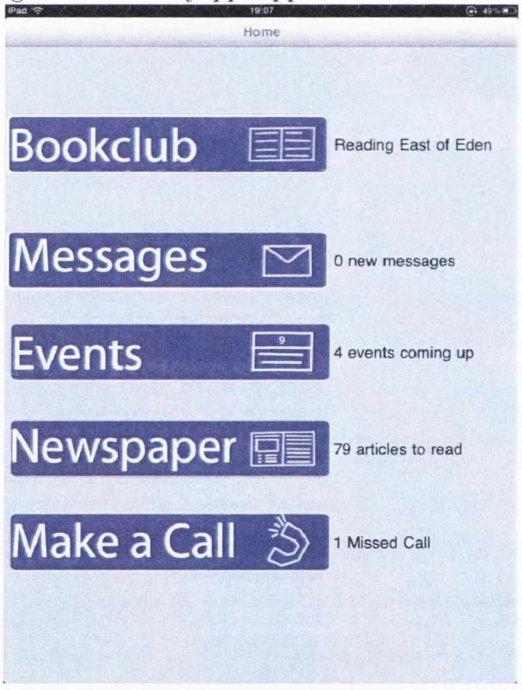
There were 4 parts to the system in total, namely first application (called 'myapp') with calendar, newspaper, bookclub information and messaging features. A book reading application and movie watching application were also added. The fourth part was 'Skype', but this was accessed through the 'myapp' application for use in phone calls.

The book club was originally to use Apple's iBook system, but (as discussed later) shortly after the first trial started this was changed

to the 'Kindle' book application by Amazon, as the iBooks application had a very small number of books, which participants reported as not being interesting to them.

The movie application originally selected for use by the participants was the 'VLC' iPad application (an open source video player), but as it is not possible to obtain movies that can legally be played on it, the Apple developed 'Movies' application was used instead. It had a wide selection of movies for the participants to watch, and these were purchased by the researcher on a regular basis.

Figure 7: The 'myapp' application home-screen



The first application ('myapp') would be designed in a hierarchical structure, but with a standard menu bar on all pages, which was located at the top of screen. This ensured consistency and enabled

the user to go back a page, go to the home screen or ask for help from any point in the system. Building Bridges recommended such a menu system [1] and early trials with only a back button had shown the users were unable to get back to the home screen without help. Furthermore, many of the buttons were kept at the top of the screen so as to avoid participants accidently touching them when they were using the device [1].

From the home screen on the 'myapp' application, the user could view information about this week's book club, send a message, view the calendar of events that week, read the newspaper headlines or make a call.

Button sizes were kept large, few icons were used and objects were made to look different from buttons if at all possible, to stop pressing of things that were not buttons. This was to keep in line with guidelines that had been suggested previously, as well as findings from the Building Bridges Project.[1].

5.3.2 System Design: Software Integration

As it would not be possible to integrate some of the system components, such as Skype and the books and movies applications completely into one single application, the design of the system was split into parts, with one application handling movies, one handling books and the last handling communication and activities. Navigation between each application was accomplished through the home button on the iPad, the only hardware button on the front of the iPad. Within each application, navigation was accomplished through touchscreen buttons. While it would have been preferable

to have everything within the one application, it was felt that it would be acceptable to users to have multiple applications on the system, and certainly preferable to using a keyboard and mouse, which they already had problems with when the care centre tried to start computer classes.

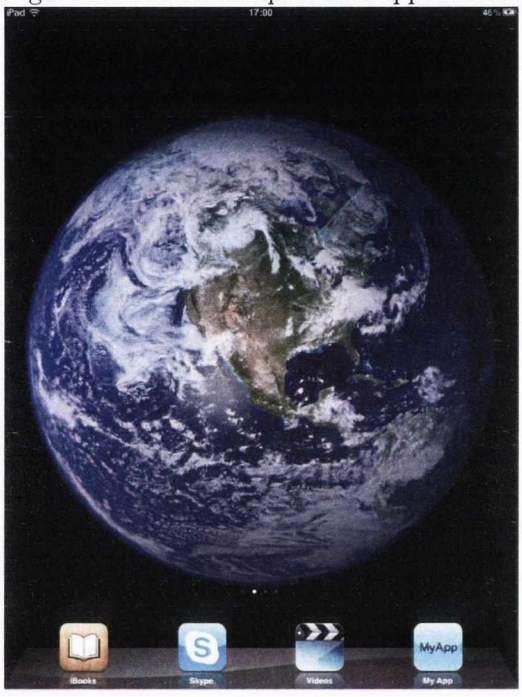
Each part of the system will now be discussed in detail, including how it operated, what was needed to develop it, what problems arose during the development and how they were overcome, as well as any other relevant information.

5.4 System Development

The specification and design of the system were discussed in Section 5.1 to 5.3. The following section deals with the development of the system.

5.4.1 Home Screen of iPad

Figure 8: iPad Launchpad with applications



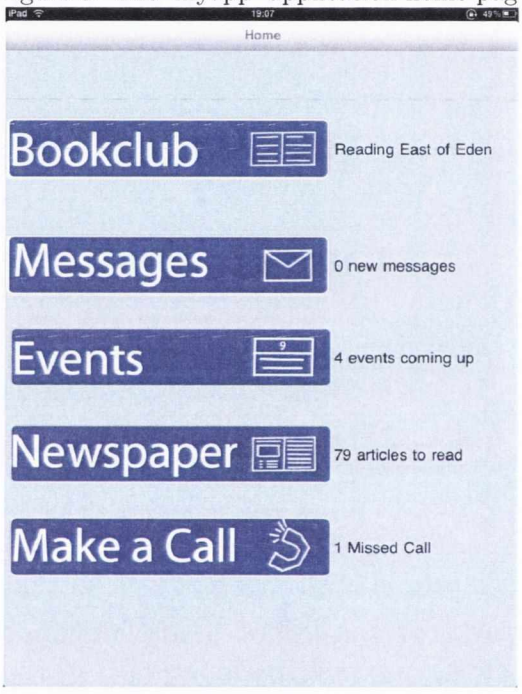
The home screen on the iPad was modified so that it contained no applications apart from the 4 (later 5) applications that were used in the study - the Kindle application for books, the movies application for videos, the 'myapp' application which contained the calendar for the nursing home, message sending, newspapers, book club details and call making, and the Skype application. Later, the YouTube application was added.

The 5 applications were displayed on what is called the 'launchpad' which is a set menu at the bottom of the screen. This meant that they were visible at all times so that users did not have to use the search features of the iPad to find the application they wanted.

5.4.2 System Development: 'MyApp' Application

The 'myapp' application developed as part of the research had 5 functions - sending messages, a calendar of events for the care centre, book club information, making a call and newspaper headlines.

Figure 9: The 'myapp' application home-page



The system was developed using Objective C, the development language most used by Apple for iPad applications. The Model-View-Controller Design Pattern was used in the development, where each 'View' (basically what you see on the screen) is separated from the data management (the 'Model'), and links them via the Controller. This was used for each view in the entire application.

Apple provide local database (SQLlite3) creation and storage on the

iPad. However, given that there would be communication between the participants (via calling and messaging), it was decided to use a centralised server with a MYSQL database that all devices could read and write to. This server and database acted as a 'middleman', passing information between each device. This database was located on university servers for security reasons.

PHP scripts were developed on the server that allowed each device (by passing a unique id) to connect to the database. They could then retrieve contact information, alert if they were going to take part in the book club or check their messages, as well as many other things. Each part of the system will be discussed in detail below.

Each view needed information to display, with this information coming from a variety of sources. A MYSQL database was set up on servers located in the university, as the university supplied this service specifically for projects, but also to keep the information (which at most consisted of anonymous email addresses matched to first names) in a secure and properly maintained location. It was necessary to keep the servers and databases running at all times as messages could only be sent through the servers, and the databases stored information such as contact lists and the list of book club attendees.

It was anticipated that the application could connect directly to this database, however, this database was not accessible from computers outside the college network, so a workaround was required.

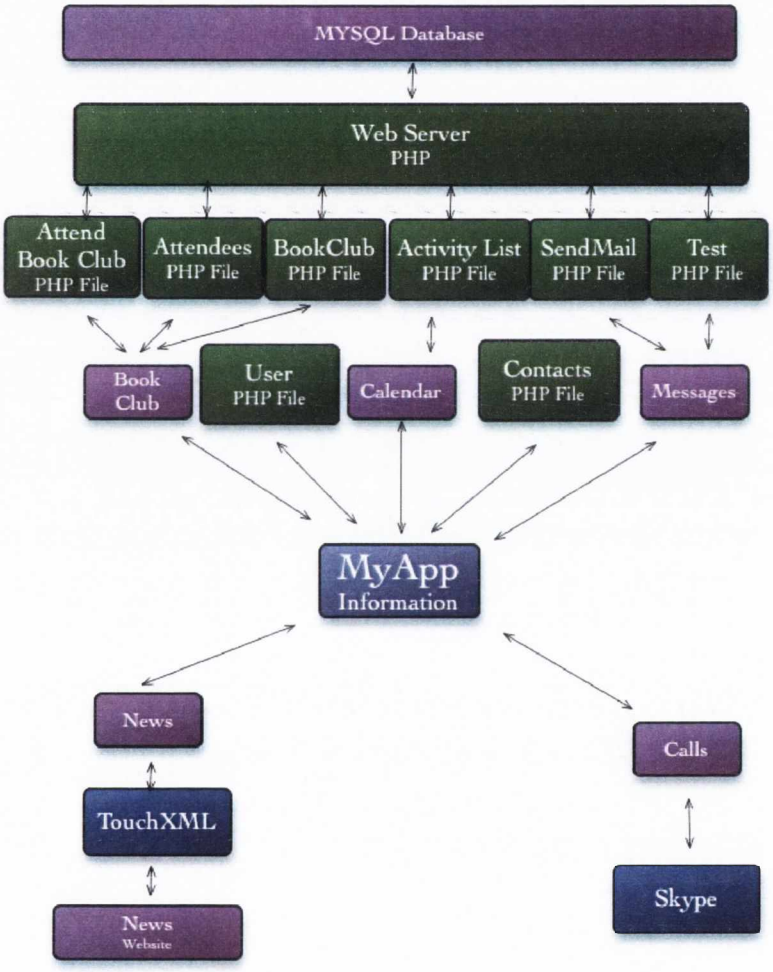
PHP (Hypertext Pre Processing) is a web scripting language that can connect to a database and return the information collected locally back to a system for further manipulation. Furthermore, the university allowed the hosting of PHP web pages that can be ac-

cessed externally. Finally, objective C supports connecting to a PHP web page, and receiving data from the page in a variety of formats. Using these 3 techniques, it was possible to create a system that allowed the 'myapp' application to connect, send and receive data to the department hosted MYSQL database. This was the solution implemented in the application and is described below.

There were some further changes that needed to be made as well, but these related to the set up of the email part of the application, known as messaging to the participants. Changes to the PHP installation that the university was using needed to be made so that email could be sent and received. Specifically, the IMAP plugin, which allowed the sending of email via PHP was enabled so that this could occur.

5.4.3 System Development: PHP Webpages

Figure 10: The PHP and SQL Pages that supported the application, the code is listed in Appendix H, with a short description of each below.



There were a number of PHP webpages created, each with a different function. Each is described below, and are listed in Appendix H.

- activitylist.php - This connected to the MYSQL database and returned the list of activities happening that week for the care centre.
- attendees.php - This connected to the MYSQL database and returned the names of all the people who were attending the book club that week.
- pushmail.php - This was an unused file in the final implementation but attempted to 'push' (the system would not have to check for email, they would automatically be sent to the device) new email to each device. Although the code worked, it could not be used as the connection ports required for this service were not open on the university servers.
- user.php - This connected to the MYSQL database and returned the information about the user to the application so as to get information such as contacts. Later, this was replaced by keeping these settings on each device.
- bookclub.php - This connected to the MYSQL database and returned information about the book club happening that week.
- sendmail.php - This sent mail to specified email addresses that participants selected. It was the backbone of the messaging system.
- contacts.php - This connected to the MYSQL database and returned the list of contacts for an individual, to populate their address book.
- attendbookclub.php -This connected to the MYSQL database and updated it with the name of the person and whether they were or were not attending the book club to be held that week.

- test.php - This checked for emails on the gmail server, checked through each one, parsed them and returned them in a list for display and use on the device. Each page returned data back to the application in JSON (JavaScript Object Notation format), which could then be formatted and used by the application to display the relevant data.

Each of these pages was hosted on the researcher's computer in the department, and the 'myapp' application could connect to the MYSQL databases through them.

5.4.4 System Development: MYSQL Database

The MYSQL database stored information about a number of different aspects of the research, such as user details and contacts, activities and the bookclub that was held every week. In an effort to reduce the size of the database, it was made relational, so that a unique identifier from one table could be used as a foreign key in another.

The tables are discussed in turn here:

- Users - this stored user information, such as their first name, email address and Skype username.
- Contacts - This stored the contacts of each individual, referencing the 'Users' table. There were some common contacts (such as other participants) and these were specifically marked as such.
- Activities - This stored the activities that were taking place in the care centre on a weekly basis. This was updated weekly

by the researcher, who obtained the information from the care centre every week.

- Activity Attendance - The stored the activities that each individual took part in, referencing the activity table. In reality this referred to just the book club, as many of the participants did not attend activities.

Some of the tables in the database were used in multiple parts of the 'myapp' application, while others were just used in one part, or when the application first loaded up. Each will be discussed in the context of the page in which they were used.

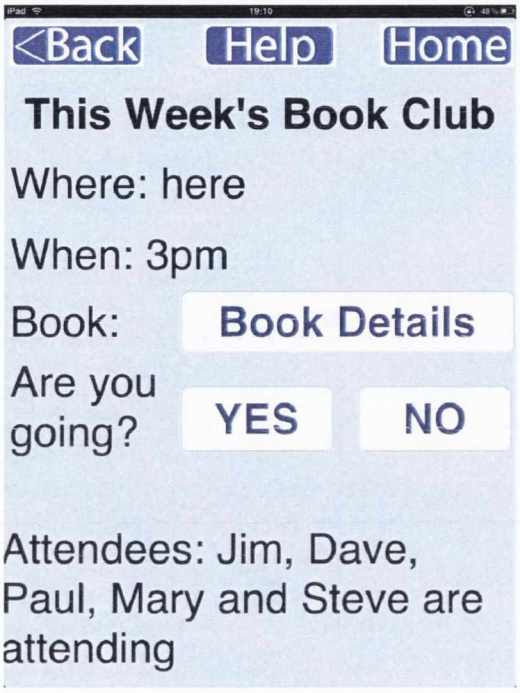
5.4.5 Log Database on the device

Each device also had a database, specific to it, which logged usage of the various applications, where possible. An example would be the number of messages sent by an individual (but not the content).

It was not possible to log all activity with the device, such as with the book, YouTube and movie applications. For user protection, Apple restrict developer access to this sort of information. However, analysis of the 'history' data of each application coupled with interviews could also provide some insight into the usage of these applications.

5.4.6 System Development: Book Club

Figure 11: The book club information screen. This includes dummy data.



The book club feature was composed of 2 separate features in the system. One application allowed the participants to read books, and was not designed or developed by the researcher (originally it was the iBooks application, but subsequently the Kindle application was used).

The second part of the feature was contained within the 'myapp' application. This would display the title of the book, when the meeting was taking place, and who else was attending. The purpose of this was to create a social pressure of sorts, and encourage more attendance. This information was stored on the SQL database on the server, which each device could access. Furthermore, the users

could decide themselves on the device if they wanted to attend, by pressing the yes/no buttons. This would then update the database accordingly.

A second application allowed participants to watch videos on the in-built video application, as an extra activity (and therefore another discussion topic for the weekly meeting) for the participants. Again, this was not designed or developed by the researcher. It was not possible to build such book and movie systems due to licencing issues, as well as whether it was worth the time to develop them when perfectly good applications already existed.

The participants used these applications throughout the week, and every weekend a book club meeting would be held, using the books and videos as a basis for discussion.

This book club feature worked using a combination of objective C, the built-in application 'Movies', the Amazon 'Kindle' application, PHP, and MYSQL. It was possible to see how much of the books the participants read or how much of the movies they watched through examination of the applications coupled with interviews with the participants.

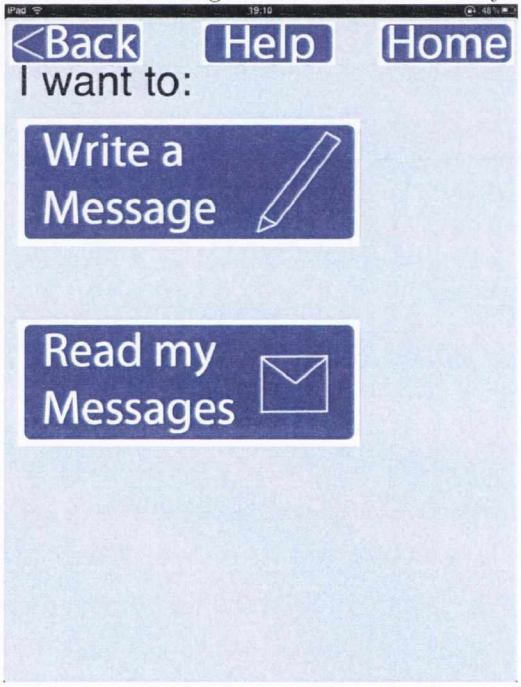
The book club feature employed a view/interface, with the code connecting to the PHP script called 'bookclub.php'. This was hosted on a server located on the university network, which then connected to the MYSQL databases, returning information regarding the book club, such as the title, description and when the weekly meeting was to be held.

The participant is also able to say whether they are attending the meeting or not. When the participant says that they are attending

(by pressing the 'yes' button), the application connects to the 'attendingbookclub.php' webpage on the server, which populates the database with the attendees name. The participant could also cancel if they wanted to as well, which was again achieved through the same PHP webpage. This code is listed in Appendix H

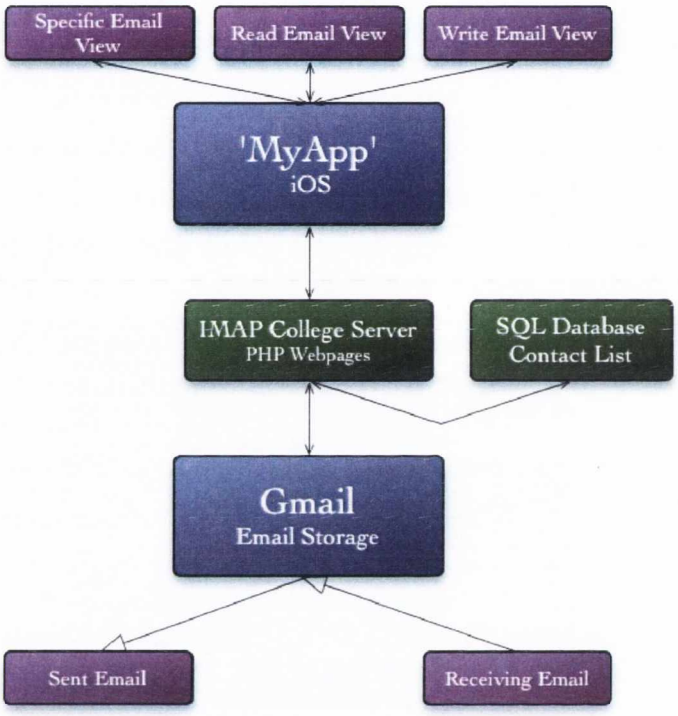
5.4.7 System Development: Email / Messaging

Figure 12: The message home screen for the system.



The messaging system was essentially email, using email accounts to communicate both with users and with friends of users. It was felt that to reduce complexity and computer terminology, it would be better to use the word message rather than email.

Figure 13: The messaging feature technical diagram. The views at the top are what the user would see and interact it. The rest of the system is hidden to them.



The messaging system used IMAP to connect to 'GMail' (internet mail) accounts specifically set up for this purpose. The system would pass information, such as the recipient of the message, the message itself and other relevant information to the PHP script, which would then connect to GMail and send the message. Similarly, when a participant wanted to check for email that had been sent to them, another PHP script would connect to GMail, download any mail present and send it back to the system, which would then display it for the user.

Originally, it was intended that each device could communicate di-

rectly with the email server. Apple provide an email page that can be inserted into any program and works directly with the mail application on the iPad. However, this would have brought up more issues relating to email addresses, as the page is not customisable, meaning that users would have to enter the email addresses themselves. Concerns around the size of buttons on the screen for older people also meant that it was not the best solution for the system. The goal in the initial prototype was to try and hide as much of the settings and customisation that needed to be done so that the participant could focus on the message. As such, when a participant wanted to send a message, they pressed a name, not an email address. The system then pre-filled the name into the screen, so the participant was not asked to remember any email addresses. They were stored in the contacts table in the main database.

Their own email address was stored on the iPad in the settings tab, shown below. The participants did not have to enter this information, it was provided for them. Furthermore, if they wanted to add their relatives' email addresses, they could be provided to the researcher, who would input them into the database.

Figure 14: The settings tab for the 'myapp' application, showing the email and unique identifier..

A 'wizard' was used to guide the user through the process of sending a message. The purpose of this was to make it as simple as possible to send a message. If the user wanted to write a message, the next screen offered a list of contacts to send messages to. There was no email addresses visible at this point, it was focused on selecting the right individual. Once a user pressed the name of a person they wanted to email, the next screen simply included a keyboard, a send button and the name of the person the message was being sent to.

Figure 15: The message home screen for the system.

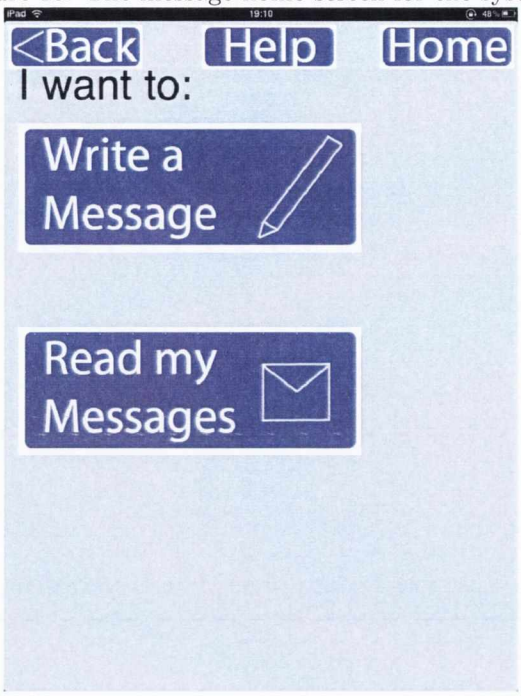
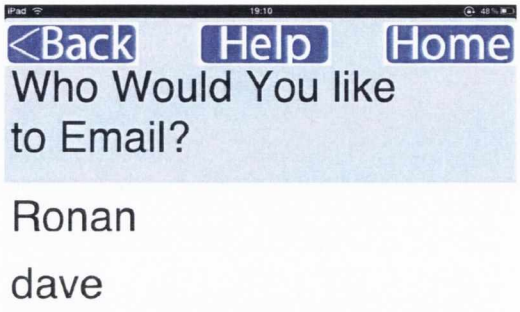


Figure 16: Screen showing how a user can choose a contact to send a message to.



If the participant wanted to read their messages, the system contacted the GMail server and downloaded all messages for display on the device. These would be displayed with the name and the title visible, from which the user could press any of them to view more details of the email. The user could then reply to the message or send it to someone else, if they wished, bringing up the same dialogs present in the write message feature. This code is listed in Appendix H.

5.4.8 System Development: Server

The server handled the email sending, book club meeting details, calendar details and contact lists for each user. Each user could request information via a PHP webpage that connected to the MYSQL database and returned the information in a 'JSON' format (described in the next paragraph), whether that be calendar, contact or any other information. This data was stored in an SQL database (It was more secure to store this data on university computers, so the database was run by the Computer Science Department, while the server was located on campus and used the campus network).

The mail sending and receiving PHP scripts connected via IMAP (Mail Protocol) to Gmail accounts that had been set up specifically for this purpose. This information was not stored in the database, though keystrokes were logged to observe error rates, and were not used for any other purpose.

5.4.9 JSON - Javascript Object Notation

JSON, which stands for Javascript Object Notation, is a data format used to transmit data over a network connection. Similar to XML, it transmits in the format

{string:value}

An example of this would be {age:11}. This was passed back to the system, which parsed and stored it accordingly for use when a particular part of the system needed it.

5.4.10 System Development: Newspaper

Figure 17: The overall software design of the newspaper feature. The TouchXML feature could be configured to connect to any newspaper that offered an RSS feed, but defaulted to the RTE news site. Participants were asked what newspaper they wanted access to.

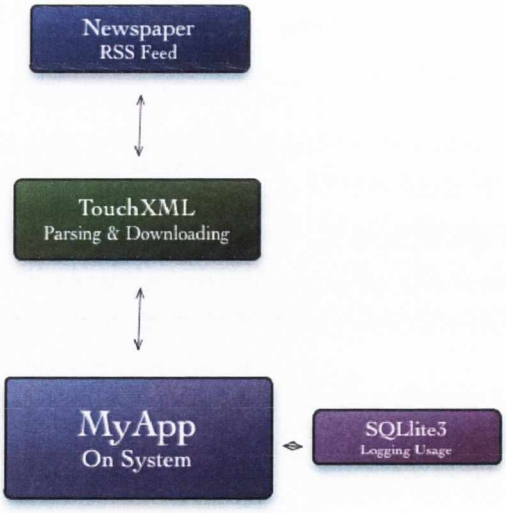


Figure 18: The newspaper headlines

The newspaper system used RSS (Real Simple Syndication) to download articles from major newspapers. RSS is a feature that websites can implement, allowing machine-readable text to be downloaded from their site. The system could work across a number of newspapers, so it could be customised to use the RTE news feed (Irish national news station) or the Guardian (British newspaper) feed, for example.

In slight contrast to many of the other features, the system did not connect to a PHP script sitting on a server based in the university, as there was no need for this. This script connected to whatever newspaper website it was directed to and downloaded the entire RSS feed. Using an add-on called TouchXML, the system extracted the title and article from the feed and displayed it to the user. The

user could then press on the title, and access the article itself.

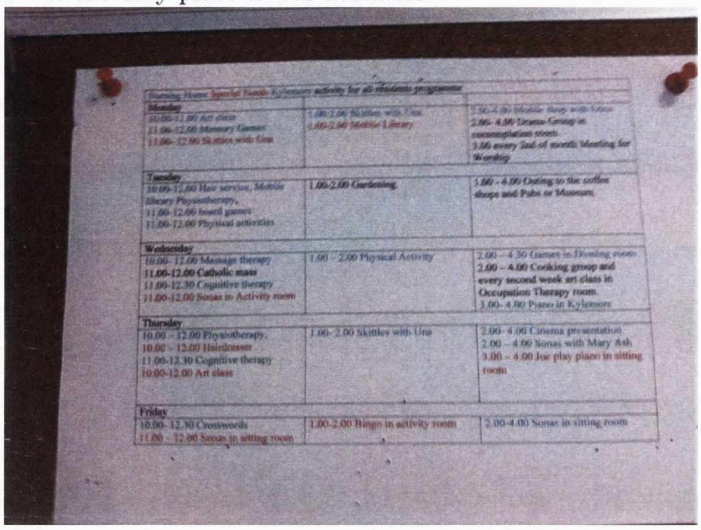
TouchXML is a lightweight add-on for applications that allows easy manipulation of XML encoded data, such as RSS feeds. It strips out a lot of unnecessary features that usually have to be implemented when working with XML encoded data.

The TouchXML code sat between the application and the RSS feed, connecting to a news website upon request from the application, downloading any RSS feed in XML format, converting it to a data format that could be easily used by the application and passing it back for display to the user. This code is listed in Appendix H

5.4.11 System Development: Calendar

The calendar feature displayed the events that were happening for the week in the nursing home. Each week, the researcher would note the various activities taking place in the nursing home, and enter them into the MYSQL database located on the server. Each device could then connect to the system and retrieve this information to display to the user.

Figure 19: The Activity Schedule as used in the home. Many of the activities are divided by resident type. This was displayed inside the door of the care centre and was the only place it was available.



There was a weekly excel spreadsheet posted at the reception, but was hard to read and was not distributed widely (see figure above).

While some of the participants had stated that they were aware of the activities taking place in the nursing home, and that the staff would alert them to particular activities they were interested in, when questioned further on this, they seemed to be unaware of or had forgotten about many of the activities taking place.

The calendar feature on the system displayed where and when the activity was taking place for any given week. The main screen would also note how many upcoming events were taking place that week. The intention was to give basic information to the participants so that they could be fully aware as to what was occurring in the nursing home.

Figure 20: The Calendar Screen

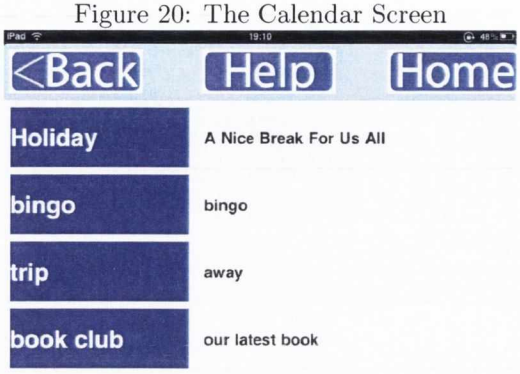
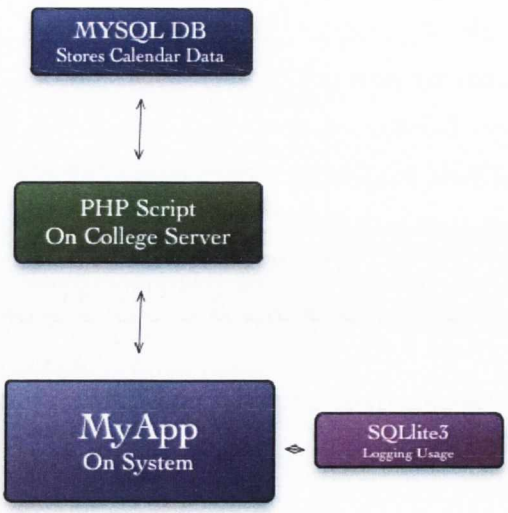


Figure 21: The Calendar Software Diagram



Each week, the researcher added in the activities into the MYSQL database. This feature worked through use of a PHP script, which connected to the MYSQL databases, and returned the information to the feature, which then displayed it to the participant. This code is listed in Appendix H.

5.4.12 System Development: Phone Calling

Figure 22: The Calling Screen. When a name is pressed, Skype launches automatically into a call.

The calling feature relied on Skype as a communication tool. Essentially, a similar screen to the write message screen would appear when a participant pressed the 'make a call' button on the home screen, where they would be presented with a list of names, from

which they could press the name of the person they wanted to call. This would launch Skype straight into a call with that person. This code is listed in Appendix H.

Ideally, tighter integration would have been preferred with any calling system but given the time limits in development as well as the difficulty and cost in implementing a custom solution, it was considered an adequate trade-off. Furthermore, there were very few alternatives for tablets at the time the selection of hardware was taking place. Finally, some of the participants wanted to call abroad to friends and family, and Skype offered this at a cheap rate. Future work could include fully integrating into a single application.

5.5 First Prototype and Feedback

In May 2010, the first iPad was purchased. It was brought in, running some iPad applications, and presented to some of the participants for examination. Up to this point, the system development had taken place on a simulator which Apple provided via their development software. This allowed the researcher to test the code on a virtual iPad, even if no physical iPad was available.

Immediately, most of the participants were interested in it, and when shown Amazon's 'Kindle' Application, noted how clear the text was for reading, and were impressed that the font could be increased in size.

5.5.1 First look

A prototype of the system was developed as described and presented to 2 participants. There was no functionality in the system, but users could move between screens and see pre-filled data on those screens.

First, the users were shown the 'iBooks' application, and asked to navigate through it. Initially, the participants were unsure how to navigate between pages, but once they were shown how to swipe to change the page, they were able to navigate successfully.

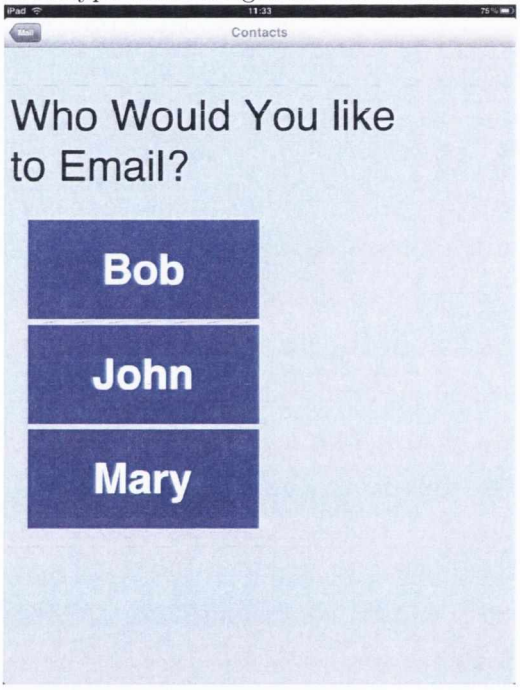
However, when they were shown the 'myapp' application, the participants tried to swipe to change pages (when asked to navigate to the home screen) as in iBooks. However, swiping was not set up as a gesture for the application and participants became confused. Once shown that pressing an icon would change between pages, the participants were able to navigate successfully.

It seemed better to use one 'gesture' only - e.g just tap, just swipe - as mixing gestures caused confusion.A tap or press seemed like the most useful choice of gesture as the pressing buttons with a swipe would not be very intuitive. In guidelines for PC development for older people, manipulation issues with scrollbars and keyboard/-mouse combinations are common, and are not recommended for older users [18].

Participants also struggled to get back to the main page of the 'myapp' application with ease. There was a 'back button' on every page, but participants still became confused if they had to navigate through a number of screens to get back to the home page. This

meant that there was a need for a constant 'home' button, visible in the same place on every screen. Participants were getting confused when navigating through 'messaging wizard', which allowed them to send an email. However, once they had sent an email, they were unable to get back to home screen.

Figure 23: First Prototype with Navigation Bar. Note the small back button.

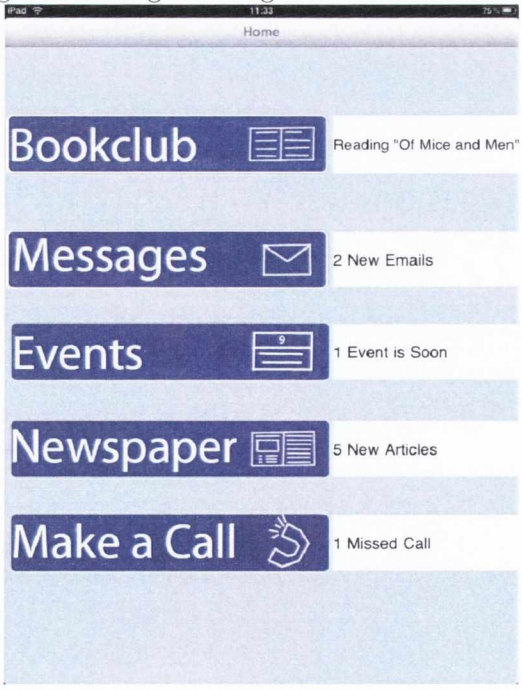


Other issues that were observed included the size of font on the main screen of the 'myapp' application. On the main screen, there was text beside each button which had information pertaining to that feature, for example in the mail feature it might state that there was a new mail, or a number of upcoming events on the calendar feature. While the participants could read the buttons clearly, one had to put on his glasses to read the smaller information text.

Originally, the application used a navigation bar, which was automatically generated by the operating system. It came in one size and while extra buttons could be added to the bar, these were also a fixed size and shape. It was observed that these buttons needed to be pressed on multiple occasions by the participants before they responded. This was not a question of latency, more that the participants' fingers were not accurate enough due tp the small size of the buttons. It was decided that bigger navigation buttons were required, and remove the navigation bar in favour of a custom one.

Finally, the participants pressed a lot of things that were not buttons, such as text that had a box around it. Buttons needed to be clearly distinguished from non-buttons.

Figure 24: Image showing white box around text.



Positively, the participants remarked on clarity of using it, stating that it didn't require glasses to read (with the exception of the small information text mentioned earlier). Consistent naming was also important - a message had been labelled email, which was removed and replaced with 'messages' instead.

5.6 Think Aloud and Findings

Following this first look, the initial testing of the system consisted of several stages, conducted individually with each participant so as not to bias the results.

Each participant was shown the system, and asked to perform several tasks, using the think-aloud protocol. Participants were told exactly what to do for these tasks, but were not shown how to complete them. These tasks were recorded on video, and were quite varied in nature. The following tasks were attempted by each participant:

- Accessing information relating to the book club;
- Reading and sending a message to someone;
- Making a call;
- Accessing the newspaper and reading an article;
- Accessing the help screen;
- Accessing information in the calendar;
- Switching between applications on the system;

The findings of the experiment were analysed in multiple ways. Observation notes were made during the experiment and by watching the video after the experiment for any issues encountered. From these findings, changes were made to the system.

There were several problems with the first iteration of the software. In contrast to testing within the university network, the system was slower to start up in the care centre as it had to download information from the university servers. As there was no 'splash screen' (a loading screen that is displayed while an application is starting up) participants were presented with a blank screen for a number of seconds, and believed the system to be broken.

Some of the participants struggled with switching between applications, such as from the iBook application to the 'myapp' application. Ideally, this would not have been an issue but it was impossible to integrate the system into one all-encompassing application. However, after the test, participants were able to understand and learnt how to switch.

Other issues included poor choices of wording, leading to confusion among participants. On a screen where users had to choose the name of the person they wanted to email, users were asked "Who would you like to email?". The participants were unsure as to whether they should start writing, or what the next step should be. The text was changed to "Press the name of the person you want to send a message to". Other similar terminology changes were made.

Figure 25: Image showing terminology confusion, with 2 'emails' instead of messages.

There was also an issue with some of the text displaying incorrectly (longer newspaper headlines could not be seen) but that was fixed in the next iteration of the software. Some of the buttons did not work either due to a programming issue but this was also fixed.

5.7 Conclusion

This chapter has described the process of choosing the most appropriate hardware and software for use in the system, based on a review of literature and the input of the participants. The development of the software has been described in detail, including the various pieces of technology used, the rationale behind using them

and how they were integrated into the complete system.

Following the successful development of a prototype, and several usability tests including using think alouds as well as observation and feedback from the participants, the next stage of the study could begin, namely a series of trials, each more comprehensive than the previous one.

The first trial involved a short trial for two weeks, examining the content that the participants would like as well as further usability trials. The second trial, also 2 weeks long, included the addition of the book-club meeting, in order to test the whole system in operation. Finally, an 8 week trial was conducted to test the system over a longer period of time. These tests are discussed in detail in the next chapter.

6 Evaluation of the System in Operation

The previous chapter, Chapter 5, described the process through which the system was created and developed and initial feedback was collected.

This chapter focuses on the evaluation of the system in three different trials. Each trial was more comprehensive than the last, and had slightly different goals.

Trial one was a short trial to test the basic features of the system, as well as examine some usability issues. Trial two built upon trial one, incorporating participant feedback regarding the type and amount of content, and consisted of a two week trial with a group meeting at the end, held face-to-face rather than through the system, which was, as stated previously, used to facilitate engagement, rather than replace it. Both of these trials were essentially pilot trials in preparation for the longer final trial.

The third and final trial compared two different care centres, one of which had been involved in the previous trials, Centre A and one which had not, Centre B.

6.1 Addition of a Second Care Centre

It was felt that it would be important to trial the system in a second care centre, as the participants to date had taken part in every step of the trial. One participant from Centre A had moved to a second centre (Centre B), but still wished to keep involved in the research. He had participated in the interviews (section 4.6) and storyboards

(section 4.9) stages before he left, but had taken no further part.

After discussions with the Director of Nursing in Centre B, ethical approval was sought and granted to undertake the study in Centre B, and the original participant was added back into the research. A researcher who had worked in Centre B suggested a second potential participant, who was approached and agreed to take part in the trial. This participant had not taken part in the study previously.

The trials in Centre A and Centre B were run separately, though contact was facilitated between the participants via email and Skype, as some of the participants knew each other but had no way of contacting each other previously, despite constantly asking about each other. Therefore, they had a desire or need to use the system to contact friends.

6.2 Trial One - Usage

Trial one was conducted with 2 participants (Participants One and Two in this study) in Centre A. The devices were used by participant Two for a number of weeks, and by Participant One for a week, due to him becoming ill the day after receiving the system.

Each participant was supplied with an iPad, with the 'myapp' application, Skype, iBooks and 'VLC' (a movie playing application) installed. A selection of books and movies were provided for participants. These were chosen by the researcher but based on what participants said that they liked.

Each participant was guided through using the device and each application. While participants became quite familiar with the device

while in the presence of the researcher, they expressed concern as to whether they could continue to use the system successfully once they were on their own.

It was decided to produce a short guide detailing how to use the iPad and all the related applications. A copy of this was distributed to each participant, and is included in Appendix ??.

Initial feedback when talking to the participants was good. Participant Two immediately mentioned, upon viewing the messaging feature, that he could use the device to contact his daughter who lived overseas. This was very promising as he had reported earlier in the process that he would have no use for email or calling, meaning that the device could potentially allow for increased interaction with his family, that had been impossible before.

However, when interviewed after the trial, both participants expressed an interest in using the system, but said that 'there was not enough to do on it'. They wanted more movies and books loaded onto the system, rather than different features, which was an interesting finding. Furthermore, participants wanted to pick their own books, rather than rely on the researcher to choose for them. Participant one reported that he had a low reading ability, and would prefer books from his childhood that he enjoyed, where as participant two wanted a 'bestseller'.

6.2.1 Connectivity

Centre A provided internet for the residents in the dining hall. Attempts had been made to extend the range but an affordable solution had not been found. The researcher installed a power-line based so-

lution that allowed the extension of the wireless internet down to the bedrooms of some of the participants. However, when tested, it would not cover all of the bedrooms, and as such could not be used. Furthermore, the connection itself was regularly broken and went weeks at a time without being fixed, making it unusable for the trials.

In the Building Bridges Project, Eircom (an Irish Telecoms Company) were contracted to provide internet access at the homes of all the participants. This used their existing phone lines. While potentially a good solution, it was simply too expensive, as well as being costly for the nursing home itself, as building work may have been required to install the lines. This was simply not feasible for this project.

As a result, an alternative solution was needed, which the iPad was able to provide, and could be entirely controlled by the researcher. Apple also develop iPads that can, with the aid of a sim card, connect to the internet via the mobile phone networks. They could be paid monthly, have a fixed amount of data allowed and would be using the far more reliable mobile phone networks. After testing with a number of companies, it was decided to go with sim cards at a cost of 20 euro per month with a 5 Gb download limit.

These would need to be topped up on a monthly basis, but would be cheaper, more reliable and could be used anywhere in the care centre, unlike the wireless internet provided by the care centre.

6.3 Trial Two - Testing the system

After the first trial, a short second trial took place with participants one and two in centre A, incorporating changes that arose from analysis of the first trial, but added a face-to-face book club meeting at the end of the week. Due to one of the participants not being available on the weekend, the trial ran for two weeks rather than one, but other than that no details were changed from the first trial. Furthermore, the systems were logged for usage, to complement the interviews taking place.

Some changes in the system took place. Movies were purchased using iTunes and as they would only play using the movie application due to licensing restrictions the VLC application was removed. Furthermore, due to a lack of suitable books, the Kindle book application from Amazon was used instead of iBooks.

Participants were again given the system for two weeks. Each participant had purchased a book with the researcher, and a selection of movies were also supplied. The second weekend after receiving the system, a meeting was held where the participants talked about what they had done with the system, the books they read and the movies they watched. Following this, each Participant was interviewed. Data from scales including the Intrinsic Motivation Inventory [97] and Microsoft Product reaction Cards [96] (discussed in section 6.3.1) were also taken. Finally, data taken from the system showing usage of some of the applications was recorded.

Interestingly, participant 2 reported accessing the YouTube iPad application, which had been hidden (several apps on iOS cannot be deleted). This became one of his most used applications, and he

would search music and videos that he would have watched when he was younger. On top of that, he also looked at quizzes and educational programs. He also suggested to participant 1 that he use it, following which the researcher showed participant 1 how to use the YouTube application. He quickly began to use it on his own.

6.3.1 Trial Two Analysis

The following tools were used to analyse the results of the second trial:

- Microsoft Product Reaction Cards [96] - A series of words (approx. 100) are presented to users, and they are asked whether they associate the word with the product. From this subset of chosen words, the users are then asked to select the 5 words they most associate with the product, with a short discussion as to why they chose those words.
- Intrinsic Motivation Inventory [97] - A scale that assesses how much the users enjoyed the system, their perceived competence using the system, their effort to use the system, the value or usefulness of the system, whether they felt pressure to use the system, and perceived choice while using the system, thus yielding six subscale scores.
- A short interview - asking questions around what they liked/disliked and used throughout the system.
- Usage Data

Participant one chose the following 5 words from the Product Reaction Cards

- Easy to use
- Impressive
- Trustworthy
- Usable
- Valuable

Upon questioning as to why he chose these five words, he described the system as "a necessary part of having something to do" and "useful to me". He did also mention that he could not really use the device when he first received it, but "investigated" it and soon learned how to use it.

During the interview, he said that he mostly listened to the music on YouTube or watched the films that were supplied. He noted that he used the 'myapp' application the least, but had noted previously that he would use it to contact his friends and family via email once he received their addresses. He did not take part in activities, and as such did not use the calendar feature at all. He used it mainly at night-time and noted that the system had "a selection of activities" that he could come back to as and when he chose. He also enjoyed the chat held at the end of the trial and was interested in a weekly repeat of it.

Separately, this participant did leave the care centre on a regular basis to go shopping, usually for other residents in the centre.

His intrinsic motivation scale came back with the following scores:

- Interest/Enjoyment using the system: 47/49

- Perceived Competence of using the system: 39/42
- Effort/Importance he attached to using the system: 24/35
- Pressure/Tension he felt (internal and external) while using the system (lower is better): 21/35
- Perceived Choice he had to use the system: 49/49
- Value/Usefulness he felt the system had for him: 39/49

He was generally very positive towards the device.

Participant two chose the following 5 words from the Product Reaction Cards.

- Stimulating - He felt it was important to "get the brain working properly and thinking and reacting fast"
- Convenient - "That's the main thing about it! It's very convenient to access things"
- Easy to Use - "It's easier to use than the computers" - he felt that he couldn't use computers that used a keyboard and mouse.
- Entertaining - The system allowed him to "hit upon a lot of things that I was in the past entertained by", and "opened up a whole new set of memories". This was through the viewing of TV shows on YouTube.
- Exciting - The system "is the opposite of boring and holds your interest better." He was "happy to be on that track where you're not bored"

His intrinsic motivation scale came back with the following scores:

- Interest/Enjoyment using the system: 46/49
- Perceived Competence of using the system: 28/42
- Effort/Importance he attached to using the system: 16/35 - (though from other responses this seems low - perhaps a question was misunderstood)
- Pressure/Tension he felt (internal and external) while using the system (lower is better): 22/35
- Perceived Choice he had to use the system: 36/49
- Value/Usefulness he felt the system had for him: 41/49

A short interview was also conducted. He described the device as "a blessing", reporting that he used to switch off the television and use the system instead, and mainly used the device at night when the care centre was quiet. This seemed to be a common feature, with other users in all trials reporting using the device mainly in the evenings.

He enjoyed the book-club meeting that was held at the end of the trial, and was interested in continuing them as it offered a chance to engage in more discussions.

There was a noticeable improvement in the use of the device by this participant throughout the trial, as well as an urge to move beyond the initial features of the system. Through exploration and experimentation, the participant managed to locate and use some of the other applications installed on the device, such as Safari (a web browser) and YouTube (allowed access to the YouTube video

sharing web site). It was also interesting to see whether they (Safari, YouTube) would be used eventually by the participants, showing an increase in technical ability.

The participant initially found the system hard to use, but "got the hang of it eventually", and found it "much handier than a computer interface". It is interesting that almost all the users did not see the system as a computer, reflecting Dewsbury et al.'s research to avoid the "preconceptions" that a standard computer can encourage [42]. However, after each book was chosen (the researcher and the participant chose one together), participant two actually managed to buy a second book accidentally (the researcher had forgotten to remove his credit card details from the Kindle application). While the participant seemed unaware that he had purchased it, there are implications for system design as he could have been charged a significant amount, had he purchased more books. As it was, the researcher received an email whenever a purchase was made and was therefore quickly able to remove purchasing details, stopping the problem occurring again.

While participant two enjoyed reading the book provided, he preferred to read from an actual book itself. He read the newspapers supplied in the application, and looked at the calendar of events and book club details, even noting that the book club details were incorrect (test data had been left in the system by mistake).

He had described the variety of choice on the device as a key reason as to why he liked the device. He enjoyed the YouTube application and the book application, but also liked the 'Maps' application (allowed access to the Google Maps website and another core application that could not be deleted).

The YouTube application was described as "nostalgic", with the participant reporting that he spent a lot of time looking up old TV shows and songs from times gone by. This kept him busy in the evenings when it was quiet and there were few people around in the care centre.

6.4 Final Trial - 2 months

There are a number of difficulties associated with working with residents of care settings. Due to deterioration in health, participants may no longer be able to take part in the research. Other considerations, such as residents moving or leaving the home also affect participant numbers, as well as having an effect on any activities that may be provided as part of this research. During this research, 15 individuals were approached to take part in the study, with 7 signing consent forms; however, in several cases the residents who signed the consent forms did not actually participate as they had left the care centre or had a deterioration in their health. Recruitment therefore needs to be on going, because participants can become unsuitable soon after they sign the consent forms.

As discussed already, a participant moved to a new nursing home (Centre B) during the course of the research (after the storyboard phase but before the system development began). However, the participant was still very eager to take part in the research, as he wanted to keep in contact with his old friends. He also remarked that the features that had been selected for development were the types of activities and interactions that he would participate in if they were available in the centre .

It was felt that it would be useful to compare the experiences of individuals who had not been part of the research up to this point and those that had been, to see if the positive feelings towards the system as well as the participants' ability to use it was because they had a long period of exposure to the system. As mentioned earlier, many of the participants preferred those storyboard scenarios which involved group interaction. As such, it was decided to augment the study to incorporate him into it, once ethical approval was granted and the participant signed a new consent form. A fourth participant, the second from Centre B was recruited after this.

The third and final trial was a longer (8-week) version of trial 2, with a book-club meeting every weekend. The only change to the system from trial two to trial three was that the send message screen was changed to a landscape orientation from portrait. This was because participants said they found it difficult to see the touch-screen keyboard buttons in portrait mode. By moving them to a landscape orientation the buttons were made bigger and easier to see for the participants.

6.4.1 Pre-Trial Data

Four participants in total took part in this final trial, two from each care centre. Participants one and two were in centre A, with participants 3 and 4 in centre B.

Each participant took part in some pre-trial evaluations.

- The device was shown to each participant and a walk through of the features was performed. Following this, a think-aloud

using several of the features was performed.

- Arnold Lund's USE [98] questionnaire was administered, which measures the usability of a system. This was introduced in trial three as a technique to compare how the new participants and existing participants felt about the usability of the system.

- A short interview asking what the users were most looking forward to using and in the case of the participants who had not been part of the research, a more comprehensive interview including what they did during the week was also conducted.

Participants 1 and 2 had taken part in all stages of the research up to this point, including the previous trial. Participant 3 was completely new to the research. Participant 4 was the resident at the Centre A who had moved to Centre B.

Participant 1 had irregular contact with his family and only had one or two friends that he felt he could depend on or contact on a monthly basis.

He was positive about the device during his pre-trial three interview (having used it previously) and his 'USE' results backed up these statements.

- Usefulness: 48/56

- Ease of Use: 66/77

- Ease of Learning: 24/28

- Satisfaction: 42/49

During the interview, he described the system as "marvelous - an addition to anyone who hasn't got an outlet". He also noted that he regularly discussed the system with Participant 2, speaking about what sort of things they looked at (he described some of the TV shows Participant 2 liked to watch on the YouTube application). They also discussed any problems that they had with it, such as when one of the users exceeded his monthly bandwidth limit in two weeks.

He also described the learning curve to using the system, noting that he was afraid at the beginning of it but that he wasn't any more and could use it "comfortably". He also felt that it allowed "access to the outside world" for those who were no longer able to go out regularly.

Participant 2 had also taken part in the previous trial. He had reported very little contact with family and friends in his interview.

The Arnold Lund 'USE' Questionnaire was administered and the following results were reported.

- Usefulness: 56/56
- Ease of Use: 69/77
- Ease of Learning: 22/28
- Satisfaction: 49/49

He had previously used the system and enjoyed the YouTube application, discovering many old television shows and songs that he used to watch previously, which "is entertaining, that's what I need". He also said that it gave him "a wide range of different things to do".

He had problems with the system at times, specifically the internet, but this was due to him exceeding the monthly limit on the sim card.

Participant 3 was a new participant who had some cognitive and physical impairment due to a stroke he had suffered a number of years previously. However he was still relatively active and was eager to stimulate his brain in order to improve it.

He did have difficulty with the system when first presented with it. However his feelings around the potential of the system were high - the following are the results from the USE questionnaire that was administered:

- Usefulness: 53/56
- Ease of Use: 69/77
- Ease of Learning: 21/28
- Satisfaction: 47/49

The participant qualified the slightly lower scores in the ease of learning section, stating that they were due to his own feelings that he may take longer to learn how to use it due to learning issues related to his stroke.

Participant 4 had taken part in the early stages of the research, but not in the development stages. He had some physical impairment due to a stroke he had suffered a number of years previously, but was very keen on strengthening and improving the damaged parts of his brain.

Like participant 3, he struggled with the system at first, but again saw potential in it, and hoped he could learn to use it.

His scores from the USE questionnaire were:

- Usefulness: 56/56
- Ease of Use: 69/77
- Ease of Learning: 22/28
- Satisfaction: 49/49

6.4.2 Think Aloud Findings

Each participant undertook a think aloud test, where after watching the researcher step through each feature, they were asked to use the device themselves.

A number of problems arose. There were issues around the touch-screen keyboard, with some of the participants reporting that they could not see some of the numbers and letters on the keyboard when writing a message, though it was also noted by the participants who reported this that they needed new glasses. There were also issues on occasion where participants would inadvertently press multiple buttons as they did not lift their finger from the screen completely, or held the system by the side of the screen.

A solution was proposed to change the orientation of the screen from portrait to landscape. When in landscape orientation, the iPad on-screen keyboard and individual keys are bigger. A quick test with the participants suggested that this would be easier to use than the current portrait orientation, even if it meant that they had to rotate

the device. The reason for keeping the interface consistent with tap interaction and no rotation was important at the beginning of the project in order to reduce confusion, but the participants did not struggle with it in reality.

It was necessary to spend extra time with with Participant 4 (who had slight memory impairment) so that he could learn more about how to use the system. There was a noticeable improvement after only one session.

Another issue that arose was that when returning into the system after the lock button had been pressed, the last used application would appear on screen, which was initially confusing to some participants. An adjustment of the user guide (Appendix **??**) that accompanied the system was made accordingly.

Finally, the users were looking at the keyboard while typing, so would not notice any typing mistakes until they had finished typing. Moving from a portrait to a landscape orientation might improve this and there would be less of a space between the keyboard and the typed text.

6.5 Trial Summary

Once this was completed, the technology was then evaluated with the 4 participants for 8 weeks in Care Centre A and B with Participant one and two in Centre A, and three and four in Centre B.

Each participant received an iPad with the 'myapp' application, the Kindle Book application, the Movies application, the Skype appli-

cation and the YouTube application installed. These were placed on the front screen of the iPad, and any other applications were moved to another screen.

Every week, a meeting was held separately in each care centre. This was scheduled to take place at a time most convenient for the participants, sometimes when activities were not on. In Centre A, there were generally no activities scheduled at the weekend (the activities co-ordinator worked Monday to Friday), so it was decided to hold the meeting on Saturday afternoon, usually directly after lunch. Participant one usually went out on Saturday afternoon around 3 p.m., but did not come out of his room till around 12:30pm, leaving a few hours in which to hold the meeting. In centre B, the meeting was held on a Friday afternoon (around 2.30 pm), before an activity that began at 3.30 pm.

In total, 16 meetings were scheduled, 8 in each centre. In reality, 6 meetings happened in each centre. In centre A, 2 meetings did not happen due to illness. In centre B, on one occasion a relative of participant 4 called to visit, and another occasion participant 3 had a medical appointment which took longer than expected.

During each meeting, participants were asked about what they looked at on the system during the week, and if they had any problems using the device that needed to be dealt with.

It was originally anticipated that each week, a new book (or movie) would be chosen in consultation with the participants. However, this was not what happened in reality for a number of reasons.

- Participants could not finish the books in one week, so it was better to stretch out the books over a number of weeks. In

total, 2 books were used over the 6 meetings. 2 movies were also available.

- There was a gradual learning curve experienced by all the participants (discussed in more detail in section 6.6) meaning that they began to use more of the applications on the iPad, such as the the Safari internet browser and the YouTube application, to watch old songs, tv shows and movies. This meant there was a broader range of topics to discuss.

- Participant One reported that he found reading difficult, and so asked if it was possible to could listen to them instead. He was provided with 2 audio books over the course of the trial.

- Participant Two reported that he did not like reading on the screen of the iPad, preferring to read from books.

6.6 Gradual Improvement of Technical Ability of Participants

There was a gradual improvement in technical ability by each participant over the course of the trials. Certainly, the participants in Centre A (where the first two trials took place) were more advanced than the participants in Centre B at the start of Trial 3, but there was a technical improvement in all participants as they became more confident. This led to richer discussion at the weekly meetings as participants talked about tv shows and characters that they used to watch.

The improvement roughly followed the same route for each participant. Initially, the participants were apprehensive about the system,

using the user guide (Appendix ??) regularly and sticking to the applications presented on the main screen of the iPad.

This continued for 2 or 3 weeks and certainly this was reflected in the meetings held in the first few weeks of the trials, where the main focus was books, adding contact addresses so some of the participants could contact their family, and technical issues.

After these first 2 or 3 weeks, participant 3 and 4 (in centre B) began to ask whether it was possible to listen to music or watch tv shows. Initially, it arose as Participant Two had discovered YouTube while exploring the device - he mentioned that he just kept pressing buttons until he found something he liked. Eventually he stumbled across the YouTube application, and began accessing songs and tv shows that he liked. Soon, it became the main application that he used.

As stated previously in section, Participants one and two, who were based in Centre A, began to access YouTube towards the end of Trial Two, which was approximately after 3 or 4 weeks of usage. Participants 3 and 4, who received their iPads at the start of Trial Three, began to access it a number of weeks into that trial. Participant 3 began accessing YouTube about 4 weeks in, while Participant 4 (probably the most impaired of all the participants), did not begin this until week 7. He did struggle with the system, but eventually began to get used to it.

6.7 Analysis of Trial Three

Following the 8 week trial, the following tools were used to analyse it:

- The Microsoft Product Reaction Cards were administered.
- The Intrinsic Motivation Inventory scale was administered.
- Arnold Lund's USE questionnaire was administered.
- A short interview asking what the participants used the most (and least), what were there initial expectations and how (if they had) these had changed, where the device fitted into their life. These interview questions are included as Appendix ??.

Each Participant is now discussed in detail.

6.7.1 Participant One

Participant one picked the following 5 words from the Product Reaction Cards:

- Valuable - "It gives me another lease of life"
- Time Saving - "Just press a button and it comes on"
- Effortless - For similar reasons to time saving
- Attractive - He asked if interesting was a word that could be used (it's not one of the words) - "I can pick what I want to watch"
- Useful - He can use it to communicate with people (he sent a message and received one back from Participant Four, which he was delighted with) "You can get anything you want on it", and it had a "varied choice" of activities.

His intrinsic motivation scale came back with the following scores:

- Interest/Enjoyment: 49/49
- Perceived Competence: 42/42
- Effort/Importance: 26/35
- Pressure/Tension: 14/35
- Perceived Choice: 49/49
- Value/Usefulness: 49/49

He was very happy with the device, and the lower scores in the effort section were due to him not feeling that he needed to expend as much effort as he thought to use the system. Similarly, he remarked that the pressure he felt was high because he had put pressure on himself initially to "get it right", and "didn't think it would ever work" when he first got the system.

His 'USE' Questionnaire scores were the following:

- Usefulness: 56/56
- Ease of Use: 77/77
- Ease of Learning: 28/28
- Satisfaction: 49/49

indicating a 100% satisfaction with the system, and a marked improvement from his score in the second trial.

Initially, he "didn't have an expectation of using" the system.

> "I didn't think I'd ever turn it on ... Then one night, I started, and I got one thing, I got "Rattle and Hum" (a

> music band) ... I went down the corridor with my hands on my head ... I had the whole world ... that's how I got started".

During his interview, he remarked that "life is more interesting" since he received the system, and uses it once every 2 days. He watches a lot of YouTube clips on the device, such as old episodes of television shows that he used to watch. He mainly uses the system during the evening or at night, which was similar to with all the other participants. His day time activities have not changed much (he does not take part in activities but does leave the centre to go to the shops), but he noted that he spends a lot of time during the day thinking about what he is going to look at on the system later and what "it's going to do for him".

He described the weekly meeting as "brilliant", noting that it was the only social activity that he took part in the Centre A. Furthermore, he said that his relationship with Participant B has changed "vastly", saying that they were "more than friends" as they had bonded over the shared experience of owning an iPad and other pieces of technology, as well as the trouble they have with technology, such as topping up a mobile phone.

> "Myself and (Participant 2) have more of a banter (rapport).... the two of us have more interests"

When asked if he would have liked more participants in the meetings,

> "Myself and (Participant 2) and (the researcher), that was ideal, too many cooks spoil the broth".

The system is also a focal point of discussion outside the meetings, as Participant one recounted how Participant two told him he had watched a full (2 1/2 hour long) movie on the system. This was brought up in one of the meetings, but it was clear that the two participants had discussed it outside of the meeting as participant one described the scenario. Overall, he felt that he had more contact with Participant two since the trial started. In fact, he mentioned that as a result of being part of the trial and owning an iPad, that more people are talking to him about the iPad, as "they're all interested", with the questions he faced revolving around how he could afford it and where he got it from. He was also very careful not to let anyone else touch the system in case they broke it and had to "ban" people from touching it as a result.

While he does not use the messaging and calling systems to contact people outside the home, he says that it has positively affected his communication with his friends outside Centre A, saying that he is now "vastly" more able to talk to people as he can talk about his interests more to them.

> "If you were sitting down, drinking coffee all day, you'd talk to no-one, but because you've an interest, you're able to explain things more and do things more".

He did send one message to Participant 4 (in Centre B), which delighted him.

> "What surprised me more, was (Participant 4) answering the message".

Participant one has not used a computer in years (apart from the iPad), and stated that he was scared of them, recounting an experience where he printed 45 sheets of blank paper while trying to print out a 1 page CV about 20 years ago.

When asked what the difference between the iPad and a computer was, he replied:

> "You press just the one button, you get what you want, and you have it all on screen ... you're touching it rather than looking at it".

He also seemed to think that the iPad had more content than a computer, and watched music and videos mainly, but also watched some of the movies supplied 4 times, as well as the audio books that were supplied to him instead of the written books.

Initially, he had problems with the interface, but said got used to it. The fact it only had one button, as opposed to the many buttons on computers, which "scared" him, was a big benefit. He seemed to use a trial and error strategy until something worked, rather than searching for the most efficient way to use it.

> "No that didn't work, why did I touch it like that?"

6.7.2 Participant Two

Participant two, like participant one, was also resident in Centre A.

He picked the following 5 words from the product reaction cards.

- Useful - "I can dig up things that I wouldn't normally know about, like educational things".
- Simplistic - "It's simple to use, gives you an answer straight away".
- Novel - "It's something I've never used before - a whole new area for me".
- Helpful - "I find out so many things that I wouldn't be able to get access too".
- Convenient - "always nice to have there when something comes into my mind to look at it or answer".

His intrinsic motivation scale came back with the following scores:

- Interest/Enjoyment: 49/49
- Perceived Competence: 39/42
- Effort/Importance: 19/35
- Pressure/Tension: 18/35
- Perceived Choice: 43/49
- Value/Usefulness: 49/49

His effort/importance score was lower as he felt he didn't need to put in as much effort to use it, which is a positive finding as he felt he could use it successfully by this point. Similarly to participant one, he put pressure on himself to use the system, and as a result had higher scores in the pressure section.

His 'USE' Questionnaire scores were the following:

- Usefulness: 40/56
- Ease of Use: 66/77
- Ease of Learning: 28/28
- Satisfaction: 49/49

During the interview he noted that he uses the system mainly at night, instead of watching the television. He never uses it during the day, and starting around 9 o'clock in the evening when he receives his last set of tablets for the day, closes the door to his room and begins using it. He uses it daily, and in fact has used it so much that he ran out of credit early twice and had to be topped up again.

> "the television now isn't so good, so I change to the iPad, and I'm fiddling with the iPad all night".

He uses the system a lot on his own, mainly to watch television shows via the YouTube application.

> "I've lots of memories, and that (the system) fills them up for me - I only have to think of something, print (type) it out and it's there in front of me".

He also browsed the internet using the Safari internet application, reading newspaper headlines and browsing current affairs sites. He sees the system as very "personal", bringing back memories from the past.

> "I've watched a terrible lot of television in my lifetime, and these things keep coming back to me, the shows I've

> enjoyed in the past ... so the past is important to me, the nostalgic end of it ... I'm amazed at what (the system) has dug up ... old dance bands, old singers and comedians".

He enjoyed the weekly meetings, describing them as "enlightening".

> "Some things that are discussed (in the meetings) sometimes 'click', and it's interesting"

However, he did not feel like his relationship with Participant one had changed as a result. He felt that they watched different things, and did not see each other any more than usual as a result of the trial. He was happy using the system on his own, saying.

> "I find I've plenty of personal enjoyment with it, and don't discuss it with anyone".

This was also reflected in his lack of use of the contact and messaging functions. His daughter had provided her email address to the researcher and was entered into the system, but he did not contact her throughout the trial.

> "In the past 20 years I've had no (major) contact with any of my family ... we're on good terms ... we've gone into different types of living".

He doesn't use any other type of computers at the moment, but expressed interest in owning another computer, now he has used the system, but feels he needs to be taught properly and slowly.

> The system "is more of a personal thing, but the laptop has a much bigger range of items".

He sees a distinction between the system and a normal computer, seeing a computer as providing everything, with the system more for accessing personal memories. He recounted how he used the Safari Web Browser, but struggled to see the text as it was too small on the websites that he went to. When he used the multitouch zoom function, he found himself lost on the page.

> "I can't get to grips with it"

However, he felt this would not have been a problem if using a laptop, as the text would be much larger.

Overall, participant two enjoyed using the system, describing himself as "enamored" with it. It certainly filled periods in his day when no activities were available, such as in the evenings or at weekends. The meetings provided information and discussion, but he did not feel he was any closer to or had more contact with participant one as a result.

6.7.3 Participant Three

Participant 3 was resident in Centre B, living in a house on the grounds. He was new to the study, only taking part in the final trial, and was not part of any of the earlier stages of the research.

He picked the following 6 words

- Impersonal - "doesn't interfere with your own life"

- Usable - Very obvious how to use it
- Accessible - Easy and well laid out, easy to understand, as simple as an ATM
- Clear - leads you on to the next thing very clearly, like the wizard in the messages, tells you what to do
- Impressive - he was impressed at the speed at which you get the information
- Appealing - "modern technology that's easy to handle."

His intrinsic motivation scale came back with the following scores:

- Interest/Enjoyment: 46/49
- Perceived Competence: 41/42
- Effort/Importance: 35/35
- Pressure/Tension: 5/35
- Perceived Choice: 49/49
- Value/Usefulness: 49/49

His 'USE' Questionnaire scores were the following:

- Usefulness: 53/56
- Ease of Use: 77/77
- Ease of Learning: 27/28
- Satisfaction: 49/49

He noted that, like all the other participants, he mainly used the system during the evening, reading in bed before going to sleep. He particularly liked that he could read in bed without having a light on, as the iPad screen has a backlight. He does not use in much during the day, though he does read the news headlines on the 'myapp' application in the morning when he first wakes up.

Like participant two, he notes that the system has made him interested in buying a standard computer for email and research. He gave an example of searching for a new television using the internet, that his relative showed him was much cheaper online.

> "It's made me think about buying a computer, I'm thinking of going online ... because that was contrary to my mind, I couldn't handle a computer and there was no use in thinking I could ... I could handle one now".

He feels he has become closer with Participant 4 (also in Centre B). Before the trial, he knew Participant 4 "hardly at all", but have bonded over the common interest of the system, with Participant 3 helping participant 4 and checking how he was getting on (Participant 4 had a stroke and was probably the most cognitively and physically impaired of the 4 participants, and struggled the most with the system). Furthermore, they have discussed each other's past, with Participant 3 describing Participant 4's career in shipping, as well as his family and other interests. Furthermore, they did meet up on a number of occasions separate to the organized meetings, where participant 3 helped out with any problems participant 4 had, and having a general chat about the books they read. He also felt that the meetings were re-assuring personally, giving him "the confidence that he was doing it (using the system) right."

Similar to participant 1 and participant 4, the comparing of how you are doing to everyone else was important at the weekly meetings, which seem to have been used by participants for social contact as well as reassurance.

He used the messaging, book reading, and newspaper headline features the most. Occasionally, he used the music and YouTube applications, but less than the others.

He was the most frequent user of the messaging system of all the participants, sending on average one message a week to his family (usually short messages like 'How are you getting on'), as well as a message to the researcher that he was unable to attend the weekly meeting on one occasion. He liked the 'wizard' format of the messages, as it would "lead you on to the next thing very easily and tell you what to do".

He used the calling features of the system the least, as he had his own phone (landline and mobile) so was not in need of it. While he read the newspaper headlines on a regular basis, he would like to have more access to features and the complete news story if possible, rather than just the headline and summary of the story.

He also feels that the system has helped with his concentration, which was damaged as a result of a stroke he suffered approximately 10 years ago. Specifically when reading the books, he feels that he can concentrate more than he did as a result of it.

6.7.4 Participant Four

Participant Four was also resident in Centre B, living in a self-contained apartment in the main building. He had taken part in the early stages of the research, but only took part in the third and final trial, and not the first two.

He picked the following five words from the product reaction cards to describe the system

- Controllable
- Time Saving
- Fast
- Friendly
- Fun

His intrinsic motivation scale came back with the following scores:

- Interest/Enjoyment: 39/52 - he was frustrated with it but found it very interesting.
- Perceived Competence: 19/42
- Effort/Importance: 35/35
- Pressure/Tension: 25/35
- Perceived Choice: 49/49
- Value/Usefulness: 49/49

His USE Scale results were the following:

- Usefulness: 34/56
- Ease of Use: 40/77
- Ease of Learning: 13/28
- Satisfaction: 33/49

Participant 4 left the system on the table in his sitting room, and uses it in between activities, but mainly at night. He does not use it so much to fill the time and he has nothing else to do, but because he wants to. He could "go to 1 o'clock in the morning" using the system.

Participant 4 used it to listen to music via YouTube and surfed the internet using Safari on occasion, but also focused a significant amount of time on just pressing things with his finger "until I find something". He suffered from memory and physical impairment on the right side of his body due to a stroke he suffered a number of years ago, and one of the main issues using the system that he recalled was that he found it very difficult to trace back his steps - "having got something very good and helpful for me, I couldn't recall it".

He also felt, like Participant 3, that the system has had a positive improvement on his health, but it simultaneously frustrated him:

> "I saw myself, all the nice things that were paraded in front of me, and I wasn't able to recall them ... so it was very frustrating in that way."

He still feels that he has inadequate social interaction, despite attending "quite a few" activities, due to shyness on his part. The

system has helped him in this regard, and he has decided to join in the painting classes that Participant 3 also takes part in, after hearing about it during the weekly meetings.

> "Whenever I'm frustrated or lonely or whatever, I pull it out and try to input or output something from that, and it does lift the monotony, does in a big way, but I would dearly love to be able to use it".

He found the meetings "quite interesting", but struggled to understand Participant 3 (who has slight speech impairment since his stroke). He still believes that he knows Participant 3 better as a result of the trial, and sees him more as a result. He talks to him "much more", about things such as the books they are currently reading, and how they are getting along with the system.

> "Before, I used my usual evasion trick when I didn't know what he was saying ... until I could understand it a bit better, but I can usually get something out of what he does ... he is very good at finding out things and he doesn't mind sharing"

He used to read (physical) books, but cannot do it much anymore due to his eyesight, however he has found it easier to read as a result of using the Kindle application, reading some of the books that were chosen.

6.8 Conclusion

This chapter has described the evaluation of the system in 3 separate trials, with a total of four participants located across two nursing homes. Each trial was longer and more comprehensive than the last, with the first focusing on the usability of the system, the second on the system and group meetings in tandem and a final, longer 8-week trial to evaluate the system over a longer period.

The participants stated during the requirements gathering (described in Chapter 4) that they would like activities that they could undertake in their personal time and would subsequently provide for "discussions" (as one participant stated) in group meetings. The findings from the trials largely reflected what was reported by the participants earlier in the research.

The participants spent significant amounts of time using the system in their personal time, such as reading books and watching movies. This activity was then discussed both in the arranged group meetings held every weekend with the researcher, but also between the participants informally, when the researcher was not present. Furthermore, some of the participants visited each other in their rooms to discuss the system or to help each other if they were having problems.

The majority of participants felt they had become closer to the other participants as a result of using the system, but some also used the system to contact friends and family. It was felt that this was not the key (but still important) feature of the system following the requirements gathering discussed in Chapter 4, and this was borne out with participants contacting their friends and family, but

spending more time engaging with people inside the care centre than with people located outside.

The participants also grew into the system, initially using the developed application exclusively but then expanding beyond it to use many of the applications provided by the iPad. Some began using the YouTube feature more regularly, and this became an extra activity that they undertook on their own (mainly at night or in the morning) but also one which they described to and discussed with other participants, further reflecting what they reported during the requirements gathering process. This suggests that it may be better to build a system that can grow as the users become more adept at using it.

An additional finding was that the participants watched and discussed a lot of TV shows from their past, and this reminiscence could be another potential avenue to increasing engagement and communication within the care centre. This will be discussed further in Chapter 7.

7 Discussion, Conclusions and Future Work

The introduction to this thesis suggested that social isolation has a negative impact on the health and well-being of older people, and those in care settings, potentially isolated from friends and family, are particularly at risk. Keeping older people active and engaged has been shown to have a positive impact on their lives.

Furthermore, technology-based solutions have been used in some studies, but much modern technology does not necessarily cater towards to the needs of older people, who can suffer from impairment and a lack of experience with technology.

While previous interventions have examined designing communications technology for older people, the majority have focused on older people living at home. This study examined designing this type of technology with those in care, whose needs can be quite different from those still based at home. As such, the following research questions were proposed:

- Research Question 1: How can a technology-based communications system contribute to an improvement in the psycho-social well-being of older people in residential care settings?
- Research Question 2: What sort of features should such a system contain?
- Research Question 3: How can such a system be successfully designed and to what extent does the approach required for older people in residential care settings differ from that required for older people living at home?

- Research Question 4: What types of technology are the most suitable for older people in residential care settings?

This study has provided a technology-based communications system for older people in care settings, using a User-Sensitive Inclusive Design process. This process identified key features that older people in care settings would like, developed and implemented system with them based on these features, and over the course of three trials, tested it with 4 participants (each with different levels of impairment) based in two different care centres. It also identified some differences between designing for those at home and those in care, such as the involvement of staff and the focus on connecting with other people in the care centre to increase engagement. Specifically, this addresses question 3, as a process for successfully designing a such systems was identified and evaluated, with the differences between designing for those in care and those at home highlighted. It is also related to research questions 1 and 2 as the study identified the types of features such a system should contain as well as demonstrating a potential impact on the psycho-social well-being of users through increased communication and engagement. Findings from the evaluation of the system suggested increased engagement and communication in the group.

The aim of developing and testing the system was to provide a validation of the design approach, which addresses research question 3. Furthermore, the testing was designed to see if and how the needs of older people in care differed from those who were not in terms of communication and activities (addressing the second part of question 3), to explore modern input systems such as touchscreen based devices and how older people managed with them (addressing question 2 and 4 and it related both to the features such a system

should contain and the types of technology suitable for older people), and whether a group activity based on activities in personal time was a suitable way of increasing contact and interaction between older people in care settings (which incorporated choosing suitable features, which addressed question 2, and illustrating any differences in designing for this group in care, which is related to question 3).

At the start of the project, using technology to enhance communication between an older person in care and their family and friends was thought to be the key feature, and to an extent this is supported by some of the data from the resident and staff interviews. However, while contact with friends and family outside a care centre is one way to increase social engagement, feedback and findings from this study suggest that a more appropriate solution may be to reduce boredom and increase contact within the care setting, through the use of group activity and allowing residents to have more control over their own personal activities. These particular findings address questions 2 and 3 as the features of such systems should be designed for increasing engagement between people in care settings. Furthermore, this differs from studies that have designed for those at home in a number of ways, such as the frequency of meetings as well as the methods of communication (face-to-face vs through a computer), as there are opportunities for engagement between those in care settings that are not present for those at home.

7.1 Participant Feedback and Trial Analysis

The feedback from participants and data from the trials, through a mixture of interviews and scales, was largely positive. Despite the relatively small numbers, all the participants regularly used the

system (each in slightly different ways), and the majority enjoyed the weekly meetings, feeling they had become closer to the other participant in the care centre as a result. Each group also reported discussing the system outside the scheduled meeting, and recounted stories that other participants had told them indicating an increased level of communication. Furthermore, participant four is intending to take part in some of the activities that participant three does in Centre B, as a result of what he has heard at the weekly meetings. So as well as increased contact at the meetings, some of the participants are increasing engagement outside the meetings, as well as using these meetings as a way of exchanging information and finding out what is going on in the centre. Through this analysis as well as interviews conducted before and after using the system, participants reported increased interaction and engagement within the care centre, which supports the hypothesis that a system designed can increase engagement and interaction between older people in care and provide more activities for them in their personal time (addressing question 1). It is important to note that it is the combination of the meetings facilitated by the technology is key, with the technology providing both a common experience and topics of discussion for the meetings (addressing question 2).

The meetings also seem to have been used by the participants as a checkpoint, to see if they were progressing as fast as everyone else. Furthermore, they also used them to report any problems and get reassurance that they are using the system correctly.

Communication between participants not in the same care centre was not as frequent, but did occur, with messages exchanged between participant one and four. However, while this communication was considered the major feature of the system, there was more of

a focus on increasing engagement between individuals in the same centre. This finding supported the decision to focus on increasing engagement within the care centre, highlighting the differences in designing for those in care and those at home, thereby addressing question 3. Communication with family was more regular, with participant three communicating with his son on several occasions via the messaging feature and participant four receiving calls from his nephew in the United States via Skype. Again, however, the communication within the care centre was the main feature, which back the findings from the requirements gathering process described in chapter 4. This also addressed question 2, as it suggests that this is one type of feature such systems should contain.

All participants reported enjoying using the system, describing many of the activities they undertook. The 'IMI' scale provided further backing to these statements, with all participants giving high scores in the 'interest/enjoyment' category. It was interesting to note that all used the system at night before going to bed. Some also used it in the morning or between activities, or at the weekend when no activities were scheduled (such as in Centre A). This would suggest that the system is used to supplement their day, rather than replacing activities they were already doing, which was considered important by the participants during the early interviews. This suggests that the applications chosen (Kindle, Movies) and the features in the 'myapp' application, along with YouTube, are among the major types of software of use to older people - this is related to research question 2.

7.2 Learning Curve

All of the participants began with the same core set of features, but quickly progressed (sometimes through asking the researcher, on other occasions by exploring the system themselves) onto other applications. This would suggest that the touchscreen system is more suitable for older users initially (addressing question 4), though further work is needed to explore this. However, several participants reported that they felt they couldn't use a computer before the research, but were far more confident and interested as a result of the introduction of this system. Feedback from the 'USE' questionnaire indicate that the participants had difficulty at first, but quickly adapted. This backed the hypothesis that a lightweight, touchscreen-based computer, rather than a more standard PC may be suitable for this group, which again addresses question 4.

Some participants were slower learning to use the system than others, and this may be due to increased impairment. Participant 4, who had suffered a stroke approximately 5 years ago, found the system the most difficult to learn, but did improve like the other participants did, albeit at a slower pace. He also felt that the system had improved his cognitive function and expressed optimism that he could soon "crack the code" of his brain and really benefit from the system. He stated that his main problem was tracking where he had been and getting back to that point, for example back to a video he liked, as the stroke had impaired his memory. This could suggest that further work is required to develop a system for those with more impaired memory function. Participant 3 also suffered a stroke (approx. 10 years ago) and had similar physical impairment but less of a memory impairment. He used the system more suc-

cessfully than participant 4, further suggesting that memory was the issue for that person. This is related to research question 4 and may lead to future work as while the more impaired participants took longer to learn the system, they were able to learn it, suggesting that this type of technology could be suitable for a wider variety of individuals than were part of this study.

7.3 Comparison to previous interventions

Cattan [30] suggested a number of characteristics that successful interventions shared in their literature review:

- Group interventions with an educational input or provided support activities (e.g. carer support).
- Targeted specific groups.
- Consultation with the target group before the intervention.
- Include a process evaluation, such as information on activities, feelings and hidden changes that occurred during the intervention.

One-to-one interventions conducted in people's own homes were the only common characteristics of ineffective interventions.

This study adhered to many of the characteristics described above. It provided a group activity (not one-to-one) to a specific group, consulted with them before the implementation, making them a partner in the research process through the use of a user-sensitive inclusive design process. It also included a process evaluation, obtaining in-

formation on activities and feelings through interviews. Cattan also states that:

> "It would seem that incorporating activities known to enhance self-esteem and personal control may improve the long-term effectiveness of group interventions."

The features provided by the system were intended to provide this personal control, which many participants felt they had lost. During the interviews, many of the participants reported how the activities provided by the system allowed for increased control over their activities, allowing them to look at "whatever came into [their] mind at the time". This is related to research question 2.

7.4 Using individual activities to increase engagement in care settings

Like the Building Bridges Project [1], the aim of this study was to use activities as a shared experience to promote discussions in the meetings. Building Bridges used a shared radio show that participants listened to together, and participated in a group chat afterwards. This was a suitable choice given that the participants did not live together, or even near each other in some cases.

This study built upon the findings of that project and augmented them for use in care settings. It provided personal activities that seem to reduce the reported levels of boredom and periods of inactivity that participants reported, while simultaneously providing a group meeting at which they could discuss their common experience, potentially increasing contact with each other. The majority

of participants stated that they were closer as a result of the system, and had more activities, particularly at the evening and weekends when organized activities are reduced. This is related to research questions 1 and 2.

7.5 Involvement of Carers and 'non-users' in the research

Newell and Gregor [71], in discussing user-sensitive inclusive design, suggest that the user group:

> "might also need to be expanded to include informal or formal carers and medical therapeutic and rehabilitation experts who might not formally be 'users' of the systems"

From this study, it is suggested that when conducting research to design communications technology in care settings, it is essential that these other stakeholders such as staff and management of the care centre the research is taking place in are involved from as early a stage as possible. This research would not have been possible without their involvement, from agreeing to support the research in their care centres, as well as providing feedback and input in the data gathering stages of the research. This is related to research question 3.

7.6 Integration of Application

Before the trial, it was thought that the entire system would ideally have been integrated into one application, so participants would not

have to constantly change between applications. In hindsight however, this lack of integration allowed participants to explore other applications (such as YouTube and Safari, a web browser) on the device and in fact was a big benefit to the participants.

It facilitated the learning curve experienced by all the participants and perhaps in future work the design of such systems could allow the ability to add-on features or remove some of the restrictions as participants become more experienced and able to use them. This is related to research question 2.

7.7 Touch-based Interaction

As stated previously, touch-based devices have been used successfully by older adults [1] [23]. Participants in this study reported that, despite struggling at first, they quickly got used to them and were able to use many of the applications in the system successfully. The use of a single gesture at first (tapping the screen) for the majority of the applications seems to have helped with this, as one participant described how the 'pinch to zoom' functionality in some of the other applications (such as Safari) confused him. Similarly, participants were unaware at times that it was possible to swipe down in the newspaper feature in the 'myapp' application at first. This is related to research question 4.

Again, the findings suggest that the more impaired an individual, the more they struggled with the system (participant 4 found it quite difficult). Think-aloud experiments indicated the participants could use the system successfully, though some changes were required participants managed to become familiar with the system

and use it successfully.

7.8 Contextual Factors

Otjacques et al. [2] recommended an examination of the best place to locate computer systems in care settings, stating that some of the participants in their study did not use the system they developed as it was in the main lobby of the care centre.

In the study presented in this thesis, many of the participants used the system late at night in bed, which suggests that, if possible, participants should get an individual device rather than sharing one, and provide connectivity so that the participants can use it wherever they want, rather than the researcher selecting a location. It also suggests a lightweight portable device that does not need a table to support it may be more suitable for this type of technology. The use of sim cards in this research allowed the participants to use it wherever they wanted to, and it is interesting how they all used it late at night, on their own, in the comfort of their beds. This is related to research question 4.

7.9 Communications Technology in Care

From the research presented in this thesis, it seems that communications technology in care settings can provide activities that reduce boredom, which can then be used as a route to strengthening friendships and increasing engagement. Certainly, 3 of the 4 participants in this study reported increased levels of contact with other participants and those same 3 participants were in contact with people

outside their own care centre. All reported using the system regularly, especially when no other activities were scheduled in the care centres, showing that it can provide engagement and activity outside arranged activities and keep residents occupied during these quieter periods, potentially replacing other activities such as watching television. This is related to research questions 1 and 2.

This thesis suggests that activities from the past and recounting memories may be the basis of features that could work for older people in care, as well as providing information and resources such as books, movies and newspapers. In this study, all of the participants used a variety of different system features, but notably learned quickly and soon began to move away towards the features they liked the most, such as the YouTube application or Safari. This suggests that in the design of these systems, it may be prudent to design the system with stages, so that as a user becomes more comfortable and familiar with a system, they can do more and more. The participants in this study did not all learn at the same pace, but did follow the same path in what they accessed and how they accessed it. This is related to research question 2 and 4.

The face-to-face communication held every week provided participants with reassurance as well as finding about what other participants were doing with the system and exchanging information about activities. All of the participants reported some level of benefit from the meetings, with the majority reporting that they were more friendly with the other participants as a result. Further research could carry out a longitudinal study with a larger group. This is related to research question 1.

7.10 Designing for Older People in Care

A user sensitive inclusive design process was used in this research, and enabled the development of communications technology for older people in care. Newell and Gregor state that "it is vital that clinicians be members of the research team" [22] on certain projects. This research presented in this thesis suggests that clinicians and staff from the care centre the research is being conducted in are also crucial to the project, as this research would not have succeeded without their input. Otjacques et al. [2] suggest the importance of staff in designing technology in care settings that both staff and resident may use, and this seems to extend to resident only technology.

Taking in total the research questions and how different facets of each have been addressed (as described throughout this chapter), this study has identified a process for designing technology for older people using existing literature and guidelines as a baseline. It has identified the types of features such technology should contain, namely activities that can be undertaken in personal time but can also be used as a basis for group discussion. Findings from the trials suggest that these activities could involve reminiscence of some sort, for example watching old TV shows or reading books from the past.

This study also illustrated some differences between designing for those in care and those at home, such as the involvement of staff who may not be present at home and the potential for face-to-face communication with other residents in care that again is not always possible for those still at home. It has also identified technology that could be used by older people in care, and potentially by more impaired individuals too. The iPad (and other tablets that have since become commercially available) seem to be suitable for this

age group both in terms of hardware (e.g. portability, lightness, few physical buttons) and software (e.g. simpler design, no keyboard/-mouse).

Overall, this research has presented a method to design such technology, what features the technology should have, what type of technology is suitable for the group using it. and evaluated the technology successfully with an appropriate user group over a number of months.

7.11 Limitations and Future Work

The approach and resultant system described in this work describe an opportunity for the use of communications technology within a care setting to increase activity on an individual level, and using those activities to increase social contact and engagement on a group level. At the outset, while there were studies examining the use of communications technology by older people, they had not examined those in care settings.

This system was tested on a small user group with a variety of impairments. Older people are quite varied in terms of impairments and abilities and further work could consist of examining it with older people with different levels of impairments, such as memory loss as a result of a stroke or dementia. While this research did not focus specifically on these types of impairments as there are significant numbers of people in care within Ireland who are not suffering with dementia, the number of people with dementia is expected to double within the next 20 years [99], indicating that future research would need to take this growing group into account. A review of

ICT-based services for unmet needs in people with dementia by Lauriks et al. [100] stated that people with impairments such as mild to moderate dementia "are capable of handling simple electronic equipment and can benefit from it". Furthermore, as dementia progresses in an individual, their needs can change, with memory support in mild dementia to support in almost all activities of daily living (ADL) when suffering from severe dementia [100]. The review identified and focused on 4 need areas: generalised and personalised information, support for symptoms of dementia, social contact and health monitoring/safety. With modification, the designed system could potentially address needs in a number of these areas, especially social contact, information and support of symptoms.

Interviews with nursing home residents and meeting centre visitors who suffered from dementia suggested that social contact (both with friends and family) and enjoyment of activities such as watching TV or reading a book are important for their quality of life (QOL). Furthermore, they also state that self-determination, or being able to do "what you want, when you want" was important for them [101]. Clearly, this links in with the research presented in this thesis, as the participants in this study were able to watch the TV shows and movies that they wanted, or as one participant said "whatever came into [their] mind at the time". This also suggests that a similar technology and meeting system could also work for this group.

However, many of the needs of dementia sufferers in care can be unmet, with one study showing that given an average of 16.5 needs per resident with dementia in the UK, 4.4 were unmet and 12.1 were met, with social needs such as daytime activities and interaction with others often unmet. The most common unmet need was for "stimulating daytime activities", while company was the third

highest unmet need [102]. Again, the designed system presented in this thesis could provide some support for these unmet needs, both providing daytime activities and, as Droes et al. [101] suggest, the ability for the resident to choose the type of activity they wish to undertake.

It is apparent from the previous paragraphs that the system presented in this thesis could, with modification, be used by those with dementia to increase their activity levels, contact levels and self-determination levels. But what sort of modification would be required? What sort of features and activities would be suitable for this group, and is the type of technology used in this thesis (tablet computer/iPad) suitable for this group too?

A study by Hart et al. [103] suggests that many clinicians feel that portable electronic devices could be used as an aid to learning/memory and planning/organisation for those undergoing brain injury rehabilitation, including storing calendars electronically, planning the daily schedule and shopping lists. Other studies have examined the potential of mobile phones to stream video messages reminding people with mild dementia to undertake daily activities [104]. Again, the calendar feature of the 'myapp' application could be modified to incorporate such functionality with relative ease. The iOS software present in the iPad also allows for 'Push' notifications, where a user could be alerted at certain times to perform a task or be reminded of some event, further demonstrating that the applicability of the system to this group.

However, much research has focused on reminiscence therapy, which "involves the discussion of past activities, event and experiences with another person or group of people" and has "promising indications"

that it can have a positive effect on older people with dementia, though the authors also state that more work is required to draw firmer conclusions on this [105] . The authors further state that this reminiscence work could be conducted in a group with other people with dementia or with cognitively intact older people, or in the creation of a life-story book. However, they also suggest that it is "likely that therapeutic approaches need to be tailored to the degree of impairment of the participants". The system presented in this thesis could be modified to allow a user to create a life-story book in their personal time, for discussion at a group meeting similar to those held during the evaluation section of this research, though potentially this would need to be adjusted depending on the level of impairment each user had. This could be linked to the future development of a system where the system could 'grow' with the user and become more complex or less depending on the ability of the user, as described in the Learning Curve (Section 7.2) and Integration of Application (7.6) sections of this chapter.

Several studies have taken place using technology as the method of providing access to nostalgic media - Olsen et al. developed "Media Memory Lane" interventions using an easy-to-use, push-button picture based system to play songs and videos from the 1950's [106]. They reported that older people with dementia who used them chose to use them more often in their free time than any other activity, and have a positive impact on engagement and increased activity-related talking. Other research projects include the CIRCA Project, which is used by a person with dementia with a relative or caregiver to "augment the user's ability to carry on a conversation" [107]. One particularly interesting and relevant aspect to their research was the fact that they used a touchscreen for their system, citing it as essential as "research that we and others have conducted established that

people with dementia can almost always use touch screens", and the difficulty they can have learning new skills like how to use a mouse. This means that no major hardware adaptations would be needed to the system presented in this thesis, and the use of a touch-based operating system (designed exclusively for finger-based interaction) also ensures that the software (once the appropriate features have been chosen) is also potentially suitable for this group.

Finally, it is worth examining whether existing iPad applications would be suitable for a more impaired group than the participants in this study. Certainly, issues may arise with some of the features that are present in the applications and would require modification or adjustment for this group. Many of the applications, such as the Kindle and YouTube applications, require the user to log-in for certain features, such as accessing playlists. This issue is two-fold as people with dementia already have short-term memory issues [107], so asking them to remember a password would be very difficult. Furthermore, it also adds a layer of complexity to a system where it is not necessarily needed - perhaps clicking a image of the user would be simpler as a method of identification. Finally, this could create problems on devices where multiple people are using it as there would be a constant need to log in and out, with all the previously described issues regarding memorization of passwords as well.

Other features that may need revising include providing a basic selection of movies/books/pictures rather than requiring the user to search using keywords - users with dementia may struggle to use this, though it could be done in combination with a caregiver/relative performing the search based on conversation with the participant. Positively, however, the sheer amount of data available through applications like YouTube and Kindle mean that it may be possible to

find something for everyone on these applications, once certain user interface issues were resolved.

In general, the iPad/tablet computers seem to be quite popular with older people, with a Nielsen study indicating that 19% of tablet purchasers in quarter 2 of 2011 were over the age of 55 compared to just 10% 9 months previously, indicating a rapidly expanding group [108]. There are specific applications in the Apple App Store for identifying suitable applications for people with dementia [109] as well as an constantly expanding set of applications specifically designed for older people, including Silver Surf [110], which modifies the existing internet browser for use by older people with larger navigation buttons, expanded zoom and other features to make it easier to use. Furthermore, the American Association of Retired People has created an iPad version of their magazine, clearly indicating a growing market for them [111]. There are many more other applications designed specifically for older people, indicating that there is an ever growing market for them.

Overall, the system has many aspects to it that may be applicable to those with more severe impairments such as dementia. Existing research has shown that older people with dementia have many unmet needs and activity and engagement rank highest of those needs [102], with self-determination also important to these individuals [101]. The system in it's current form already provides the ability for users to choose the types of activities they wish to undertake and allows them to undertake them at a time of their choosing.

Furthermore, studies focusing on older people with dementia have already used a media system with a simple interface in order to increase activity-related communication [106]. Other more recent

studies have used touch-screen based technology as they have established that older people with dementia can successfully use them without needing to learn any additional skills, which can be difficult for such users [107]. There are many similarities between the research presented in this thesis and these studies with dementia sufferers as in each case the technology has been used to facilitate discussion and engagement, rather than replace it. They have also used touch-screen technology and a simple interface designed for ease-of-use.

Reminiscence may be one specific way of using the system with those suffering from dementia in any future research. Many of the participants in the research described in this thesis the participants used YouTube to watch TV shows and listen to music from their past. However, these applications would need modification in order to be used successfully by more impaired adults.

Other ways of using the system include for memory and organization, such as shopping lists and a calendar of events. With modification, the 'myapp' application could be used to store such information and the operating system supports the reminding of users at specified time. The portability of the system also meant that it could be carried more easily than a laptop or some other portable devices.

As such, there are many potential future routes that the research could take. Several areas for further work within the current research have also been identified, including a larger trial to see if the same reported increased levels of social contact are replicated in larger groups. Another area would be the development of an administrative system so that it can be managed by the staff of the care setting, such as inputting events and selecting books or media

for the week.

The learning curve of participants also presents a future challenge, in designing a system that can 'grow' as the participants do. Two of the four participants intend to buy a computer as a result of this trial, and it would be worthwhile aim to investigate whether a system could be developed that grows with them, removing or adding features as users become more familiar with them.

7.12 Conclusion

The primary contribution of this thesis has been to propose and provide a technology based system for use by older people in care settings to provide activity and engagement in their personal time that can also provide the basis for a group discussion through shared experience. It has been found to positively support activities by participants in an 8 week trial, and participants reported increased engagement and friendship with other participants as a result of using the system and taking part in the meetings.

It has also provided an approach based on a user sensitive inclusive design, using staff, expert and resident involvement, into designing such communications technology. The findings suggest that the use of touchscreen systems may be more suitable for less experienced computer users, potentially giving them the confidence to try to use a computer at a later stage.

Finally, it is hoped that the research presented here will encourage further research into designing such technology in care settings.

7.13 Contributions

This thesis has, using a user-sensitive inclusive design process, designed a communications system for older people in care settings that provided them with activities and also promoted increased engagement and interaction inside and outside the care centre. This addresses research question one.

Several features that may be useful for older people in care (revolving around personal activities/entertainment and communication) were identified and tested during a number of trials, that provided activities for those in care settings while also using these activities to increase levels of engagement and interaction. This addresses research question two.

Using a user-sensitive inclusive design process and involving the staff and residents from the earliest stages of the process possible, a process for designing communications technology in care settings has been identified, addressing research question three.

Finally, the use of touch-screen technology and light, portable hardware with a minimum of phyiscal buttons may be suitable for some older people resident in care settings. Relying on more mobile systems, like iPads, that have their own internet connections may be more appropriate for novice computer users. This addresses research question four.

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8 Appendices

Appendix A - Stakeholder Interviews

1. What type of resident is generally here? (mental/physical injury/disability etc.)
2. Is there a program of facilities scheduled for the residents into their day?
    a. Is there anything organised by the residents themselves?

"Group interventions providing social support"

3. What social interactions and activities are provided by the facility?
    a. Why do they do this?
    b. Why do the able not take part (if they don't)?
    c. What problems have you had getting residents to take part in activities?

"Need for Validated Measuring Tools"

4. Is there any monitoring of social isolation/loneliness within the care setting? How is this quantitatively measured and what scales are used?
    a. Have you had any instances of residents who were socially isolated
        i. What were the causes (in your opinion).
    b. Is there a procedure for dealing with this social isolation?

"Tele-Conferencing a cost-effective strategy"

5. Are there any methods (beyond physical visits) for residents to be in contact with other people both in and out of the hospital?
    a. Policy on mobile phones and technology in facility
    b. IT policy
    c. Attending Mass etc, is there a way of people listening from their bed or wherever they are located, if they cannot attend the church/chapel?
    d. Existing users – where do they get confused at the moment?

"Educational or Training Input"

6. Do you have computers for resident use? Are there technologies (computers etc) that are provided for use by the residents?
    a. Is there training provided?
    b. What are they allowed use?
    c. Is internet allowed? Restricted?
    d. Cleaning of these devices?

7. Have there been requests by the residents for any technologies or social activities?

Interventions should be "within existing service"

8. As part of discharge from the facility, is there any program/protocol for keeping in contact with people in hospital, or to reconnect with people outside – e.g. join a community group etc

9. Have there been any projects into social isolation/loneliness conducted previously? How did they fare?

10. Is there internet access for the residents? Is this broadband? Restrictions?

11. What is the worst thing that could happen wrt this project?

12. Is there anyone else on staff you feel we need to speak to?

13. How would you like to be involved in the rest of the project?

14. What are the demographics and skills of potential users? What sort of variation?

15. Differences in user roles and tasks? (e.g. different impairments requiring different input)

16. Existing users – where do they get confused at the moment?

17. Opinions from staff.

Appendix B – Resident Leaflet

My Research Project:

Introduction:

Hello! My name is Ronan McDonnell and I am a student in Trinity College Dublin.

The aim of my research is to look at how people communicate with each other. Specifically, I am looking at how people in Bloomfield communicate with each other and with people outside of Bloomfield (friends/family etc). I am also interested in seeing whether there is technology that could make communicating easier. But don't worry! You don't have to use computers or mobile phones, I just want to hear your opinion on them, and the more opinions I get, the better!

What does this involve?

If you are interested, I'm giving a talk in Bloomfield next Thursday 4th February at 3 O' Clock. I'd love for you to be there, but if you are interested but can't make it then I can meet you individually, just tell any of the staff and they'll pass on the message. At the talk, I will go into more detail as to what is involved, but essentially, there are 3 parts. The total time may last a number of months, but it won't be every day for that time, as you'll see below.

1. I will talk to you individually (and privately, everything I do will be confidential) about how you communicate, what a typical day for you is, your experiences with technology etc. I may also have a focus group (where a group of people discuss a set topic) about your experiences with technology or activities that you like etc.
2. From these meetings and focus groups, I will start designing some technology based on what you said. If you are interested, I would very much like your feedback on it, even if you have never used technology before, as I want to make it as easy to use as possible.
3. Finally, I will ask some of you to test my technology, to see is it easy to use, is it useful, and whether you like it or not! This may last a few weeks, but, like everything else in this study, is completely voluntary. You can withdraw at any time without a problem.

Thanks for reading this and looking forward to seeing you on the 4th!

Ronan

Appendix C - Resident Questions:

1. Background – where they came from, why etc.?
2. Daily Activities
    a. Briefly describe a typical day
    b. Set meal times?
    c. Visiting times?
    d. Leaving the home?
3. Social Activities
    a. What sort of social activities do you take part in here?
    b. What activities are available?
    c. How do you find out what's on?
    d. Are there any other activities that you would like?
    e. How does this compare to pre-care levels?
    f. What are the biggest problems in regard to the activities (finding out about them etc.)
    g. What are the best /worst things about the activities here?
4. Communicating with External People – Friends/Family
    a. How do you keep in touch with your family/friends here?
    b. What is the method by which you do this?
    c. Best and worst things about this?
    d. Have you done anything to work around the problems?
        i. If so, how and why?
    e. How does this compare to when you were at home?
    f. How frequently do you keep in touch?
    g. What would you expect it to be able to do?
    h. Would you like more contact? Would your family like it?
5. Computer Use:
    a. Do you use computers here?
    b. What do you use them for?
        i. What sort of applications do you use?
        ii. Awareness of software for communication?
        iii. Has there been any training?
            1. Would you be interested?
    c. What is the method by which you do this (own laptop, public pc etc)?
    d. Best and worst things about current way of using them?
    e. (If any problems) Have you done anything to work around the problems?
        i. How and why?
    f. How does this compare to when you were at home?
    g. What would you expect it to be able to do?

Appendix D – Consent Forms

SJH / AMNCH RESEARCH ETHICS COMMITTEE

Patient Information and Consent

1. **Title of study: Keeping Connected in Care – Development of technology to stimulate social interaction among older people in care facilities**

2. **Introduction:**
   The aim of this project is to develop communication technology for use by older people in residential care settings to increase their opportunities for social engagement and interaction. We are also interested in enabling new and useful ways for older adults to keep connected with their family and friends while not in their home.

   The study is being carried out as part of my PhD research in the Centre for Health Informatics, Trinity College Dublin. It is funded by IRCSET (Irish Research Council for Science, Engineering and Technology) and the TRIL (Technology Research for Independent Living) Centre, whose objective is "to assist older people to live longer from wherever they call home".

3. **Procedures:**

   Participants will be adults over 55 who are residents in a care facility.

   There will be several stages in the study. The entire process may last several months, and will be split into three parts that require your involvement:

   1. The functionality of the technology (what the technology will do) will be determined through meetings with you which may include a series of focus groups, workshops and interviews etc.
   2. Once stage one is completed, a prototype of the technology will be built, which will we bring to you for feedback and suggested improvements. This may be repeated several times.
   3. Once the technology is fully built, a 'pilot' will take place where you will use the technology for a number of weeks to measure how easy it is to use and whether it is enjoyable to use.

4. Benefits

Benefits will be dependent on the final technology that is developed, but may include increased communication abilities with relatives and/or the local community. There will also be increased knowledge of technology, most likely computers, as we will be asking you to use the technology for several weeks.

5. Risks: There are no financial or unusual health risk associated with participation in this study. Whatever technology is developed, it will be completely free to use.

Finally, it is important that you should note that this study is absolutely voluntary, and you may choose not to participate or end the discussion at any time. Furthermore, we must ask for your written consent before we can use any of the information you give us.

6 Confidentiality:

We will ask you to report your experience of using the technology. This will be done through semi-structured interviews. The interviews will be recorded, but you will NOT be identified by name.

Your identity will remain confidential. Your name will not be published and will not be disclosed to anyone outside the facility. Furthermore any data involving your use of the technology that is collected will be anonymous, with code numbers used instead of identifying details.

7. Compensation:
(Non-sponsored trial): Your doctors are covered by standard medical malpractice insurance. Nothing in this document restricts or curtails your rights.

8. Voluntary Participation: You have volunteered to participate in this study. You may quit at any time. If you decide not to participate, or if you quit, you will not be penalised and will not give up any benefits which you had before entering the study.

9. Stopping the study: You understand that your doctor or the study leaders may stop your participation in the study at any time without your consent.

10. Permission: This project has approval from the St. James' Hospital/ The Adelaide and Meath Hospital, Dublin Incorporating the National Children's Hospital Research Ethics Committee.

11. Further information: You can get more information or answers to your questions about the study, your participation in the study, and your rights, from Mr. Ronan McDonnell who can be telephoned at 0863998004 or 014428519. If your doctor learns of important new information that might affect your desire to remain in the study, he will tell you.

SJH / AMNCH RESEARCH ETHICS COMMITTEE.
CONSENT FORM

Title of research study:

This study and this consent form have been explained to me. My doctor has answered all my questions to my satisfaction. I believe I understand what will happen if I agree to be part of this study.
I have read, or had read to me, this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction. I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights. I have received a copy of this agreement and I understand that, if there is a sponsoring company, a signed copy will be sent to that sponsor.
Name of sponsor:

PARTICIPANT'S NAME:

PARTICIPANT'S SIGNATURE:

Date:
Date on which the participant was first furnished with this form:

Where the participant is incapable of comprehending the nature, significance and scope of the consent required, the form must be signed by a person competent to give consent to his or her participation in the research study (other than a person who applied to undertake or conduct the study). If the subject is a minor (under 18 years old) the signature of parent or guardian must be obtained:-

NAME OF CONSENTOR, PARENT or GUARDIAN:
SIGNATURE:
RELATION TO PARTICIPANT:

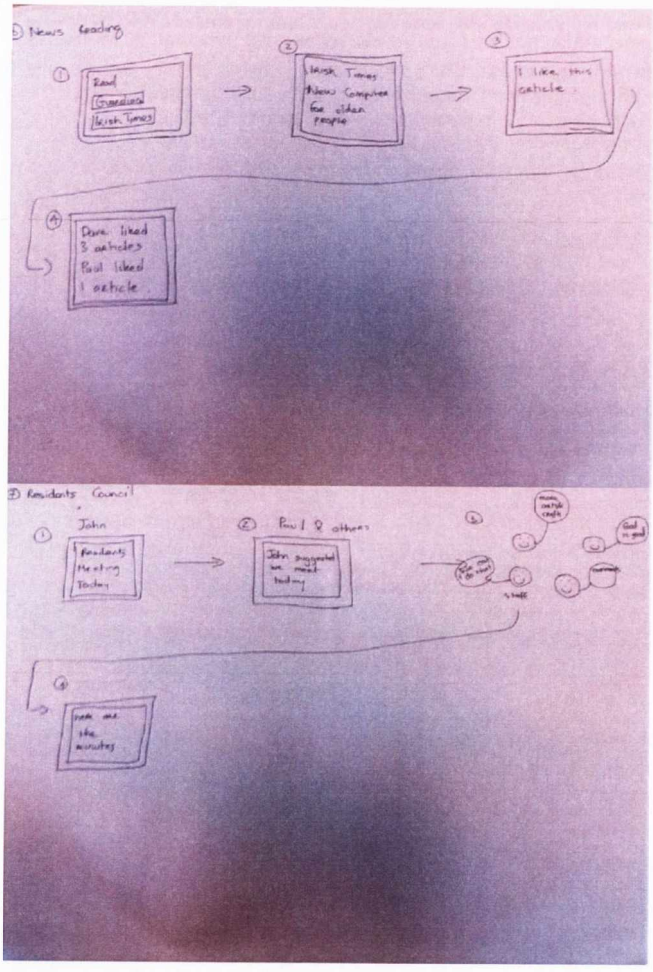
Where the participant is capable of comprehending the nature, significance and scope of the consent required, but is physically unable to sign written consent, signatures of two witnesses present when consent was given by the participant to a registered medical practitioner treating him or her for the illness.

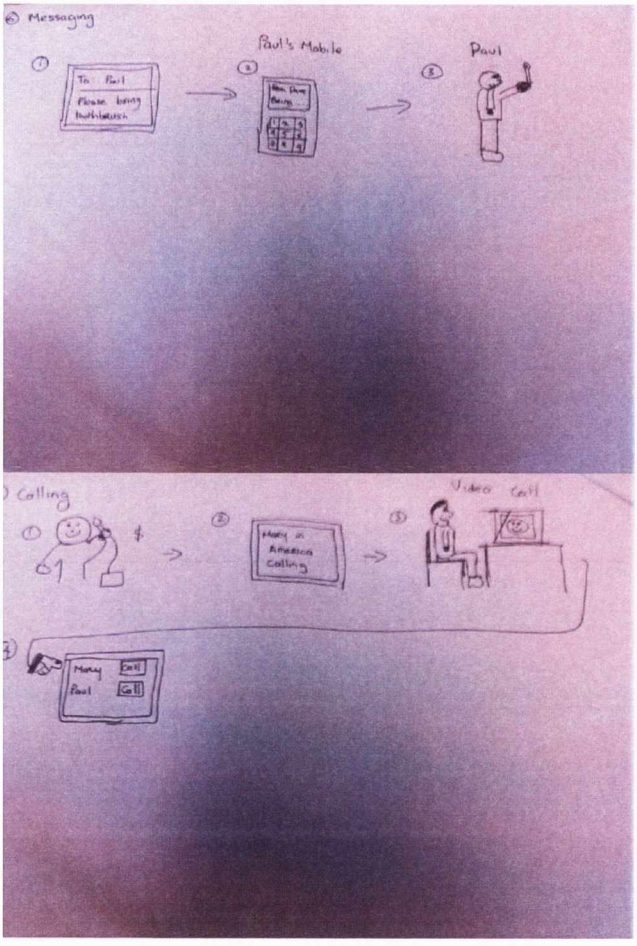
NAME OF FIRST WITNESS: SIGNATURE:
NAME OF SECOND WITNESS: SIGNATURE:

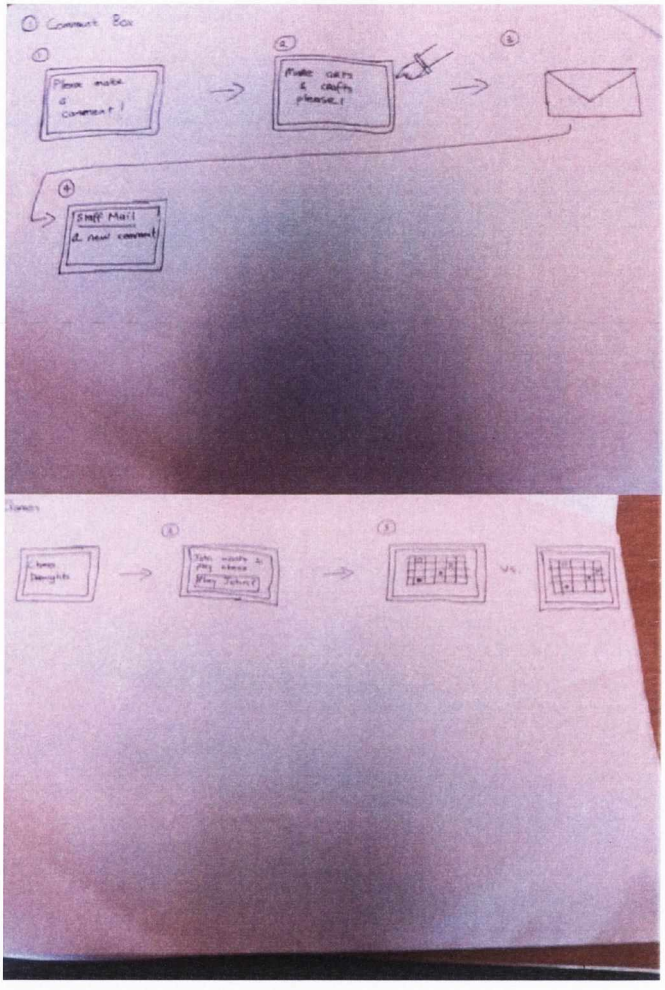
Statement of investigator's responsibility: I have explained the nature, purpose, procedures, benefits, risks of, or alternatives to, this research study. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

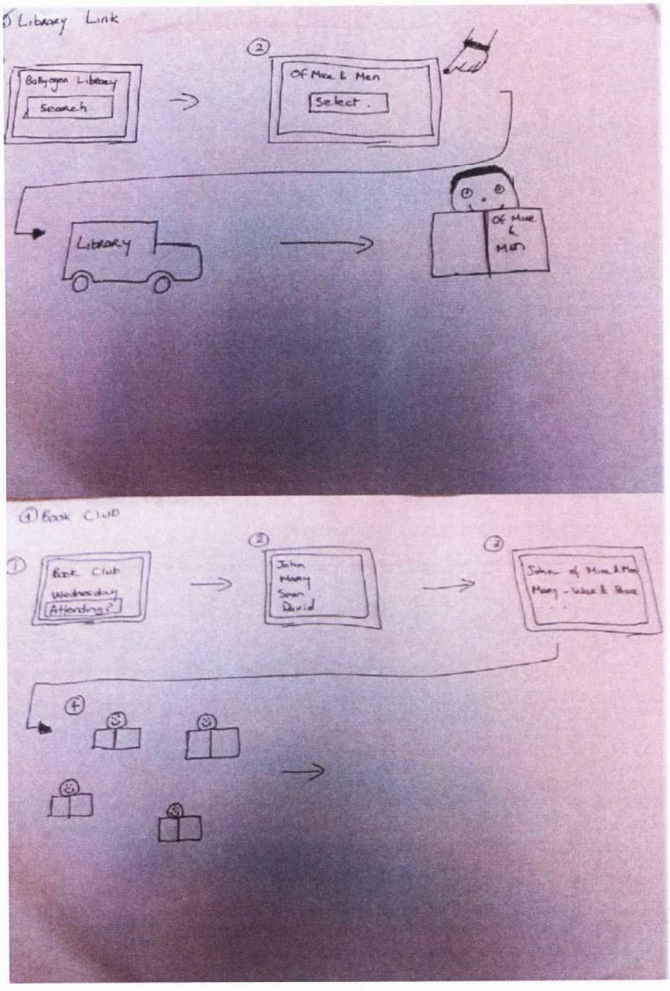
Physician's signature:
Date:
(Keep the original of this form in the participant's medical record, give one copy to the participant, keep one copy in the investigator's records, and send one copy to the sponsor (if there is a sponsor).

Appendix E – Storyboards




Messaging
Paul's Mobile
Paul
To Paul
Please bring toothbrush
Calling
Video Call
Mary is America Calling
Mary
Paul
Call
Call


Comment Box
Please make a comment!
Make cards & crafts please!
Staff Mail
A new comment
vs.


1 Library Link
Ballygan Library
Search
2
Of Mice & Men
Select.
Library
Of Mice & Men

1 Book Club
1
Book Club
Wednesday
Attending?
3
John
Mary
Sean
David
2
John of Mice & Men
Mary - Mice & Men
4

Appendix F – iPad User Guide

iPad User Guide:

An introduction into the basic features of the device and of the programs on it.

Table of Contents:

1. About the iPad

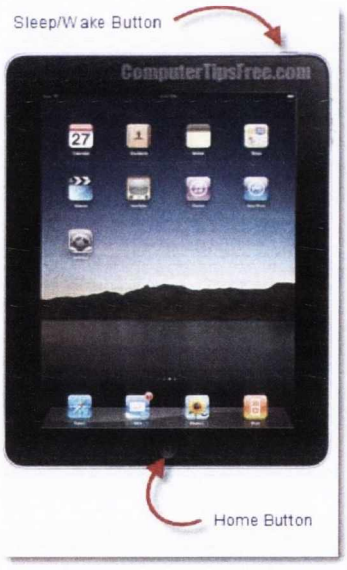
This is your iPad.

Buttons

A few simple buttons make it easy to turn iPad on and off and adjust the volume.

Sleep/Wake Button

You can lock iPad when you're not using it. When you lock iPad, nothing happens if you touch the screen, but you can still listen to music and use the volume buttons.



2. How to use it

If it is locked, you press the sleep/wake button as shown on the previous page. Then slide your finger to unlock as shown below (where the white arrow is pointing)

3. How to access books/movies/my program

First, make sure you have unlocked the iPad (see 'How to Use it' for instructions on this)

You will see a home screen like this.

Tap each picture to access it.

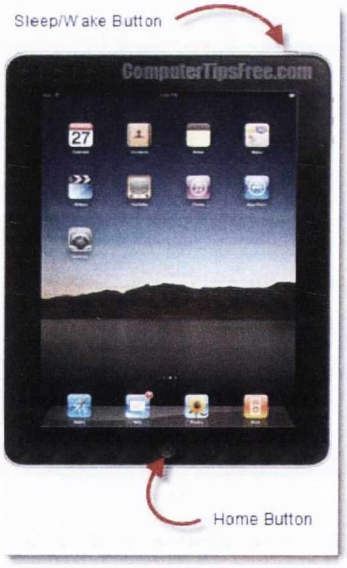
'My App' is my application with newspapers and messaging.

'Videos' is where all films are.

iBooks is the book application

4. How to exit and application and use another

If you are using an application, and wish to use another, simply press the home button as shown below, which will take you to the main screen, where you can select another application.



5. How to use my program

After accessing my program (see section 3)

-You will be greeted with the home screen

-There are 5 buttons

-The first describes the book club for the week, who is attending. You can say whether you are attending too.

-The second allows you to send and read messages.

-The third describes the events of the week.

-The fourth displays the latest newspaper headlines

-The fifth allows you to call someone

6. How to read books

Access the iBooks program

If the bookshelf appears, select the book you wish to read

If a book appears, continue reading or press 'library' in the top left of the screen to go back to the bookshelf

7. How to watch movies

Press the 'videos button

Tap the movie you want to watch.

8. Any problems?

Send me a message – go to messages -> write a message and press my name!

Call me on 0863998004

Call me using my program – press 'make a call'.

Appendix G – Exit Interviews for Residents

Exit Interviews

What I want to accomplish from this interview:

- Qualitative Data on what features were/weren't used and why
- Compare this data to the logs
- Find out how much face to face chat about the device took place (both through my meeting and in their own time)
- Find out what can/needs to be improved for trial
- Ask about added features
- Ask about the discussion group.

Also use: Arnie Lund Usability

Resident Questions:

1. Background – where they came from, why etc.?
2. Daily Activities
    a. Briefly describe a typical day
    b. Set meal times?
    c. Visiting times?
    d. Leaving the home?
3. Social Activities
    a. What sort of social activities do you take part in here?
    b. What activities are available?
    c. How do you find out what's on?
    d. Are there any other activities that you would like?
    e. How does this compare to pre-care levels?
    f. What are the biggest problems in regard to the activities (finding out about them etc.)
    g. What are the best /worst things about the activities here?
4. Communicating with External People – Friends/Family
    a. How do you keep in touch with your family/friends here?
    b. What is the method by which you do this?
    c. Best and worst things about this?
    d. Have you done anything to work around the problems?
        i. If so, how and why?
    e. How does this compare to when you were at home?
    f. How frequently do you keep in touch?
    g. What would you expect it to be able to do?
    h. Would you like more contact? Would your family like it?
5. Computer Use:
    a. Do you use computers here?
    b. What do you use them for?
        i. What sort of applications do you use?

ii. Awareness of software for communication?
iii. Has there been any training?
1. Would you be interested?

c. What is the method by which you do this (own laptop, public pc etc)?
d. Best and worst things about current way of using them?
e. (If any problems) Have you done anything to work around the problems?
i. How and why?
f. How does this compare to when you were at home?
g. What would you expect it to be able to do?

More think alouds

1. What were your initial expectations of using the device
   a. Have these changed after using it.
   b. In what way? Specific Examples
2. What feature did you use the most? Why?
3. What feature did you use the least? Why?
4. Is there anything you would like to see more of?
5. Is there anything you would like less of?
6. What did you like about the interface?
7. What did you not like about the interface?
8. What did you think about the meeting?
9. Go through each feature – what they liked and disliked?
10. Using to contact friends and family?
    a. What about those in other nursing homes
    b. Has this changed since you started
11. What times did you use the device?
12. When did you not use it?
13. Tell me about the weekly meetings, how did you find them
    a. Did you feel you had more contact?
    b. How could they be improved
    c.

Appendix H – Code Listings

activitylist.php

This connected to the MYSQL database and returned the list of activities happening that week for the care centre.

```
<?php
$hostname = '';

$username = '';

$password = '';

$dbConnection = mysql_connect($hostname,$username,$password)
or die ('Failed');

$dbname = 'mcdonnra_db';
mysql_select_db($dbname);
$result = mysql_query("SELECT * FROM activity");
$i = 0;
$outputArray = array();
if($result) {
    while($row = mysql_fetch_assoc($result)) {
        $where = $row['location'];
        $when = $row['time'];
        $title = $row['title'];
        $id = $row['id'];
        $description = $row['description'];

        $arr = array ('id'=>$id, 'title' =>$title ,
        'description' => $description, 'location'=>$where,
        'time'=>$when);
        //echo json_encode($arr);
        $outputArray[] = $arr;
        $i++;

        }
echo '{"activities":'.json_encode($outputArray).'}';

    }
?>
```

attendees.php

This connected to the MYSQL database and returned the names of all the people who were attending the book club that week.

```
$hostname = '';

$username = '';
```

```
$password = '';

$dbConnection = mysql_connect($hostname,$username,$password) or die
 ('Failed');
$userid = $_POST["userid"];
$bookclubid = '0';
$dbname = 'mcdonnra_db';
$output = array();
mysql_select_db($dbname);

$result = mysql_query("SELECT * FROM activity_attendees
WHERE activity_id = 0");
     while($row = mysql_fetch_assoc($result)) {
               $who = $row['user_id'];
               $arr = array ('id'=>$who);
               $output[] = $arr;
               }
echo '{"attendees":'.json_encode($output).'}';
?>
```

pushmail.php

This was an unused file in the final implementation but attempted to `push' (the system would not have to check for email, they would automatically be sent to the device) new email to each device. Although the code worked, it could not be used as the connection ports required for this service were not open on the university servers.

```
$apns = stream_socket_client('ssl://' . $apnsHost . ':' .
$apnsPort, $error, $errorString, 2,
STREAM_CLIENT_CONNECT, $streamContext);
$apnsMessage = chr(0) . chr(0) . chr(32) .
pack('H*', str_replace(' ', '', $deviceToken)) . chr(0)
 . chr(strlen($payload)) . $payload;
fwrite($apns, $apnsMessage);
socket_close($apns);
fclose($apns);
?>
```

user.php

This connected to the MYSQL database and returned the information about the user to the application so as to get information such as contacts. Later, this was replaced by keeping these settings on each device.

```
<?php
$hostname = "";

$username = '';
```

```
$password = '';

$dbConnection = mysql_connect($hostname,$username,$password)
 or die ('Failed');
$userid = $_GET["userid"];
$bookclubid = '0';
$dbname = 'mcdonnra_db';
$output = array();
mysql_select_db($dbname);

$result = mysql_query("SELECT * FROM users
WHERE id = '$userid'");
      while($row = mysql_fetch_assoc($result)) {
            $name = $row['name'];
            $email = $row['email'];
            $number = $row['skypenumber'];
            $arr = array ('name'=>$name, 'email' =>$email,
            'skypenumber'=>$number);
            $output[] = $arr;
                                                }
echo '{"user":'.json_encode($output).'}';
?>
```

bookclub.php

This connected to the MYSQL database and returned information about the book club happening that week.

```
<?php
$hostname = '';

$username = '';

$password = '';

$dbConnection = mysql_connect($hostname,$username,$password)
or die ('Failed');

$dbname = 'mcdonnra_db';
mysql_select_db($dbname);
$result = mysql_query("SELECT * FROM bookclub");
$row = mysql_fetch_array($result);
$where = $row['location'];
$when = $row['time'];
$title = $row['title'];
$id = $row['id'];
$description = $row['description'];
$arr = array ('id'=>$id, 'title' =>$title ,
'description' => $description,
'location'=>$where,'time'=>$when);
```

```
echo '{"books":'.json_encode($arr).'}';
?>
```

sendmail.php

This sent mail to specified email addresses that participants selected. It was the backbone of the messaging system.

```
<?php

$host = "imap.gmail.com:993/imap/ssl";
$user = $_GET['user'];
$password = "";
$mailbox = "{imap.gmail.com:993/imap/ssl}INBOX";
$mbx = imap_open($mailbox , $user , $password);
$receiver=$_GET['receiver'];

//$receiver = '';
$message=$_GET['message'];
echo $message;
$subject = $_GET['subject'];
$sender="From: ".$_GET['user'];
$tempmessage = urldecode($message);

echo $message;
$send = imap_mail ($receiver, $subject ,$tempmessage, $sender );
echo $tempmessage;
?>
```

contacts.php

This connected to the MYSQL database and returned the list of contacts for an individual, to populate their address book.

```
<?php
$hostname = '';

$username = '';

$password = '';

$dbConnection = mysql_connect($hostname,$username,$password)
or die ('Failed');
$user = $_GET["user"];
$dbname = 'mcdonnra_db';
mysql_select_db($dbname);
//select all contacts for that one person or common
contacts (with userid 0)
$result = mysql_query("SELECT * FROM contacts
WHERE userid=$user
OR userid='0'");
```

```
$i = 0;
$outputArray = array();
if($result) {
    while($row = mysql_fetch_assoc($result)) {
        $email = $row['email'];
        $number = $row['number'];
        $name = $row['name'];
        $arr = array ('name'=>$name, 'email' =>$email,
         'number' => $number);
        $outputArray[] = $arr;
        $i++;
        }
echo '{"contacts":'.json_encode($outputArray).'}';
}
?>
```

attendbookclub.php

This connected to the MYSQL database and updated it with the name of the person and whether they were or were not attending the book club to be held that week.

```
<?php
$hostname ='';

$username = '';

$password = '';

$dbConnection = mysql_connect($hostname,$username,$password)
or die ('Failed');
$userid = $_GET["userid"];
$answer = $_GET["answer"];
$bookclubid = '0';
$dbname = 'mcdonnra_db';

mysql_select_db($dbname);
if($answer = "Yes"){
$result = mysql_query("INSERT IGNORE INTO `mcdonnra_db`.
`activity_attendees` (`activity_id` ,`user_id` )
VALUES ('0' ,  '$userid')");
echo "hello";
}
else if($answer = "No")
{
$result = mysql_query("DELETE FROM `mcdonnra_db
`.`activity_attendees'
WHERE user_id = '$userid'");
}
?>
```

test.php

This checked for emails on the gmail server, checked through each one, parsed them and returned them in a list for display and use on the device.

```
<?php
$hostname = '{imap.gmail.com:993/imap/ssl}Inbox';

$output = '';

$username = $_GET['user'];

$password = '';

$inbox = imap_open($hostname,$username,$password) or die
('Cannot connect to Gmail: ' . imap_last_error());
$search = $_GET['search'];
/* grab emails */

$emails = imap_search($inbox,$search);
/* if emails are returned, cycle through each... */
if($emails) {

 /* put the newest emails on top */
 rsort($emails);
 /* for every email... */
 $outputArray = array();
 foreach($emails as $email_number) {
  /* get information specific to this email */

  $overview = imap_fetch_overview($inbox,$email_number,0);

  $message = imap_fetchbody($inbox,$email_number,1);


    $mailHeader = imap_headerinfo($inbox,$email_number);
    $from = $mailHeader->fromaddress;
    $pattern = '';

 preg_match ($pattern, $from, $matches);
 // echo "We extracted " . $matches[0] . " from $from";
  //echo $from;
 // echo $matches[0];
   /* output the email header information */
   $arr = array ('from'=>$matches[0],'message'=>$message);
   //echo json_encode($arr);
       $outputArray[] = $arr;

 }
echo '{"mail":'.json_encode($outputArray).'}';
```

```
// echo $output;

}
/* close the connection */
imap_close($inbox);
?>
```

iPad Code:

Code to connect to PHP server with Book Club Information

```
- (void)viewDidLoad {
        //sw.transform = CGAffineTransformMakeScale(2, .5);
  [super viewDidLoad];
        [[self navigationController] setNavigationBarHidden:YES];
        NSError *error = nil;
        NSData *jsonData;
        NSDictionary *dict;
        //get the book deatils from the server
        NSString *urlstr = [[NSString alloc] initWithFormat:@""];
        NSURL *url = [[NSURL alloc] initWithString:urlstr];
        NSString *ans = [NSString stringWithContentsOfURL:url encoding
        :NSASCIIStringEncodingerror:&error];
        if(ans !=nil){

                jsonData = [ans dataUsingEncoding
                :NSUTF32BigEndianStringEncoding];
                dict = [[CJSONDeserializer deserializer]
                deserializeAsDictionary:jsonData error
                :&error];
                if (dict)
                {
                        bookClubDetails = [dict objectForKey:@"books"];
                        [bookClubDetails retain];
                }
        }
        //get the attendee deatils from the server
        urlstr = [[NSString alloc] initWithFormat:@""];
        url = [[NSURL alloc] initWithString:urlstr];
        ans = [NSString stringWithContentsOfURL
        :url encoding:NSASCIIStringEncoding error
        :&error];
        jsonData = [ans dataUsingEncoding:
        NSUTF32BigEndianStringEncoding];
        if(ans !=nil){
                dict = [[CJSONDeserializer deserializer]
                deserializeAsDictionary:jsonData error
```

```
:&error];
        if (dict)
        {
                attendeeDetails = [dict objectForKey
                :@"attendees"];
                [attendeeDetails retain];
        }
//create the labels
NSMutableString* bookClubLabelText =
[[NSMutableString alloc] initWithString
:@"Where: "];
NSMutableString* whenLabelText =
[[NSMutableString alloc] initWithString
:@"When: "];
NSMutableString* attendeesLabelText =
[[NSMutableString alloc] initWithString
:@"Attendees: "];
//access the book details from the dictionary
NSString* location = [bookClubDetails objectForKey:@"location"];
NSString* time = [bookClubDetails objectForKey:@"time"];
NSString* attendeekey = @"id";
NSString* attendees;
NSInteger i = 1;
for (NSDictionary* attendeeID in attendeeDetails)
        {
                attendees = [attendeeID objectForKey:attendeekey];
                if(i < [attendeeDetails count])
                {//NSString * bob = 0;
        NSInteger tempInt = (NSString*)[attendees integerValue];
        NSString* temp = [usernames objectAtIndex:tempInt];
        [attendeesLabelText appendString:
        /*[usernames objectAtIndex:tempInt]*/temp];
        if(i < [attendeeDetails count] - 1)
        {
                [attendeesLabelText appendString:@", "];
        }
        i++;

        }
else
{
[attendeesLabelText appendString:@" and "];
[attendeesLabelText appendString:
[usernames objectAtIndex:[attendees intValue]]];
[attendeesLabelText appendString:@" are attending"];
}
}

        //NSString* attendees = [attendeeDetails objectForKey:@"id"];
```

```
        //update the labels with the book club info and display them
        // on screens
        [bookClubLabelText appendString:location];
        [whenLabelText appendString:time];
        //[attendeesLabelText appendString:attendees];
        locationLabel.text = bookClubLabelText;
        timeLabel.text = whenLabelText;
        AttendeesLabel.text = attendeesLabelText;
        }
        else {
                locationLabel.text = @"Unknown";
                timeLabel.text = @"Unknown";
                AttendeesLabel.text = @"Unknown";
        }

}
```

Code to send a message

```
-(IBAction) sendButtonPressed:(UIButton*)sender
{
        NSDateFormatter *formatter;
        formatter = [[NSDateFormatter alloc]init];
        [formatter setDateFormat:@"dd-MM-yyyy HH:mm:ss"];
        NSString* date = [formatter stringFromDate:[NSDate date]];
        int senderNumber = [[NSUserDefaults standardUserDefaults]
         stringForKey
        :@"name_preference"];
        [self logdata:date:0:@"Write Mail Screen":@"Send Navigation
        Button Pressed"];
        int replyNumber = 0;
        if (message != NULL) {
                replyNumber = 1;
        }
        NSError *error = nil;
        //NSString* user = userid;
        //assign the userID global variable here
        //append the userID for inserting into the DB
        NSString* emailText = [receiverEmail
        stringByAddingPercentEscapesUsingEncoding
        :NSUTF8StringEncoding];
        NSString* messageText = [mailText.text
        stringByAddingPercentEscapesUsingEncoding
        :NSUTF8StringEncoding];
        NSString *urlstr = [[NSString alloc] initWithFormat:@"
        ?user=\%@\&message=\%@\&subject=Message
        \&receiver=\%@",[[NSUserDefaults
         standardUserDefaults]
         stringForKey:@"email_preference"], messageText, emailText];
```

```
        NSURL* url = [[NSURL alloc] initWithString:urlstr];
        //this is the line that inserts into the database
        NSString *ans = [NSString stringWithContentsOfURL:
        url encoding:NSASCIIStringEncoding
         error:&error];
        [self messagedata:date :senderNumber :emailText
        :messageText :replyNumber ];
        sentMessage *sm = [[sentMessage alloc]init];
        [self.navigationController pushViewController:sm animated:YES];
}
}
```

Code to get the newspaper feed using Touch XML

```
- (void) getFeed:(NSString*)feedAddress{
        paperArticles = [[NSMutableArray alloc]init];
        NSURL *url = [NSURL URLWithString: feedAddress];
        NSUInteger articleCount = 0;
        //create a CXML object, a class that reads XML documents.
        //supplying it with url as the xml document.
        CXMLDocument *rssParser = [[[CXMLDocument alloc]
        initWithContentsOfURL:url
         options:0 error:nil] autorelease];

        NSArray *resultNodes = NULL;
        NSArray *resultText = NULL;
        NSMutableArray *description = [[NSMutableArray alloc]init];

        // Set the resultNodes Array to contain an object for every
         instance of a node in
        //our RSS feed
  resultNodes = [rssParser nodesForXPath:@"//item/title" error:nil];
        resultText = [rssParser nodesForXPath:@"//item/description"
         error:nil];
  // Loop through the resultNodes to access each items actual data
  for (CXMLElement *resultElement in resultNodes) {
    // Create a counter
    int counter;
    // Loop through the children of the current  node
    for(counter = 0; counter < [resultElement childCount];
    counter++) {
                        Article* article = [[Article alloc]init];
      // Add the article title in.
                        article.title = [[resultElement
                        childAtIndex:counter] stringValue];
                        //add dummy value here so no crash :-)
                        article.text = @" ";
                        [description addObject:article];
                        [article release];
                }
```

```
        }

                for (CXMLElement *resultElement in resultText){
                        int counter;


                        for(counter = 0; counter < [resultElement
                        childCount]; counter++) {
                                //get the (currently) title only
                                 article from the list
                                Article* article =
                                [[Article alloc]init];
                                article = [description
                                objectAtIndex:articleCount];
                                // get the description of
                                //each article and add it in order
                                 //to the list
                                // of articles
                                article.text = [[resultElement
                                 childAtIndex:counter] stringValue];
                                [paperArticles addObject:article];

                        }
                        articleCount = articleCount + 1;
                }
}
```

Code to get calendar details from server

```
- (void)viewDidLoad {
  [super viewDidLoad];
        NSError *error = nil;
        events = [[NSMutableArray alloc]init];
        [[self navigationController] setNavigationBarHidden:YES];
        NSString *urlstr = [[NSString alloc] initWithFormat:
        @"http://www.cs.tcd.ie
        /~mcdonnra/activitylist.php"];
        NSURL *url = [[NSURL alloc] initWithString:urlstr];
        NSString *ans = [NSString stringWithContentsOfURL:url encoding:
        NSASCIIStringEncoding error:&error];
        if(ans !=nil){
        NSData *jsonData = [ans dataUsingEncoding
        :NSUTF32BigEndianStringEncoding];
        NSDictionary* dict = [[CJSONDeserializer deserializer]
        deserializeAsDictionary
        :jsonData error:&error];
        if (dict)
        {
                //assign the sql data to the events array
```

```
            events = [dict objectForKey:@"activities"];
            [events retain];

        }

        }
}
```

Code to call a person when name is pressed - it launches Skype

```
- (void)tableView:(UITableView *)tableView
didSelectRowAtIndexPath:(NSIndexPath *
)indexPath
{

        //get the corresponding index of the contact pressed
        int contactIndex = [indexPath indexAtPosition: [indexPath length]
        -1];
        //attach the email to the next view controller
        NSString* test =[[contacts objectAtIndex: contactIndex]
        objectForKey: @"number"];
        NSString* skype = @"skype:";
        NSString* call = @"?call";
        NSString* number = [NSString stringWithFormat:
        @"\%@\%@\%@",skype,test,call];
        //attach the email to the next view controller
        //get the date and log the press
        NSDateFormatter *formatter;
        formatter = [[NSDateFormatter alloc]init];
        [formatter setDateFormat:@"dd-MM-yyyy HH:mm:ss"];
        NSString* date = [formatter stringFromDate:[NSDate date]];
        NSString* callerDetails = [NSString stringWithFormat:
        @"\%s\%@","Calling ",test];
        [self logdata:date:0:@"Choose Call Receiver Screen":
        callerDetails];
        NSURL *skypeURL = [NSURL URLWithString:number];
        [[UIApplication sharedApplication]openURL:skypeURL];
}
```